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International Marine Engineering

JANUARY, 1911.

A 22,000-TON FLOATING DRY DOCK FOR BRAZIL.

The Brazilian Government has recently received delivery at Rio de Janerio of the new 22,000-ton floating dock built by Messrs. Vickers, Sons & Maxim, Limited, of Barrow-in-Furness. This dock is intended for accomodating the *Minas Geraes* and *Sao Paulo*, the two super-Dreadnoughts lately built for Brazil by Sir W. G. Armstrong, Whitworth & Co., Limited, of Elswick-on-Tyne, and Messrs. Vickers, Sons & Maxim, Limited, of Barrow-in-Furness, and it will be moored in the entrance channel between Governador Island and Boqueira Island, the Brazilian naval store yard at Rio de Janiero.

The dock is of the double-sided, self-docking type known as the bolted-sectional type, and has been built from designs prepared by Messrs. Clark & Standfield, consulting engineers, of Westminster, London. It consists of a pontoon, or lifting portion, and two parallel side walls, built on to, and forming part of, the same, and the whole is divided lengthwise into three sections of unequal length by vertical joints running round the whole profile of the dock. The following is a table of some of the leading dimensions:

	Ft.	Ins.
Over-all length of dock over 25-foot platform	550	6
Over-all length of dock over pontoons	500	6½
Over-all length of central section	165	3
Over-all length of each end section	167	7¾
Over-all width of dock	136	0¾
Over-all depth of pontoon at center	18	3¾
Over-all depth of pontoon at foot of walls	17	9¾
Over-all length of side walls, including docking lands	450	6
Over-all height of side walls above pontoon deck	45	6
Over-all height of side walls and pontoon	63	3¾
Over-all width of side walls at base	18	0¾
Over-all width of side walls at top	12	6½
Clear width	100	
Maximum draft of vessel	30	
Height of keel blocks	4	
Depth of water required to dock vessel of 30-foot draft, including 6 inches for troughs and 5-inch clearance	53	3
Freeboard of side walls	10	6

A 22,000-TON FLOATING DRY DOCK BUILT IN ENGLAND AND TOWED TO BRAZIL.

The pontoon consists of a rectangular structure plated in all round, with the exception of the portion of the deck which comes directly under the walls, and stiffened internally by longitudinal and transverse girders. It is divided into three sections by two joint chambers. The middle section is 165 feet 3 inches long, and rectangular in plan, and the two end sections are each 167 feet 7¾ inches long, and have their outer extremities built in the form of a point or bow, terminating in

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a working platform, carried on strong plate and braced girders.

The general construction of all three sections is, however, the same. The bottom plating runs transversely in the home and rider strakes, and is lap-jointed. The top or deck plating is similar, but here there are end butt joints with inside covers. The sides of the pontoons are formed by the back plating of the walls. The pontoon is divided into six compartments by five longitudinal watertight plate bulkheads, occurring one at the center or keel line, and the others (called the inner, intermediate, and outer intermediate bulkheads) on each side of the center. These bulkheads are of varying heights to suit the camber of the deck of the pontoon. The deck of the pontoon is built with a camber. The central portion under the keel blocks is flat for a width of 10 feet thus affording a parallel base for the keel blocks. Outside, the plating cambers off until at its junction with the wall it is 6 inches lower than at the center. Transversely the pontoons are divided (in addition to the joint chambers) into fifty bays, sixteen in the central section and seventeen in each end section, by transverse girders. The end bay in the points is 5 feet long, but all the others are 10 feet long. The walls of the dock are rectangular structures in plan, but they have a batter to the face or inside. They are in two tiers or stores, and are situated on the top of the pontoons, of which they form a continuation.

At a distance of 20 feet below the top deck is the engine-deck, which is continuous over the whole length of the side walls. On this deck are placed the boilers, engines, dynamos, and machinery, the various rooms containing these being divided off by partition bulkheads. Above the same deck the necessary accommodation for the crew of the ship is provided. The engine-deck, which is longitudinally plated and single riveted throughout, is attached to the side plating by an angle ring, and is watertight over its whole length. Each wall is divided, in addition to the joint chambers, into twelve watertight divisions by plate bulkheads coming in line with the bulkheads in the pontoon, of which they are a continuation. These extend to the height of the engine deck, and are plated transversely, and single riveted throughout. In each end section of the dock the engine-deck is divided off by watertight collision bulkhead, being a continuation of the first watertight bulkhead in the side wall. The engine-deck of the end sections is further divided by three non-watertight partition bulkheads, a doorway being provided to give access from one room to another. The upper portion of one of these bulkheads is made watertight to form an end to the water tank. Each wall of the central section is divided by similar partition bulkheads. The joint bulkheads of all sections are made watertight, and provided with a watertight door at the engine-deck level to give access from one section to another.

About 1 foot below the top deck an iron running deck extends from ladder to ladder, as shown on the general view of the dock, consisting of chequered plate and an edging angle, and carrying on its outer edge a rubbing timber supported by brackets projecting from the face plating of the wall. These brackets occur in way of every other side frame. At a distance of about 8 feet 6 inches and 19 feet, respectively, below this, two further stages, known respectively as painting and shoring stages, are provided. They are of similar construction to the running deck. The running deck is provided for enabling ropes to be easily handled and run from one end of the dock to the other outside the stanchions. On it are placed the timber heads, fairleads to capstans, and such fittings as are required in berthing the vessel.

The berthing stage is chiefly fitted for slinging stages from it to the vessel for the purpose of painting, and to a moderate extent it might be used as a shoring stage. The shoring stage, which occurs at the level of the engine deck, is specially stiffened and built for the purpose of shoring up the sides of the vessel by means of horizontal shores, a timber walling being provided along the face of the wall, against which the heel of the shores may be wedged up.

In close proximity to each boiler a coal bunker is fitted into the engine room, and a fresh water tank, of a capacity of about ten tons, is likewise provided in the wall close up to each boiler. The space in the upper chambers of the side wall above the engine deck, which is not utilized for the main or auxiliary machinery of the dock, has been fitted up for the accommodation of a crew of 600 men and 70 officers, as far as regards their sanitary requirements and the cooking of their necessary food.

Both ends of the central section and the square ends of the terminal sections are provided with a joint chamber and joint, by means of which the sections can be joined together or parted. The length of the joint chamber is 5 feet 3 inches center to center of the joint bulkhead plate. This length is equally divided over the two sections. These sections are stiffened, top and bottom, by means of lugs and gussets falling in line with the frames on the joint bulkhead, and by a continuation of the longitudinal bulkheads. The actual joint across the bottom and up the sides is by means of angles, riveted to the bottom and side plating by a zig-zag pitch of rivets. Over this portion the plating is doubled, the doubling plate being flush with the joint angle, and extending back as far as the first rider plate, but the plating itself on the central section is ¾ inches short of this, to form a recess into which a rubber or other compressible ring may be inserted, and which, when pressed against the flat face of the half of the joint chamber, makes a watertight joint. The joint angle is pierced by holes to take the joint bolts which connect the two sections together. The joint above the angle across the pontoon deck, and up the sides of the wall to the level of the top strake of the side plating, is formed by a single cover-plate, bolted or riveted to the skin plating, watertightness being obtained by means of a canvas or felt strip. The joint over the top strake of plates is similar, but it has double covers. Across the top deck the deck plate is doubled, and the joint made with double covers. In way of the intermediate and longitudinal bulkheads of the pontoon a further connection is made by prolonging those bulkheads into the joint chamber, the two being joined by a single cover plate.

The hull of the dock has been constructed throughout of mild Siemens-Martin steel of the quality used in shipbuilding under Lloyd's rules, and all the plates were punched in a multiple punching machine, whereby the absolute accuracy and correct distance of every hole, lengthways and crossways, was assured, the design of the dock having been so arranged that all lengths and breadths of plates, positions of butts, frames, and bulkhead rings were multiples of the unit rivet pitch of the dock. All countersunk holes were countersunk to at least three quarters of the thickness of the plate. The rivets throughout the dock consist of ⅞-inch steel rivets, except where the scantlings are under 7/16 inch, in which case ¾-inch rivets have been used. The riveting of the whole of the outside of the pontoon is flush countersunk, the remainder of the work being riveted according to Vickers' general practice, and where non-countersunk work was used the points were carefully set up so as invariably to leave a sufficient quantity of metal outside the hole. The pitch of the rivets on all watertight seams has not exceeded 3 inches, and that on non-watertight seams and frames 6 inch. On the flange of the joint angles attached to the plating where zig-zag riveting was specified the pitch of the rivets was 4½ inches.

The machinery of the dock comprises the boilers, engines, pumping plant, valves, and the valve lifting gear, and everything necessary for the sinking and raising of the dock. There are two identical installations, one situated in the port and the other in the starboard wall. This machinery is capable, when

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combined, of lifting a vessel drawing 28 feet, and of a displacement not exceeding 22,000 tons, within a period of four hours, counting from the mean of the times when the ship bears on the keelblocks fore and aft, until the pontoon deck at the center of keel line is 7 inches out of the water, due allowance being made for any total stoppage of the machinery for berthing the vessel or other purposes. The plant in each wall consists of three boilers and three engines and pumps—one in each section—sucking from a continuous main drain extending the whole length of the wall. Any one of the three pumps can therefore empty its entire half of the dock.

Each installation consists of three Babcock & Wilcox portable type boilers, each of 909 square feet heating surface and of 150 pounds steam pressure. One spare boiler is provided, making, therefore, seven for the whole dock. The boilers were manufactured at Vickers, Sons & Maxim's Works at Barrow. A feed pump, with connecting piping, is supplied with each boiler and suction piping, leading to the reserve water tank. A branch is provided on the discharge for attaching a hose for washing-down purposes. A 3-inch steel steam pipe extends the full length of each wall with connections, fitted with stop valves to each separate boiler. This steam piping serves all the auxiliary engines, such as capstans, etc., thus allowing any one boiler to be used for this purpose.

The centrifugal pumps are of the "Invincible" type, as manufactured by Gwynnes, Ltd. The suction and delivery pipes are 18 inches diameter. They are each driven directly by a compound non-condensing engine, with cylinders 11 inches and 17 inches by 10 inches, placed at right angles to each other, the engine being placed on its side, and driving direct on to the end of a long vertical shaft, which descends to the pumps at the bottom of the dock. The engines are carried on strong bed-plates, secured to the deck of the engine room, and arrangements have been made to reduce vibration to a minimum, and the interior of the walls in way of the engines has been suitably stiffened. A sensitive high-speed governor controlling the throttle valve is fitted to each engine, and arrangements are made to enable them to be turned by hand. The barring gear is of the self-liberating type. The screw-down regulating valves, opening against the steam pressure, which are fitted to each engine close to the slide valve casing, are worked from the starting position with worm or other suitable gear, so as to prevent jar of the valve and gear when the engines are at work. While the engine cranks are directly attached to the top of the vertical pump shafts, this attachment is not rigid, but allows slight vertical movement, so that the weight of the pump shaft is entirely supported on its own thrust bearings, and does not hang on the engine crankshaft.

Each vertical shaft is supported at intervals in gunmetal-lined plummer blocks attached to the internal framing of the dock. On the upper extremity of these shafts is cottered the upper portion of the ball bearing which carries the weight of the vertical shaft and pump disc. The lower portion of the ball bearing is carried in a casting bolted to the engine deck. The upper portion of the ball bearing is made with a lip to come over the lower portion and prevent dust getting into the races. A watertight gland, which has an extra long sleeve, so as to form a side guide to the shaft, is fitted to the vertical shafts where they pass through the engine deck.

The pumps are seated directly on the top of the main drain running along the bottom of the walls. They take their water entirely from the under side—which is clear of all foot bearings—and discharge it direct at their own level through the skin plating of the wall. Their bodies are of cast iron, carefully finished and specially designed so as to be easily taken apart for the purpose of inspecting or removing the impellers. The bottom of the pump and of the flange of

THE BRAZILIAN DRY DOCK EN ROUTE FOR RIO DE JANEIRO.

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the discharge are faced. The impellers are of gunmetal, and they are firmly keyed and pinnned to the spindle, which is of steel. An extra long stuffing box or guide is provided on the top of the pump to ensure steady running, and the end of the spindle terminates in a forged coupling with turned face and socketed for attaching by means of turned bolts to the terminal coupling of the vertical shafts. The pump discharges are in cast iron, with flanges faced and bolted, one end to the discharge valve and one to the skin plating of the dock. The sea end has a projecting lip passing through the plating and fitting into the hole cut therein.

Each discharge is governed by a screw-down sluice valve, placed between the pump delivery flange and the discharge pipe. The body and sluices or gates are in cast iron, and bushed with gunmetal to all moving parts. The lifting screw of the valve is an inside one. The valve spindle is coupled by a deep socket and double-pinned to a solid shaft, which is led up to the top deck, and there furnished with a removable hand wheel. Where the valve rod passes the engine and top decks it is furnished with cast iron stuffing box bushed with gunmetal and a gunmetal gland. A standard is erected on the top deck to steady the rod when being turned, and there is an indicator to show the position of the valve.

The pump discharges are protected by an automatic rubber-faced flap valve making itself tight against the projecting lip of the discharge pipe. The base or seatings of the pumps are bolted directly on to a main drain running the whole length of the walls, and they have been placed as low down as possible, being seated directly on the top of the floors. They are of cast iron of varying diameters, in suitable lengths, with expansion joints and with connection piece between the different sections of the dock.

There are two systems of continuous main drain, one in each wall of the dock. On each system of main drain six flushing inlets—making twelve for the whole dock—branch out of the same. They are in the form of easy bends, standing on top of and bolted to flanges cast on the main drains. These bends are at right angles to the line of the drain and carry a screw-down gunmetal faced valve, similar in every respect to the discharge valves, and the spindles likewise are led up to the top deck. The flushing valves are bolted by flanges to a short length of cast iron pipe passing through the back plating of the wall with a projecting lip, as in the case of the pump discharges. The flushing branch through the back plating is further governed by a flap valve making itself tight against the projecting lip of the discharge pipe. This flap is provided with a lever on its face, so that it can be opened and held open by means of rods and chains running over pulleys attached to a small hand winch with pawl. Each of these flushing inlets is protected by means of a grid, which is of such dimensions as not seriously to obstruct the free flow of water into the flusher.

The branches to which the distributing pipes leading to the different watertight compartments of the dock are bolted are cast on the main drain. Each branch leaves the main drain either in the form of a bend of easy radius or with a well-formed cone. They are provided with a faced and drilled flange at the outer end to receive the distributing valve. The distributing valve attached to each of these flanges is of the direct-lifting type, with double gunmetal ports, held apart by springs and fastened to a gunmetal spindle by a pin of the same material. The body of the valve is of cast iron, gunmetal bushed on the contact surfaces and with gunmetal glands. The valve rods are of galvanized iron pipe, screwed on by means of a socket to the valve spindle and pinned to the same. They are led up through the engine-deck, being fitted with a gunmetal-bushed, watertight gland where passing through this deck. On the other side of the distributing valves, and bolted to them with wrought iron flanges, are the distributing pipes leading to their respective chambers. The ends of these pipes are turned down in their respective troughs. Each separate watertight compartment is fitted with a galvanized wrought iron air pipe led up above the deepest draft line of the dock.

At each corner of the dock, gage or draft boards of timber, painted in figures to show the draft over the keel blocks, are affixed. These are carried on hinges so that they may be swung back out of danger when a ship is entering the dock.

In each section of the dock and on each wall a vertical duplex pump of Hayward-Tyler & Company's manufacture is placed in the engine-room, taking its steam from the line of the auxiliary steam piping. The steam portion of the pump is in the engine room, but the pump barrel is placed in the interior of the dock about the level of the pontoon deck, the piston rods from the cylinders passing stuffing glands on the dock and connecting to the pump plungers. Each of these pumps is capable of providing a full stream of water for two 2½-inch fire hoses at a pressure of 120 pounds. The suction of this pump is connected to the main drain of the dock, so that it may be used as a drainage service for emptying any one particular compartment. The delivery is on the face of the dock about the level of the running deck, and is in the form of breeches pipe, finished with two screwed nozzles protected by brass caps and stopcocks. There are six pumps for the whole dock, making therefore twelve fire branches. Twenty-four 40-foot lengths of canvas fire hose with twelve fire nozzles are provided.

Each watertight compartment of the dock is provided with a means of indicating in the valve house the level of the water inside it. These indicators, supplied by Chadburn's (Ship) Telegraph Company, Ltd., are in the form of an iron inverted cup of about 4 inches diameter fastened to the frames in the bottom of each compartment. From the top of these cups or bells a pipe is led up through the interior of the dock into the valve house. These pipes are in continuous lengths, and where the pipes pass through watertight bulkheads or decks they have a watertight joint. In the valve house the ends of these pipes are soldered into a T-piece, one end of which is connected to an aneroid gage, capable of reading by pressure from a 6-inch head of water up to the highest head that can occur in the compartment in question. The other lead of the T communicates with a receiver pipe, common to all the indicators in the block, and such branch is governed by a small plug valve. The receiver pipes are connected to a small air reservoir, so that by opening the plug valve air may be forced through any of the tubes and into the compartment, the pressure necessary to do this being registered on the dial of the aneroid pressure gage. The gages are placed in the valve house, and in a prominent position as near as possible to the levers that control the valves of the compartments they indicate.

The compartment valves of the dock are all operated from one control valve house, 24 feet long by 9 feet wide, situated on the starboard wall. For this purpose the Westinghouse electro-pneumatic system is used. It is based on the principle of operating presses by air compressed to 5 or 6 atmospheres, and controlling the same from a distance by means of valves operated by an electric magnet requiring less than 1 watt to energize it. The position of the apparatus is indicated back to the valve table by electrical means. At the engine deck level each distributing valve rod is attached to the stirrup of its own press, which is of 6 inches diameter and has a stroke of 12 inches. The standard Westinghouse electro-magnetic valve is mounted on the wall of the dock. Upon the magnet being energized the exhaust passage to the press is closed and the inlet opened, and the air passes into the press, thereby lifting the distributing valve. The inlet is suitably proportioned, so that the press lifts as slowly as desired. All the time the magnet remains energized the distributing valve is lifted, but

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as soon as the current is cut off by the motion of the lever on the valve table the weight of the valve and valve rod expels the air from the press, and the valve closes. Attached to the left arm of the stirrup is a circuit breaker of standard type, which indicates to the operator in the valve house the position of the press and distributing valve. A Westinghouse non-seizable cock is inserted in the air pipe of each press, so that the air can be cut off or throttled, as may be required. In the event of a failure of the electric current the control valves can be operated by hand. Should the air pressure fail, a jack or lever can be placed under the stirrup, and the valve thereby lifted by hand. The valve tables in the valve house are of timber, polished and finished in oil. On this table small levers, placed in positions corresponding to the compartments of the dock they control, actuate the necessary contacts, and electrical indicators alongside indicate the position of the distributing valves; that is, whether open or shut. The water level gages indicating the actual depth of water in the different compartments are placed to the right of the levers. The apparatus on the table is connected by wires to the battery and motors on the engine deck. There are no pipes in the valve house.

The air is supplied by a Westinghouse 8-inch by 8½-inch pump into a reservoir, from whence an air pipe is taken along each engine deck in order to supply the different presses. The capacity of the pump at 100 strokes per minute is 30 cubic feet of free air per minute. The size of the reservoir is such that the pump can raise the pressure in less than ten minutes, and that then all the valves can be lifted and closed three times in one minute without lowering the pressure too much for successful operation. A duplicate air pump is provided as a stand-by. The reservoir is placed near the pump, and it has a safety valve and blow-off cock.

The air piping is of wrought iron steam piping, and the wires are chiefly No. 18 copper of high conductivity, insulated with vulcanized india rubber of 600 megohm grade. They run in wooden troughing on the engine decks, and in 4-inch watertight piping between the port and starboard decks. Where air or cable pipings pass through watertight bulkheads the joints have been made watertight.

Electric current is provided from the main, current being reduced to required voltage. On the valve table there is a switch for cutting off the battery, so that no current is consumed for indicating the position of the pump valves except when the attendant operates the same.

For the convenience of controlling the dock, certain of the watertight divisions are grouped together, in which case such group is controlled by a single lever on the valve table. Robinson's mechanical telegraphs communicate from the valve house to the engine-room. The valve house has also been fitted with two large spirit levels—at right angles to each other—so as to indicate the levelness of the dock, in order that the valve master may have under his hand indicators giving all the information required to enable him to control the lifting and sinking of the dock from the valve house.

The electrical installation on the dock was supplied from the Sheffield works of Vickers, Sons & Maxim, Ltd. The large electrical generating unit is capable of a continuous output of about 600 amperes at 220 volts, the engine, which is of the Brotherhood vertical compound type, being connected to and supplied with steam from the main boilers. The small generating unit is capable of a continuous output of 60 amperes at 220 volts. The engine is connected to a vertical boiler fixed adjacent to the engine, and provided with a chimney, water-feed pump and injector complete independent of the main boilers. But the steam piping is arranged, and the necessary valves provided, for connecting this engine to the main boilers should it be desired to run it from this source. Each engine is provided with an approved type of governor, which maintains the speed constant within 4 percent between full load and no load. All moving parts are provided with means for continuous lubrication. The plant is capable of developing 25 percent overload for a period of two hours without undue heating. The dynamos are of the compound-wound type, arranged to give 2 percent above the stated pressure when working at full load, while the commutators are of hard-drawn or strip-forged copper, and provided with a sufficient number of segments to ensure sparkless commutation at all loads without shifting the brushes. The brushes are of the carbon type, having sufficient contact surface to prevent rise in temperature. The magnet and armature windings are of a section to ensure that the rise in temperature of any part does not exceed 70 degrees F. (21 degrees C.) above the surrounding air temperature when running continuously at full load.

There is a main switchboard erected in a position adjacent to the generating sets. On the panels of the switchboard are mounted one pair of copper bus bars, which can be divided into two parts by removable copper connecting links. One part of the bus-bars is connected by two single-pole switches and fuses to the large generator, and the other part by two single-pole switches and fuses to the small generator. To the end of the bus-bars joined to the large generator are connected through fuses the cables leading to the main connection box on the dock wall. To the other end of the bus bars are connected single-pole switches and double-pole fuses controlling the dock lighting circuits and the cross-dock cable. On this board are mounted one ammeter for each dynamo, indicating up to 25 percent above the normal output of each dynamo, and one voltmeter reading to 250 volts, which, by means of a suitable switch, can be connected to any of the dynamos or bus bars.

In an accessible position on the dock wall is a watertight cast iron box having a hinged door. Inside this box is mounted a double-pole switch having a carrying and breaking capacity 25 percent above the full load output of the generating plant, provided with four terminals, two on each pole, suitable to receive the thimbles attached to the cables for supplying power to the ship on the dock. On the opposite wall of the dock to the generating plant is erected a suitable switch pillar having a hinged door, and fitted inside with a slate or marble panel, provided with bus bars to which the cross dock cables are connected. There are also single-pole switches and double-pole fuses controlling the lamps, etc., on this side of the dock.

The outside lighting of the dock is carried out by a number of deck standards, erected at intervals along the top of the dock wall, and provided with brackets which overhang sufficiently to allow the lamps to illuminate the space between the dock walls. These brackets are capable of being turned a quarter of a revolution to prevent damage when a ship is being docked. In the base of each standard a hinged door is provided to give access to a double-pole switch and fuse mounted inside the standard. At the end of the bracket an enameled iron shade and guard is fixed, containing six lamp holders and lamps of not less than 50 candlepower. All the necessary pendent electric lamps and wall plugs are controlled by separate switches and fuses, grouped together and mounted in watertight boxes with hinged doors. At intervals along the dock walls above, but accessible from the gangway attached thereto, are mounted watertight chambers having hinged fronts and containing sockets to receive plugs for portable lamp clusters. Portable lamp clusters, consisting of four lamps contained in enameled iron shades and guard, are provided. Also single-lamp shades and guards with leads and plugs attached.

All the lamps in fixed positions and on deck standards are of the metallic filament type, working with not more than two watts per candle-power. This also applies to all portable

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lamp clusters where there are more than two lamps in one cluster. Single portable lamps are of the carbon type, taking not more than 4.5 watts per candle-power.

The cables have been drawn into seamless steel tubing with screwed joints. At all places where bends occur watertight inspection chambers are provided, and where tappings are made there are watertight tee boxes. Distribution switch fuse boards are enclosed in cast iron watertight boxes, into which the conduit has been screwed. All cables and conduits are fixed inside the dock walls. The cross dock cable is of the concentric type, lead covered and armored. The valve-house, engine and boiler-rooms, and all the compartments in the top wall are wired for electric lighting, and wall plugs have also been provided in all compartments, from which inspection lamps, or small ventilating fans, or other gear can be carried to any portion of the compartments. A system of electric mains is carried inside the dock along the entire length of each of the walls, with plug boxes accessible from the outside of the dock. From these plug boxes flexible wires and lamp clusters can be led to illuminate any portion of the ship's interior.

All conductors consist of copper wire not less than 100 percent of Matthiessen standard of conductivity. No cable carries more than 1,000 amperes to the square inch. The area of cable is such that the drop in pressure from the switchboard to the farthest lamp does not exceed 2½ percent of the working pressure. The cables are insulated so as continuously to withstand a temperature of 100 degrees F. without deterioration. It was further specified that the insulation of the cables, after immersion in water for forty-eight hours, had not been less than 1,000 megohms per mile, and that the cross dock cable should be capable of periodic immersion in salt water without deterioration of the armoring or insulation.

There are two traveling cranes, one on each wall of the dock. Both were supplied by the Appleby Crane & Transporter Company, Limited. These cranes have a radius of 45 feet from the center of pivot to center of chain, and a lift of 45 feet from the top deck to the bottom of the slinging hook. They each run over the entire length of the top deck. The gear is carried on top of a four-legged traveling platform running along the rails fixed on each side of the wall of the dock. The height of the platform permits of the cranes passing over the valve houses and cowls, etc., on deck, and over the funnels, which have been made telescopic or lowering for this purpose.

Each crane is capable of lifting 5 tons on two falls of rope reeved through a snatch block, or 2½ tons on a single fall. The speed of hoist in the first case is 15 feet per minute, and in the second, 30 feet per minute. Slewing is performed at speeds not exceeding 60 feet per minute, according to the load being handled, while traveling is at the rate of 60 feet per minute. The cranes are traveled by hand by means of wire ropes secured to them and worked from the capstans. All the aforementioned movements are performed with the full load of 5 tons slung from the jib.

A substantial cast iron roller path is provided, machined on the tread, and with turned conical rollers. In addition to the stability obtained by the use of a balance weight, a pair of clip plates is fixed on each side to prevent the tipping of the cranes due to accident or rough handling, or the heeling of the dock. These consist of vertical plates, each 9 feet long, with lips projecting under the heads of the rails. Ordinary rail clips are provided at each corner to prevent the crane launching itself during docking. To suit the above clips the rails are of the flat-bottom type, with a weight of about 80 pounds per yard, and they have a wide head to afford good grip.

There are eight capstans—supplied by Messrs. Hatfield. The capstan on the top deck of the wall is of cast iron. It has efficient pawling gear, and is fitted with a row of bar holes for working by hand, and has a brass cover at its head. The capstan spindle is of forged steel, and is carried down through the deck to the engine deck, and stepped into a gunmetal bushed bearing on the engine bedplate. The capstan baseplate is of cast iron, and bushed with gunmetal. Where the spindle passes through it a wrought steel collar is fitted under the boss of the capstan base, so as to prevent the spindle from lifting. The engine is of the horizontal type, with two cylinders, each 8 inches diameter by 12 inches stroke, and fitted with piston slide valves, having hard gunmetal rings. The reversing of the engines is effected by a cylindrical valve, having hard gunmetal rings, and is arranged to be worked by right-hand screw and gear, with movable handle from the top deck. Gear is supplied to enable the capstans to run at two speeds in the ratio of about 1 to 3, one for rapidly taking in slack, and the other when the full load is on the capstan. Fifteen tons are taken at 20 feet, and seven tons at 60 feet.

The control of the capstans is by removable levers of handles from the top deck of the dock.

Bollards strong enough for holding vessels of the largest size the dock is capable of accommodating are fixed on the top and at each end of the upper deck, while similar heavy bollards are provided on the projecting ends of the low wall at the stern end, and smaller bollards at the joint ends of the separate sections, for maneuvering them when they are being self-docked. Cast iron timberheads or snubbing posts are along the edge of the running decks for the purpose of checking or snubbing vessels entering the dock. Eight mechanical side shores are provided.

These shores consist of timber working inside a wrought iron tube built into the side wall of the dock. The shore carries on its underside a cast iron rack, by means of which it can be screwed in or out by a standard fixed on the top deck, and provided with two handles. The shores are marked to a scale showing the distance to which they project, and are placed opposite to each other, that is, four on each wall of the dock, so that a vessel may be centered between them. The keel and bilge blocks are of three types. First, the keel blocks proper, occurring over the central axis of the dock. Secondly, the side or docking keel-blocks, and, thirdly, the bilge blocks. The keel blocks consist of a lower portion about 2 feet high, formed of cast steel, and an upper portion consisting of a pair of oak wedges hopped at each end and strapped together, making up a height of 1 foot 9 inches. On top of these a short capping piece, also of oak, 3 inches thick, is affixed, to bring up the total height of the keel blocks to 4 feet. There are 201 of these keel blocks provided for the whole dock. The docking keel-blocks—sixty-six in number—are similar in every respect to the keel blocks, with the exception that their base is a little longer, so as to spread the load more uniformly over the floor of the pontoon. The bilge blocks—sixty-eight in number—as regards the lower portion, are again similar to the two other types, but somewhat longer, so that they can be used anywhere on the deck of the dock outside the specially strengthened zone. They carry on the top of the lower portion, which is of steel, sliding oak wedges, which can be pulled in and out by means of ropes or chains carried over pulleys and led up to the top deck. The length of these bilge blocks is 10 feet, so as to allow the bilge blocks proper to be pulled into the shape of the ship when she has taken the keel blocks. The whole of the blocks are movable, and can be shifted from one position to the other.

The working platforms at each end of the dock are strong enough to afford very appreciable support to a ship with a greater length of straight keel than 500 feet, which might have to come on the dock. For such a ship it is evident that the

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side docking keel blocks would not be required, and they could, therefore, be shifted and placed as desired anywhere over the platforms. At the stern end of the dock, and on each wall, is a large timber roller fender, strongly supported on brackets, and projecting slightly beyond the line of the rubbing timbers on the painting stages. These roller fenders protect the structure of the dock from possible damage by an incoming vessel.

At the bow end of the dock a pair of flying gangways or swinging bridges affording access from one wall to the other are fixed on top of the low wall. They are of lattice construction, with their top formed of a chequered plate 3 feet wide, and protected by handrails. Means are provided for opening these gangways should the necessity arise for passing a ship out at the end of the dock. In addition to these there are two light timber bridges of a length of 20 feet, and two of a length of 30 feet, for the purpose of giving access from the top deck of the walls to the deck of the vessel on the dock.

Accommodation ladders with easy rises and treads lead from the upper deck of the dock down to the pontoon deck. There is such a ladder at each end of the wall, and, in addition, ladders lead down into all the compartments of the wall above the engine deck, while ordinary service ladders lead into each compartment of the lower wall and each watertight division of the pontoons.

Distilling apparatus of the Normandy standard type, as manufactured by the Thames Ironworks, Shipbuilding & Engineering Company, Limited, is provided on the dock, and is capable of producing 1,000 gallons of fresh water in twenty-four hours. The boiler and auxiliary boiler rooms, the engine and auxiliary engine rooms, and all portions of the dock walls where steam is used are efficiently ventilated by means of electric fans.

During the progress of the construction of the floating dock the Brazilian Government have been represented at Barrow-in-Furness by Captain J. M. de San Jaun and Dr. Olympio de Assis, assisted by Dr. Frederico Burlamaqui.

The dock left Barrow-in-Furness July 4 and arrived at Rio de Janeiro Sept. 29. On the journey to Rio the towing gear was composed as follows: On one part of the dock two heavy chain bridles were attached, and on to these were spliced 4½-inch circumference, specially flexible Bullivant steel wires of a length of 35 feet each. These wires were connected to extra superior manila ropes, 18 inches circumference and 120 fathoms length. On the other end of the ropes there were again 4½-inch steel wires fastened on to the towing bits of the tugs. The towing was done by Messrs. Smit & Company, of Rotterdam, and this is the seventeenth floating dock which this company has delivered to oversea ports. They also have now in hand the towage to Bahia of a 1,250-ton dock, built by Messrs. William Hamilton & Company, of Port Glasgow, and another of 5,000 lifting capacity, which Messrs. Vickers, Sons & Maxim, Ltd., have on order for Aberdeen.

In the annual report of the Bureau of Construction and Repair of the United States Navy it is stated that the United States can build first-class battleships in as short a period of time as any other shipbuilding country, and actual experience seems to demonstrate that the rapidity of construction in the United States is greater than the average rate of construction in the principal foreign shipbuilding countries. This decreased time of construction has been obtained concurrently with a decrease in the unit cost of construction. In fact, the total cost per ton of displacement of battleships built by contract for the United States navy within the past few years has been less than the total cost per ton of displacement of similar vessels built in foreign countries.

OLD TRANSATLANTIC STEAM LINERS.*

BY FRANCIS B. C. BRADLEE.

To meet this formidable opposition, the Cunards (who had started their New York service with the *Hibernia* in January, 1848) placed the paddle steamers *Asia* and *Africa* on the line. They were sister ships and magnificent steamers for their day, built in 1850 by Robert Steele, at Glasgow, of oak, double-planked, 2,226 tons gross, 266 feet long, 40 feet beam, side-lever engines by Napier, with two cylinders, each 96¼ inches in diameter, 9 feet stroke, indicating about 1,800 horsepower, but, either owing to their models or boilers, they were not quite as fast as the Collins boats, their best passage West being 10 days 10 hours, and East 10 days.

In 1852 the Cunard line built the *Arabia;* she was their last wooden paddle steamer and also the first of their fleet to be fitted with tubular boilers instead of the old return flue type. The *Arabia* was 2,403 tons gross, 285 feet long and had a set of very powerful side-lever engines (by Napier), indicating over 3,000 horsepower, but consuming no less than 120 tons of coal daily. She proved very fast in smooth water, but in a head sea she buried herself, and her engines being too powerful for her hull, she gradually worked herself to pieces and eventually was broken up. Her best time from New York to Liverpool was 9 days 17 hours in August, 1853.

Extraordinary interest was manifested in the competition on both sides of the Atlantic and heavy bets were constantly made. Notwithstanding the fact that the Collins line carried, in 1852 50 percent more passengers to New York and 30 percent more to Liverpool than the Cunards, and that Congress increased their subsidy from $385,000 (£79,000) to $858,000 (£176,000) per annum, they were not successful financially, probably owing to bad management and reckless extravagance, and a series of disasters completed their ruin. The *Arctic*, while on her passage from Liverpool to New York, was run into September 27, 1854, about 65 miles from Cape Race, during a dense fog by the French iron screw steamer *Vesta*. She was struck a few feet forward of the paddle boxes and was so severely injured that she filled in about three hours and sank stern foremost, engulfing 322 out of the 368 souls on board. Captain Luce lost control of his crew, or of the larger portion of it, who seized the boats and sought to save themselves regardless of others. Mr. E. K. Collins, one of the proprietors of the line, lost his wife, only son and two daughters, and among other passengers lost were the Duc de Grammont, an attaché of the French Embassy in Washington; F. Catherwood, a well-known artist; Edward Sanford, a distinguished New York lawyer; Professor Henry Reed, of the University of Pennsylvania, etc. It is interesting to note that at this time none of the wooden transatlantic liners were equipped with watertight bulkheads. The only ones having any were the Inman iron screw steamers, then running from Liverpool to Philadelphia, and two iron propeller steamships of the Cunard line, the *Andes* and the *Alps*, built in 1852 for their freight and emigrant service. Nor did any of the liners at that time, as far as can be traced, have steam fog horns, or show the now obligatory colored lights at night.

A. Fraser McDonald, who made a passage in 1848 from Liverpool to Boston in the Cunard *Niagara*, says in "Our Ocean Railways," that the only fog signal was made by a sailor standing on the forecastle and blowing a tin horn at intervals, and it was not until some time after the loss of the *Arctic* that it was stated in the Cunard line advertisement that "the British & North American Royal Mail steamers now carry a green light on the starboard side, red on the port and a white light at the masthead." Only a little more than a year elapsed after sinking of the *Arctic* when the

* Concluded from the December issue.

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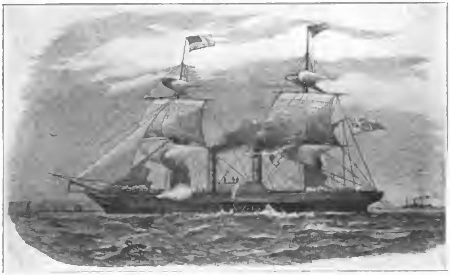
Collins line lost the *Pacific*. She left Liverpool for New York, running against the new Cunarder *Persia*, on January 23, 1856, with 45 passengers and a crew of 141 persons on board and was never heard of again.

From wreckage that was picked up and the experience of other steamers at about the same time, it was thought that the *Pacific* ran into an enormous ice floe and went down immediately with all hands. That these disasters were, in part, due to the intense desire of the managers of the Collins line to make fast passages there is no doubt. John H. Morrison, in his "History of American Steam Navigation," says, "This driving ahead at such a speed under conditions similar to this case (the dense fog at the time of the loss of the *Arctic*) was deemed extremely hazardous by some of the captains of the line, and one who was thought to be a very prudent commander is known to have said that he has been in the pilot house of his vessel with the engine-room bell pull in his hand and trembled for the safety of his vessel and passengers, for he was aware of the great risk he ran in dashing ahead at such a rate of speed in a fog, but it was necessary that time be made."

The last and largest of the Collins line fleet was the *Adriatic* (she was originally called the *Antarctic*), designed and built at New York by George Steers, of the yacht *America* fame. She was originally started in 1855, but owing to numerous changes in the engines was not completed until late in 1857, and in December of that year she made her first and only trip in the Collins service. The *Adriatic* was built of oak, with diagonal double-laid iron straps, was brig rigged, had two very lofty funnels and was divided into six watertight compartments. The tonnage (gross) was 4,144; dimensions: length, 351 feet; beam, 48 feet; depth, 33 feet; the ma-



CUNARD STEAMSHIP ARABIA (1853).

WOOD, SIDE-WHEEL STEAMER VANDERBILT (1856)

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chinery consisted of two oscillating engines having cylinders each 100 inches in diameter, 12 feet stroke; the indicated horsepower ranged over 4,000, giving a speed of about 13½ knots on a coal consumption of 95 tons daily. The *Adriatic* was commanded by Captain James West, formerly of the *Atlantic*. After the withdrawal of the Collins line in February, 1858, the *Adriatic* was laid up for some time and then sold to the North Atlantic Steamship Company (an American line), who ran her between New York and Havre via Southampton until the early part of 1861, when she was again sold to the (English) Galway line, and while in their service ran from St. Johns, N. F., to Galway, Ireland, in 5 days 19 hours and 45 minutes (May, 1861).

When the Galway line was finally given up in 1864, the *Adriatic* was laid up in Liverpool for some time, then made into a sailing vessel, and was as late as 1899 used as a coal hulk at Sierra Leone. Such was the fate of a steamer that originally cost over $1,100,000 (£225,000). The *Atlantic* and *Baltic* were used as transports during the Civil War, and during 1866-67 were employed on the North American Lloyd's line (promoted by Messrs. Ruger, of New York) between New York and Bremen via Southampton. The *Atlantic* was broken up at New York in September, 1871, and the *Baltic*, after several years' existence as a sailing vessel, was broken up at Boston in 1880.

One of the first American screw steamers to cross the Atlantic was the *Samuel S. Lewis* from Boston to Liverpool and return in October, 1851. She was a wooden boat, fitted with a pair of vertical direct-acting engines (that were not a success), having cylinders 60 inches by 40 inches stroke.

In 1855 Cornelius Vanderbilt, or "Commodore" Vanderbilt as he was better known, who had previously been identified with the Long Island Sound and coastwise lines, determined to enter the transatlantic trade. He tried to get a subsidy from the United States Government for carrying the mails, but failed, and agreed to make the experiment of transporting them for what was known as the "sea postage" only, so much per letter. He had built at New York by Jeremiah Simonson (his nephew) a large wooden side-wheel steamer named after himself, the *Vanderbilt*. She was 3,321 tons, 331 feet long, 37 feet beam, with two "walking beam" engines, built by the Allaire Works, New York, having two cylinders, each 90 inches in diameter, 12 feet stroke; the paddle wheels were of enormous diameter, 41 feet; there were four return tubular boilers, carrying a pressure of 18 pounds to the square inch; the indicated horsepower was 2,800.

The *Vanderbilt* was a success as a fast boat, breaking the record by running from Southampton to New York, in 1860, in 9 days 7 hours, but not so much so as a comfortable one, as she rolled like a barrel and her vibration was excessive. She and several smaller boats of the same type, named the *North Star, Illinois, Ariel, Ocean Queen*, all with "walking beam" engines, some double and some single, except the *Illinois*, ran between New York and Havre, and sometimes Bremen via Southampton, during the summer months from 1855 to 1861. They did not attempt to run in the winter at all, as the "walking beams" perched up high overhead were found ill adapted to the wild weather of the "western ocean." Indeed, it is said that in stormy weather these engines would only make four or five revolutions per minute, and that the engineers had to stand by to help them over the center with the starting bar.

THE CARROLL OF THE BALTIMORE AND LIVERPOOL STEAMSHIP COMPANY (1865).

During the Civil War Commodore Vanderbilt presented the *Vanderbilt* to the United States Government to help catch the Confederate *Alabama*, as she was one of the few American ocean steamers capable of maintaining a speed of 13 knots. In 1863 she missed the *Alabama* at Cape Town by only a few hours, and some time before that, in 1862, just before the engagement of the *Merrimac* and *Monitor*, when the *Monitor* was an unknown quantity, the Government at Washington seriously considered loading the *Vanderbilt* and the old Collins liner *Baltic* with stone and having them run down and sink the *Merrimac* by sheer force of weight. Some years after the Civil War the *Vanderbilt* was made into a sailing vessel and called the *Three Brothers* (for some years she was the largest sailing vessel in the world); she is now a coal hulk at Gibraltar.

After the Civil War the first attempt to start a line of American transatlantic steamers was made by the Baltimore & Ohio Railroad Company, who bought three wooden screw steamers that had been built at New York in 1862 for the Government service. These were the *Worcester, Carroll* and *Somerset*. The *Worcester* was the largest of the three, being 1,500 tons gross; dimensions, 218 feet by 35 feet by 20 feet, with inverted direct-acting engines having two cylinders, each 44 inches in diameter by 48 inches stroke. The *Somerset*

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opened the line by leaving Baltimore for Liverpool with the United States mail on board in October, 1865. The boats, however, were too small and slow for the trade and were withdrawn in October, 1868. The *Worcester* and *Carroll* afterwards ran for many years on the Plant line between Boston and Halifax, N. S., but have now disappeared, probably in the "bone yard."

After the Civil War trade conditions in the United States were in a very unsettled condition, and especially so was everything concerned with the shipping business, but, nevertheless, in 1866, William H. Webb, the noted New York shipbuilder, and Messrs. Ruger Brothers determined to try their luck in the transatlantic steamship business and accordingly formed what was known as the "North American Lloyd." Their route was from New York to Bremen via Southampton, and during the last part of their career the European terminus was Copenhagen and sometimes Stettin. To carry on the line the old Collins liners *Atlantic* and *Baltic* and the New York and Havre *Fulton* were bought, and various steamers, such as the *Quaker City*, *Western Metropolis* (which had a "walking beam" engine that had been in use on the Great Lakes in a steamer of the same name) and the *Merrimac*, an iron screw steamer built in 1862 by Harrison Loring at South Boston, were chartered.

The service was begun in 1866 and lasted with more or less regularity until 1870, when it was given up, the reason given by the proprietors being "that a combination was formed by the English and German steamship lines to put on a steamer for New York at the same port and on the same day that the vessels for this line were advertised to sail, and to take freight and passengers to New York at reduced rates. The result of this combination was death to our line." In the early 60's the Cunarders made only bi-monthly trips to Boston. This was felt to be not enough to accommodate the growing passenger and freight business of the port, and so the American Steamship Company was organized in 1864. Its board of directors included many merchants and business men of high standing.

THE ERIE (1867), LARGEST WOODEN SCREW STEAMER EVER BUILT.

After many difficulties and delays the company had built by George Jackman, Jr., at Newburyport, Mass., in 1866, two magnificent wooden (oak and hackmatac) screw steamers, the *Ontario* and *Erie*. They were 2,900 tons each, divided into five water-tight compartments, 325 feet long, 43 feet beam and 29 feet deep; the engines, designed by George W. Copeland, of New York, were built by Harrison Loring at South Boston, and consisted for each vessel of a vertical-geared engine having two cylinders, each 74 inches in diameter, 4 feet stroke, the indicated horsepower being 1,700. These two ships, at the time they were built, were considered the handsomest vessels that had ever entered Boston harbor. The

THE OHIO, OF THE PHILADELPHIA AMERICAN STEAMSHIP COMPANY (1873).

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Ontario, Captain Hallet, sailed on her first trip to Liverpool on August 5, 1867; she made three round voyages and proved herself very fast, but on her arrival from Liverpool in January, 1868, she was laid up and the American Steamship Company went out of business. This was partly through lack of capital and partly because they failed to secure a mail contract.

The *Erie* never made a trip on the line, and after laying up for a long time both steamers were sold to the United States & Brazil Mail Steamship Company about 1870. The *Erie* was burnt at sea January 1, 1873, with a cargo of coffee on board valued at $1,500,000 (£310,000), and the *Ontario* was broken up in Boston in 1885.

After 1870 there were no lines of American transatlantic steamers until the Pennsylvania Railroad Company organized the International Navigation Company in 1872 to run steamers between Philadelphia and Liverpool. The Cramp Shipbuilding Company built and engined for the line four iron screw steamers, all alike, the *Ohio*, *Indiana*, *Illinois* and *Pennsylvania*, each ship being 3,119 tons gross, 343 feet long, 43 feet broad, 34½ feet deep, brig rigged, with vertical two-crank compound engines having cylinders 57 and 90 inches in diameter, 4 feet stroke, boiler pressure 60 pounds to the square inch. In May, 1873, the *Pennsylvania* inaugurated the service which is maintained to this day, only, as the International Company gradually expanded its fleet, the new ships were built in England and flew either the English or Belgian flag, as being cheaper to operate. After getting control of the Red Star line, running between Antwerp, New York and Philadelphia, the International Company, in 1886, bought out the Inman (English) line, running between New York and Liverpool, and in 1893 a new service was begun to Southampton under the name of American line. At the same time two of the English ships, the *City of New York* and *City of Paris*, were by special act of Congress admitted to American registry and renamed *New York* and *Paris*, the *Paris* being now called the *Philadelphia*. In 1895 the American line added to its fleet the two now well-known steel twin screw steamships *St. Louis* and *St. Paul*, which, with the *New York* and *Philadelphia*, carry on the service, and there the matter stands to-day.

The Bureau of Navigation of the Department of Commerce and Labor reports that 70 sail and steam vessels of 16,349 gross tons were built in the United States and officially numbered during the month of November, 1910. Three steel steamers, aggregating 6,355 gross tons, were built on the Atlantic and Gulf coasts, and 3 steel steamers, aggregating 7,760 gross tons, were built on the Great Lakes. The total tonnage of sailing vessels built during the month was 206, and all were of wood. The largest ship built on the coast during the month was the *El Occident*, 6,008 gross tons.

SCREW FERRYBOAT DUTCHESS.

The *Dutchess* is a screw ferryboat of the following dimensions, designed and built by the T. S. Marvel Shipbuilding Company:

Length over all	160 feet 1 inch
Length inside of the propeller posts	134 feet 11 inches
Beam over guards	56 feet 4 inches
Beam, molded	34 feet
Depth, molded	14 feet 6 inches
Displacement	542.7 tons
Net tonnage	405

The principal scantlings of the hull are shown in the midship section, Fig. 2. The stem and shoe are of cast steel, the stem 4 inches by 7 inches and 4 inches by 6½ inches, and the shoe 5¼ inches by 9 inches. The keelson angles are 3½ inches by 3 inches by 6.6 pounds. The intercostals are of 12.5-pound plate. Between the collision bulkheads the frames are spaced 21 inches centers and at the ends 12 inches. In the engine and boiler space the reverse frames are double.

In accordance with the ferryboat law there are five watertight bulkheads. The belt frames are 11 inches wide and the deck beams 5 inches by 3 inches by ⅜ inch on every frame amidships and on alternate frames at the ends. The guard beams are 5 inches by 11.6-pound zee bars.

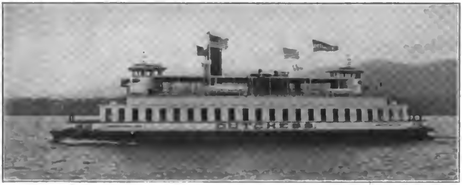

FIG. 1.—STEEL FERRY STEAMER DUTCHESS.

The deck over the hull is entirely plated with 10.2-pound plate. The centerhouse and side bulkheads of the team gangway are of steel, 10.2 pounds to the square foot. The shell plating is 20 pounds for the garboards, 15 pounds for the shell amidships and 17 pounds for the sheer strake. The waterline plating is 20 pounds at the ends. All seams have joggled edges. The hull is stiffened by a longitudinal truss of channels on each side.

There is a coal bunker athwartship forward of the boilers. Cylindrical water tanks are provided with a total capacity of 6,000 gallons.

The rudders are of the balanced type with 6-inch stocks covered with 12-pound plates. There are four escape ports, 12 inches by 18 inches, and the gangway coamings are of steel.

The plank sheer is 4 inches by 18 inches, reduced to 3 inches by 15 inches at the ends. The balance of the deck planking is 3 inches by 5 inches in the teamway and 2½ inches by 2½ inches in the cabins.

The joinery work is of pine and cypress. There is a stairway on each side leading to the upper deck. The general design is colonial, modified to suit marine work. The inboard sides of the cabins are finished in canvas panels and the outboard sides with canvas panels between stationary windows. There is an awning deck over the upper deck leading from pilot-house to pilot-house.

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MACHINERY.

The vessel is propelled by two comopund engines on one shaft coupled together. Each engine has cylinders 15 inches and 30 inches diameter, with a common stroke of 22 inches. Slide valves are fitted to each cylinder, operated by double-bar Stevenson link motion. Steam reversing gear is fitted and all pumps are independent. The main shaft is 7½ inches diameter. The propeller shaft is covered with a brass casing in the stern tubes between bearings. There are two thrust bearings of the horseshoe type.

The condenser outfit consists of a Blake vertical simple air pump and jet condenser, arranged to draw from a tank and total heating surface of the boilers is 1,395 square feet; the total grate surface 91 square feet, making a ratio of heating surface to grate surface of 30.6 to 1.

A vertical donkey boiler is installed in the center house and piped to the boiler circulating pumps, etc. A Reilly feed-water heater is fitted. Products of combustion from all boilers are exhausted through a double stack, 65 inches outside diameter, which extends to a height of about 53 feet 6 inches above the base line.

Electricity is supplied by a single 15-kilowatt, direct-connected General Electric generating set. Two 18-inch searchlights are installed.

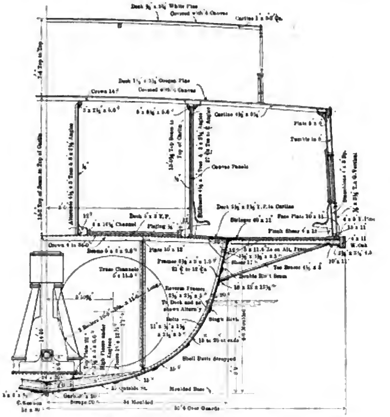

FIG. 2.—MIDSHIP SECTION OF THE DUCHESS, SHOWING PRINCIPAL SCANTLINGS.

the sea. The size is 10 inches by 22 inches by 12 inches. There are two sea suctions of large size on each side to allow water to be drawn from the side of the boat most free of ice.

The fire pump is extra powerful, being 18½ inches by 12 inches by 12 inches. It is of the horizontal duplex type, arranged to discharge at stations in the gangway and on the upper deck. Monitor nozzles are fitted at each pilot-house.

The feed pump is 7½ inches by 5 inches by 6 inches. There are two boiler circulating pumps, 5¼ inches by 3½ inches by 5 inches.

The propellers are of cast steel, designed for winter service. They are about 7 feet 6 inches diameter.

Steam is furnished by two Scotch boilers, designed by the T. S. Marvel Shipbuilding Company, and built by P. Delaney & Company, Newburgh, N. Y. The boilers are 10 feet 9 inches diameter by 11 feet 6 inches long, designed for 135 pounds working pressure. Each has two Morison corrugated furnaces, 42 inches inside diameter, of the horse-collar type. There is a steam drum which takes steam from both boilers, and a 7-inch steam main leads from this to the engines. The

There are two sets of Welin quadrant davits complete with metallic lifeboats.

In service no vibration is noticeable, and the coal consumption is 5½ gross tons in a period of eighteen mours, or a working day.

CONCERNING THE UNITED STATES NAVY.

In his annual report, recently published, the Secretary of the Navy makes recommendations which should result in eventual economy and tend to increase the efficiency of the naval establishment. In this connection some of the more important suggestions concern the abandonment of the naval stations at New Orleans, Pensacola, San Juan, Port Royal, New London, Sacketts Harbor and at Cavite. Secretary Meyer points out that all of these smaller stations are unnecessary and, on the whole, useless, as their location and equipment are not such as to enable a general overhaul or

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accommodation of ships of the size as now built for the navy. For the protection of the Gulf and the Panama Canal, the Secretary advocates Guantanamo as possessing strategic superiority, and that this station should be properly equipped as a naval base. Owing to the increased cost in maintaining the fleet on the Pacific, it does not seem advisable, in the Secretary's opinion, to transfer any large portion of the battleship fleet there at the present time.

Although at a disadvantage, owing to its lack of railroad communications and its great distance from the labor market, the Secretary regards the Bremerton yard as necessary, and should, therefore, be developed. The Mare Island yard has the disadvantage of being inaccessible, owing to the shallowness of the channel leading to it and the impurities in the water. Too much money, however, has already been expended to abandon this yard, and it should be used for the repair of such ships as can readily be sent there. San Francisco Bay seems the logical point in the future to establish a docking and repair station for battleships.

The principal insular defense base should be made at Pearl Harbor, in Hawaii, and Alongapo, in the Philippines, should be made a repair station and Cavite disposed of.

With respect to new constructions, Secretary Meyer recommends the authorization and building of two battle-ships, one collier, one gunboat, one river gunboat, two sea-going tugs, two submarines and one submarine tender.

REPORT OF THE ENGINEER-IN-CHIEF.

Satisfactory progress has been made on the machinery for the *Florida*, now building at the New York navy yard. As an example of the efficient organization now existing in the machinery department of this yard, is cited the successful casting of all the turbine casings for this vessel without the loss of a single casting.

One of the most important pieces of work carried out at the Norfolk yard was changing the engines of the *Louisiana* and *Virginia* from in-turning to out-turning. A highly gratifying feature of this work rests in the fact that it was done for about 55 percent of what the contractors, who built these two ships, wanted for doing this work after the engines had been completed as in-turning.

Boilers of both Babcock & Wilcox and Mosher type have been tested by the builders of said boilers in accordance with requirements stipulated in the bureau's specifications, with special regard to acceptance for battleship installations.

In order to determine the relative backing power of ships with turbines and reciprocating engines exhaustive trials were undertaken with the three scout cruisers, *Birmingham*, *Chester* and *Salem*.

The experience gained with the burning of oil fuel as auxiliary to coal in the battleships *Delaware* and *North Dakota* shows that satisfactory burning of the oil, which, when used as indicated, is sprayed on top of the coal, and, therefore, with lessened furnace volume and space for combustion, has been difficult of accomplishment. As installed in these two vessels, it is intended to be used only to assist in maintaining power on long full-power runs.

A high-speed marine turbine, with reduction gear, is being installed in the collier *Neptune*. This is a twin-screw vessel of 19,360 tons displacement, with a speed of 14 knots. Steam is supplied to each of the two Westinghouse-Parsons turbines at 200 pounds gage. The power expected is 4,000 horsepower on each shaft when the turbines revolve at 1,500 revolutions per minute, while the propellers run at 136 revolutions per minute. The reduction gear is of the Melville-Macalpine type.

Recommendation is renewed for an appropriation of $250,000 (£51,400) for the pruchase of internal combustion engines, to be installed in a naval collier, should it be thought advisable to experiment along these lines.

BIDS AND CONTRACTS FOR UNITED STATES NAVAL VESSELS.

TORPEDO-BOAT DESTROYERS.

On Nov. 8 last, bids were opened at the Navy Department, Washington, for six torpedo-boat destroyers, the contracts for which were awarded on Nov. 22. The awards were made as follows:

The Bath Iron Works, Bath, Me., two destroyers at $645,000 (£132,500) each, to be completed within 24 months and a guaranteed speed of 30 knots.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., one destroyer; to be completed within 24 months and a guaranteed speed of 29½ knots, at a price of $630,000 (£129,400).

The New York Shipbuilding Company, Camden, N. J., one destroyer at $640,000 (£131,500), to be completed within 24 months and a guaranteed speed of 29½ knots.

The Wm. Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa., one destroyer at $653,000 (£134,000), to be completed within 24 months and a guaranteed speed of 29½ knots.

The Fore River Shipbuilding Company, Quincy, Mass., one destroyer at $648,700 (£133,200), to be completed within 24 months and a guaranteed speed of 29½ knots.

The machinery of the first five are to be turbines of Parsons type, and that of the last-named to have Curtis turbines with twin screws. The boats to be built by the Bath Iron Works and the Fore River Ship Building Company to have their trials on the regular Government trial course off Rockland, Me.; the others on the Lewes-Delaware course, for the privilege of which the builders made a reduction of $5,000 (£1,030) on each boat.

All of the foregoing destroyers have practically the same dimensions as those contracted for in September, 1908, and May, 1909, which are 742-tons displacement and have 12,500 horsepower.

BATTLESHIPS NEW YORK AND TEXAS.

Owing to restrictions contained in an amendment to the bill authorizing the construction of the two latest battleships, Nos. 34 and 35, which provide for an eight-hour workday, only one bid was received by the Department Dec. 1, the date set for opening bids. The bid referred to was by the Newport News Ship Building and Dry Dock Company, Newport News, Va., who offered to build one battleship (No. 35) according to the following schedule:

Class 1. Department's plans for hull and machinery, with turbines of Parsons type, for $5,790,000 (£1,191,000), or with turbines of Curtis type for $5,775,000 (£1,181,000). Class 2, Department's plans for hull and builders' plans for machinery, with reciprocating engines, for $5,830,000 (£1,190,000).

The ship to be completed in 36 months and have a guaranteed speed of 21 knots. The bill also authorizes the Secretary of the Navy to build one of these two ships at a navy yard, but, owing to the increased cost, this will not be decided upon before Congress authorizes the limit of the increase in cost. Meanwhile, the Newport News Company has informed the Department of its willingness to construct both ships at a price for each given in their bid for one. Should Congress decide to build the *New York* by private contract new bids for this ship would probably be invited.

The General Electric Company in their bid for machinery offered to build machinery of a turbo-electric type for $352,000 (£72,400).

COLLIERS.

Two bids were received for the construction of colliers Nos. 9 and 10. One of these, from the Union Iron Works, San Francisco, Cal., offers to build one vessel for $1,595,000 (£328,000) in accordance with the Department's specifications.

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The other bid, from the Moran Company, Seattle, Wash., offers to build one vessel, on specifications prepared by the company for the machinery and the Department's plans for hull, for $987,000 (£203,000).

The first bid exceeds the limit of the appropriation by $595,-000 (£122,300), and the second bid was unaccompanied by the required bond, and irregular also in other respects.

GUNS AND ARMOR.

The Midvale and Bethlehem Steel Companies submitted identical bids for the armor plates to be used in the construction of battleships, and were as follows:

Class A, 11,340 tons at $480 (£99) per ton.

Turret armor, 1,416 tons at $480 (£99) per ton.

Class C, at $470 (£97) per ton.

Class D, at $655 (£135) per ton.

Class E, at $512 (£105) (Midvale), and $508 (£104) (Bethlehem).

Bids for ten 14-inch guns complete, including some spares, but without gun carriages, the Midvale Steel Company's bid was $747,700 (£153,700), and that of the Bethlehem Steel Company $779,000 (£160,000). The time of delivery of the first gun of the former company was 13½ months, and that of the latter 14 months, thereafter one gun every 60 days.

NAVAL ENGINEERING PROGRESS.

BY ENGINEER-IN-CHIEF H. I. CONE, U. S. N.

SCOUT TRIALS.

Extensive trials have been carried on with the *Birmingham*, *Chester* and *Salem*—scout cruisers, similar in design except as regards their machinery installation. The *Birmingham* has reciprocating engines on two shafts; the *Chester*, Parsons turbines on four shafts; and the *Salem*, Curtis turbines on two shafts. The boilers on the *Birmingham* and *Salem* are identical in design, while those on the *Chester* are of similar type.

At a speed of about ten knots the total water per hour for the main engines only is 21,988 pounds for the *Birmingham*, 25,492 for the *Chester* and 30,182 for the *Salem*.

On full power, with respective speeds of 24.15, 24.67 and 25.12 knots, this water consumption is 253,372 pounds for the *Birmingham*, 253,662 pounds for the *Chester* and 292,751 pounds for the *Salem*, or 17.42 pounds per indicated horsepower, 13.7 pounds per shaft horsepower and 16.2 pounds per shaft horsepower, respectively.

The speeds on contract trials were: *Birmingham*, 24.325 knots; *Chester*, 26.52 knots; *Salem*, 25.947 knots.

An interesting point developed in the trials is the economy obtained in the Parsons system by the use of cruising turbines at low power. These cruising turbines have been omitted in recent British designs. At 10 knots, with the cruising turbines, a water rate of 28.1 pounds per shaft horsepower was obtained; while without the cruising turbines this increased to 44.9 pounds per shaft horsepower.

In comparing the results of these trials it should be remembered that the Curtis turbines of the *Salem* represent a much earlier period of development than do the Parsons turbines of the *Chester*.

STEAM TRIALS OF THE DELAWARE AND NORTH DAKOTA.

The trials of the *Delaware* and *North Dakota* present an interesting study in similar ships of the comparative efficiencies of reciprocating engines and Curtis turbines in battleships.

The *Delaware*, which is our latest and perhaps last reciprocating-engined battleship, showed such an excellent performance on her contract trial that there is doubt in the minds of some of us as to the superiority of the turbine for a battleship of that type and speed. The steam consumption per indicated horsepower of the main engines was 15.48 pounds at 12 knots, 12.7 pounds at 19 knots and 12.9 pounds at 21 knots.

As compared with the *North Dakota* the main engines of the *Delaware* showed a smaller steam consumption at all speeds, and at 12 knots this superior economy amounted to about one-third the total consumption. Translated into cruising radius, this superiority, if maintained on service, is significantly important.

The principal improvements in the *Delaware's* machinery over that of her predecessor's consist in:

(*a*) Improved cylinder ratios and reduced clearance in main engines.

(*b*) Forced lubrication of main bearings, crank pins, eccentrics and cross-head pins.

(*c*) The use of superheated steam.

Forced lubrication similar to that of the *Delaware* is being applied to the older vessels. During the present year it will be fitted to the *Vermont*, *New Hampshire*, *Georgia*, *North Carolina*, *California* and *Colorado*, and, if it proves successful, as rapidly as possible to the other armored vessels of the fleet.

Some difficulties have developed in connection with the use of superheated steam, due to erosion of valves in the steam lines of the *Delaware*, and there is still some doubt as to whether the economy gained is not counterbalanced by the increased difficulty of maintenance of plant. We are experimenting with metals suited to high temperatures, and hope to find a valve material to overcome these troubles.

THE BACKING POWER OF TURBINES AS COMPARED WITH RECIPROCATING ENGINES.

With reciprocating engines a backing power equal to the ahead power is afforded without any increase in weight except that of the backing eccentrics, rods and links. With turbines, however, the ability to reverse requires additional turbines, with a considerable increase in weight.

It is necessary, therefore, to restrict the backing power of turbines to that actually required by tactical considerations. The intention has been to provide a backing power estimated at 50 percent of the ahead power. In practice, however, the backing power of turbine vessels has been found not to exceed 40 percent of the ahead power.

Trials have recently been held with the three scout cruisers to determine the sufficiency of the backing power provided by Parsons and by Curtis turbines, as compared with that obtained by reciprocating engines. The basis of comparison has been taken as the distance ahead reached by the vessel during the interval required to bring her dead in the water from a given speed ahead.

These trials were conducted with great care and thoroughness, the condition of displacement, sea speed, and number of boilers in use, were practically identical for all, and the results may be taken as an authoritative indication of the relative backing powers of the three types of machinery as now installed.

The speeds selected for the trials were 10, 16, 22 and 24 knots. Three runs were made by each vessel at each of the two lower speeds, two runs at 22 knots, and one run at the high speeds. At each speed only the boilers required for a sustained run at this speed were used.

There was no bottling up of steam preparatory to backing, and no speeding up of blowers during the backing interval. It was required that the boiler pressure be not reduced to such extent as to cause priming.

It was found that at all speeds the reciprocating engine provides better backing power than the Curtis turbines, and that the latter is superior to the Parsons turbine.

* Abstract of a lecture delivered at the Naval War College at Newport, R. I., August, 1910.

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The commanding officer of the *Chester* (with Parsons turbines) states: "However, under all the usual experiences of service, I have felt, during the past four months' experience, no uneasiness as to the adequacy of the backing power, provided I always had six boilers in operation." The *Chester* has twelve boilers, and on the trials six were used at 10 knots with natural draft.

The adequacy of the *Chester's* backing power is, I believe, debatable, and I submit it to you gentlemen, it being a tactical rather than an engineering question.

Similar trials are to be carried out with the *North Dakota* and *Delaware*.

The British battleship *Dreadnought*, displacing 17,900 tons, and with 23,000 shaft horsepower in Parsons turbines, at a speed of 20 knots, was stopped in three minutes in 5.9 ship lengths, and at 12 knots in 4.2 ship lengths, the time for the latter speed not being given.

The strategical features governing the design of naval machinery are quite different in the case of other nations with whose vessels ours are ordinarily compared. Certain European nations, for instance, are building fleets for service in the North Sea. Their probable enemies are close at hand, the probable sphere of their naval activities is limited, and, as a result, their fleets must be prepared to make short changes of base at high speed. The result is apparent in recent British designs, in which the predominant features are high speed and simplicity of machinery, at the expense of cruising radius. For their purpose the increased economy gained by the use of cruising turbines is not justified by the increased weight, space and complexity involved.

We, however, must build our ships for service beyond the seas. Economy of fuel at cruising speed is to us of paramount importance, and our problem becomes the difficult one of combining a maximum of cruising radius with an ability to make the speed required by tactical considerations.

This extends even to our destroyers. Their cruising radius should approximate that of the battleship fleet, and this at a sustained speed of 15 knots. We are now considering in the designs of the new destroyers methods of reducing their steam consumption at 15 knots, in an endeavor to build up their cruising radius at this speed. Two methods present themselves. In the one the cruising turbines hitherto shown in our three-shaft destroyers are replaced by small high-speed turbines connected by mechanical reduction gear to the low-pressure shafts. A clutch coupling is interposed to permit throwing out the cruising element at the highest speeds and when backing. The small turbine works the steam from the boiler pressure down to about atmospheric pressure, and exhausts through the main turbines, the power at 15 knots being about equally divided between the three shafts.

The other proposition is to install a small reciprocating engine in place of the high-speed turbine and reduction gear. On account of the low power required for 15 knots (about 450 horsepower on each shaft), and because of the comparatively high efficiency of the reciprocating engine when working in the range of pressure presented, the design of an engine which will be satisfactory on service is by no means difficult. A moderate piston speed and forced lubrication can be provided which should insure ease of upkeep.

Either of these proposed cruising elements can be installed within the weight and space of the cruising turbines hitherto used, and each method promises an improvement in economy of about 20 percent. The resulting increase in cruising radius may justify the departure from simplicity of plant entailed by the employment of one of these methods, particularly since total disability of the cruising elements would still leave a full-powered plant.

PROSPECTIVE DEVELOPMENTS IN METHODS OF PROPULSION.

Although there have been marked improvements in the design of recent turbine machinery, an all-turbine installation in a battleship is still unsatisfactory as regards economy of coal at cruising speeds, due to the inefficiency of the turbine at low peripheral speeds. There is, therefore, a well-defined need for a method of propulsion which, at cruising speeds, will allow a high-speed turbine to drive a slowly-revolving propeller shaft, thus conserving both turbine and propeller efficiencies. It is probable that three methods of propulsion radically different from existing types and all aiming to accomplish this end will be tried within the next two years.

HIGH-SPEED MARINE STEAM TURBINE WITH REDUCTION GEAR.

This form of drive is to be installed in the collier *Neptune*, building at the works of the Maryland Steel Company, Sparrows Point, Md. She is to be a twin-screw vessel, similar to the *Cyclops*, displacing 19,360 tons, with a speed of 14 knots. Steam at pressure of 200 pounds will be supplied by three double-end Scotch boilers to a Westinghouse-Parsons turbine for each shaft, each turbine developing about 4,000 shaft horsepower on 1,500 revolutions at full power. Between each turbine and its propeller shaft is to be interposed a Melville-Macalpine gear, reducing the propeller speeds to 135 revolutions per minute at 14 knots. Low speeds are obtained by slowing down the turbine, and astern turbines are provided for backing.

It is expected that, incidental to the trial of this method of propulsion, the installation in the collier will afford an opportunity to benefit by the broad experience of the Westinghouse Company in the development of details of the work. For instance, it is proposed to adapt the company's electro-pneumatic railway-switch-operating mechanism to permit the operation of the machinery from the bridge. Again, the installation will permit a trial of the Leblanc air pump, as used by the company in its commercial work, and of radical changes in design and construction of the Parsons turbine.

This installation is being made on very liberal terms to the Government, the cost being that of the reciprocating engines originally contemplated, and the Government being duly guaranteed against possible failure.

The principal points to be developed with this installation are the extent of wear on the gears, quietness of operation, and the adaptability of the gears for reversing. In shop tests the gear has transmitted 4,500 shaft horsepower for 40 hours, with an efficiency in excess of 98 percent, and with no apparent tendency to wear.

EMMET'S METHOD OF ELECTRIC PROPULSION.

Mr. W. L. R. Emmet, an engineer of the General Electric Company, has submitted a form of electric propulsion in which General Electric high-speed turbo-generators drive motors on the propeller shafts at speeds considered proper for propeller efficiency. He estimates an efficiency of transmission of 94 percent. His installation in a battleship contemplates two turbo-generators driving four motors on two main shafts. By this multiplicity of units, combined with pole-changing devices on two of the motors, an economy close to the maximum is promised at all speeds above ten knots.

In the case of a collier, whose cruising speed would probably be near her maximum, the installation proposed consists of two generators and two motors, one on each propeller shaft. The motors would not be arranged for pole-changing, but would be equipped with resistance for reversing. At speeds below 11 knots one generator would be used on both motors. At a speed of 14 knots a water rate of 12.6

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pounds per shaft horsepower per hour is promised, and at 10 knots the water rate is stated to be less than 15 pounds.

It is hoped that this method of propulsion may be installed in a collier authorized by the last Congress, similar to the *Neptune*, under conditions similar to those governing the Westinghouse installation in the latter vessel.

Although many of the features of the electric drive proposed by Mr. Emmet have been developed as the result of actual installations in shore plants, there are so many novel features involved that the system will require careful scrutiny before its use in an important vessel is considered. It is difficult to predict what disadvantages, if any, will be found, but the following points will be the subject of special investigation in the trial installation:

(*a*) Weight as compared with all-turbine drive.

(*b*) Ventilation of the generators and motors, there being considerable heat generated in the armatures.

(*c*) Cooling of resistances. Under certain conditions there are large quantities of heat to be suddenly dissipated from the resistances.

(*d*) The possible failure of the machines, or parts of the machines, due to access of water.

(*e*) Complexity of accessories—switches, pole-changing devices, resistances, etc.

(*f*) The degree of delicacy of speed control.

(*g*) The effect on chronometers, compasses, and personnel of grounds, the tension being in excess of 2,000 volts.

THE MAVOR AND COULSON SYSTEM OF ELECTRIC DRIVE.

This system is based on an ingenious spinner motor, which gives three speeds in either direction at maximum motor efficiency, control being had from two double-throw switches.

The motor consists of an ordinary squirrel-cage rotor on the main shaft. Concentric with the rotor and around it, adapted to revolve freely on extensions of the main-shaft bearings, is a spinner, provided with a brake. On its inside surface the spinner is wound to drive the rotor, while on its outside periphery the spinner has a squirrel-cage winding that enables it, in turn, to be driven as a motor by a surrounding stator built into the ship. Thus the machine consists of two motors concentrically arranged around a common axis, either of which may be made to revolve in either direction, or the spinner may be held by the brake while the rotor is revolving. The speed of the spinner, in this manner, may be added to or subtracted from that of the rotor, giving three speeds in either direction without the use of resistances in the rotor circuit, without varying the periodicity of the main circuit and without pole changing. The relative speeds of the rotor and spinner are determined by the number of the poles in the spinner and stator.

In the case of a battleship similar to the *Florida*, this method would contemplate a three-shaft arrangement, developing 30,000 electrical horsepower at 150 revolutions per minute. The estimated loss in transmission in dynamos and motors is 10 percent, which, it is claimed, would be more than compensated for by the gain in turbine and propeller efficiencies.

The turbo-generators would have a speed of 1,200 revolution per minute. The rotor revolves at 90 revolutions per minute, the stator at 60. The three speeds at which maximum efficiency would be obtained are, therefore, 30, 90, and 150 revolutions per minute, corresponding, respectively, to steerage way, to 10 knots, and to 20.5 knots.

The equipment would weigh considerably more than an all-turbine arrangement. The overall diameter of motors would be 15 feet.

It is reported that an installation of bituminous producer-gas engines, driving generators for this method of propulsion, is to be installed on a cargo vessel on the Great Lakes during the present year. No reliable data concerning this installation have been received. Its development will be followed with great interest.

NUMBER OF PROPELLER SHAFTS.

Having definitely abandoned the single screw for all important vessels, it is almost axiomatic that an arrangement of propelling machinery on two shafts is the best that remains, for reasons of simplicity and of propeller efficiencies. But we are sometimes forced into a three or four shaft arrangement for reaction-turbine ships by the excessive length of engine room which otherwise would be required. This is not without advantages, however, in the case of overhaul afforded by the smaller turbines and in the minimizing of the effect, on the total propulsive power of the vessel, of damage to one of the units.

As between three shafts and four shafts the latter are preferred for large vessels, on account of the probability of better propeller efficiencies. Our lack of experience renders the design of the center propeller in a three-shaft arrangement rather difficult. The proximity of this propeller to the hull and the likelihood of its being robbed of its water by the wing propellers introduces an element of uncertainty as to its efficiency. It is probable that when properly designed and located three screws will give almost the same efficiency as two or four, yet there are startling instances of trials of triple-screw vessels in which the best speeds were obtained with the center screw idle. We have rejected the three-shaft arrangement for the new battleships, because with reaction turbines the four-shaft arrangement requires a shorter engine room. With impulse turbines the two-shaft design gives more room and greater simplicity on less weight; but, in case we go to higher powers in our future battleships, three screws will probably be necessary in order to avoid excessively large units.

In the case of destroyers we use three shafts for Parsons turbines and two shafts for the Curtis and Zoelly turbines.

INTERNAL-COMBUSTION ENGINES.

Tests have recently been completed at the Norfolk Navy Yard of internal-combustion engines for launches. Nineteen representative makers submitted engines for the tests. Each engine was tested for four or five days in the shop, and an equal length of time in a 40-foot launch.

As a result of these tests, eight 4-cycle gasoline (petrol) engines and one 2-cycle kerosene (paraffin) engine were found suitable for naval use.

A gasoline (petrol) engine, to be sufficiently reliable for service use, must be of heavy construction and securely mounted in a heavily-built boat. It has been conclusively demonstrated that a lightly-built high-speed engine, however carefully built and operated, will not serve. A 4-cycle engine should weigh not less than 45 pounds per horsepower, and the 2-cycle engine (for small powers) not less than 35 pounds per horsepower. The revolutions should not be much greater than 500 per minute.

Designs are being prepared in the Bureau of Steam Engineering for standard gasoline (petrol) engines for service use. It is probable that eventually the heavy-oil engine will displace the gasoline (petrol) engine on account of the danger incident to keeping gasoline (petrol) on board ship. The department is bending every effort towards the development of an oil engine suitable for small boats.

The use of internal-combustion engines for propulsion of large vessels has long been an attractive subject to naval engineers. Such engines have shown marked economy in large units on shore with constant load when run by producer gas. We are often asked why we do not use such engines in naval vessels. The variations in load, the provision that must be

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made for reversing, and the necessity for a control of speed in a marine installation, sufficiently delicate for maneuvering, present difficulties that have not thus far been successfully met. There are difficulties, too, in connection with the design of a producer suitable for bituminous coal. The size of gas-engine cylinders suitable for marine work is at present limited to about 100 horsepower on account of temperature difficulties in larger cylinders. Thus, in the present state of the art, an installation for one of the new battleships would require 320 cylinders, and, needless to say, limitations of space alone would prohibit such an installation. With a gas engine, too, the cylinders are absolutely independent, one of the other; there is no mutual understanding, as with the cylinders of a steam engine, in which each cylinder is very much concerned with the performance of its neighbors. For this reason the problem of simultaneously reversing all the cylinders of a gas engine is a difficult one.

The British gunboat *Rattler* was in commission for about eight months, with an anthracite producer supplying gas to a 5-cylinder, 500 horsepower single-acting engine, making 120 revolutions per minute, exhausting into the smokestack. Speed could not be reduced below 65 turns. A hydraulic clutch was used for reversing; this wore badly and was unsatisfactory. The weight of the installation was greater than that of a steam plant of equal power.

At present, therefore, internal-combustion engines are unsuited for marine installations of greater than 1,000 horsepower, and in small installations are justified only in special cases. There is, however, prospect of a considerable improvement in the design of bituminous producers, and a well-directed effort to overcome the difficulties which I have enumerated, so that the subject is still very much alive.

Our experience with internal-combustion engines in launches is that their maintenance is very expensive, amounting to 35 percent per annum of the original cost.

In the British and German navies, heavy-oil engines are used to drive a portion of the dynamo plant on some of the recent vessels. Such an arrangement permits the lighting and ventilation of the ship when, for purposes of overhaul, all boilers are cold.

With us, however, this contingency is so remote that the use of internal-combustion dynamo engines has not been justified. Our principal navy yards are all capable of furnishing current to ships whose dynamo plants are disabled.

OIL-BURNING BATTLESHIPS.

Our experience with liquid fuel, while limited, has been sufficient to convice me that, considered from an engineering point of view, the expediency of its use in battleships to the exclusion of coal is clearly indicated.

The principal argument advanced against the use of liquid fuel, in large vessels, is the alleged difficulty and uncertainty of obtaining it in the seaports of the world. This is a strategical question, and belongs to you gentlemen rather than to me, but I will discuss it very briefly. New oil fields are being developed in many localities where until recently they were unknown. The Argentine Government has directed the installation of oil burning as an auxiliary in their battleships that are being built in this country, and in connection with this appears the statement that large oil fields have recently been discovered in Patagonia. California produces an excellent grade of fuel oil, but we are sending Pocahontas coal around the Horn for use in our vessels on the West Coast. I have seen the statement that the new oil fields in Oklahoma produced last year an amount of oil equal to twice the coal burned by the United States navy during the same time.

The United States produces more than half the world's oil supply, and it is being shipped abroad for use as fuel in the vessels of foreign navies. It would appear that fear of difficulty in obtaining oil should not seriously interfere with the adoption of this ideal fuel for use in United States naval vessels.

In time of war we must depend on the fuel stored at our naval bases or carried in our cargo vessels; and it is easier to store and carry oil than coal. With the Panama Canal completed, oiling stations at our possessions in the Pacific, together with some oil-carrying vessels, would afford a certainty of fuel supply at least equal to that now provided for coal.

It should be remembered that all our future destroyers will probably be oil burners, and that their work is with the battle fleet. Thus we are already committed to the establishment of means of supplying oil for the destroyers at all bases at which it would be required by battleships.

That oil-burning battleships have not been advocated more seriously abroad is due entirely to the fact that, with the exception of Russia, no European nation has a supply of oil that can be depended on in time of war. It is logical, therefore, that our nation, producing, as it does, more than one-half the world's supply of fuel oil, should be the first to accept the great military advantages of oil-burning battleships. These advantages have been argued so often that I will not dwell upon them now. Briefly, with liquid fuel, we can:

(*a*) Reduce the weights and space required for boilers.

(*b*) Reduce the fireroom personnel.

(*c*) Eliminate ashes and cinders, and practically eliminate smoke.

(*d*) Increase the cruising radius.

The principal advantage, from a military point of view, of oil burning in a turbine-driven vessel, lies in the ability of such a vessel to be driven at full power with but slightly greater effort on the part of the personnel than at low speed, and in the fact that full speed can be maintained for periods limited only by the supply of fuel.

I wish to place myself emphatically on record as advocating oil-burning battleships for our service.

IMPROVEMENTS IN ECONOMY ON BATTLESHIP FLEET.

In comparing the present coal consumption of the battleship fleet, which means its cruising radius, we will use as a standard that shown on the cruise of the battle fleet from San Francisco to Hampton Roads, during which, as you will remember, a considerable improvement was shown over the first leg of the world cruise.

The average coal consumption per knot of the battle fleet at present, referred to a standard speed, is 6 percent better than that of the best ship on the world cruise.

The average coal consumption per knot of the battle fleet at present, at 12 knots, is practically the same as that at 10 knots on the world cruise.

Since the world cruise there has been an improvement in coal consumption per knot in the battle fleet of 20 percent.

There is a similar improvement in the small vessels of the service.

The armored cruisers have apparently not improved, but are burning a little over 1 percent more coal per knot than last year.

In consumption of lubricating oil per knot there has been an improvement of 8 percent from December, 1909, to April, 1910, over that of the preceding year for all vessels of the navy. The average cost per knot of lubricating oil for all vessels is now 3.9 cents. This is not as good as the best merchant practice, but is constantly being improved. Our best ships cost less than one cent per knot.

As illustrating the ability of ships to maintain themselves, the cost of repairs due to casualties was four-tenths of a

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cent per horsepower during the last year. The cost of new machinery and boilers for naval vessels, included under the head of "navy yard repairs and changes," was 53 cents per horsepower during this period.

Including the power of the auxiliary machinery the average cost of developing one horsepower in the navy is now about 2.04 pounds of coal per hour. This includes all expenditures of coal for whatever purpose, and also includes all power developed for whatever purpose. The figure is the average result, as shown by the steam logs of vessels in service. The ratio between the average power developed and the maximum power of naval vessels is extremely low as compared with any economical commercial practice. Considering this low-power factor the present result is not bad. The coal efficiency compares very favorably with that obtained under steaming conditions elsewhere. According to reports received, in one very large navy the cost in coal of developing a horsepower-hour is 25 percent greater than in the United States navy. These improvements in coal economy have been principally due to the following causes:

(*a*) *The converting of evaporating plants from single to double effect.* The power to distil fresh water sufficient for all purposes is a most essential feature in self-maintenance, and especially so if engaged in a compaign. The economy in making water simply means that the radius of action is increased accordingly. The gain in economy from the use of the double effect is theoretically 48 percent. Actual gains of from 35 to 40 percent are obtained. There is no appreciable reduction in the capacity of the plant.

(*b*) *More careful and systematic firing, induced by analysis of smoke-pipe gases.* Most of the larger ships have been equipped with apparatus for sampling smoke-pipe gases, and determining the proportion of CO_2 therein. It is found that the percentage of CO_2 gives an accurate measure of the efficiency of combustion when coal is used as fuel. The principal furnace loss is the heat in the excess air which passes up the funnel. With a CO_2 percentage of 14, a condition of maximum efficiency is obtained in which there is no excess of air. Should this drop to 5 percent, as was the condition in many of our ships when this apparatus was first installed, there is a loss in efficiency of 24 percent, due to excess air. In some of the ships a record of the CO_2 percentage of each fireman is kept, and the ability of the fireman is rated thereby. On one ship, where this system is followed, it was found that the number of buckets of coal required per watch varied progressively from 30.5, with a CO_2 percentage of 11.9 to 34.4, with a percentage of 9.0, the amount of steam generated remaining the same. One of the first things learned by gas analysis was that our boiler casings leaked air. These have been made tight, with a corresponding saving in coal, reported in some cases to amount to as much as eight percent.

(*c*) *The tightening of the pressure parts of boilers, particularly the bottom-blow valves.* A new type of valve has been fitted on the larger ships during the past year, which removes a serious source of loss that has hitherto existed, due to the inability to keep the valves of the old type tight.

(*d*) *More efficient propellers* have been fitted on the *Kansas* and *North Carolina*, and are being made for the *Mississippi* and *Vermont*. As soon as accurate data on the efficiency of existing propellers under service conditions can be obtained, it is hoped to improve the efficiency of the fleet as a whole by replacing those propellers which are least efficient at cruising speeds.

(*e*) *Greater attention to steam traps.* It is found that leaky traps have in the past caused considerable losses.

(*f*) *A more careful attention to auxiliary machinery, particularly to the condition of the valves and steam cylinders.* In a battleship at cruising speed, one-third of all the steam generated by the boilers is used in the auxiliaries.

As the service in general fully realizes, smokeless combustion is greatly to be desired, and, while we have made some progress along this line, notably in the new coal-burning destroyers, still the problem has not been solved as yet. There are a number of smoke-consuming devices on the market, but we have been unable to find one that is even fairly efficient in a shore plant, and practically all are prohibitive in service installations because of confined space and high rate of combustion, and especially from the fact that nearly every one of them requires the expenditure of considerable steam for its operation.

FULL-POWER TRIALS OF BATTLESHIPS.

Full-power trials of the battleships were held off Guantanamo last winter, as compared with their trial performances.

With the exception of weakness in the feed pumps and blowers of three of the ships the trials were most satisfactory. Omitting these vessels, the fleet, with an average displacement 830 tons greater than on contract trial, developed an average speed .449 knot greater than the designed speed, and .066 knot greater than the average contract trial speeds.

On these trials the main engines withstood overloads amounting, in the case of one ship, to 40 percent, in excess of the designed load.

An interesting feature, developed by the trials is the improved propeller efficiency of the *Virginia* and *Louisiana*, whose engines were changed from in-turning to out-turning shortly before the trials.

COMPARISON OF MEASURED-MILE COURSES AT ROCKLAND, PROVINCETOWN AND DELAWARE BREAKWATER.

The Board of Inspection and Survey for Ships has recently held exhaustive comparative trials of the *Michigan*, *Reid* and *Flusser* over the measured-mile courses at Rockland, Provincetown and Delaware Breakwater, to determine the effect of depth on speed.

The depth on the Rockland course varies from 330 to 480 feet; that at Provincetown from 150 to 160 feet, and at Delaware Breakwater from 135 to 150 feet.

These trials indicate that the *Michigan*, with 16,000 tons displacement and 24 feet 6 inches mean draft, requires about 1,900 less indicated horsepower for a speed of 19 knots on the Rockland course than at the Delaware Breakwater, and somewhat less power for this speed at Provincetown than at the Breakwater. There is a corresponding effect in the case of destroyers. The *Reid*, displacing 700 tons, and with a mean draft of 8 feet ½ inch, requires for a speed of 31 knots about 1,000 less shaft horsepower at Rockland than at the Breakwater, and less at Provincetown than at the course in Delaware Bay.

REPAIR SHIP.

Our battleship fleet is, to a greater degree than ever before, self-sustaining as regards repairs to engineering material. This is evident in a decreased amount of navy-yard work. The machine-tool equipment of many of the ships has been increased to as great a degree as is possible within the limitations of space available. In some of the ships small cupolas capable of melting 100 pounds of brass and 60 pounds of iron have been improvised, and have proved very valuable for the manufacture of small castings not subject to much stress. A standard oil-burning furnace will be supplied to all the larger ships.

The repair ship *Panther* has rendered most valuable aid to the fleet and has done much of the work heretofore done at the yards.

For times of war, however, when the ability of the fleet to be self-sustaining may be of the utmost strategic importance, our facilities for repairs are hopelessly inadequate. Realizing

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this, there have been prepared designs of a proposed repair ship of 13,500 tons displacement and 14 knots speed, with an equipment which will enable it to—

(*a*) Make patterns and castings up to four tons in weight. This includes all iron castings for small vessels, and, in case of a battleship, all except main cylinders and turbine casings. (These, in any event, would be repaired by a welding process.)

(*b*) Forge anything on board ship except main shafting.

(*c*) Roll and bend any plate that may be required for the hull or for boiler drums.

(*d*) Build up lengths of copper piping, and repair and tin defective piping.

(*e*) Do any required machining.

(*f*) Carry all materials for the prosecution of this work.

The proportion of foundry and forge equipment is such as to provide sufficient material for its own machine shop and for the machine-shops of all vessels of the fleet. Thus, in emergencies, all the equipment of the individual ships, as well as that of the repair ship, could be run at full capacity.

The design of the repair ship provides for convenient and efficient handling of material progressively from its raw condition through the process of casting, forging and machining in well lighted shops.

The acquisition of such a vessel is of vital military importance to the fleet, in that it will, in time of war, enable the fleet to repair damages sustained in action to a sufficient extent to render it seaworthy and capable of renewing action. In time of war or peace it will render the fleet self-sustaining as regards all repair work to machinery, hull or ordnance equipments, except that necessitated in general refitting.

The experience of the world cruise of the battle fleet demonstrated rather conclusively that extensive cruising does not of itself contribute to deterioration of steam machinery, provided the nature of the cruising is such that fixed periods for periodic overhaul are provided.

It has been too frequently the case that in arranging itineries no attention has been paid to this point, and in many cases commanding officers hesitate at allowing disablement of the main engines for periods greater than twenty-four hours, although such disablement is required in the interests of an efficient maintenance of the plant.

An instance of this has recently developed in the case of two armored cruisers which reqnire such extensive repairs in their engineer department as to render it necessary to lay them up for a period extending over several months. Until these repairs are completed these ships are without strategic value as a component part of the fleet. The present condition of the machinery of these vessels can best be described as generally run down. This is due in great degree to the nature of service to which they have been subjected—extensive cruising with improper spacing of overhaul intervals.

Undoubtedly, our most important duty as regards the machinery of the fleet is that of upkeep—the taking of the proverbial stitch in time which will prevent the accumulation of trouble in such quantities as to disable the fleet as a fighting unit.

This, however, requires co-operation, such as is being accomplished under the present organization.

BOILERS.

The question of the type of boiler for future battleships is one that is receiving due attention. The present Babcock & Wilcox boiler is giving satisfaction, and that company has recently completed an exhaustive series of tests of a sample boiler for the *Wyoming* and *Arkansas*. In these tests the boiler more than meets every guarantee, and, in fact, attains improved economics of evaporation at all rates of combustion. The boiler stood further test of forcing under five inches of air pressure, burning 70 pounds of coal per square foot of grate surface; all without signs of damage.

Notwithstanding all this, there is a growing sentiment favoring the small-tube express type of boiler for battleships, as giving more elasticity in forcing, especially in a turbine installation, as well as saving weight, on almost the same economy. The Experimental Station at Anapolis has been engaged in research work for more than a year, with considerable success, in an endeavor to determine proper methods and materials for the interior preservation of our boilers. This, of course, is quite essential if we adopt small or bent tubes in boilers.

In-swinging furnace doors have been fitted on all the battleships and are rapidly being installed in other naval vessels. The design of these doors is such as to cause them to close automatically in the event of a ruptured tube. Already, in the *Georgia*, they have prevented serious injury to the fireroom force.

Mosher boilers are being installed in the battleships *Kearsarge*, *Kentucky* and *Illinois*, to replace their Scotch boilers. The contract for these boilers calls for a guaranteed evaporation of 11¼ pounds of water per hour per pound of combustible at full power, when burning 40 pounds of coal per square foot of grate.

The difficulties heretofore existent with the reciprocating engines of forced-draft blowers have been overcome by the adoption of turbine-driven blowers for destroyers and motor-driven blowers for battleships.

Our new destroyers, propelled by turbines, with liquid fuel and turbine-driven fans, are provided with a machinery installation from which most of the frailties hitherto existent on vessels of this type are eliminated, and which should render them capable of running at full power at any time on demand and for periods limited only by the fuel supply.

Turbine-driven centrifugal feed pumps are being developed and, although at present they are somewhat handicapped by excessive weight and space required, it is probable that these disadvantages will be overcome to a sufficient extent to allow us to show them in new designs. Experience with these pumps in shore plants indicates that they are less prone to disablement than reciprocating pumps.

In conclusion, I will say that engineering in our naval service is to-day in a position more nearly commensurate with its importance to the fleet than seemed possible a few years ago. This is due in part to the enthusiastic efforts of the younger line officers who in recent years have operated our machinery afloat, more to the legacy of experience, ability and good will from the old Engineer Corps, but is principally the result of an appreciation of the importance of engineering on the part of the older officers in the service, who, in responsible administrative positions, both in the Department and in the Fleet, under our able Secretary, are welding the personnel and matériel of engineering into the organization of the fleet in such manner as cannot fail to produce perfect homogeneity.

Lloyd's Annual Report.

According to the annual report of *Lloyd's Register of Shipping*, for the year 1909-1910, classes were assigned to 540 new vessels, the total gross tonnage of which was 929,946. Of this new construction 66 percent was built for the United Kingdom, and 34 percent for the British Colonies and foreign countries. Over 90 percent of the new vessels were steamers. Few features of exceptional interest from the point of view of the designer are mentioned, the most noteworthy being, perhaps, the increase in the number of vessels built on the Isherwood system of longitudinal construction. Up to the present time forty-three vessels of this type have been approved for classification by the society.

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A TANK STEAMER FOR THE MOLASSES TRADE.

There has just been completed at the yards of the Fore River Shipbuilding Company, Quincy, Mass., the steamer *Currier*, named for Mr. Guy W. Currier, of the well-known law firm of Currier, Rollins, Young & Pillsbury, of Boston, and specially designed for the Cuba Distilling Company, of New York, to run between Cuba, Porto Rico and New York in the molasses trade.

The *Currier* is a single-screw steamer with the machinery located aft, constructed of steel to the highest class in Lloyd's Register, being specially surveyed under construction by the officers of that society to obtain the Class 100-A-1, and specially designed to operate in either the molasses, bulk petroleum or general freight trades, a combination rarely met with in vessels of this type. To provide for the safety of the vessel and crew the most modern methods and equipment are employed, including wireless telegraph and submarine signals.

The principal dimensions are as follows:

Length from fore-side of stem to after-side of rudder post	370 feet
Beam, molded	52 feet
Depth, molded to upper deck	30 feet
Load draft	23 feet
Gross tonnage	4,711
Net tonnage	1,841

GENERAL ARRANGEMENT.

The general arrangement and scantlings of the vessel are shown on the accompanying deck plans and section.

She has a straight stem, semi-elliptical stern, two continuous steel decks, and a full poop, bridge and topgallant forecastle.

Accommodations are provided in the 'midship house for the officers, with saloon, guest room, pantry, bath and toilets, and on the bridge deck is a specially arranged suite of rooms for the captain, having a commodious pilot house and chart house over same. In the 'midship house there is a room fitted up for the wireless telegraph outfit.

The long poop encloses quarters for the firemen, seamen, oilers and petty officers, and in the Liverpool house on the poop deck are arranged the quarters for the engineers, with officers' and engineers' mess, bath and toilet. The crew of the *Currier* comprises forty men.

The general arrangement of the ship consists of five double tanks bounded by transverse and centerline bulkheads, with a general cargo hold forward and aft of these tanks, the machinery being placed right aft and separated from the after cargo hold by a cross bunker. The main tanks are isolated at the forward and after ends by cofferdams extending the full depth of the ship and by a continuous inner bottom 4 feet deep, which is fitted as far forward and aft as practicable. These tanks may be utilized for the transportation of either molasses or bulk petroleum oil, a special pumping system having been installed for loading and discharging liquid cargo, and a steam-heating system for liquefying the cargo as well as to efficiently clean all the spaces by steam.

The total capacity for stowing molasses is 138,000 cubic feet, representing over 1,000,000 gallons of molasses. When used as a bulk petroleum carrier the vessel has a capacity, with oil carried in the tanks and inner bottom, of 1,400,000 gallons, with the usual allowance in the expansion trunk to take up the expansion of the oil.

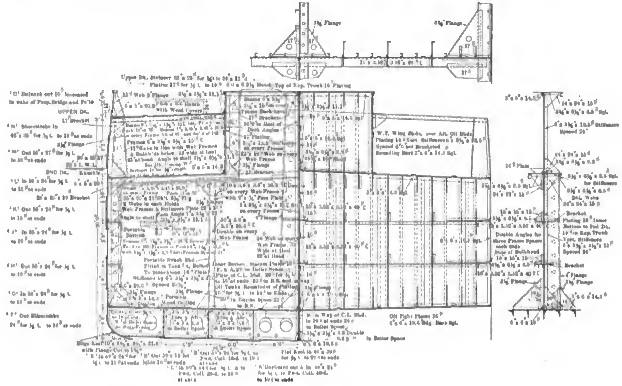
STEAMSHIP CURRIER, BUILT BY THE FORE RIVER SHIPBUILDING COMPANY FOR THE CUBA DISTILLING COMPANY.

If it is desired to operate this vessel as a general cargo and freight steamer, freight may be carried in the five molasses tanks by removing the portable swash bulkhead, after cleaning out the tanks by steam. The cargo may be handled through steel cargo hatches 8 feet 3 inches by 5 feet. The wing compartments may also be used for freight space, operating through 8 feet 6-inch by 6 feet 6-inch hatches fitted with wooden covers. In addition to this, two large cargo holds occupy the forward and after boundaries of the tanks, these holds having steel cargo hatches 8 feet 6 inches by 20 feet.

The total cargo space avilable for stowage of general freight is about 255,000 cubic feet, and on 23 feet mean draft, with the vessel carrying 1,000 tons of bunker coal, feed water and stores, a dead-weight cargo of 5,800 tons may be carried.

The vessel is rigged with three pole masts, the fore and main mast being of steel and the mizzen mast of wood. The cargo booms consist of four 53-foot and four 40-foot wood derricks, each capable of working a load of 5 tons. A complete suit of sails is provided for the vessel, comprising fore and main sails and stay sails.

The poop deck from the front of house and bridge deck is laid with 3-inch by 5-inch clear, long-leaf yellow pine, having a 10-inch margin plank worked in way of deck house and waterway. The flats of cargo holds are laid out with 2½-

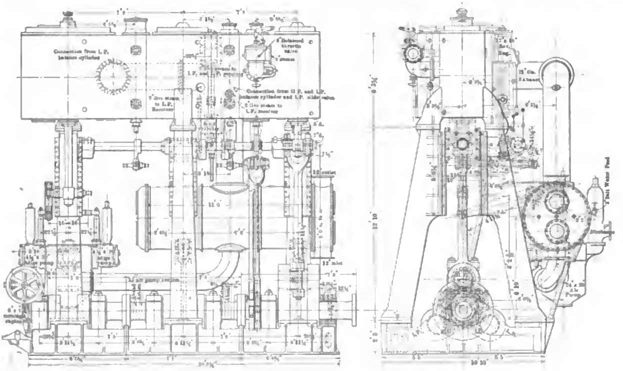


MIDSHIP SECTION OF THE CURRIER.

inch yellow pine ceiling in portable shutters, and portable sparring is fitted for sides of vessel for general cargoes.

The joiner work and furniture in quarters is finished generally in oak. Transoms and seats are upholstered in leather. The floors in officers' quarters are covered with linoleum. The galley floor is laid in unfinished red tile, and the bath rooms in ceramic tile. The pilot-house and chart room are built of teak.

The sanitary arrangements are very complete, flowing water being supplied to all fixtures. The salt water is kept under pressure by a salt-water sanitary pump, while the fresh water



MAIN ENGINES OF THE CURRIER, SHOWING CONDENSER AND PUMP CONNECTIONS.

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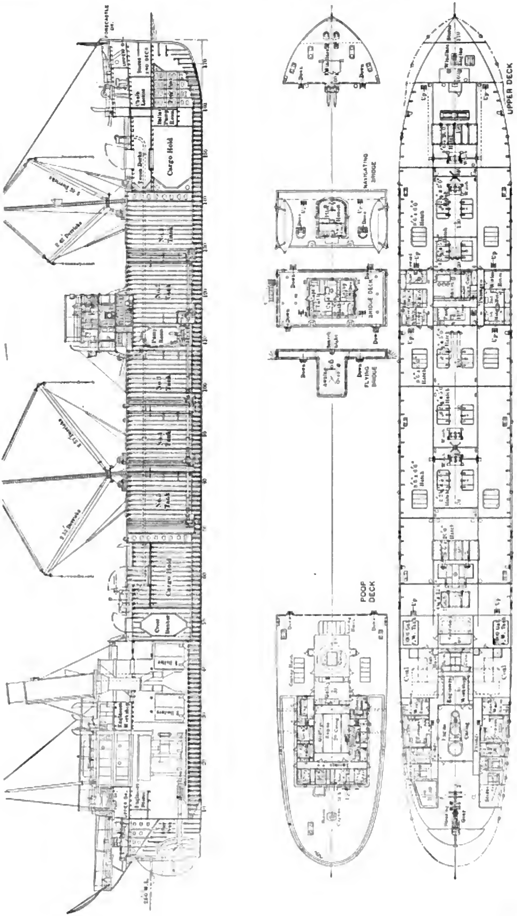

INBOARD PROFILE AND DECK PLANS OF THE TANK STEAMER CURRIER.

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flows by gravity from a daily service tank supplied by the fresh-water sanitary pump. The officers' lavatories are supplied with hot as well as cold water.

In addition to the usual ventilators for the engine-room and fire-room, of which there are two 21-inch for the former and two 36-inch for the latter, at each cargo hold, there are installed four 18-inch ventilators and two for the pump-room. Cast iron swan-neck ventilators are also fitted on top of expansion trunks.

The life-saving outfit consists of two 24-foot wooden lifeboats, one 16-foot wooden dinghy and one 20-foot wooden gig, fitted with gasoline engine. The lifeboats are handled by the ordinary round-bar davits, and the dinghy and gig handled by davits of the Mallory type.

DECK MACHINERY.

The steering gear is of the Hyde steam screw gear type, with an 8-inch by 8-inch engine, operated through shafting and bevel gears from steering stands in the pilot house on the flying bridge and top of the after-house. Hand wheels for hand steering are direct connected to screw gear in after steering compartment. An emergency steering gear is fitted, by which the vessel may be steered by a tackle leading from a spare tiller to a steam capstan on the poop deck.

A No. 10 Hyde steam brake windlass is located on the forecastle deck, operated by a worm and spindle from a vertical engine on upper deck. The wildcats on the windlass are suitable for 2⅛ inches diameter stud link cable. Large quick operating warping ends are fitted on each side of the windlass.

Four Hyde double drum, double cylinder, reversible steam hoisting winches with cylinders 8 inches diameter by 8 inches stroke are located on deck, for cargo handling purposes. Two of these winches are fitted with extended warping ends.

A Hyde reversible steam capstan of the quick warping type is located aft on the poop deck, operated by an 8-inch by 8-inch engine under the deck.

PUMPING SYSTEM.

The pumping system on the *Currier* for handling liquid cargo was especially designed for pumping heavy viscous liquids such as molasses or oil. The cargo pump is of the Blake horizontal duplex piston type, with steam cylinder 16 inches diameter, pump cylinder 12 inches diameter with 18-inch stroke.

A 14-inch suction main of wrought iron extends through the cargo holds on the port side above the innner bottom, with 12-inch branches extending into suction wells in each tank, each branch being fitted with a brass gate valve and bell mouth suction end.

A 10-inch discharge main of wrought iron pipe extends through the wing compartments below the main deck, on each side with branches leading to each tank, and to overboard discharge connections, forward, amidships and aft.

Sluice valves are fitted in the centerline and transverse bulkheads dividing the main holds, so that the cargo may be trimmed the full length of hold spaces.

The entire system is so arranged that the cargo pump can pump from the cargo tanks and discharge overboard, from storage tanks on shore direct to the cargo tanks, from any cargo tank to any other, from sea to any cargo tank for ballast purposes. The tanks may also be filled through the discharge main.

The vessel is designed primarily to carry molasses in bulk, in which case the double bottom in way of cargo tanks is used for water ballast. In the event of the vessel carrying oil in bulk, the double bottom manhole covers are removed and the double bottom compartments used as a part of the oil cargo space. Portable bolted plates are fitted in the bottom of all molasses suction wells, so that when the vessel is to carry oil these plates may be removed and an extension piece attached to each suction branch, thereby making the branch sufficiently long to pump oil from double bottom compartments.

The forward ballast system consists of a steam pump located in the forward pump room, with a manifold having connections to sea, bilge and forward double bottom compartments.

The after ballast system consists of a steam pump in the engine room, with manifolds having connections to sea, bilges and double bottom. The double bottom compartments under the molasses tanks are so arranged that they may be entirely cut off from the remainder of the ballast system.

The electric lighting plant consists of one 15 kilowatt direct connected General Electric Co. marine generating set, with combined generating and distributing switchboard. The distribution is on the two-wire system and supplies current for one 18-inch searchlight and 150 16-candlepower incandescent lamps in addition to running and signal lights.

The wireless telegraph outfit supplied by the United Wireless Company is installed in the bridge house. In addition, the receiving apparatus of the Submarine Signal Company is provided, nothing having been omitted which would add to the comfort or safety of the vessel or crew.

PROPELLING MACHINERY.

The propelling machinery, located in the stern of the ship, consists of a vertical inverted, three-cylinder, triple expansion engine with cylinders 25-41-68 inches diameter having a stroke of 48 inches, supplied with steam at 190 pounds pressure by three single-ended Scotch boilers working under a heated forced draft system.

The bedplate of the main engine is of the usual box section type of cast iron in three sections, having six main bearings of cast iron lined with white metal. Bearing caps are forged steel. All lower main bearings may be removed while the crank shaft is in position.

The cylinders are supported by six cast iron columns of box section, three front and three back. All crosshead guides are fitted for water circulation.

The crankshaft is of the built-up type, of forged steel throughout, in three interchangeable reversible sections. The diameter of the shaft at the bearings is 13¾ inches. The crank pins are 14 inches diameter by 14 inches long, the crank slabs 25¾ inches wide by 9½ inches thick, and all couplings are 27 inches diameter 3¼ inches thick, joined by six steel bolts.

The cylinders are arranged, beginning at the forward end of the engine, high-pressure, intermediate-pressure and low-pressure. The high-pressure cylinder is fitted with a liner, and the valve is of piston type, 13 inches diameter, taking steam in the middle and exhausting over the ends. The intermediate and low-pressure cylinders are fitted with double ported slide valves working on cast iron false seats. All valves are fitted with balance cylinders for taking weight of valves and gear. In addition, the intermediate-pressure and low-pressure slide valves are fitted with balance rings on the back for relieving pressure on valve seat.

The pistons are of conical form, the high-pressure is of cast iron, while the intermediate-pressnre and low-pressure are cast steel. All pistons are fitted with Mudd's rings and east iron followers. The piston rods are 6 inches diameter, the low-pressure being fitted with a tail rod, 4 inches diameter. Piston rods and valve stems are packed with metallic packing. The forged steel crossheads are secnred to the piston rods by steel nuts, the lower ends of the rods being tapered to fit the crossheads. Crosshead slippers are cast iron faced with white metal and crosshead pins are 7 inches diameter and 7½ inches long. The connecting rods are forged steel, 9 feet between centers. The top and bottom end boxes are cast steel lined

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with white metal, the caps being secured by forged steel binders. The valve gear is of the usual Stephenson double bar link gear type.

An 8-inch balanced throttle valve worked by a hand wheel, and a butterfly valve worked by a hand lever, control the supply of steam to the high-pressure valve chest. The receivers are cast with the cylinders. The main exhaust pipe to the condenser is of copper, 21 inches diameter.

The reversing gear consists of a direct acting steam cylinder, 12 inches diameter and 18 inches stroke, secured to the back of the intermediate-pressure cylinder. A reverse shaft, 6½ inches diameter, carried in bearings at the back of the engine, transmits motion from the reverse engine to the links. The cut-off of each valve may be adjusted separately by means of a sliding block working in slotted reverse shaft arms. Smooth action of the reversing engine is secured by a 6-inch diameter piston working in a hydraulic cylinder.

A 6-inch by 6-inch single cylinder turning engine is secured to the after end of the main engine bedplate.

The thrust shaft is 13¾ inches diameter, with nine collars 20 inches diameter, 1⅞ inches thick, forged solid with the shaft. The propeller shaft is 14¾ inches diameter, protected throughout its entire length by composition sleeves shrunk and pinned in place. The propeller is secured to the tapered end of the shaft by a forged steel nut and feather. All shaft couplings are 26 inches diameter 3¼ inches thick, connected by six forged steel bolts 3¼ inches diameter.

The thrust bearing is of the usual horseshoe type having nine adjustable cast iron horseshoes faced with white metal. Each shoe may be adjusted separately, while the entire bearing may be moved fore and aft by means of wedges. The bottom of the pedestal forms an oil chamber into which the collars project. The stern tube bearings are of composition lined with lignumvitae.

The propeller is of the built-up type 16 feet 9 inches diameter, 18 feet pitch, 92.3 square feet developed area, having four adjustable bronze blades secured to a cast iron hub by bronze studs and nuts. The pitch may be adjusted from 17 feet to 19 feet.

AUXILIARIES.

The air pump is of the Edwards type, 24 inches diameter, 20-inch stroke, driven by beams and links from the low-pressure crosshead. The body of the pump is cast iron having a composition liner.

The condenser, placed on brackets at the back of the engine, has a cylindrical steel plate shell with cast iron water chests and covers. There are 1394 ¾-inch brass tubes, 11 feet long, between tube sheets, giving a cooling surface of 3011 square feet. The tube ends are packed in the usual manner with cotton wicking secured by brass glands screwed into rolled composition tube sheets. Circulating water for the condenser is taken from a centrifugal pump of the Fore River type having 12-inch suction discharge. The pump, driven by an 8-inch by 8-inch vertical engine, has the following connections: Suction from sea, and discharge overboard through condenser, also a small connection is fitted to the evaporator.

The following additional pumps are fitted:

Two feed 10-inch by 7-inch by 10-inch vertical duplex Worthington Admiralty type, with suctions from sea, after tank, auxiliary condenser, feed tank and boilers and discharge through the feed-water heater or direct to the boiler through the main or auxiliary feed line, or overboard. The connections are such that either pump can be used independently of the other. When acting as feed pumps they are automatically controlled by a float in the feed tanks.

One ballast, 10-inch by 12-inch by 10-inch vertical duplex, with suction from sea, bilge manifold, ballast manifolds, and from engine and fire-room bilges, and discharge to fire main, ballast manifolds and overboard.

One forward ballast system pump, 8-inch by 8½-inch by 12-inch horizontal duplex.

Two bilge pumps, 4½-inch by 20-inch plunger type, connected to the main air pump crosshead, have suction from the engine and fire-room bilges and bilge manifolds, with discharge overboard.

One salt-water deck service and fire pump, 6-inch by 4-inch by 6-inch horizontal duplex, with suction from sea and discharge to the sanitary system, fire main, deck-washing pipe and engine-water service. This pump is interchangeable with the auxiliary condenser circulating pump.

One fresh-water, 3½-inch by 4-inch by 4-inch horizontal duplex, with suction from fresh-water tanks and discharge to ship's fresh-water system.

One auxiliary condenser circulating, 6-inch by 4-inch by 6-inch, with suction from sea, discharge end of condenser and after tank, and discharge through the auxiliary condenser overboard and deck-service lines.

One cargo pump, 16-inch by 12-inch by 18-inch horizontal duplex.

One 2-inch Hancock injector is fitted, with suction from the reserve feed tank auxiliary condenser and sea discharge to the auxiliary feed line and hose connection.

The vessel is fitted with one double circular stack, 9 feet 6 inches outside diameter and about 80 feet high above the grates.

The boilers are 13 feet 9 inches mean diameter and 11 feet 1 inch long over the heads, arranged in a single fire room. Each boiler has three Morison furnaces, 42 inches inside diameter and three combustion chambers. The tubes are 2½ inches outside diameter. The total heating surface for three boilers is 6,501 square feet, with 154.5 square feet of grate, giving a ratio of about 42 to 1. The grates are about 5 feet long.

Air for the heated forced draft is delivered to the furnaces by a fan located in the fire room and driven by a 6-inch by 5-inch vertical engine working at a steam pressure of 125 pounds. The fan is 84 inches diameter, and at 312 revolutions per minute delivers 24,000 cubic feet of air per minute at a pressure of 3 inches of water. On each uptake there is a heater box containing 193 3¼-inch tubes 3 feet 6 inches long, around which the air passes before entering the furnaces.

An auxiliary condenser containing about 400 square feet of cooling surface is located in the engine room. Circulating water for this condenser is taken from the ballast and sanitary pumps.

A feed-water heater of the Quiggins vertical type is located in the engine room on the discharge side of the feed pumps. The heater has a rated capacity of 2,700 horsepower.

All living quarters of the ship are heated by steam. Radiators constructed of iron pipe are used throughout the ship except in the pilot house, where brass pipe is used.

One 25-ton evaporator of the Blake type is installed in the after end of the engine room. Steam for operating is taken from the auxiliary steam line and the vapor is discharged to the condenser, feed tank, and after tank.

The refrigerating plant consists of a 2-ton Brunswick ammonia compressor, driven by a vertical engine.

Both fire-room ventilators are fitted with sheaves for hoisting ashes. A Hyde double-cylinder ash-hoist engine is fitted for raising ashes to the spar deck, where they are handled on trolley ways on each side of the ship. A hand ash-hoist gear is also fitted.

During the four-hour trial the ship averaged a little over 10½ knots.

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COLUMN TABLES FOR SHIP WORK—III.

BY E. EARLE ANDERSON.

EFFECT OF FORM AND THICKNESS.

The relative dimensions and the form of parts composing the cross-section of a column must necessarily have a considerable influence upon its strength. The matter is one which has rested largely upon the judgment of the designer, and there is an almost entire absence of data, either experimental or theoretical, throwing any light on the subject. All accepted column formulas, including those dealt with in the proceeding sections, contain the area of the section and the radius of gyration, and in some cases the distance to the extreme fiber appears in a secondary manner. No other functions of the cross-section appear. To a person devoid of judgment it would seem that the greater the radius of gyration the smaller might be the area, even to the extent of a radius of gyration approaching infinity with an area approaching zero. Thus, in the case of a tubular column, there is nothing in the formulas to indicate that the efficiency cannot be indefinitely increased by making the diameter very great and the thickness of wall an inappreciable quantity. This is, of course, absurd, but the limit below which it is rational and above which it is absurd unfortunately remains undetermined.

In the case of compression members built of plates and angles or otherwise having webs and flanges there are two rules in existence, both of which appear to be entirely empirical. Johnson's "Framed Structures" (chapter by C. W.

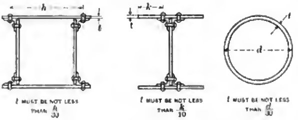

FIG. 4.

Byran) gives a rule for box or latticed columns that when pin-connected the thickness of the web plates normal to the pin should be not less than one-thirtieth the distance between the lines of rivets, and the thickness of the plates parallel to the pin should be not less than one-fortieth the distance between rivets; in the case of square or fixed ended columns both thicknesses are limited to one-thirtieth (Framed Structures, page 253). This rule appears to be based upon Bouscaren's experiments (Trans. Am. Soc. C.E., Vol. IX., page 452).

The American Railway Engineering and Maintenance of Way Association limits the ratio of unsupported width of outstanding parts to ten times the thickness of metal.

While these two rules are empirical and apparently rest more upon a basis of judgment than experiment, they have evidently been acceptable, and have given satisfactory results. For the present purpose they may be stated thus:

In the cross-section of a compression member the thickness of each part must be at least one-thirtieth the breadth of that part between supporting parts, and in the case of outstanding parts at least one-tenth the outstanding breadth (see Fig. 4).

It will be observed that neither of these rules is applicable to a tubular column.

As previously stated, a series of experiments has been made by Prof. W. L. Lilly on the effect of secondary flexure or wrinkling on the strength of columns, with a view to determining the relation between the strength of a column and the form and relative dimensions of its cross-section.

These experiments are at present only partially complete and have so far been applied only to certain elementary forms. He obtains a formula for the limiting stress, which contains the thickness and a constant, the latter depending on the form of the cross-section and on the material. This formula expresses the limiting load on a column of one wave length (i. e., the length of one wrinkle of the secondary flexure) and is as follows:

$$p = \frac{f}{1 + k\frac{r}{t}}$$

where k is some constant and t is the thickness. This formula has a rational basis but rests upon empirical constants. The rational basis is practically that of Rankine's formula.

He also states that k takes the form Nf/E, where N is a constant depending only on the form of the section.

He gives the values of N as follows:

for ○ section, $N = 50$
for □ section, $N = 60$
for + section, $N = 120$
for Δ section, $N = 80$
for I section, $N = 70$

(Note.—In *London Engineering* these values of N are incorrectly given and are corrected in the pamphlet *The Design of Columns and Struts.*)

Dr. Dilly then puts this limiting stress into Rankine's formula, with the following result:

$$p = \frac{f}{1 + K\frac{r}{t} + C\frac{l^2}{r^2}}$$

where C is an additional constant. He goes to considerable length to show that this formula is rational, but it is to be noted that not only C and K are empirically evaluated, but f also.

In the usual form of Rankine's formula f is taken as about two-thirds of the ultimate tensile strength. Dr. Lilly, in his proposed formula, takes f as something greater than the ultimate tensile strength, observing that his tests for l/r close to zero show a value of the average unit stress exceeding the tensile strength. The values of the other constants, therefore, rest upon this assumption. While Dr. Lilly's tests are by no means the only ones which show a high value of p at l/r nearly zero, other tests, notably those of Tetmajer and Marshall, made for the specific purpose of evaluating f_1, do not show such high values.

The objections raised against Rankine's formula apply equally to Dr. Lilly's in the form in which he proposes it, and it should be noted that the formula contains no factor for inherent eccentricity.

It is interesting now to compare Dr. Lilly's expression for the limiting strength with the results of the tests made at the Norfolk Navy Yard. For 2½-inch by ⅛-inch tubing, with an ultimate tensile strength of 65,500 pounds, we have by Lilly's formula, for the limiting compression stress on a column of at least one wave length (using $f = 80{,}000$ and $K = 1/8$, as given by Lilly):

$$p = 45{,}600.$$

The highest observed stress on this tubing was about 60,000 pounds per square inch (for $l/r = 2½$), and wrinkling occurred at an average unit stress of 66,000 pounds at $l/r = 13$. For 1¾-inch by ⅛-inch tubing, with an ultimate tensile strength of 60,000 pounds, we have by Lilly's formula:

$$p = 54{,}300.$$

The highest observed stress was 79,000, with wrinkling occurring at 75,000 at $l/r = 13$.

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In the case of the Watertown tests referred to in Section VI (*Eng. News*, Aug. 26, 1909), the tubes were 5 inches by 0.36 inch. By Lilly's formula the limiting stress for a tube of one wave length would be

$$p = 54{,}400;$$

while for $l/r = 12\frac{1}{2}$ the Watertown tests ran as high as 60,000 pounds per square inch.

In view of the above it does not seem best to accept the formula proposed by Dr. Lilly at the present time, and it is unfortunate that the results of his experiments have not been interpreted by means of some formula more closely in accordance with general experimental data and more strictly rational than Rankine's. It should be noted also that the formula does not lend itself to tabulation.

Use may be made of the formula, however, for determining a rule for limiting the thinness of tubular columns.

Assuming that wrinkling occurs when the average stress is equal to the elastic limit (inspection of the Watertown tests cited above seems to bear out this assumption) and that the elastic limit is $f_t/2$, we would have for r/t the value 8. If we take f as 80,000, as given by Lilly, and put $p = 30{,}000$ for the elastic limit, we have $r/t = 13$. It would seem reasonable to take the limiting value of r/t as 10, and this will cause no serious hindrance in reasonable proportioning.

The radius of gyration of a tube is:

$$r = \frac{1}{4}\sqrt{d^2 + d_i^2}$$

For a thin tube no great error is made if the inside and outside diameters be taken as equal, so that we may write:

$$r = \frac{d}{4}\sqrt{2} = 0.354\,d$$

Expressing t in terms of d then, instead of in terms of r, we have for $r/t = 10$, the corresponding value $d/t = 28.3$, which, to bring an even figure, may be called 30.

The following rule is, therefore, proposed for the thickness of tubular columns and struts:

The thickness of wall must be not less than one-thirtieth the diameter.

CONSTRUCTION OF THE TABLES.

In applying Moncrieff's formula to a given material, the two properties of the material which are used are the modulus of elasticity and the ultimate compressive strength.

For wrought iron, and the various classes of steel, the ultimate compressive strengths have been taken as equal to the corresponding tensile strengths and the commonly accepted values of the modulus of elasticity have been used, namely, 28,000,000 for wrought iron and 30,000,000 for steel. There is no sufficient evidence to show that the modulus of elasticity for steel varies with the tensile strength or with the chemical composition; in fact, abundant authority may be cited to the contrary. The actual tensile strengths used correspond to those required by the navy specifications.

For the compositions (brasses and bronzes) the ultimate compressive strengths were also taken as equal to the corresponding tensile strengths; and as no very definite strength classifications exist for these materials, the three values of 40,000 pounds, 60,000 pounds and 80,000 pounds were taken as about covering the range of tensile strengths obtainable with the various compositions, the unit column strengths for other values of the tensile strength being obtainable from the tables by interpolation. The modulus of elasticity varies somewhat for the various compositions and is not as definitely determined as for steel. The value 13,000,000 was used as fairly well representing all classes of composition, this being a conservative figure based upon a careful examination of the test data published by Prof. R. T. Thurston, "Materials of Engineering, Part III, Brasses, Bronzes and Other Alloys." These tests are a part of a very full investigation made by the Committee on Metallic Alloys of the United States Board appointed to test iron, steel and other metals. So far as the writer has been able to discover, there are no published test data for composition columns. The broad experimental basis of Moncrieff's formula allows us, however, to extend it to this class of material with a reasonable degree of confidence.

In the case of the various kinds of wood the ultimate compressive strengths are much less than the corresponding tensile strengths, and the compressive strengths themselves have therefore been used. The values employed for the ultimate compressive strength and the modulus of elasticity are as follows:

	Ultimate Compressive Strength.	Modulus of Elasticity.
White pine	5,400	1,400,000
Douglas fir (Oregon pine)	6,700	1,700,000
Spruce and ash	7,200	1,600,000
Yellow pine	8,000	2,000,000
Oak	8,500	2,000,000

These figures are based upon tests made for the Department of Agriculture by Prof. J. B. Johnson (see U. S. Forestry Circular No. 15 and Johnson's Materials of Construction, pp. 671). They are strictly applicable only to timber having a "standard moisture" of 12 percent—that is, for timber thoroughly seasoned—and consequently for timber less well seasoned a proper allowance should be made in the factor of safety. Green timber may be expected to show about half the strength indicated in the tables.

In Fig. 5 are shown curves plotted from Moncrieff's formula for the various classes of steel, wrought iron and composition. It will be seen from these curves that for the lower values of $\frac{l}{r}$ the value of f_t has a considerable influence, while for the higher values of $\frac{l}{r}$ the controlling factor is the modulus of elasticity. The result of this is that for values of $\frac{l}{r}$ less than, say, 100 there is an appreciable advantage obtained by using a material of high tensile strength, while beyond 100 this advantage rapidly diminishes and finally becomes inappreciable.

It will also be seen that the low value of the modulus of elasticity of composition causes its strength to fall off very rapidly as $\frac{l}{r}$ increases, so that as compared with steel of equal tensile strength the strength of brass or bronze columns may be only about one half that of the stiffer material for usual values of $\frac{l}{r}$. This is an important fact that is perhaps little appreciated.

It is desirable to point out that the use of the Construction and Repair tables will lead to no very great change in practice except as they give information for classes of material for which column data have not before been presented in sufficiently convenient form to permit of general use. In Fig. 6 is shown a curve plotted from these tables for the safe unit load for columns of 60,000-pound steel with a nominal safety factor of 4, in comparison with a number of other accepted working formulas placed as nearly as practicable upon the same basis. The great diversity of results obtainable from these various formulas is again illustrated in this figure, but it will be seen that the curve representing the Construction and Repair tables,

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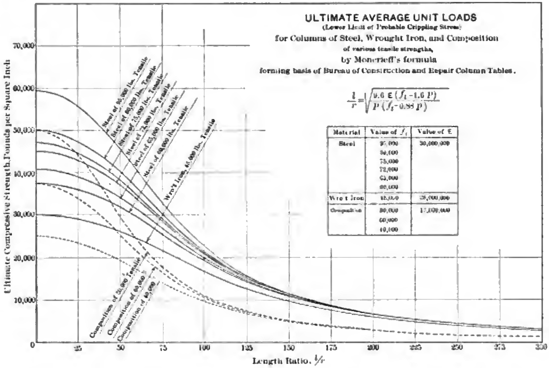

FIG. 5.

while somewhat conservative, lies within the field occupied by the other formulas. The fact that it most nearly corresponds to the Pencoyd curve is significant, inasmuch as the Pencoyd curve is based solely upon tests without the intervention of any formula, either empirical or rational. The correspondence would be still closer were it not for the fact, already

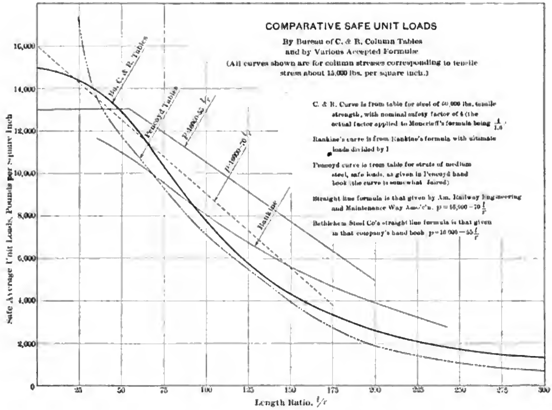

FIG. 6.

ULTIMATE LOADS PER SQUARE INCH.

(Lower Limit of Probable Crippling Stress.)

For Safe Loads, divide values given in table by six-tenths of nominal safety factor

$\frac{l}{r}$	Wrought Iron 48,000 Pounds Tensile Strength	Steel of 60,000 Pounds Tensile Strength.	Steel of 65,000 Pounds Tensile Strength.	Steel of 72,000 Pounds Tensile Strength.	Steel of 75,000 Pounds Tensile Strength.	Steel of 80,000 Pounds Tensile Strength.	Steel of 95,000 Pounds Tensile Strength	Composition of 40,000 Pounds Tensile Strength	Composition of 60,000 Pounds Tensile Strength.	Composition of 80,000 Pounds Tensile Strength.	White Pine.	Douglas Fir (Oregon Pine).	Spruce and Ash.	Yellow Pine.	Oak
25	29,100	38,100	39,050	43,100	44,750	47,600	55,950	23,600	34,300	44,300	3,130	3,350	4,120	4,630	4,890
30	28,660	35,500	38,150	42,200	43,800	46,500	54,120	23,000	32,900	41,800	3,020	3,250	3,960	4,470	4,710
35	28,100	34,900	37,300	41,100	42,600	45,300	52,500	22,250	31,390	39,100	2,900	3,130	3,760	4,250	4,500
40	27,460	34,000	36,500	39,900	41,300	43,700	50,500	21,400	29,450	36,650	2,760	3,000	3,550	4,060	4,250
45	26,810	33,100	35,330	38,600	39,850	42,000	48,350	20,400	27,460	32,900	2,610	2,850	3,320	3,830	4,000
50	26,000	32,100	34,100	37,100	38,250	40,230	45,950	19,440	25,450	29,800	2,450	2,700	3,080	3,580	3,730
55	25,330	31,000	32,800	35,500	36,550	38,330	43,400	18,360	23,450	26,930	2,270	2,540	2,850	3,300	3,460
60	24,520	29,700	31,400	33,700	34,750	36,400	40,700	17,200	21,500	24,250	2,110	2,380	2,620	3,080	3,180
65	23,680	28,600	30,000	32,050	33,000	34,300	38,000	16,100	19,700	21,850	1,960	2,220	2,400	2,840	2,930
70	22,780	27,100	28,500	30,350	31,100	32,200	35,400	15,090	18,000	19,790	1,800	2,000	2,190	2,620	2,680
75	21,840	25,800	27,050	28,700	29,300	30,150	32,950	14,050	16,400	17,800	1,660	1,910	2,000	2,400	2,460
80	20,850	24,400	25,530	27,100	27,600	28,200	30,600	13,050	15,000	16,080	1,530	1,770	1,800	2,210	2,260
85	19,800	23,100	24,000	25,450	25,750	26,400	28,250	12,100	13,700	14,800	1,410	1,630	1,680	2,030	2,070
90	18,800	21,800	22,600	23,850	24,100	24,700	26,250	11,270	12,550	13,150	1,300	1,510	1,540	1,870	1,900
95	17,830	20,600	21,250	22,300	22,550	23,100	24,350	10,470	11,570	11,950	1,200	1,400	1,420	1,720	1,740
100	16,900	19,400	20,000	20,800	21,100	21,500	22,600	9,700	10,600	10,900	1,110	1,300	1,300	1,580	1,610
105	16,010	18,300	18,800	19,500	19,800	20,100	21,000	9,060	9,750	10,000	1,020	1,200	1,200	1,470	1,480
110	15,160	17,200	17,700	18,200	18,500	18,730	19,500	8,400	8,940	9,200	950	1,120	1,110	1,360	1,370
115	14,350	16,200	16,650	17,100	17,300	17,530	18,150	7,800	8,200	8,500	880	1,040	1,020	1,260	1,270
120	13,580	15,300	15,680	16,000	16,200	16,400	16,900	7,320	7,650	7,900	820	970	950	1,170	1,180
125	12,850	14,400	14,720	15,000	15,200	15,400	15,860	6,850	7,100	7,350	760	910	885	1,090	1,100
130	12,160	13,600	13,920	14,140	14,260	14,460	14,810	6,400	6,620	6,800	710	850	825	1,020	1,020
135	11,510	12,900	13,120	13,340	13,400	13,600	13,930	6,000	6,190	6,400	665	800	775	950	950
140	10,900	12,100	12,340	12,550	12,620	12,800	13,100	5,630	5,810	6,000	625	750	725	890	890
145	10,320	11,460	11,700	11,830	11,900	12,050	12,350	5,300	5,470	5,600	585	710	680	835	835
150	9,800	10,800	11,020	11,180	11,220	11,350	11,630	5,000	5,170	5,200	550	670	640	785	785
160	8,850	9,700	9,850	9,970	10,040	10,120	10,350	4,450	4,600	4,650	490	590	570	690	690
170	8,000	8,730	8,850	8,950	9,020	9,100	9,300	3,980	4,100	4,130	440	530	510	620	620
180	7,320	7,900	8,000	8,100	8,180	8,200	8,300	3,590	3,680	3,700	390	470	450	560	560
190	6,690	7,300	7,260	7,320	7,350	7,400	7,500	3,250	3,300	3,300	355	420	410	510	510
200	6,110	6,550	6,610	6,670	6,700	6,750	6,800	2,950	3,000	3,000	320	380	370	460	460
210	5,570	6,000	6,050	6,100	6,100	6,150	6,200	2,700	2,730	2,720	290	340	340	415	415
220	5,100	5,500	5,550	5,600	5,600	5,650	5,700	2,480	2,500	2,500	265	320	310	380	380
230	4,700	5,100	5,130	5,150	5,150	5,200	5,230	2,280	2,280	2,280	240	290	280	345	345
240	4,330	4,700	4,720	4,750	4,750	4,800	4,800	2,100	2,100	2,100	225	270	260	320	320
250	4,030	4,350	4,370	4,400	4,400	4,450	4,450	1,930	1,930	1,930	210	255	245	300	300
260	3,750	4,060	4,070	4,100	4,100	4,130	4,130	1,790	1,790	1,790					
270	3,500	3,800	3,800	3,820	3,820	3,850	3,850	1,660	1,660	1,660					
280	3,260	3,500	3,500	3,520	3,520	3,550	3,550	1,550	1,550	1,550					
290	3,050	3,300	3,300	3,310	3,310	3,330	3,330	1,460	1,460	1,460					
300	2,860	3,100	3,100	3,100	3,100	3,100	3,100	1,380	1,380	1,380					

mentioned, that the safe loads given by the Pencoyd tables are obtained from the ultimate loads by means of a factor of safety which increases with the value of $\frac{l}{r}$.

THE MARINE STEAM ENGINE INDICATOR—XVII.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

THE EXPANSION LINE.

The law of the compressibility of gases was first published by Boyle in 1662, and by Mariotte in 1679, the latter having made experiments entirely independent of Boyle. In Great Britain this law is commonly spoken of as "Boyle's Law," and on the Continent as the "Law of Mariotte." It is as follows:

The temperature remaining the same, the volume of a given quantity of gas is inversely as the pressure which it bears.

Until quite recent times, Boyle's law was supposed to be true for all gases at all pressures. Depretz was the first to obtain results incompatible with the law. The experiments of Regnault in 1847 were distinguished by the extreme nicety with which they were made and finally established the fact that the law is not exact. Regnault's conclusions were, in part, as follows: "That no gas rigorously obeys Boyle's law; the divergence being small for low pressures but increasing with the pressure." The divergence from the law is greater with easily liquefiable gases, such as carbonic acid and ammonia, than for (the gases called in Regnault's time) permanent gases, such as oxygen and nitrogen. Thus to reduce air to 1/20 of its original volume, he found that a pressure of 19.72 atmospheres (19.72 × 14.7 pounds) was required, instead of 20, hydrogen required 20.27, while carbonic acid required only 16.71 atmospheres.

Turning now to expansion in the steam cylinder: It is safe to say that all engines (excepting direct acting steam pumps and certain classes of auxiliaries) use steam expansively, that is, the supply of steam is cut off before the piston reaches the end of its stroke. James Watt was the first to apply the cut-off and used this as one of several methods to increase the economy of his engines. He assumed that the law of Boyle was true in the case of steam and explained the superior economy of his engines (so much as was due to using the cut-off) by the aid of what he termed a "diagram of work done during expansion." His method of reasoning was somewhat as follows: *Work* (in the case of an engine) may be defined as *pressure multiplied by the distance through which it acts.* Suppose we have a piston of 100 square inches area, the piston working through a stroke of 1 foot. If this piston is acted upon by a pressure of 1 pound per square inch, the load on the piston is 100 pounds and the work 100 pounds times 1 foot or 100 *foot-pounds* per stroke. To get this 100 foot-pounds it is necessary that the cylinder be completely

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filled with steam from the boiler at each stroke. If the steam be cut off at half stroke the average or mean pressure per stroke will be about .85 pound per square inch with 1 pound initial pressure; the total load on the piston will be 85 × 100 pounds and the work per stroke .85 × 100 × 1 or 85 foot-pounds. Without cut-off, a whole cylinder full of steam gives 100 foot-pounds, while with cut-off at half stroke a whole cylinder full of steam will drive the piston through two strokes and produce 85 × 2 or 170 foot-pounds, a result showing 70 percent more work for the same quantity of steam than was produced without cut-off. This gain, however, is purely theoretical and, for various reasons, which will be discussed later, is considerably more than is actually realized.

quently hear it referred to as a $p\ v$ curve. There are many simple methods in use for laying out this curve, but in the writer's opinion the best way is to locate the points by computation as follows.

Get the value of $p\ v$ first. In the curve of Fig. 101, $p = 100$ and $v = 1$. Therefore $p\ v = 100$. Next compute the value of v at any desired number of places above the line OA (which is drawn at 45 degrees with OX and OY) thus: $100 \div 90 = 1.11$, $100 \div 80 = 1.25$ and so on to $100 \div 35 = 2.85$. Locate the points on the co-ordinate lines. Now, beginning on the other side of OA, solve for p instead of v $100 \div 4 = 25$, $100 \div 5 = 20$, and so on until the final pressure $100 \div 10$ is reached. As a check, the point where the

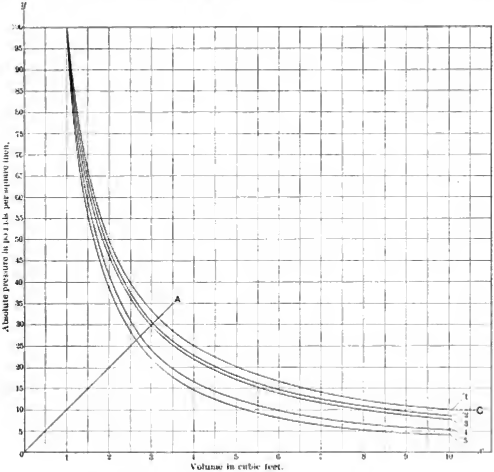

FIG. 101.

Referring to Fig. 101, the upper curve (or curve No. 1) is a rectangular or common *hyperbola*, rectangular, because its co-ordinates form an angle of 90 degrees with each other. Its equation[1] is $p\ v = constant$, where p = pressure and v = volume. This curve, as drawn in the figure, represents graphically the expansion of one cubic foot of a perfect gas at 100 pounds absolute pressure to 10 cubic feet, all at *constant temperature*, in accordance with Boyle's law. Its height above the zero line of pressure, or base, shows the gas pressure at the corresponding volume. In mathematics, this curve is known as a hyperbola, as stated above, and in consequence expansion which takes place in accordance with Boyle's law is often called hyperbolic expansion. The curve is also known as an *isothermal* or curve of equal temperatures and we fre-

[1] See September, 1910, issue, page 378.

curve crosses OA may be computed from the following formula:

Let T = the distance XC,
L = " " from O to 10 on the X axis,
$T \times L = D$ (in inches)
and let F = the distance in inches from O at which the hyperbola crosses the diagonal OA.

Then will $F = \sqrt{2D}$.

In Fig. 101, if we assume each of the lines forming the squares to be one inch apart and substitute these dimensions in the formula we shall have $TL = D$ or $20 \times 2 = D$ and by substituting this value of D in $F = \sqrt{2D}$ we have

$$F = \sqrt{80}$$
or $F = 8.9$ inches.

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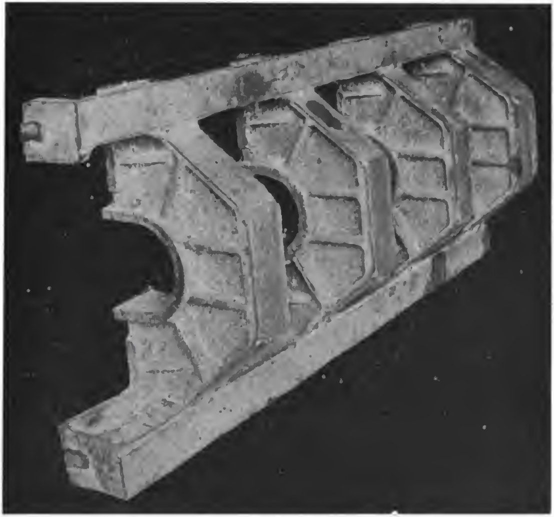

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A cylinder 9-16 of an inch thick, three inches in diameter and fifteen inches long has been subjected to a pressure of nine thousand pounds.

TENSILE STRENGTH on 1" Section:
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TENSILE STRENGTH:
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WRITE FOR CATALOG

VANADIUM METALS COMPANY
FRICK BUILDING
PITTSBURGH, PENNA.

PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries, Breakdowns at Sea and Repairs.

Explosion of a Valve Receiver.

Have you heard of an explosion happening in an engine while cool?

This was what occurred in the steamship *Cantabria* off the coast of the Philippine Islands, where I was third engineer. This steamer, formerly named *Formosa*, of the Hongkong-Manila Line, was fitted with a triple-expansion engine of approximately 700 indicated horsepower. The cylinders and valve chests were arranged in the following order, beginning from the foreside: Intermediate-pressure valve receiver, high-pressure piston valve, high-pressure cylinder and low-pressure cylinder; the low-pressure valve and receiver were placed at the post side of its corresponding cylinder. This receiver was fitted with two covers, one vertically and the other horizontally placed. (See Figs. 1 and 2.) One steam pipe connected the intermediate-pressure and low-pressure receivers. As is seen in Fig. 1 there were two stay-rods of 2-inches diameter, with straps fastened to the cylinder walls to keep them closed.

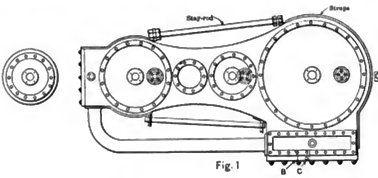

Fig. 1

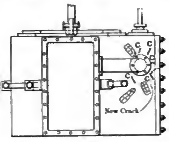

Fig. 2

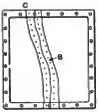

Fig. 3

Fig. 4

On the morning of Good Friday of 1904 we arrived at the port of Legazpi, at the foot of the volcano Mayon. After cleaning out the grease we allowed the engine to become cool. The chief engineer, on the next day, about 10 o'clock A. M., gave us orders to get the engine ready for examining the leads of the three steam valves. After connecting the turning gear we turned our attention to the high-pressure piston valve, removing the cover head, scraped the cake oil and turned the engine in an effort to find the high dead point of the high-pressure crank. After examining the leads of both go-ahead and astern we turned the engine and placed the crank at its lower dead point. The chief examined the leads, and finding both bottom and top O. K., ordered us to cover the valve and take off the cover of the intermediate-pressure. We did so, and when we got it opened and placed the intermediate-pressure crank at its high dead point the chief came down, grasping with his right hand a bunker lamp and went to examine the valve leads, reflecting the light into the valve chest on the same side where the connecting pipe was fixed. At the precise moment that he got the light inside we heard a tremendous noise that produced a great commotion in the whole ship, as if a charge of dynamite had exploded. A large quantity of grease and black smoke escaped from the open receiver, tarnishing the bulkhead, which was about 28 inches away, and burning part of the chief engineer's face and right eye.

After a brief moment of very natural fright we went to the assistance of the chief. The captain and other officers who advanced to the skylight to inquire about the cause of the explosion called out attention to a light white smoke noticeable between the low-pressure receiver and its vertical cover. I went there, and to my great surprise readily saw that the cover was broken in two pieces (Fig. 3). I also noted two 1-inch studs with their respective nuts laying on the floor; studs which had been rooted out from their location on the broken cover (Fig. 3 c.).

Then we aided the chief in going to his bunk, where he was assisted by the deck officers. The second engineer and myself turned back to the engine room, where we proceeded to make a more complete investigation of the thing which we looked upon as phenomenal. We removed the broken cover, as well as part of the cylinder lining, and at once saw several cracks in the fore part of the receiver (Fig. 2) and two more on the stud-holes of the upper edge, where were fixed the rooted-out studs of the vertical cover, one of the cracks extending to the upper corner, reaching the port side edge of the upper cover.

We also noticed that there were several cracks existing and also, as could be plainly seen, patches. So we concluded that the recent explosion had a precedent in the same engine, which idea was reinforced on our part by the two stay-rods and straps that were fixed for strengthening the upper part of the engine.

As we had to continue the trip, and, moreover, as there was no machine shop in the town, we set about making the necessary temporary repairs with the tools and materials that we had at our disposal on board. First we drilled a row of 7/16-inch holes along the edge of each broken piece of the cover, having a distance of about 5/8 inch and about 2½ inches apart from center to center. The holes were tapped with ½-inch thread. Then, with one 5/8-inch iron plate, the only plate that we had on board, we made a patch, giving it a width of about 6 inches to cover the sinuous line of fracture, making the rivets with one ½-inch iron rod, threaded at one end to screw down the cover, and subsequently fixing the patch on the inside face of the cover by means of good riveting.

As we had only one drill (ratchet) we were compelled to finish one part of the repair before attacking another. So after having concluded the cover we then proceeded to remedy as quickly and as well as possible the larger cracks recently produced on the receiver. This we fixed by several bolts along the cracks to hold them within their limits, until our arrival at Manila, where better means for good and permanent repairs could be accomplished. We completed the repairs and were able to set steam 24 hours after the explosion. The trip was continued with some steam leakage through the cracks.

As may be supposed, from the moment of the explosion we began to inquire (among ourselves) how such breakdown could have happened and what was its prime cause. The engine was cool, as has been said, and several complete turns had been given it, and furthermore a light, the same bunker lamp used by the chief (and which acted as a fuse) was introduced in the high-pressure cylinder valve without disturbance of any kind. The supervising engineers of the ship and of the insurance company, who boarded the ship immediately on our arrival at Manila, after investigating the conditions, gave as their opinion that the cause of the disaster was due to decomposed gases, caused probably in part by the cylinder oil and in part by the petroleum used on the boiler by former engineers.

That this oil and petroleum by accumulation in the pipe had converted itself in a specy like a cannon.

Can any opinion be given different from the one expressed?

When we arrived at Manila and after the supervising engineers authorized the repairs, we began the fixing of a new cover and patching the cracks of the receiver. And in order to augment solidity to the weakened receiver (and it could not be renewed, for the cylinder and receiver were of a solid piece and the machine shop had no materials to cast a new one), an iron frame ½ inch thick, of the shape of the upper cover, was fitted, renewing, of course, all studs by larger ones. (Fig. 4.)

The ship was unfortunate and subsequently was wrecked by a typhoon in September, 1906, when every soul perished in her.

Philippine Islands. AUGUSTO SUZARA.

A Broken Thrust Shaft.

The S. S. "B——," while on a voyage from India to England, with a full cargo of tea, broke her thrust shaft, which the engineers of the ship managed to repair temporarily. The repair was made in this way: We cut a slot through the broken ends and inserted one of the crank shaft keeps into the slot, keeping the shaft ends and keeps in position with wrought iron bands. After we had traveled several hundred miles, however, the repairs gave out, and we were left helpless; at this point of the voyage we were out a long way from Bombay, so our captain decided to make for this point under sail; after five days, we reached this port safely under the aid of our scanty sails alone, which, I might say, were made from canvas hatch covers. We then set about looking for another shaft, and after considerable hunting, we got one which turned out to be something near what we wanted. We had it cut to suit the length, and turned out to suit the thrust block rings; it was also fitted with two cast iron couplings, 9 inches thick at either end. The couplings were secured to the shaft by longitudinal keys. Having had these repairs completed, we proceeded up the Red Sea and through the Canal without anything unusual happening, except of course that we had to keep a strict watch on the shafting. After leaving Port Said, however, for a Mediterranean port, it was observed from the working of the thrust block and stern tube that the whole of the shafting and its connection seemed to be strained and out of true alinement, so much so that the inner end of the stern tube worked round with each revolution no less than half an inch, causing a constant and serious leakage of water into the ship. However, by keeping the pumps at work all the time, we managed to get to port safely, and there we underwent an examination and had an entirely new thrust shaft, bearings, and tube fitted.

F. J. S. N.

Practical Operation of Parsons Turbines.

A venerable Scotchman, the senior chief engineer of a certain line of 'cross Channel steamers, was transferred to the latest addition to the fleet, a high-speed vessel, driven by Parsons' turbines. After the new job had been running a few weeks the superintendent of the line, feeling that the old man would find the turbines a vast change from the slow-speed paddle engines to which he had been accustomed, asked him if he found any difficulty with the new system. "No," said he, "I do not. "I'll tell ye (very confidentially), it's just like this with the turbines—you open the regulator and trust in God."

So far as it went, his observation was entirely correct, but there are other things required in the successful management of a turbine installation in addition to faith, and the object of these notes is to point out what some of these other things are.

Coming from the reciprocating engine, with its multiplicity of working parts to lubricate and adjust, the engineer will naturally consider the operation of the turbine, with its absence of visible working parts and automatic lubrication, to be a much simpler business. So it is, but, all the same, the turbine calls for intelligent handling and in some respects is a much more delicate piece of machinery than a reciprocating engine.

In a Parsons turbine there are hundreds of revolving blades with their tips running within from 25/1000 to 1/10 inch of the stationary cylinder, and hundreds of stationary blades with the revolving portion running at similar clearances from them. In addition, the fore-and-aft clearance between the revolving dummy and the stationary dummy rings is usually about 20/1000 inch. Should any of these clearances disappear the result would be disastrous.

On the other hand, it must not be imagined from this that breakdowns are frequent—far from it. In fact, it may be said that when properly designed and constructed and intelligently handled it would be difficult to improve upon the Parsons turbine, as far as freedom from breakdown is concerned. A breakdown with a reciprocating engine is seldom of such a nature that it cannot be repaired at sea. However, with the turbine, when breakdown does occur, it is usually in connection with the blading or dummy rings, and such an accident is often in the nature of a complete smash which is beyond the

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power of the operating engineers to repair. It behooves the engineer in charge, therefore, to keep the idea of these fine clearances (which are entirely out of his sight and control) constantly before him, and to err always on the side of caution and take no risks.

Now the operation of a turbine installation may be divided into three sections:

1. Heating up the turbines and getting under way.
2. Operation when under way.
3. Overhauling.

Considering Section 1 it is evident that the turbine cylinders, although perfectly cylindrical and symmetrical when cold, will distort to some extent when hot, consequently the blade-tip clearances will be reduced. The clearances are usually made ample to allow for this. On the other hand, if the turbine is quickly or carelessly warmed up so that unequal expansion results, the distortion of the cylinder becomes very much greater and a grave risk is run of stripping the blading when the turbine is started up. Thus, the greatest care is necessary to make the heating-up process as long and gradual as possible. With even the smallest installation it is advisable to take not less than six hours to the operation, and about twelve hours with large turbines.

The procedure in warming up may be somewhat as follows, although, of course, it may be modified to suit individual circumstances:

Usually an auxiliary boiler is set away previously, so as to have auxiliary steam available. If water-tube boilers are installed a single boiler may be selected for warming up, but if cylindrical boilers are fitted they will all have to be lighted up as soon as possible.

When fires are set away and all air cleared off and steam showing, crack open the boiler stop-valve. Open the bulkhead stop-valves and regulator valves, and any drain cocks that may be fitted to the main steam range. The self-closing valves in the receiver pipes between the turbines should be opened wide, so as to allow the vapor to pass through the turbines to the condenser. Open full all the turbine drain valves and also the valve (usually fitted at the air pump) which drains the turbines to the bilge.

The circulating pumps should be started up and kept going slowly during the process of heating up. After the air has been driven off and steam is blowing at the drain to bilge, close this valve and start the air pumps, keeping them just on the move.

The pressure on the turbine should not be allowed to exceed about 12 pounds per square inch for the first few hours. It is the usual practice to put in the turning gear and give the rotors a turn, say, every half hour, to insure that they expand equally, but if plenty of time is given to heating up this may be dispensed with. After six to eight hours, the turning gear may be taken out. During this time the available steam pressure will have risen considerably, and it will have been necessary to almost close down the main regulating valve.

When full pressure is reached, the turbines being now hot, very little is necessary to set them moving. The regulator may be opened at intervals for a few minutes at a time to keep the turbines thoroughly warmed up, without actually moving them, until nearer the time for getting under way. Before reporting ready, the lubricating oil pump should be started and kept going slowly, and the oil test cocks and sight doors on the bearing looked to, to see that the oil is moving properly. Steam may now be put on the outer pockets of the turbine glands, the valves being adjusted to give a pressure of about 1 pound per square inch. The various drain cocks about the steam system should also be tried, to make sure that all water is cleared out.

Having ascertained that the propellers are all clear, sufficient steam may be given to each turbine in succession (including the astern turbine) to cause it to move a few revolutions, and steam should be left on the turbines that will be used for maneuvering. The air, circulating and forced lubrication pumps may be speeded up in readiness for starting and everything being satisfactory "All ready" may be reported.

Just before starting, the drain valves on the turbines which are actually to be used should be closed. If the usual three-shaft arrangement of turbines is fitted, with the high-pressure on the center shaft and the low-pressure and astern turbines on the wing shafts, the wing shafts only will be required in working out of harbor. The high-pressure turbine will be allowed to revolve idly in a vacuum, its drain valve being left open, which is practically equivalent to connecting it to the condenser. This applies to any turbine which is allowed to revolve without doing work, no matter what arrangement of turbines is installed. Thus, when cruising turbines are fitted, their drain valves are kept open when these turbines are not developing power. The drain valves of the turbines in which work is being done are kept closed when under way, the whole system being drained from the exhaust end of the low-pressure turbine through a non-return valve of the "Kinghorn" type and a water seal.

When starting the turbines it is of great importance to open the regulating or maneuvering valves gradually. If this is not done a sudden rush of steam will result which is very apt to start priming and cause damage to the blading. The turbine has the reputation of being much more liable to cause priming than the reciprocating engine, and the writer's experience bears this out.

The engineer should remember that the turbine can take up as much steam at starting as when it has run up to speed, whereas the reciprocating engine's appetite for steam only increases with the speed at which it runs. Gradual opening out is especially necessary when operating the astern turbines, as with them only comparatively few rows of blades separate the boilers from the condenser. This caution is essential, and even when gradually opened out, full steam should not be given to the astern turbines unless full boiler power is available.

Several cases of severe priming with turbine jobs have come within the writer's experience which were due to the boiler stop valves being opened too widely. The stop valves on the boilers nearest the turbines should only be opened slightly if priming is to be avoided. This applies more especially with ordinary cylindrical boilers.

Turning now to Section 2, operation when under way, once in open waters the turbines must be changed over from maneuvering to running conditions. Thus, if the usual three-shaft arrangement is fitted, the high-pressure turbine drain valves should be closed, the maneuvering steam valves (ahead or astern) shut, and main steam admitted to the high-pressure turbine. If cruising turbines are installed, the proportion of full power to be developed will decide which (if any) are to be used in conjunction with the main turbines, or whether they are to revolve idly with their drain valves open.

If the vacuum augmentor system is adopted, circulating water may be put on the augmentor condenser and steam admitted to the augmentor jet. The air and circulating pumps should be operated to give the highest vacuum attainable. The vaccum is a most important point in a turbine installation and should receive the fullest attention. With a turbine (unlike a reciprocating engine) the vacuum cannot be too high, every increase showing a marked decrease in the steam consumption for the same power. The engineer in charge cannot give too much attention to this part of the system, and additional care with the jointing that is subject to the vacuum will be well repaid. Only the turbines should exhaust to the main

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condensers if a high vacuum is to be obtained. If the closed exhaust arrangement is fitted it should certainly be used. With this arrangement the exhaust from the auxiliary engines is connected to any one of several points on the main turbines—the connection to be selected depending on the degree of power being developed by the turbines. This decides at which connection a suitable pressure will be found. Thus, at low powers the auxiliary engine exhausts may be connected to the beginning of the second expansion of the high-pressure turbine (if cruising turbines are fitted), while at full power the suitable point would probably be the second expansion of the low-pressure turbine. Again, at intermediate-powers the exhausts may be put into the receiver pipes between the high-pressure and low-pressure turbines. By adopting this system not only is additional power obtained by utilizing the auxiliary engine exhausts, but the improved vacuum results in a gain in economy.

It will be readily understood that any steam connection which enters the turbines in way of the blading requires careful handling, as any sudden rise in temperature is very liable to cause local distortion, with the risk of blade stripping. Thus, when operating such of the closed exhaust connections which enter the turbines in way of the blading, the controlling valve should be first well drained before being gradually opened.

The by-pass valve which admits full-pressure steam to the end of the first expansion of the high-pressure turbine calls for cautious operation, and several accidents have been caused by careless handling of this fitting.

The steam to the turbine glands should be adjusted to allow a slight escape of steam, just sufficient to insure that no air can leak in. A pressure of about 4 to 5 pounds per square inch in the outer gland pocket will usually suffice. The high-pressure and cruising turbines are usually fitted with glands having two and sometimes three steam pockets. The inner of these have valve-controlled connections led to some point of lower-pressure to which the steam which escapes past the first rows of gland fins is "leaked-off."

Thus the inner pockets of a cruising turbine gland would be connected to some point down the expansions of the high-pressure turbine, while the high-pressure turbine inner gland pocket may be connected to the second expansions of the low-pressure turbines. The outer pockets of the high-pressure and cruising turbine glands have generally a steam connection to obviate air leaks, and in addition a connection for leaking-off the escaped steam to the condenser, should the inner pocket leak-off be unable by itself to relieve the pressure. The engineer should endeavor to keep a suitable pressure in the outer pocket without having to use the connection to the condenser. If the high-pressure or a cruising turbine be revolving idly in a vacuum, the inner pocket leak-off must be closed, and the steam on the outer pocket will keep out the air.

The low-pressure turbine glands are always subject to a vacuum, so that a single pocket fitted with a steam connection only is all that is required. The actual operation of the gland steam is probably simpler than the explanation, but the arrangements adopted vary to such an extent that it is only possible to treat the subject generally. In merchant vessels the connections are usually very simple, the more elaborate arrangements being fitted to naval vessels in which cruising turbines are adopted.

A vital point in a turbine system is the lubrication. Forced lubrication is generally fitted, the oil being pumped through a cooler (similar to a surface condenser) on its way to the bearings. The circulating water for this cooler is sometimes taken from the discharge side of the main circulating pumps, or a special pump is fitted, which should, of course, be started up with the forced lubrication pump. On the turbine bearing caps are fitted sight doors, a pressure gage, and a test cock, which call for frequent observation. The oil after leaving the bearings flows by gravity to the oil-drain tank, from which the pumps draw, the oil passing through a strainer on its way to the pumps. The pumps are usually in duplicate, one acting as a stand-by, and it is a great advantage to have two oil-drain tanks, as one can be used to allow the oil to settle and cool, while the other is in service. The oil coolers are not always very effective and they are very liable to trap air. The writer has found the fitting of an air cock to be of considerable advantage in some cases.

It is usual to carry an oil pressure of about 1 pound per square inch at the bearings, as a high-pressure is very liable to cause leakage, but every job should be treated on its own merits. The temperature of the bearings is generally higher than is usual with reciprocating engines. Trouble with hot bearings is not common with turbines, but when a bearing does heat up it heats up quickly. The oil supply must never be allowed to cease even for the shortest period. A case occurred within the writer's experience in which the stoppage of the oil pumps was unnoticed for a few moments, and he is not likely to forget the result. As an additional precaution reserve oil tanks arranged as high up as possible are sometimes fitted, and these tanks can in an emergency supply oil to the bearings by gravity. Thermometer connections are now commonly fitted to indicate the temperature of the oil leaving the bearings, and the temperature so indicated should be recorded.

When under way the turbine requires little attention in comparison with the reciprocating engine. Every effort should be made to keep the vacuum high while the oil pressure and bearing temperatures should be carefully observed. In addition, a lookout should be kept for any variation in the steam pressures at the various turbines and gland pockets. The dummy clearance should be tried at the "finger piece" every watch, while a more accurate measurement by means of the dummy clearance micrometer may be made every day. However, the detailed explanation of the method of carrying out these operations would require a special article in itself.

The engineer should, of course, pay attention to any variation in the usual noise of the turbines, as the presence of loose binding strips, etc., or foreign matter in the blading may sometimes be detected in this way. The presence of water in the turbine also modifies the sound.

On the other hand, the writer remembers a turbine which at one particular speed made a noise resembling a brass band, although the blading was quite sound. Again, on the trial trip of a certain 'cross Channel steamer, at which the writer was present, when on the measured mile a tremendous, shrieking noise was set up. As this was in the early days of the turbine trouble with the blading was feared, and the engines were immediately stopped.

After some investigation, the cause of the trouble was eventually traced to the main regulator valve. This valve was fitted with flexible disc seats and at one particular pressure these flexible discs vibrated, causing the shrill noise.

OVERHAULING.

The overhauling of a set of turbines is generally a big job. A lot of pipes and fittings have to be dismantled and stowed away, and often a considerable amount of gear has to be erected before the actual work of opening up the turbines can be commenced. At least a week would be required for the overhaul of even the smallest job, while three or even four weeks would not be excessive with some of the larger installations. Thus the opening up of a set of turbine machinery is carried out at much longer intervals than is usual with reciprocating engines.

On the other hand, there is no doubt that the engineer in charge should see the inside of his turbines and ascertain the conditions of the blading, dummy rings, etc., as often as

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possible. If it is impossible to get the time necessary for a complete overhaul, only one turbine may be opened out whenever an opportunity occurs. The various steam strainers should be examined at intervals, the cages being withdrawn and cleaned. The bridge gage which measures the wear-down (if any) of the turbine rotors should be tried at the end of every trip and the results carefully recorded.

Before proceeding to open up any of the turbines, the engineer in charge should carefully consider what operations are to be carried out, exactly how they are to be carried out, and in what order, if confusion is to be avoided. The exact arrangement of the turbine lifting gear to be adopted depends on several circumstances, and naturally varies with the arrangement of turbines and the space available. The builders usually supply a drawing with the ships which indicates the methods to be followed, and a careful study of this will usually repay the engineer.

One point should be noted. When the astern turbine is incorporated with the low-pressure (as is usual), it must be remembered that the astern cylinder joint (which is inside), must be broken before the low-pressure cylinder cover can be lifted. The writer remembers a case where this point was forgotten, with the result that one of the lifting lugs (cast with the cylinder) was broken off.

After a cylinder cover is lifted on the four guide pillars it is usually traversed by the lifting blocks in either a fore and aft or athwartship direction and deposited. Or it may be suspended from the deck. The rotor may then be lifted and secured on the special guides provided, leaving the lower part of the casing also open to inspection.

With very large turbines the cover is sometimes raised and secured to the four guide pillars, which are in this case attached to the ship's structure at their upper ends. Then, when the examination of the blading, etc., of the cover is concluded the rotor may be raised inside it and also secured.

When completely exposed the blading should be gone over very carefully, the tips of the blades being examined for indications of fouling, while particular attention should be paid to the condition of the binding wire and lacing. The engineer should look out for any bent or twisted blades and any signs of looseness. He should note the condition of the dummy rings and examine the pins of the radial dummies and of the turbine glands. He should see that the ramsbottom rings in the glands are sound and wearing well and if their lubrication appears to be sufficient.

If there is a dirty sediment in the turbine the engineer will know that water has been brought over, and all sediment must be carefully cleaned out. The rotor should be examined for any signs of pitting or corrosion, which is often the result of allowing the turbine to stand with the drains unopened. The interior of the rotor drums should also be looked to for any indication of corrosion, and may be given a coat of graphite paint. The screwed pins which secure the rotor drum to the wheels should be carefully examined for slackness. The bearings and adjusting blocks must, of course, be overhauled and the oil ways and holes cleared of any gummy deposit. Any hard places on the faces of the adjusting block may be slightly eased with a scraper, but it is scarcely likely that there will be any necessity for this.

The oil wells under the bearings should be emptied and all sediment cleaned out. The lower half of the turbine cylinder with the bearings and adjusting block, when not actually under examination, should be kept covered up and the greatest care should be taken to insure that nothing has been left in the blading before closing up again.

The most vital point in the overhauling of the turbines—the adjustment of the dummy clearance—has not been mentioned. A complete treatment of the methods to be adopted would unduly extend these notes, so that this subject would be best considered separately. Until the engineer is thoroughly familiar with the method of carrying out those adjustments he should leave the dummy clearance (if satisfactory) severely alone.

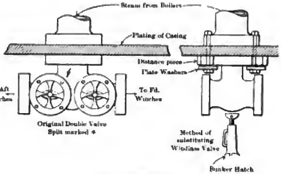
Assuming that the dummy clearance is satisfactory and that no adjustment is to be made, the adjusting nuts (which fix the fore and aft position of the adjusting-block cap) should be carefully marked before the cap is lifted, and set to the same position when reassembling. K.

Making Use of Odds and Ends.

The following mishap and its repair, I think, tend to show marine engineers aboard tramp steamers the value of taking care of what appeared at the time to be useless articles; for it proved to me the advantage of having retained from the junk dealer an old windlass stop valve which had been knifed up, or rather the valve seat had been knifed up so often that it had become thin enough to allow the steam to pass through the somewhat porous metal of which it was made.

At the time of this accident I was chief of a fairly large tramp steamer fitted with electric lights and all the usual modern auxiliary machinery, etc. Owing to the cheap and simple steam-pipe arrangements, when steam was on the dynamo engine, steering gear, etc., it was also on the deck pipe, only being shut off by the usual valves, of which two were fitted in a box on the boiler-room casing. This valve box was joined to the plating on one side and the steam pipe from the boilers on the other side, the whole being bolted together by six ¾-inch bolts passing through two flanges and the plate between, thus making a double joint. About 2 feet from this valve box, nearer the vessel's side, was a trimming hatch to the side bunkers.

One day at sea—that is, when steam was in use in the steering engine, dynamo, etc., this valve box burst at the point shown in the sketch. Fortunately no one was in the immediate vicinity, or he would have been badly scalded. There



VALVE CONNECTION.

had been no previous sign of leakage or weakness about the valve box, but on closing the stop valve on the boiler top and examining the fracture it was found to be only about 1/32 inch thick, whereas the bottom part was nearly ⅜ inch thick, a condition of things which was probably caused by some movement of the pattern when casting the valve box.

As it was almost imperative to have steam on deck again as soon as possible, I decided not to attempt to repair the damaged casting. On looking around our storeroom I came across the old windlass stop valve, which I decided to use as a T-piece, although it was some 4 inches shorter than the original valve box. The two end flanges were already drilled to the same templet as the deck steam pipe flanges. I removed the cover and valve and valve spindle (and here I must add that the cover was flanged and not screwed, as many, especially American, valve covers are). I took out the studs and found the diameter of the cover flange, which was such as permitted it to be placed against the plating, the holes for the bolts of the double joint being clearly outside. I then jointed the steam pipe with bolts through the original holes with plate washers on the back side, taking the flange of the old windlass stop valve and further placed our 5-ton screw jack between the flange and the above-mentioned bunker hatch. I then had to hook back one of the clips on the deck pipe and coax the pipe along in order to join up the pipes to the end flanges of our new T-piece. When this was done steam was turned on, and as the steam pipes were constructed with large expansion bends they sprang along further and I found the job to be quite safe as long as we did not ship any heavy seas. Further than this we were only a couple of hours in making the change.

As the vessel was bound to Moulmein, Burmah, and was to be there only a day or two, I had no time to get a new casting made and did not feel justified in going across the Bay of Bengal, etc., deeply laden with the job as it was. Fortunately, I was able to obtain very cheaply an old cast iron T-piece, with flanges somewhat near the required size and the proper length, the end flanges of which had already been drilled. These holes I had plugged up and fresh ones drilled as required, and I also had the side flange, which had not been drilled, drilled to suit the holes in the plating and the casing and the steam pipe to the boiler. It was a very simple job to joint this in place and all seemed well again except that we could not shut off steam from the forward and aft parts of the vessel, and, as the deck steam pipes passed very near the officers' accommodation, this was certainly no improvement from their point of view, especially in so hot a climate. It was suggested that I fit blank flanges in between the T-piece and the steam pipes. This I did not deem to be right, for in river navigation one never can tell when an anchor may have to be manipulated or some other deck order required, so the steam remained on.

This T-piece withstood the pressure of 180 pounds for some days, when I was lucky enough to observe a pin-hole "weep" in it, and we then and there removed same for further repairs and improvement which were fitted as follows, and the job then lasted until our arrival in Germany, where a new valve box was obtained, the original valves, valve spindles, glands, covers, studs, etc., being used, which considerably lessened the cost of our new outfit.

After removing the cast iron T-piece for repair the method I employed was this: I cut a piece of iron pipe the length of the casting and also drilled a large hole and cut it to suit the branch leading to the steam pipe from the boilers. As this pipe was some ⅜ inch too small in diameter, I placed it central with small pieces of wood, also placing a wood plug up the branch to the boilers. Then I melted a quantity of old white metal which we had taken out of a bottom end brass sometime previously, and ran this in around the iron pipe inside the casting; then withdrew the wood plug and rejointed the T-piece which, as I said before, proved a satisfactory repair.

Thus, in this case, the use of the old brass valve as well as the white metal shows the advisability of keeping many old things which one is tempted to dispose of, for one never knows what situation he may be forced to meet, nor how useful old odds and ends can become under certain circumstances.

Enfield.

Tiller Loose on the Rudder Head.

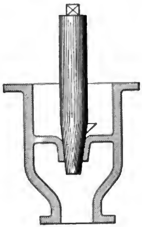
In one instance, during a voyage to the River Plate, the tiller of a vessel became loose on the rudder head and the trouble was seen to be getting worse and worse. As the effect of the looseness was to wear away the key and keyway and to grind the hole in the tiller larger and larger, it was decided to try and fix the tiller to the rudder head at sea.

The rudder was, first of all, firmly lashed and when this had been done the tiller was then taken off. Next a fire was made on the iron deck, being raised off the deck by means of fire-bricks and bars. The tiller head was heated in this fire to a dull red heat. In the meantime the keyway in the rudder head was made larger and a new key was made to fit, this key being, of course, of two different sizes. After this a sheet of tin was bound round the rudder head by means of copper wire, and then the heated tiller was put into place and then contracted on to the rudder head by playing a stream of water on it from a hose pipe. The new key was then driven firmly into place. This arrangement held the tiller hard and fast and made a good repair, which held out until the vessel arrived home some three months later, when a new tiller was obtained.

Knifing Out Valve Seats in Place.

The check valves and other valves for steam and water on board ship very often give trouble, owing to the fact that some hard substance has got between the valve and its seat. This leaves a nasty hole or bend in the mitre, and it is impossible to make a tight job by simply grinding the valve in, according to the usual practice. On stopping the engines the boiler water will leak back into the hot well if the suction and delivery valves are not tightly shut down.

It is possible, however, to knife out the valve seats in place and restore them into perfect order by means of a very simple device made out of materials which can be found on board any boat. A piece of hard wood, such as a boat oar, may be taken, and by using a rough file or rasp it can be reduced in diameter



Section of Valve, Showing Method of Knifing.

until the wood is just a turning fit by hand in the valve seat. When this is the case, the wood should be marked off at the top of the valve seat and a small piece of sheet steel should be driven into the wood parallel with its axis at about this mark. A suitable piece of metal can be obtained by using the corner of an old firing shovel. This tool can be worked down into the valve seat. The projecting piece of steel should be made into shape, either flat or tapered, so as to suit the mitre required, this forming the knife on the top of the wood. A square head should be made, so that the mandrel thus formed can be turned round either by hand or spanner. By means of this simple tool the valve seat can be cleaned up satisfactorily. After this has been done the valve should be ground in the usual way, and it will be found that the surface will operate as well as ever.

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A Significant Change.

According to press dispatches, the Hamburg-American Liner *Deutschland* is undergoing extensive alterations and when she is again placed in commission it will be as an 18-knot cruiser instead of a 23-knot flyer. This change in the speed of the vessel means a reduction in the horsepower required for propulsion of about 50 percent and a reduction in the weight of the propelling machinery of some 3,000 tons. The *Deutschland* is the first of the crack Atlantic passenger steamships to be remodeled in this manner, and the change is significant, coming, as it does, after the remarkable performances of the latest and largest turbine-driven ships. The advent of the *Lusitania* and *Mauretania* has settled the question of the speed supremacy of the Atlantic for some time to come, and it is doubtful if any steamship company will soon have an opportunity of building fast mail ships under such advantageous terms as the Cunard Line was able to do. Extreme speed can be obtained only at a tremendous sacrifice in the earning power of the vessel, and it is only under the stimulus of large subsidies that such ships can be made to pay. Undoubtedly there are other fast ships besides the *Deutschland* which would pay larger dividends if their speed was reduced. The present tendency in the design of the Atlantic liners seems to be in the direction of large ships of moderate speed with ample cargo-carrying capacity, for there are now under construction no less than four steamships larger than the *Lusitania* and *Mauretania*, all of which are being built for moderate speeds. With the increased dimensions of these new ships speeds of 21 or 22 knots can be obtained economically, where in a smaller ship the economical speed would probably be 18 or 19 knots. During the ten years in which the *Deutschland* has been in service she has more than once held the record for the fastest passage across the Atlantic, proving a credit in every way to both her builders and owners; thus the change in her design is simply a significant indication of the modern trend of commercial steam navigation.

Practical Operation of Steam Turbines.

Steam turbines are coming to play such an important part in the propulsion of both merchant and naval vessels that it behooves every marine engineer to master thoroughly the details of their operation and upkeep. Those who have not been so fortunate as to have an opportunity to study this problem from a practical standpoint will find much valuable information in the article on the practical operation of Parsons turbines which is contributed this month to our Department of Practical Experiences of Marine Engineers. The subject is, of course, too broad to be exhausted within the limits of a single article, but our correspondent has brought out many valuable points which should give the practical man food for thought. He points out that there is one striking difference between the reciprocating engine and the turbine which the operating engineer must bear in mind, and that is that, whereas most of the breakdowns which occur with a reciprocating engine can be repaired at sea, on the other hand a breakdown with a turbine is a more serious matter, and it is seldom that satisfactory repairs can be made at sea. Therefore, it is of the utmost importance for the man in charge of turbine engines to keep the strictest watch over the machinery and prevent as far as possible any opportunity for a breakdown to occur. The importance of preventing even the slightest breakdown with turbines is evident when it is realized that it takes at least a week, and usually from three to four weeks, to overhaul a turbine. For this reason the opening of a set of turbine machinery is carried out at much longer intervals than is usual with reciprocating engines. It is true that breakdowns are much less frequent with turbine machinery than with reciprocating engines, because the turbine is a simpler machine. But, at the same time, the turbine is a more delicate piece of machinery, and the clearances between the moving and stationary parts are so small that neglect or anything less than the most rigid care

are inexcusable. The proverbial "stitch in time" is nowhere of more importance than in the operation of marine steam turbines.

In operating turbine machinery all parts of the turbine should be warmed up evenly and thoroughly to prevent distortion; particular care should be taken to drain off all water, and when steam is admitted the valves should be opened gradually so as to prevent priming, and the lubricating system should be maintained in the most efficient condition possible, with a constant watch on the temperatures of the bearings. The efficiency of the turbine depends largely on the vacuum maintained and, therefore, the condensers and air and circulating pumps should be given most careful attention. Once under way, if no maneuvering is required, the turbines need little attention, as compared with reciprocating engines. This does not mean, however, that the strictness of the watch should be relaxed, but merely that there is less work involved in their operation.

Naval Engineering Progress.

The Bureau of Steam Engineering of the United States Navy has been actively engaged during the last year in important investigations with a view to improving, from both an engineering and a military point of view, the efficiency and economy of present and future warships. A comprehensive résumé of this work is given in the lecture by Engineer-in-Chief Cone before the Naval War College, which is published elsewhere in this issue.

The first, and perhaps the most important, problem discussed by Rear Admiral Cone is the question of propulsion. The introduction of the steam turbine has made imperative radical changes in the design of propellers, auxiliary machinery, lubricating systems, etc., and the Navy Department is to be congratulated on its far-sighted policy in designing a sufficient number of sister ships of various types and installing upon them rival types of engines, so that comparative data regarding their performance could be obtained. The thoroughness with which this has been done has given the engineering world some invaluable information and, incidentally, has upset some popular theories regarding the comparative value of reciprocating and turbine engines. As a result of these tests, while practically every naval power is adopting without reservation the turbine for propulsion of battleships, the United States will install reciprocating engines in her latest battleship.

In the effort to improve the efficiency and economy of naval vessels certain tendencies in design can be noted along which improvement may be expected in future. Although the question of boilers seems to have been satisfactorily settled for the present, yet there is a decided tendency toward the use of small-tube express boilers, and it is quite probable that this type of boiler will play an important part in battleship design in the future. The use of oil fuel on all future United States battleships is urgently recommended. Aside from the question of the relative merits of the direct-connected reciprocating and turbine engines, the development of reduction gears for turbine drive is progressing rapidly, and either the mechanical, electrical or hydraulic gear may prove to be the means of establishing the supremacy of the turbine drive beyond a doubt. In another direction the possibility of gas propulsion is not so remote as to preclude investigation into its merits. For small powers this seems to be thoroughly practical at the present time, and, on account of the opportunities for effecting economy, it seems probable that a decided effort will be made to develop satisfactory engines and producers for large powers. For small auxiliary engines the heavy oil engine is now becoming recognized as a valuable type.

Not the least important part of the work done by the Navy Department in the last year, however, is the improvement in the economy of existing vessels. A detailed account of various ways in which economies have been effected is given in the lecture to which we have referred, and we commend this to the careful perusal of every marine engineer. The results speak for themselves.

A most important point to keep in mind in any attempt to increase the efficiency of a marine steam plant is the matter of boiler efficiency. It has been found that air leakage in boiler settings is largely responsible for poor economy in many boilers. Leakage of air immediately affects the percentage of CO_2 in the gases. In one instance the percentage of CO_2 was increased from 4 to 11 simply by carefully plugging up all the air holes that could be found in the boiler setting. As an indication of what is going on in the furnace it is advisable to fit CO_2 recorders to every boiler. If the CO_2 recorder is accurate and is properly installed, it will give a good indication of what the firemen are doing and are capable of doing, so that a check can be kept upon their work. As stated in Rear-Admiral Cone's report, the use of automatic CO_2 recorders showed that the boiler casings on most naval vessels leaked air, and, as a consequence, after due attention had been given to the prevention of air leakage, the result was a saving in coal which, in some cases, amounted to as much as 8 percent. On ships where Scotch boilers are fitted the question of air leakage, of course, is not so important; but the use of a CO_2 recorder here will give a valuable and systematic check on the work of the fireroom force, and its use should be beneficial. Another practical means of indicating boiler economy is by autographic registration of the furnace temperature. A continuous record of the furnace temperature, taken by means of a pyrometer and recording gage, can be secured with little trouble, and it will show at a glance any great drop in the economy of the boiler.

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Progress of Naval Vessels.

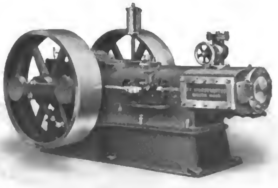
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Nov. 1	Dec. 1.
BATTLESHIPS.					
Florida	20,000	20¾	Navy Yard, New York......	80.6	83.7
Utah	20,000	20¾	New York Shipbuilding Co..	89.9	92.3
Arkansas ...	26,000	20½	New York Shipbuilding Co..	50.1	52.8
Wyoming ..	26,000	20½	Wm. Cramp & Sons.........	43.3	46.3
TORPEDO-BOAT DESTROYERS.					
Perkins	742	29½	Fore River Shipbuilding Co..	98.1	100.0
Sterrett	742	29½	Fore River Shipbuilding Co..	92.5	99.0
McCall	742	29½	New York Shipbuilding Co..	96.0	96.2
Burrows	742	29½	New York Shipbuilding Co..	85.1	96.0
Warrington..	742	29½	Wm. Cramp & Sons.........	89.1	91.2
Mayrant	742	29½	Wm. Cramp & Sons.........	86.7	90.3
Monaghan ..	742	29½	Newp't News Shipbuilding Co.	46.1	53.5
Trippe	742	29½	Bath Iron Works............	76.0	81.2
Walke	742	29½	Fore River Shipbuilding Co..	66.5	73.2
Ammen	742	29½	New York Shipbuilding Co..	76.3	79.9
Patterson ...	742	29½	Wm. Cramp & Sons.........	51.7	54.4
SUBMARINE TORPEDO BOATS.					
Seal	...	..	Newp't News Shipbuilding Co.	71.4	72.9
Carp	...	..	Union Iron Works..........	70.0	74.0
Barracuda ..	...	..	Union Iron Works..........	71.1	75.0
Pickerel	...	..	The Moran Co..............	64.3	65.0
Skate	...	..	The Moran Co..............	64.2	68.0
Skipjack	...	..	Fore River Shipbuilding Co..	57.5	62.2
Sturgeon ...	...	..	Fore River Shipbuilding Co..	57.6	64.3
Tuna	...	..	Newp't News Shipbuilding Co.	33.9	46.7
Thrasher ...	...	..	Wm. Cramp & Sons.........	20.2	22.0

ENGINEERING SPECIALTIES.

Sturtevant Horizontal Engines.

The engine illustrated is of the horizontal center crank type, built by the B. F. Sturtevant Company, Hyde Park, Mass. It is designed and built for both throttling and automatic regulation, and for medium, high and low-pressures. The manufacturers claim for these engines compactness, durability, quiet and satisfactory operation. The frame is equipped with openings which render the reciprocating parts easy of access, yet which may be closed, oil and dust tight by covers provided for the purpose. The cylinder is thoroughly insulated and equipped with relief valves adjustable to operate at any desired pressure. A water-shed partition prevents the passage of the oil from the frame into the cylinder, and steam from the cylinder into the frame. The linings of all bearings are Sturtevant white metal, which has proven its value for



high speed work for fifty years. The main bearing combines the best points of both the two and four-part boxes, and is designed in such a manner that it is impossible for any oil to flow along the shaft. The lubrication is of the gravity type, oil supply being contained in an elevated tank of large capacity, from whence pipes convey the oil to all bearings. A Rites governor located on the fly wheel of the automatic type gives accurate speed regulation. The throttling engines may be equipped with any type of throttling governor.

The Sturtevant Company claim that in this engine they are putting the best material and workmanship obtainable, and that for all work requiring a quiet running high-speed efficient engine, for either high, medium or low pressure, this engine will meet all requirements if they are within its field.

The Bradford Steam Cock.

The chief feature of the Bradford steam cock, manufactured by Miller, Dennis & Company, Victoria Works, Bradford, is its non-liability to jam under any conditions. This, it

is claimed, makes it especially durable. It is self-grinding, the plug being inverted and held in place by a strong spring which allows for expansion under steam pressure. These cocks are made in gunmetal and iron in all sizes, both screwed and flanged.

The Ideal Automatic Pump Governor.

The Ideal automatic pump governor is an oil-controlled, piston actuated, pressure controlling valve for governing pumps working under a specific pressure. These governors are manufactured by the Ideal Automatic Manufacturing Company, 125 Watts street, New York City, and the Style-A governor for fuel-oil service pumps, fuel-oil supply pumps, engine-room and fire-room and bilge pumps, forced lubrication service pumps, salt-water sanitary pumps and salt-water fire pumps, is shown in Fig. 1. The valves and governor are made of the best steam bronze metal for marine purposes. No diaphragms or cup leathers are used, and the body of oil in the trap and pressure cylinder on top of the water or other liquid being pumped follows the piston in both its upward and downward strokes, thus thoroughly lubricating and protecting the wearing surface of the cylinder walls and piston from all liability to corrode and stick fast when the pump is called upon to act. It is claimed that this piston working in oil at all times makes the governor sensitive and quick acting, as the pump will start at the slightest break in the pressure.

At the bottom of the oil trap of each governor is a pet cock, so that any dirt or sediment collecting may be readily blown off without affecting the working of the valve; for this reason it is claimed that the Ideal governors are not affected by salt water or other liquids that might corrode or leave a deposit.

As the governor hangs in a perpendicular position and under the steam line, no heat reaches the working parts, consequently the heat can have no effect on the working of the governor.

Fig. 2 shows the Ideal compound-pressure pump governor Style-B. This governor has been designed for special work on the same lines as the Style-A governor, but to give a better range of pressure than is possible with a single spring operating the piston. It is applicable to most boiler feed and other pumps where varying pressures are required. By simply shifting the lever on the quadrant up or down the working pressure desired is easily obtained. If a low-pressure is needed, the

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low-pressure spring is in action, and if a high-pressure is needed the high-pressure spring is brought into action by means of the lever tension on the high-pressure spring compounding or bringing into action both springs until the desired pressure to do the work is obtained.

A special feature of this style of governor is that in case of an accident to the apparatus being handled it is possible to use this device as a hand-operated stop valve by reversing the lever to an upward position on the quadrant, bringing the lever

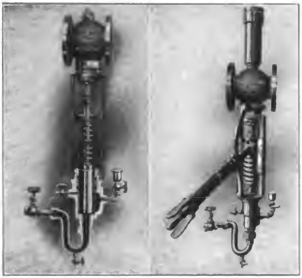

FIG. 1. FIG. 2.

in contact with the flanged nut on the valve stem proper, thus shutting the valve off tightly and stopping the pump. The pump stands in this position until the lever is shifted to the low-pressure or central position on the quadrant when the low-pressure spring is in operation, or by shifting the lever in a downward movement on the quadrant to any desired position for any intermediate-pressure by bringing into operation the high-pressure spring. This method of adjustment allows the engineer to control the pump from a low to a high-pressure, or at any intermediate-pressure which he might desire.

The Komo Steam Trap.

One of the principal causes of the loss of steam and fuel in operating the steam equipment of ships has been the use of steam traps which are worked by the use of a bucket, float or other internal mechanism which is constantly affected by the pitching or the rolling of the ship and which causes a trap of this type to open and blow through steam. The Komo steam trap, manufactured by the Linton Machine Co., New York, contains no complicated or internal mechanism, such as buckets, floats, tubes or diaphragms, which would be affected by the motion of the ship. It is claimed that this trap operates equally well on high or low-pressure steam, removing condensation continually and maintaining a steady steam pressure when used upon steam piping, engine cylinders, steam separators, evaporators, cooking tables, boiling kettles, heating sytems, laundry machinery, etc.

The bowed side rods, as shown in the illustration, operate the valve upon the Komo, and these bowed rods multiply the movement of the receiver tubes about 10 to 1, thus insuring a large opening of the valve port. The springs upon the upright rods combat the pressure underneath the disc and this makes a balance valve at the outlet, and allows the Komo to operate on a varying steam pressure of about 40 pounds, something which, it is claimed, no other trap operated by the expansion of metal has yet been able to do. This spring pressure follows down the loss of steam presure underneath the disc and keeps it tight to the valve seat. This is an important advantage for marine service, as the steam pressure carried, when a ship is moving, is sometimes much higher than when the steamer is at dock and when only enough steam pressure is carried to operate the auxiliaries. When adjusted, there is steam in the receiver tubes, and as soon as any condensation forms, being cooler than the steam, it causes the tubes to contract and open the valve and the trap immediately discharges the water. When the steam is shut off the system and the trap is closed the disc is at least ¼ off seat and the trap drains the system of all condensation, thus preventing the system or the trap from becoming air bound or freezing up.

The salient feature of the Komo is the large valve outlet, which, it is claimed, insures a large capacity, and it can pass through its outlet the same amount of water which could be delivered to its inlet connection. This advantage insures the free flow and instant discharge of all condensation, thus taking care of any floods or rush of water which may be delivered to the trap. No bypass is required and the trap can be cleansed of any scale or dirt by simply opening the valve and blowing out the trap thoroughly.

The yoke and adjustment can be thrown to one side, upon the hinged upright rods, so the disc may be inspected or renewed without the disconnecting of any pipe, flanges or pack joints.

As water from the steam collects, the receiving pipe cools and contracts, bringing the brackets toward each other and bending the horizontal rods so that they rise in the middle, forcing the vertical rods upwards. The lower nuts on the vertical rods then come in contact with and raise the yoke which carries the valve stem to lift the valve from its seat. The water is then forced from the receiving pipe up through the inner tube and outlet. As the water leaves the receiver, steam enters, expanding the pipe by its higher temperature, so that the brackets separate, pulling the horizontal rods

nearer a straight line and lowering the vertical rods, with their nuts, until the valve is reseated. Excessive expansion of the receiving pipe will merely cause the lower nuts on the vertical rods to be drawn further below the ends of yoke and the valve will be held to its seat by spring pressure until contraction of the receiving pipe brings the lower nuts again in contact with the ends of yoke, to raise the same, unseating the valve, as above explained.

No permanent water seal of 3 or 4 inches, which is constantly cooling and causing subsequent condensation, is required, as the valve is made with the tube which runs from the base of the valve seat too near the bottom of the receiver chamber. This tube prevents any escape of steam while the trap is in operation, as the condensation must be

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forced by this tube and out the valve opening; and as the steam enters and travels along the top of the receiver tubes, heating the trap and closing it, it is prevented by this tube, which acts as a seal.

Witting's H. B. Valves.

Fig. 1 is an illustration of a section through a Witting's patent H. B. valve (manufactured by Witting Bros., Ltd., 49 Cannon street, London, E. C.) screwed into a position that may have been originally occupied by an ordinary valve. The body is made of gun metal in one piece, the upper part *B* being continuous with the lower part *A* by six pillars or lugs between which the liquid flows. This connection, however, is not shown in the section. The working valve consists of two movable brass, phosphor bronze or steel rings made of thin sheet metal 1/32 inch to 3/32 inch thick, the outer edge of which forms a kind of bird's mouth opening all round; these,

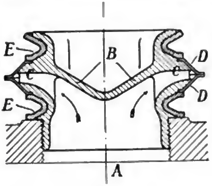


FIG. 1.

when closed, cover the annular orifice *C*. The outer edges are about 3/16 inch to ¼ inch wide, and form the valve. These rings are spun and are of great strength and resistance, and when not working the inner sides rest against the immovable body. The metal rings are kept in position and receive the necessary spring load by the V-shaped rubber rings *E*, which are sprung on and held in position by tension in the grooves in the body, and also press the metal rings against each other.

The V-shaped rubber rings form at the same time the packing between the single stages and between the valve bottom and seat ring; thus no special packings are required for multi-stage H. B. valves.

Figs. 2 and 3 are illustrations of the application of the valve in a multiple form, there being two separate valves in the one. This form can be multiplied to suit circumstances. The width of the orifice does not exceed ¼ inch; thus each lip ring moves only ⅛ inch. This very low lift, combined with

FIG. 2.

the lightness of the moving part, makes the H. B. valves particularly applicable to high-speed pumps.

Fig. 2 illustrates the valve closed, the bird's-mouth adges being closed together and held so by two rubber rings. Fig. 3 shows the open valve, both outlets being open. It is claimed these valves work equally satisfactorily, whether fixed vertically, horizontally or inclined, jamming or edging being impossible.

From careful examination and investigation of them when at work it appears that the Witting valve complies with the

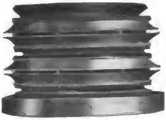


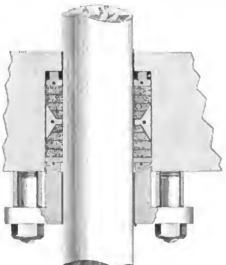
FIG. 3.

essentials of an ideal pump valve, for the reduction of noise, efficiency, durability and simple and economical renewal of parts. The working parts weigh less than a tenth part of an ordinary valve in use for similar work. The closing is prompt and uniform.

The flow of the liquid is uniform and widespread round the lips of the valve, which noiselessly close without friction. Spare valves and rings, which are the smallest and simplest parts of the mechanism, are readily and speedily substituted.

Ideal Automatic Packing.

The illustration shows a semi-metallic and fibrous automatic packing, designed and adapted for use on valve stems, piston rods and shafts under pressure where tight packing is necessary to prevent undue friction. This packing is manufactured with a float ring in the bottom of the box with distance lugs on it, distancing it off from the bottom of the box to form a pressure chamber. Above the float ring is a soft fibrous pack-



ing especially made for steam or gas or water, and above this the double female internally-coned ring in the center of the box, above which is again the fibrous soft packing, and above that a float ring next to the gland, performing the same operation as the float ring in the bottom of the box, holding the piston tight on both its forward and backward strokes. This packing is manufactured by the Ideal Automatic Manufacturing Company, 125 Watts street, New York City.

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Electric Safety Boiler Cleaner.

An electrically-driven tool for removing scale from steam boilers is manufactured by the Electric Safety Boiler Cleaner, Ltd., 6 Lloyds avenue, Fenchurch street, London, E. C. The apparatus is intended to supersede the old method of hand chipping, and it is not only more rapid but is apparently more efficient as regards the complete removal of scale. As can be seen from the illustration, the cleaner consists of several circular cutters about 2½ inches diameter, held in a frame on the same spindle and driven by a shaft which passes

through the handle of the apparatus and which receives its motion from a flexible shaft driven by a ½-horsepower electric motor. The number of cutters can be varied from one to three, according as the tool is to be used in confined narow spaces, or where there is plenty of room. The speed of the cutters may be varied from 1,400 to 4,000 revolutions per minute, but the usual speed is 3,000 revolutions per minute. The handle of the device may be shortened or lengthened as desired to suit the position of the different parts to be scaled, and no particular skill is required by the operator, as the cutters are merely moved over the parts to be cleaned.

PERSONAL.

JOHN KARKLIN, formerly first assistant engineer of the steamship *City of Augusta*, has been transferred to the position of first assistant engineer of the *City of Memphis*, running between Savannah, Ga., and Boston, Mass. Harry Stewart is now chief engineer of the *City of Memphis*.

WALTER L. PIERCE, secretary and general manager of the Lidgerwood Manufacturing Company, New York, died suddenly of heart failure Dec. 10, 1910.

GEORGE SIMPSON, formerly naval architect with the Fore River Shipbuilding Company, Quincy, Mass., is now identified with the firm of John Reid & Company, naval architects and marine engineers, 17 Battery Place, New York.

PAUL E. STEVENSON, author of "A Deep Water Voyage," "By Way of Cape Horn" and the "Race for the Emperor's Cup," died suddenly of pneumonia Dec. 20 at Garden City, L. I.

M. E. B. A. No. 33.

The annual entertainment and reception of the Marine Engineers' Beneficial Association No. 33 was held at the Lexington Avenue Opera House, New York City, on the evening of Dec. 7. The attendance was large and the entire programme a splendid success.

COMMUNICATION.

Information Wanted

EDITOR INTERNATIONAL MARINE ENGINEERING:

In looking over Simpson's "Naval Constructor" (Van Nostrand Company, 1904), I find on page 45 a formula (No. 14) which somewhat mystifies me. If any of your correspondents, or, perhaps, the author, could explain this it might be of interest to those who are using this book.

The formula is intended to give a vessel's beam for a certain metacentric height, when the displacement, the load draft, the coefficients of displacement, load waterline and transverse moments of inertia are given, and is as follows:

$$\text{Beam} = \sqrt{M - d\left(\frac{5\alpha - 2\delta}{6\alpha}\right) \times \frac{d}{m}}$$

where d = load draft; α = coefficient load waterline; δ = block coefficient; $m = \frac{i}{\delta}$ (i = moment of inertia coefficient).

The term M is not given on page 45, but is given on page 8 as M = metacenter and moment, which is somewhat indefinite.

H.

TECHNICAL PUBLICATIONS.

Buccaneer Ballads. By E. H. Visiak. Size, 4 by 6¾ inches. Pages, 43. London, 1910: Elkin Matthews, Vigo street. Price, 1s. net.

This volume includes some thirty short poems, many of which have appeared in various periodicals during recent years. No more picturesque subject could be found for the exercise of poetical imagination than the old-time buccaneer. He is largely a creature of the imagination and, to many, seems more symbolical than real. Mr. Visiak's ballads, however, give true expression to the spirit of the sea, and will reach the heart of many an old sailor.

Bureau Veritas, 1910-1911. Forty-first year. General List of Merchant Shipping. Two volumes. Steamers: Size, 10¼ by 11 inches; pages, 1,111. Sailing vessels: Size, 10¼ by 11 inches; pages, 1,008. Paris, 8 Place de la Bourse. London, 155 Fenchurch street, E. C. Price of complete work, £3 3s. Steamers, £1 15s.; sailing vessels, £1 10s.

The general list of merchant shipping published by the Bureau Veritas is a carefully edited and conveniently arranged reference book, containing statistics not only of all important steam and sailing vessels in the world's merchant marine, but also particulars of vessels arranged according to various classifications, such as their nationality, the kind of trade in which they are engaged, etc. Lists are given of steamers and sailing vessels which have had their names changed during the past year, and also of iron and steel shipbuilders arranged according to nationality; of steamship owners, arranged according to nationality, with the names and the gross tonnages of their fleets. There are also lists of the principal dry-docks, patent slips, etc., throughout the world.

Work, Wages and Profits. By H. L. Gantt. Size, 5 by 7½ inches. Pages, 194. Charts, 6. New York, 1910: *The Engineering Magazine*. Price, $2.00.

The author of this book has been closely interested in advanced work in the field of labor management for more than twenty years and for more than ten years he has been prominently identified with certain methods of labor management which are becoming recognized as of the highest importance. The subject is still obscure, however, and there seems to be a woeful lack of information on the part of many works managers. To such we can highly recommend this book as

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presenting the results of a most careful scientific investigation leading to certain conclusions which give bright promise for betterment in industrial conditions. The book contains nine chapters which treat of the following subjects: The application of the scientific method to the labor problem; the utilization of labor; the compensation of workmen; day work; piece work; task work with a bonus; training workmen in habits of industry and co-operation; fixing habits of industry, and profits and their influence on the cost of living.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

968,823. PROPELLING DEVICE. GEORGE WESTINGHOUSE, OF PITTSBURG, PA.

Claim 2.—The combination of a prime mover and a fluid pump comprising primary and secondary elements, the primary element of which is driven by the prime mover, a propeller attached directly to and driven by the secondary element of the pump, the arrangement being such that the flow of fluid through the secondary element is utilized for aiding in the propulsive effort of said propeller. Eleven claims.

971,409. PROPELLER. THEODORE ROGGENBUCK, OF SAN FRANCISCO, CAL.

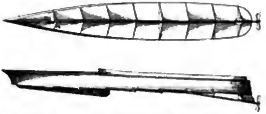
Claim 1.—The combination in a propeller of radial and pitched vanes, said vanes having overhanging plates at the ends with the outer edges of said plates inturned substantially toward the axis of the propeller. Four claims.

971,240. RUDDER. WILLIAM R. BENNETT, OF ST. JOHN, NEW BRUNSWICK, CANADA.

Claim.—A rudder comprising a post having braces and pintle knuckles integrally formed therewith, in combination with plates having their rear sections deflected outwardly, said plates being secured to said post by said braces. One claim.

971,029. HYDROPLANE BOAT. WILLIAM HENRY FAUBER, OF CHICAGO, ILL.

Claim 1.—A hydroplane boat provided at each side of the center line of the bottom of its hull with a series of hydroplane members which



form the flotation surface of the said bottom and are arranged in stepped relation and inclined laterally and downwardly toward the keel line of the boat. Ten claims.

970,607. PROPELLING AND DRIVING MECHANISM. JOSE CERVELLI, OF BUENOS AYRES, ARGENTINA, ASSIGNOR OF ONE-THIRD TO JOSE MOLINARI AND ONE-THIRD TO JEAN BERNASCONI, OF BUENOS AYRES, ARGENTINA.

Claim.—Mechanism designed to be employed for the propulsion of ships, submarines and aerostats, as well as for the production of motive power by means of a current of air or water, which mechanism comprises a rotary driving or propelling shaft, a bearing in two parts formed by the said shaft itself, a trunnion located in said bearing perpendicularly to the axis of the said shaft, blades rigidly connected to said trunnion, placed at an angle of 90 degrees to each other and provided at their bases with lateral bosses, and two stationary cam-plates arranged with relation to one another so as to form an annular guiding groove for the blades of such a form as to guide the bosses thereof in a constrained fashion on either side throughout their revolving motion, with the object of correctly and surely causing at each half revolution of the propeller shaft a movement of rotation of 90 degrees of the blade-trunnion and consequently a reversal of the position of the blades between positions which are parallel and transverse respectively to the propeller shaft. One claim.

972,180. SAFETY APPLIANCE FOR SHIPS. CONSTANTINO FUGAZZI, OF WEST PHILADELPHIA, PA.

Claim 1.—In a ship, the combination with a portion of the body of the ship, of a safety-appliance comprising an air-containing receptacle adapted to serve as a float or buoy, means for supporting said air-containing receptacle upon a portion of the upper and outer part of the ship, and mechanism for lowering said air-containing receptacle over the side of the ship, comprising sprocket-wheels, sprocket-chains passing over said sprocket-wheels, and flexible connections between said air-containing receptacles and said chains. Twenty claims.

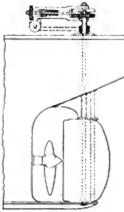
972,337. VIBRATING PROPELLER. BARTON H. COFFEY, OF BOSTON, MASS.

Claim 1.—A vibrating propeller consisting of mutually reacting motor-planes, each plane provided with means to oscillate it upon an axis and to hold it substantially motionless at the termination of each oscillation; the several means being so organized that there shall substantially always be planes in motion and planes at rest. Six claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

22,021. STEERING AND CONTROLLING DEVICES FOR SCREW SHIPS. J. P. H. LUND, ROCKHAMPTON, QUEENSLAND.

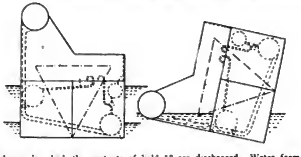
Relates to twin balanced rudders, which by this invention are adapted to be moved parallel with one another for steering purposes or to be moved symmetrically through various angles for the purpose of slowing the speed or to stop the vessel. In steering, the tiller is simply moved



about its fulcrum, then toothed segments turn pinions fixed on the rudder posts simultaneously, and the rudders are parallel in any position. In causing the rudders to act as a brake or to direct the water forward, a wheel is turned by chains passing over pulleys to turn a screw and so move a nut and connecting rods, which thus move the segments relatively to each other.

22,712. SELF-DUMPING BARGES. A. F. WIKING, STOCKHOLM, SWEDEN.

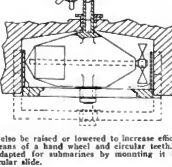
In the case of a barge, to dump the load, compressed air from 5 drives water from tank 4 through pipe 7 to tank 2 until the elevated weight causes the barge to assume, more or less, the second position



shown, in which the contents of hold 13 are discharged. Water from tank 2 is then allowed to run down into tank 3 to allow the weight of the exposed hull to right the vessel when tank 3 can be emptied back into tank 4 by gravity.

26,329. DRIVING AND STEERING VESSELS AND THE LIKE. R. C. SAYER, BRISTOL.

A propeller, with or without its motor, is mounted so that it may be turned about shaft for steering or reversing by means of a worm and



wheel. It may also be raised or lowered to increase efficiency on slides in guides by means of a hand wheel and circular teeth. The arrangement is also adapted for submarines by mounting it on half gimbal rings and a circular slide.

International Marine Engineering

FEBRUARY, 1911.

MODERN METHODS OF COALING VESSELS.

Every marine engineer knows the exasperation which is caused by the usual methods of bunkering coal. This work not only consumes much of the time while a vessel is in port but it is costly and dirty as well. In order to obviate such troubles attempts have been made in the direction of constructing mechanical coaling barges of more or less efficient types, and the attention which has been paid to this branch of industry has gradually led to the perfecting of appliances for rapid, clean and economical bunkering with the additional advantage that in many of these equipments automatic weighing machines are included so that an accurate register is kept of the amount of coal delivered to a vessel, thus in many cases saving a considerable amount of dispute.

FIG. 1.—EARLY TYPE OF SELF-PROPELLED COALING BARGE WITH LADDER SUSPENDED BY CABLES.

Another difficulty which has been experienced in connection with the older methods has been that it appeared almost impossible to transfer coal to the bunkers of a vessel without breaking it up from the large sizes, which are so desirable, into small coal, which is not nearly so efficient from a firing point of view. Any appliance which obviates this breaking up deserves the most careful consideration, and it is our intention to describe some of the equipments which have been constructed by the firm of A. F. Smulders, of Schiedam, near

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FIG. 2.—MODERN TYPE OF SELF-PROPELLED COALING BARGE WITH LADDER AND RECEIVER FIXED.

Rotterdam, for the economical handling of coal into bunkers. Before giving such description, it may be well to preface the matter by saying that one of the important points which will be noted is the entire enclosure of the coal-carrying chutes, so that the evil of depositing coal dust over the vessel, which involves so much cleaning after the boat has left port, is done away with to great advantage.

The first step in the question of bunkering a vessel is that of conveying the coal from the nearest adjacent delivery head to the vessel itself, and this is not unfrequently a very serious problem. The more important ports are, of course, now usually equipped with coal staithes, or other coal-handling appliances, whereby the fuel can be transferred directly into the hold of the vessel lying alongside at the wharf; but in smaller ports these appliances, which are costly to construct, and in some cases costly to maintain, are absent. In addition to this, however, is the fact that it is often a matter involving considerable delay if a vessel has to wait its turn at such a coaling point, as accommodation must necessarily be limited, and other things being equal it is far preferable to have some device whereby the vessel at anchor in the roadway or in its normal position for discharging or receiving cargo can be simultaneously coaled. For this reason self-propelling coaling vessels of the type illustrated in Fig. 1, showing the process of bunkering a 17,000-ton ocean-going steamer, have become of great importance, inasmuch as they can obtain their cargo of coal at any convenient point adjacent to a railway line where a small craft can anchor and then proceed under their own steam to the larger vessel which requires bunkering, and which may be occupying more important wharfing space, and there can discharge their cargo into the bunkers of the ocean-going vessel. The bunker space of the steamer permitting, 250 tons of coal per hour can be conveyed from one of these vessels with a total crew of only seven men. Moreover, to load or discharge cargo is well nigh impossible when an army of coal heavers are continually streaming up and down both sides of the steamer, so that the advantage of the new system in saving time is apparent.

FIG. 3.—COALING STARBOARD BUNKERS FROM PORT SIDE OF VESSEL.

These self-propelled coaling vessels have a hold which is divided into compartments by means of transverse bulkheads, and there is, theoretically, no limit to the size and number of these compartments. Hence the total hold capacity of the vessels depends entirely on the requirements of the port or harbor in which they are to serve. There is no reason why the hold capacity of such a vessel should not be as much as 2,500 tons or even more, and one such vessel has been constructed having a capacity of about 1,100 metric tons. The vessel shown in the illustration has a hold capacity of from 600 to 700 metric tons and a rate of discharge of 250 tons per hour. By means of sliding doors the compartments formed by the transverse bulkhead empty themselves one after another into the buckets which run in a tunnel along the ship's keel. This endless conveyor or bucket chain is driven by either of the two engines which propel the twin screws of the vessel.

Before reaching the upward bend which enables the bucket chain to pass on to the ladder shown in the illustration after the fashion of an elevator, the conveyor runs over an automatic weighing machine, which can weigh accurately within 1 percent, even if the vessel lies with a list of 10 degrees either fore, aft or athwartship. By means of the self-registering arrangement the weight of the coal delivered can be read off at any moment.

Two points with regard to this system of coal conveying may be noticed. The first is that the motion is exceedingly smooth and gentle, so that the coal during the process of manipulation does not suffer in the least, and is therefore not broken up into smaller pieces. Moreover, the shape of the buckets of the conveyor, which has the appearance of a vertebrate belt, has been so designed as to prevent the spilling of coal during its transfer from the coaling vessel to the steamer.

Turning now to the elevator portion of the vessel the ladder which is fixed at the stem performs the office of a conveyor in its ascending motion to the receiver. In the earlier types of coaling vessels of this description the ladder was made movable, being suspended by cables, as shown in Fig. 1, so that it could be raised or lowered according to the height of the bunkers to be filled. When the buckets reached the top of the ladder they bent over and emptied the coal into the receiver, from which the coal traveled through the chute shown in the illustration into the steamer's bunkers without being exposed to the open air. As the ladder was movable the receiver in its turn had to be made movable also; it was therefore suspended in a position abutting on the top of the ladder by means of a shaft on which it was pivoted.

In subsequent designs the ladder and receiver were made fixed, as shown in Fig. 2. A telescopic chute, through which the coal reaches the bunkers of the steamer, is attached to the receiver by means of a universal joint, so that when the coaling barge is moored alongside the various bunkers of a ship can be reached with a minimum amount of manipulation. It is evident that bunkering may be effected by this means at a considerable distance between the coaling vessel and the steamer by the simple means of lengthening the chute, and it is even possible to fill the starboard bunkers if the coaling vessel is moored at the portside of the steamer (Fig. 3). An examination of Figs. 2 and 3 will also show an improvement in the method of handling this chute. In the earlier form the telescopic chute was manipulated by means of a derrick, while the more modern practice is to raise, lower or move the chute to right or left by means of a pivoting crane fitted at the top of the receiver. These self-propelled coaling vessels have twin screws, enabling them to proceed at a fair speed actuated by two engines fed by a Scotch boiler. The coaling vessels are lighted by electricity, so that bunkering may be proceeded with at night.

Fig. 4 shows one of these coal-carrying bunkering vessels engaged in bunkering a steamer while the latter is being repaired in drydock, and is illustrative of the saving of time by these modern means.

FIG. 4.—COALING A VESSEL WHILE IN DRY-DOCK BY MEANS OF SELF-PROPELLED COALING BARGE.

When the hold of the coaling vessel is filled with coal, she moors alongside the steamer which is to be supplied, or if lighters happen to lie alongside for purposes of loading or discharging cargo she moors alongside the lighters. A fore steam winch sets the crane on the receiver in motion, and the telescopic discharge chute is forthwith given the desired direction and inclination as well as the requisite length, causing the chute to reach immediately above or into the bunkering hatch. The captain of the coaling vessel having been warned by a signal that all is ready, telegraphs the engineer to start the engines, and this having been done he orders the tunnelman in the same way to admit coal to the conveyor. By means of a very simple system of leverage the tunnelman opens one of the sliding doors in the sides of the tunnel and allows the coal to glide on to the conveyor. The floor of the tunnel on which the tunnelman moves about is made of planks, placed a little apart, so that he is able by the light of the incandescent lamps to watch the conveyor moving underneath, and by opening the doors to a greater or less extent he is able absolutely to control the supply of coal to the conveyor. A clinometer in the tunnel enables the man to ascertain whether the vessel preserves an even keel athwartships.

The sliding doors mentioned above are of sufficient size for

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the largest lumps of coal to pass through, while the levers which open these doors are so arranged that a single pressure downward will immediately close a sliding door. This is often necessary to prevent the conveyor from being overloaded by a rush of fine coal following the admission of a big lump.

The loaded conveyor, before reaching the ladder, passes over a weighing machine which adds automatically and with great accuracy the quantity of coal being carried over it, and from it the quantity of coal delivered to the steamer alongside may at any moment be read off.

Whenever a bunker has been filled up and it becomes necessary for the discharge chute to be shifted to another hatch the supply of coal to the conveyor is stopped and also the engine driving the conveyor. It is remarkable to see during the process of bunkering how easily the coaling vessel and her apparatus are handled. While actually bunkering only, the fireman who regulates the supply of steam, the engineer watching his engine and the tunnelman are at work, and the vessel can in this way discharge 250 tons of coal an hour until her hold is quite empty, the sloping side of the hold causing the coal to glide down of its own weight, and no trimming is required.

Up to now we have dealt with the problem in its simplest form, namely, given a coaling vessel of a definite capacity how to transfer its contents to a steamer with a minimum amount of time, trouble and deterioration of fuel. It is evident, however, that with the arrangement described above some loss of time must occur in transit of the coal vessel to and from the steamer when its contents are exhausted. Should the problems of rapid coaling demand that in the case of larger vessels additional facilities be given in order to make the coaling process as nearly as possible continuous, the provision of duplicate self-propelled vessels would be an expensive matter, and in order to deal with this proposition the firm above mentioned has developed an auxiliary piece of apparatus on its later vessels which has the effect of increasing their capacity. This apparatus is a traveling coal transporter, and Fig. 2 shows a coaling vessel having a capacity of 1,000 tons of coal, and also provided with a traveling coal transporter of the grab type, by which the vessel is able while actually engaged in bunkering a steamer to assist in replenishing the coal in its own hold.

The apparatus consists of an electric transporter mounted on four supports which run along the entire length of the hatch coamings, and take the coal from the lighters alongside. The telescopic portions of the gear, which may be seen in the illustration, can be extended either to port side or starboard in this way, and form a track for the grab or bucket running to a certain distance over the vessel's side. This grab has a capacity of 70 cubic feet, and can easily handle 50 tons of coal per hour. This is not, of course, a maximum figure, for such a process as installations for the same end of a very much larger capacity can be built. It will be seen that the operation of this grab does not interfere with the simultaneous replenishment of the cargo by other means, and which has the advantage that, owing to the telescopic arrangement, the transporter can be contracted when the apparatus is at rest so completely that it presents no obstacle to the proper navigation of the vessel.

FIG. 5.—APPARATUS FOR TRANSFERRING COAL FROM BARGES TO VESSEL OR TO RAILWAY CARS ON SHORE. HOURLY CAPACITY 500 TONS.

We may now deal with one of the latest types of apparatus used in coaling a vessel which has been constructed up to an hourly output of 500 tons of coal. This is illustrated in Fig. 5, and its use is to take coal out of the hold of barges moored alongside and to discharge it into the bunkers of the steamers, the hold of coaling or other vessels, or to deposit it on to railway trucks or on the shore. It is really a combination of a bucket elevator and a coaling vessel. As, however, it does not have to carry coal but simply to take it out of barges moored alongside and discharge into a ship or on shore, it has no hold, being erected on a very strong pontoon which easily bears the heavy weight of the structure. Although it can be built self-propelling this type of apparatus has not up to the present been

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made self-portable. The coal is taken out of the barges by means of a hydraulically-operated swinging ladder, seen to the left of the illustration, suspended to the end of a movable bearing arm and fitted with a double row of buckets. This bearing arm is lowered until the buckets which have been set in motion reach the coal in the barge's hold and fill themselves. The buckets then go up on the pontoon side of the swinging ladder. When they reach the bearing arm, which during the operation of digging hangs in a nearly horizontal position, their position changes from vertical to a horizontal one, so that they empty their contents into a channel which has nearly the same cross-section as the buckets. In this channel the coal is pushed forward by the buckets, which move along the bearing arm until it reaches the end and passes into a fixed receiver, while the empty buckets return to the swinging ladder along the upper side of the bearing arm.

When the coal is in the receiver it has two alternative paths. If it is to be discharged into the hold of coaling or other vessels, into trucks on shore, it passes from the fixed receiver on an endless conveyor supported by a movable bearing arm (shown projecting over the line of rails on the quay), which during the work is kept in a nearly horizontal position. If, however, it is required to discharge directly into the bunkers of steamers the coal passes to a ladder and telescopic chute at the stern of the pontoon, provided with self-registering weighing machines in the same way as in the self-propelled coal vessels described above. When the apparatus is at rest or in tow the first three charge and discharge chutes can be hoisted until they do not overhang the pontoon in any direction. This allows the elevator to be taken in tow without interfering with navigation in crowded harbors.

As the swinging ladder has occasionally to operate at a considerable distance outside the pontoon, and therefore the latter would list to such an extent that the accurate working of the weighing apparatus might be interfered with, an arrangement is provided which causes water to be automatically pumped into tanks fitted opposite to the swinging ladder as soon as the list exceeds a low limit, thus maintaining the equilibrium of the whole structure. Moreover, the hull of the elevator is divided into a large number of watertight compartments, so that if a collision were to take place the danger of sinking would be reduced to a minimum.

The above description, which is illustrative of the work of one firm in this specialized direction, is valuable as indicating the line along which the problems of coal bunkering can be best attacked and overcome. A very large proportion of success in this sphere of industry is only obtained by the actual encountering of practical difficulties and the overcoming of these obstacles by attention to detail in construction, so that an account of actual plant manufactured and in use is of far more value than a good deal of theory on the matter. For this reason it is hoped that the above notes may be of interest to all engineers interested in the problems concerning the efficient handling of coal.

Speed Trials of H. M. S. Gloucester.

H. M. S. *Gloucester* is a second-class protected cruiser, 450 feet long, 4,800 tons displacement, built at the naval construction works of William Beardmore & Company, at Dalmuir, Clyde. She is fitted with Parsons turbines on four shafts, and her boilers are of the Yarrow watertube type, adaptable for both coal and oil fuel. The boilers were also constructed by Beardmore & Company. Her armament consists of one 6-inch gun forward on the forecastle and one aft on the upper deck, with ten 4-inch guns for broadside work.

The official trials were for speed, gun practice, torpedo practice and maneuvering. They were effected on the Firth of Clyde.

The first speed trial was for twelve consecutive hours progressively. This trial was subdivided into three periods of four hours each for 1,600, 4,400 and 8,800 shaft-horsepower each. The speeds attained at these powers were 12.837, 17.549 and 20.799 knots, respectively. A second trial was of a thirty-hour run. It was divided into two periods—one of eight hours at 18,000 and one of twenty-hours at 13,500 shaft-horsepower. The result in speed was 25.084 and 23.447 knots, respectively. Later, after the gun and torpedo trials, there was a full-power run of eight hours. On this the mean speed attained was 26.3 knots, or 1.3 knots in excess of the estimate of 25 knots. The contract indicated horsepower was 22,000 and the actual was 24,150. These results were necessarily regarded as satisfactory. The maneuvering trials were equally satisfactory. After they were completed the ship was taken back to Dalmuir, where in the large fitting-out basin she was opened out for close inspection before being commissioned.

NEW BRITISH BATTLESHIP CONQUEROR.

The British battleship *Conqueror*, which is being built on the Clyde at the Dalmuir Naval Construction Works of Messrs. Beardmore of Glasgow, is expected to be ready for launching early in 1911. She is a sister ship of the *Monarch* and *Thunderer*, which are being constructed at the shipbuilding yards of Messrs. Armstrong, Whitworth & Company, Newcastle-on-Tyne, and the Thames Ironworks Company of London, respectively. The keel of the *Conqueror* was laid in March, 1910, and her construction has progressed in a very satisfactory manner, but she would have been launched two months earlier if the recent lockout of the shipyard ironworkers had not taken place.

She is some 55 feet longer than the *Dreadnought;* that is to say, her length between perpendiculars is 545 feet, as compared with the *Dreadnought's* length of 490 feet between perpendiculars.

The following particulars and principal dimensions of the two boats will give some idea of the rapid progress which has been made in battleship design in the short time that has elapsed since the *Dreadnought* was built:

	Dreadnought.	*Conqueror.*
Length, B. P.	490' 0"	545' 0"
Breadth	82' 0"	88' 6"
Draft	25' 6"	27' 6"
Displacement in tons	18,000	22,500
Shaft horsepower	23,000	27,000
Speed at sea	21 knots	21 knots
Main battery	Ten 12" guns	Ten 13.5" guns
Secondary battery	Sixteen 4" guns	Sixteen 4.7" guns
Cost	£1,250,000 $6,080,000	£1,750,000 $8,520,000

Official verification of these dimensions of length and beam, etc., is unobtainable on account of the British Admiralty having followed out that system of secrecy which is employed by the Admiralties of other nations. But as our information is from a reliable source, the particulars may be accepted as sufficiently accurate.

The outward appearance of the *Conqueror* will greatly resemble that of the *Dreadnought*, with two smoke stacks and one tripod mast. The mast will carry the fire control station, also the receiving wires in connection with the wireless telegraph system, and it will be placed about midships. With this tripod arrangement there will be no wire-stay ropes to the mast, so that a clear deck for action will be obtained. Like the *Dreadnought*, the *Conqueror* is of the one-caliber, all-big-gun type.

Many improvements have been made in the internal arrangements of the battleship, and one of the most notable of these is the placing of the officers' rooms in the forward part of the ship, while the crew's quarters are situated at

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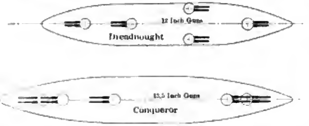
the stern. The old system of fitting sheep pens and hen runs on the weather deck has been abandoned, and the more modern cold storage room will be provided and fitted with the necessary refrigerating machinery to enable the ship to carry frozen meats. The ship will have stockless anchors, each weighing about 8 tons, and they will be stowed in the hawse pipes.

The machinery installation of the *Conqueror* will consist of steam turbines and watertube boilers, together with the usual auxiliary machinery, electric lighting machinery, steam heating and evaporating plants, deck machinery and steam capstans for maneuvering.

The turbine machinery is of the Parsons type and consists of ten turbine units on four shafts. On each outboard shaft there will be one high-pressure ahead turbine, and one astern turbine, and on the port inboard shaft there will be one low-pressure ahead and astern turbine, and one high-pressure cruising turbine, while on the inboard starboard shaft there will be one intermediate-pressure cruising turbine and one low-pressure ahead and astern turbine. As is usual in the latest four-shaft turbine arrangement, all of the turbines are designed to turn outboard when driving the ship ahead. The shaft horsepower will be 27,000, and the speed of the ship at sea will be 21 knots.

The engine room has a central fore-and-aft bulkhead, dividing the engine power into two completely independent sections, each with complete sets of auxiliary machinery consisting of condensers, air pumps, centrifugal circulating pumps, evaporators, distillers, fire and bilge pumps, etc.



COMPARISON OF DREADNOUGHT AND CONQUEROR.

The eighteen watertube boilers will be arranged in three independent watertight compartments, and the uptakes from all the boilers will be connected up to two large oval funnels. The steam pressure at the boilers will be about 200 pounds, and 175 pounds at the throttle valve of the high-pressure turbines. The boilers are designed for coal or oil fuel, and the fuel capacity will give the vessel an exceptionally wide range of action. The coal capacity is 2,700 tons, and the oil fuel 1,000 tons.

The *Conqueror* is provided with five barbettes, and each barbette will be fitted with two 13.5-inch guns. All the barbettes are on the center line of the ship. This arrangement of guns is a departure from that adopted on the *Dreadnought*, but is somewhat similar to the latest American practice. Our sketch shows the approximate positions of the guns in both ships. In the American designs the middle barbette is usually placed at such a height that the guns in it can be fired over the guns in the two after barbettes, and the inner of the barbettes forward and aft are at a higher level than the outer barbettes. But in the *Conqueror* the middle barbette is, like the two forward of it, on the forecastle deck. The two after barbettes are on the upper deck. In the *Dreadnought* there are five barbettes, each having two 12-inch guns. The forward barbette is placed on the forecastle deck and the others are all on the upper deck. With this arrangement, only eight guns can be fired on either broadside on the *Dreadnought*, but on the *Conqueror* all of the ten guns will be available for use on either broadside, and four will be able to fire straight ahead or straight astern, the second and fourth barbettes being higher than the first and fifth. This disposition of guns seems to be a better one than the American, for the greater astern fire of the American ship does not fully compensate for the placing of the weight of the two central guns so high up.

The secondary armament of the *Conqueror* will consist of sixteen 4.7-inch quick-firing guns, but the positions of these guns can at present only be conjectured.

The armor protection is the element of a battleship's design of which, perhaps, least is known. This is chiefly because the extent and the thickness of the belt is not perceptible to the eye. However, it is accepted that in the *Conqueror* and her sister ships the belt armor is about 400 feet long amidships, and that the protective deck, which is 1 inch in thickness inside this armor, is 3 inches thick at the extremities forward and aft. Where the belt ends, armored bulkheads are fitted to complete the citadel. On the ship's sides the armor extends upwards for 20 feet from about 4 feet below the waterline, and the thicknesses range from 8 inches for the highest strake to 12 inches for the lowest. There is nothing unusual in this thickness, and the disposition is similar to the latest warship practice.

To protect the ship from torpedo attack below water, she will be fitted with the latest type of torpedo defense nets all fore and aft. These metallic nets will extend from about 3 feet above the waterline to well below the vessel's keel. When not in use the nets will be stowed on the ship's deck all along the sides.

The ship has twin rudders of the battle-axe type. They are hung from the stern structure and are unsupported outside of the hull. This double-rudder system will give the ship a greater turning power than could be obtained with the usual single rudder. On each of the four propeller shafts there is one three-bladed solid bronze propeller. The two outer propellers are situated some distance forward of the inner ones. To reduce the rolling of the ship at sea, very deep bilge keels are provided.

Steel Tug Auburn.

The Staten Island Shipbuilding Company, Port Richmond, N. Y., has recently completed the steel tugboat *Auburn* for the Lehigh Valley Railroad Company. The vessel is 108 feet long, 36½ feet beam, and 14 feet draft. Her deck, deck-house and pilot-house are of steel.

The vessel is propelled by a fore-and-aft compound engine, with cylinders 20 to 42 inches in diameter by 28 inches stroke of piston, and develops 900 indicated horsepower. One steel boiler (the largest in any New York tug with the exception of the *Mary F. Scully*), 16½ feet in diameter, and containing four Morison corrugated furnaces, built by the Continental Iron Works, of Brooklyn, N. Y., furnishes steam at 150 pounds pressure. The boiler is covered with Keasby's magnesia sectional covering. The auxiliary machinery includes a fire pump that will throw 1,000 gallons per minute. A Bates steam steerer makes easy work for the captain, and a Yale & Towne differential chain pulley block in the engine-room enables the engineer to remove the cylinder heads quickly and without much effort on his part. There is a Kahnweiler metallic lifeboat, and in the pilot-house is a "Rescue" patent fire extinguisher, furnished by the S. F. Hayward Company, of 39 Park Place, New York. This craft has 150 electric lights, which are fed by a continuous-current electric generator, furnished by the General Electric Company, of Schenectady, N. Y., and she is the 530th vessel built by the Staten Island Shipbuilding Company. She represents an outlay of about $75,000 (£15,400).—*Marine Journal.*

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TORPEDO BOAT DESTROYERS PERKINS AND SERRETT.

The *Perkins* and *Sterrett* are two of the ten torpedo boat destroyers, authorized by an act of Congress, May, 1908, which have recently completed their official contract trials. The contract for these vessels was awarded to the Fore River Shipbuilding Company, of Quincy, Mass., in October, 1908. The contract time was, respectively, twenty-three and twenty-four months, and the price for each was $610,000 (£125,400), which is exclusive of equipment and certain other articles furnished by the government.

The principal hull dimensions and other data are given below:

Material	Mild steel.
Length between perpendiculars	289 ft. 0 ins
Length over all	293 ft. 10½ ins.
Beam extreme over guards	27 ft. 0 ins.
Beam on L. W .L.	26 ft. 0½ ins.
Mean draft	8 ft. 4 ins.
Displacement	742.5 tons.
Block coefficient of fineness	.414
Capacity of oil fuel tanks	242 tons.
Capacity of reserve feed tanks	14.6 tons.
Total horsepower	12,000
Speed	29½ knots.

Armament: Five 3-inch, 50-caliber semi-automatic guns; three 5-meter by 45-centimeter deck torpedo tubes; three 3-inch guns, all of which are furnished by the government.

PROPELLING MACHINERY.

The propelling machinery consists of two 72-inch, 14-stage Curtis marine turbines, operating two shafts, each with one propeller. The backing turbines are contained within the same casings as the ahead turbines and form the after part of each turbine. The main exhaust nozzle is located on each turbine casing, in such a manner as to conduct the exhaust steam from both backing and ahead turbines to the condenser placed on the outboard side of each turbine. When going ahead the turbines turn outboard, the starboard propeller being right-hand and the port propeller left-hand. The turbines, together with all the engine-room auxiliaries, are placed in one compartment aft of the boilers. The turbine-operating valves are placed on the forward engine-room bulkhead, and consist of throttle valves connecting respectively the ahead and backing steam chests by lines of steam piping to the main steam lines situated on each side of the ship.

There are two main twin, single-acting air pumps placed aft, one on each side and near the center line of the ship. Two simplex double-acting feed pumps are also located aft in the engine room on starboard side.

The condensers are box-shaped, with semi-cylindrical top and bottom. The tubes are ⅝ inch diameter by 14 feet 2 inches long, and are fitted in the tube sheets with packed glands. The combined cooling surface of the two condensers is 9,546 square feet. The cooling water enters at the bottom and leaves at the top of the condenser. There are installed neither dry vacuum pumps nor augmenters. Two independent engine-driven circulating pumps are placed, one on each side of the ship, immediately forward of each condenser. There are also placed in the engine room two evaporators and one distiller, a feed heater, two 6-kilowatt turbine-driven dynamo sets, two lubricating oil pumps with oil cooler and oil cooler circulating pump, fire and bilge pumps, feed tank and an auxiliary condenser.

BOILERS.

There are four Yarrow express type watertube boilers, placed in two watertight compartments, with one fire-room between each two boilers. The boilers are made for burning oil only, and contain each one furnace without grate. They are designed for a working pressure of 265 pounds, and have no superheaters. The tube-heating surface is 4,500 square feet in each boiler, the two inner tube rows (near the furnace) being 1¼ inches diameter, while all others are 1 inch diameter.

The oil-fuel tanks are located forward of the forward boiler room, and the oil-settling tanks abreast of the boilers. The oil burners are of the Koerting patent type, and consist of seven oil sprayers, the oil being sprayed by mechanical atomization without the use of either steam or compressed air. The air required for combustion is supplied to each boiler room by two turbine-driven forced draft blowers. The oil-burning arrangement, with respect to pumps and heaters, is in its essential details similar to that described in a general way in an article—"Modern Torpedo Boat Destroyers"—which appeared in the August number (1910) of International Marine Engineering.

There are three smoke pipes, of which the middle pipe serves the two middle boilers, and is fitted with a division plate.

Besides the fuel-oil supply and service pumps in the fire-room an auxiliary boiler feed pump is installed in each fire-room.

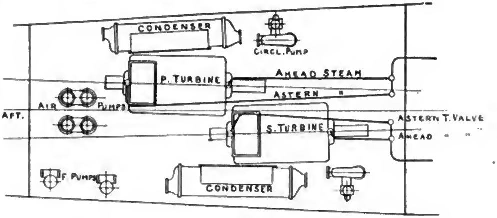
PROPELLERS AND SHAFTING.

The propellers are cast solid, and are made of Monel metal. They have each three blades, machined to give a true pitch of 6 feet 3½ inches, with a diameter of 6 feet 6¾ inches, the projected area of the three blades being 18.21 square feet.

The line shafting is made of Class A steel forgings, 8¼ inches diameter with 4-inch hole. The rotor shafts are made hollow in one piece.

TRIAL DATA.

The standardization trials of both of these destroyers were



GENERAL ARRANGEMENT OF ENGINE ROOM ON DESTROYERS PERKINS AND STERRETT.

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made on a course off Rockland, Me., for the *Perkins* on Sept. 27, and for the *Sterrett* Nov. 1, 1910. The official speed trials of the *Sterrett* were undertaken on Nov. 2, 3 and 6, over a course off the New England coast, and the data appended below are for this ship only.

4-hour full-speed trial:	
Average pressure at boilers, gage	263 pounds.
Average pressure at engine room, gage	250 "
Average pressure at auxiliary exhaust, gage	13.6 "
Nozzles open, each turbine	14
Average pressure at turbine steam chest, gage	228.5 "
Average pressure at first ahead stage of turbine, gage	87 "
Average vacuum	27.25 ins.
Average pressure in fire room, inches of water	8.28
Average revolutions per minute, forced draft blowers	1,537
Average pressure in lubricating-oil system	15 pounds.
Average double strokes, main air pumps	33
Average revolutions per minute, circulating pumps	180
Average temperature injection, degrees F	59
Average temperature discharge, degrees F	89
Total shaft horsepower	12,780
Pounds of water per hour per horsepower, all purposes	14.85
Nautical miles run per ton of fuel oil	3.733
Pounds of fuel oil per shaft horsepower per hour	1.425
Pounds of water evaporated per pound of fuel oil per hour	10.427
Draft, mean, on trial	8 ft. 5 9/16 ins.
Corresponding displacement	754 tons.
Speed per hour	30.368 knots.
Average revolutions per minute of turbines	631
Slip of propellers	22.6 percent.
12-hour, 25-knot speed trial:	
Average pressure at boilers, gage	263 pounds.
Average pressure at engine room, gage	252 "
Average pressure at auxiliary exhaust, gage	5.2 "
Nozzles open in each turbine	7
Average pressure at turbine steam chest, gage	243 "
Average pressure at first ahead stage of turbine, gage	40.5 "
Average vacuum	28.76 inches.
Average pressure in fire room, inches water	1.82
Average revolutions per minute, forced-draft blowers	1,514
Average pressure in lubricating-oil system	13.8 pounds.
Average double strokes, main air pumps	30
Average revolutions per minute, circulating pumps	112
Average temperature injection, degrees F	50
Average temperature discharge, degrees F	80
Total shaft horsepower	6,765
Pounds of water per hour per horsepower, all purposes	15.54
Nautical miles run per ton of fuel oil	6.328
Pounds of fuel oil per shaft horsepower per hour	1.319
Pounds of water evaporated per pound of fuel oil per hour	11.778
Draft, mean, on trial	8 ft. 5¼ ins.
Corresponding displacement	756.5 tons.
Speed per hour	25.21 knots.
Average revolutions per minute of turbines	489
Number of boilers used	4
Slip of propellers	17.13 percent.
12-hour, 16-knot speed trial:	
Average pressure at boilers, gage	264.5 pounds.
Average pressure at engine room, gage	252.5 "
Average pressure at auxiliary exhaust, gage	8.6 "
Nozzles open in each turbine	2
Average pressure at turbine steam chest, gage	193 pounds.
Average pressure at first ahead stage, gage	4.1 "
Average vacuum	28 inches.
Average pressure in fire room, inches water	1.41
Average revolutions per minute, forced draft blowers	1,222
Average pressure in lubricating system	14.5 pounds.
Average double strokes, main air pumps	34
Average revolutions per minute, circulating pumps	—
Average temperature, injection, degrees F	50
Average temperature, discharge, degrees F	66
Total shaft horsepower	1,596
Pounds of water per hour per horsepower, all purposes	20.9
Nautical miles run per ton of fuel oil	12.9
Pounds of fuel oil per shaft horsepower per hour	1.77 pounds.
Pounds of water evaporated per pound of fuel oil per hour	11.81 "
Draft, mean, on trial	8 ft. 6½ ins.
Corresponding displacement	765 tons.
Speed per hour	16.26 knots.
Average revolutions per minute of turbines	298
Slip of propellers	12.22 percent.

The Bureau of Navigation reports 59 sail and steam vessels of 7,341 gross tons were built in the United States and officially numbered during the month of December, 1910. Three steel steamers, aggregating 671 gross tons, were built on the Atlantic and Gulf coasts, and three steel steamers, aggregating 3,574 gross tons, were built on the Great Lakes. There was also one steel steamer of 2,183 gross tons built on the Pacific Coast.

For the six months ending Dec. 31, 1910, the Bureau of Navigation reports 589 sail and steam vessels of 137,568 gross tons were built and officially numbered. This, as compared with 562 vessels, aggregating 82,425 gross tons, which were built during the corresponding period of 1909, shows an increase of 4.8 percent in number and 67 percent in tonnage.

THE MARINE STEAM ENGINE INDICATOR—XVIII *

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

The value of $p\ v$ may be determined by taking co-ordinate measurements at any point on the curve and the curve traced by solving the equations for p only or for v only. But a little thought will show that the curve can be more accurately laid down when we solve for that dimension, which will be as near at right angles to the curve as possible. For instance, the curve of Fig. 101 (see January issue) will be more accurately determined for the point $v = 2$ and $p = 50$[1] when we solve for v instead of p, because the curve is quite steep at this point, and a small error in p would cause a large horizontal displacement of the curve from its true position.

A simple rule for solving for p only is as follows: *Multiply the absolute pressure at the point of cut-off by the fraction made by writing the number of inches of the stroke completed at* CUT-OFF *as a numerator over the number of inches of stroke completed at that point as a denominator.* For example, suppose that we have an engine of 32 inches stroke, cutting of at

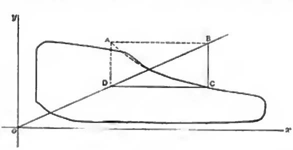

FIG. 102.

16 inches, the initial pressure being 100 pounds. The pressure at cut-off will be $100 \times 16/16 = 100$; at 20 inches, $100 \times 16/20 = 80$; at 24 inches, $100 \times 16/24 = 66.6$; at 28 inches, $100 \times 16/28 = 57.1$, and at 32 inches, $100 \times 16/32 = 50$.

The curve may be laid out geometrically in a number of ways, but only one method will be noticed here as being of general use in indicator work. Let C (Fig. 102) represent *any* point on the hyperbolic curve. Draw $C\ D$ parallel to $O\ X$. From O draw $O\ B$, cutting $C\ D$ at any desired distance from C. Draw $B\ C$ "square" with $C\ D$, producing it to cut $O\ B$ in B. Complete the rectangle, as shown by the broken lines $A\ B$ and $A\ D$. The curve will pass through A and C. By drawing a sufficient number of these rectangles the whole curve may be laid out from a single point. Great care must be taken to locate O accurately.

Heat and work are mutually convertible. One heat unit being equal to 777.5 foot-pounds.[2] If we had an ideal engine so constructed that no heat could enter or leave the working gas through the cylinder walls or piston, or through any of their attachments, we should find that the temperature of the gas would fall in spite of the non-conductivity of the cylinder. The gas in expanding and driving the piston ahead of it would convert a certain part of its heat into mechanical work, and in the ideal engine the loss of heat would be the exact equivalent of the work done at the cross-head. This would cause a continual decrease in the gas temperature as the piston advanced, and as all gases contract in cooling it is readily seen that an expansion curve made under these conditions would fall below the hyperbola or constant temperature curve. This type of curve is known as an *adiabatic*, or curve of no transmission of heat, and derives its name from two Greek words

* Copyright, 1911, by Chas. S. Root.

[1] See September, 1910, issue, page 379.

[2] The mechanical equivalent of heat according to Marks and Davis.

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signifying "not passing through." The equation of this curve is $p\ v^{10/9} = constant$. It cannot be traced by computation without the aid of logarithms, and its geometrical construction is too tedious to be of general use.

When steam is formed in a vessel in contact with water, it has a certain definite pressure and temperature[3] and is said to ing to the pressure at which the specific volume was taken. For example, 1 cubic foot of steam at 100 pounds pressure weighs .2258 pound[5]. The specific volume at 50 pounds absolute pressure is 8.51, and the actual volume of 1 cubic foot at 100 pounds expanded to a pressure of 50 pounds is .2258 × 8.51 = 1.92 cubic feet. This locates a point on the curve at

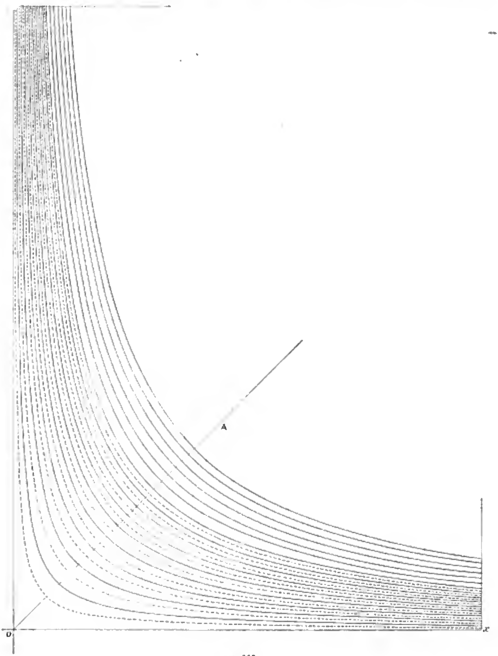

FIG. 103.

be *saturated*. If, at the same time, it holds no liquid in suspension in the form of spray it is said to be *dry and saturated*. Curve No. 2 (Fig. 101) shows the relation between *volume* and *pressure* for dry and saturated steam. This curve is readily traced from any steam table by taking the weight of steam involved and multiplying this weight by the specific volume[4] at the different pressures. The product is the volume correspond- $v = 1.92$, $p = 50$. A curve may also be computed with close approximation to the above by means of the equation $p\ v^{10/9}$ = constant, and its actual computation will be taken up when we come to consider the use of logarithms. This curve could be reproduced on an indicator diagram if dry-saturated steam were admitted to a jacketed cylinder if just enough heat could be added to keep it dry and no more.

Superheated steam is steam whose temperature is greater

[3] See page 380, September, 1910, issue, Fig. 94.
[4] Cubic feet per pound.
[5] Tables of Marks and Davis.

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than that of saturated steam of the same pressure. Curve No. 4 (Fig. 101) represents adibatic expansion of superheated steam where the superheated condition continues to the end of the stroke. The equation of this curve is $p\ v^{1.3} =$ *constant*. To attain such a result a high degree of initial superheat would be necessary. Curve No. 5 is the adiabatic for dry air.

With 100 pounds absolute pressure and ten expansions, the mean pressures for the various curves shown in Fig 101 would be as follows:

Isothermal, $p\ v =$ *constant*..........................33 pounds
Saturation, $p\ v^{17/16} =$ *constant*......................31.4 pounds
Adiabatic, dry steam, $p\ v^{10/9} =$ *constant*........30.3 pounds
Adiabatic, superheated steam, $p\ v^{1.3} =$ *constant*, 26.6 pounds.
Adiabatic, dry air, $p\ v^{1.4} =$ *constant*..............24.5 pounds

From the above table it will be noted that the superheated steam diagram shows the lowest mean pressure of any of the steam diagrams, and any reader who has served on a vessel fitted with a superheater will at once recognize the phenomenon. It is a matter of common observation that an engine working with saturated steam will slow down immediately the steam is passed through the superheater, even though the pressure at the throttle remains the same. If it is desired to maintain the same speed as before, it is necessary to run the links out for a later cut-off. This is in accordance with the fact that superheated steam will give out less work per *unit of volume* than saturated steam* if the latter is kept dry to the end of the stroke, all of which is in agreement with the diagram.

When steam first enters a cylinder at the beginning of the stroke it strikes surfaces which have just been exposed to the temperature of the exhaust and a portion of it is immediately condensed, its place being immediately taken by fresh steam from the valve chest. This is termed *initial condensation*, and if the ports and passages are ample no pressure drop will be indicated on the diagram. After cut-off takes place condensation will continue until the temperatures equalize, and this will show on the diagram by the expansion line being somewhat lower than the theoretical curve. As expansion continues, the temperature of the steam will drop below that of the metal parts of the cylinder and piston, and some of the water of the initial condensation will *re-evaporate*. This additional steam will add to the pressure and raise the expansion line above its computed position. If the steam is superheated on entering, or if the cylinder walls are kept above the initial steam temperature by some means external to the cylinder, the cylinder condensation will be eliminated in whole or in part, and the curve drawn by the indicator will closely approach the $p\ v^{17/16}$ or the $p\ v^{10/9}$ curve.

The expansion curve is very liable to be altered in form by leakage into or from the cylinder. Fig 102 shows a diagram taken by the writer from an old, single-cylinder marine engine, whose valves and piston were known to be leaky. But a glance at the diagram will show that the expansion line coincides almost exactly with the isothermal curve, which is also drawn on the card. Here various bad conditions have produced a good expansion line. If the valves only had leaked, the expansion line would have been higher than shown; while, if the leakage had been entirely at the piston packing, the line would have been considerably lower.

Owing to the many factors which affect the expansion line it is not well to attempt to judge of the tightness of pistons and valves by its position on the diagram. This is better determined in small engines by shoring the cross-head and testing under steam, and in large engines by running water on top of the piston and into the ports when the cylinders are open and noting the rate of leakage.

* For any given *unit of weight* superheated steam contains more heat and will give out more work.

The various theoretical curves are of value as a basis for comparison, but unless the diagrams form a part of a very precise and elaborate test, the work of laying down any but the isothermal curve ($p\ v = c$) is not justified.

Relative to the equation for the adiabatic curve ($p\ v^{10/9} =$ *constant*), Prof. C. H. Peabody says,[1] "There does not appear to be any good reason for using an exponential equation in this connection, and the action of a lagged steam-engine cylinder is far from being adiabatic. * * * For general purposes the hyperbola is the best curve for comparison with the expansion curve of an indicator card."

For the purpose of quick and easy comparison, if much of such work is to be done, it is convenient to have drawn and ready to hand a number of hyperbolic curves, as shown in Fig. 103. These should be carefully laid out on paper and afterwards inked in on tracing cloth.

The axis of x or base should be 10 inches long and the axis of y about 13 inches; only that part of the hyperbolas above the diagonal $O\ A$ need be computed, as the other half is a duplicate for the lower 10 inches of the upper side. The diagram should be made of the size indicated, so that it will be of use when working with large combined diagrams as well as with small cards. To use the tracing, the *clearance line and line of zero pressure must be carefully drawn on the card*. The tracing may then be placed over the indicator card, so that $o\ x$ and $o\ y$ will coincide with the reference lines drawn on the card. The actual expansion line will show through and may be easily compared with the hyperbolic curve.

(To be continued.)

Gas Power for Marine Propulsion.*

The future of gas power for marine propulsion looms big on the horizon. Much has been written of the producer-gas system, but it must be confessed that the oil-burning engine is more attractive from the standpoint of convenience and compactness. The advantage of storing oil in the ship's double bottom is great from a standpoint of cargo capacity. European countries have been active in this development: Russia with its tank ships, France with its submarines and the coast countries with their fishing fleets. Successful producer-gas equipments are to be found on some of the inland waterways of Europe, where coal is the cheaper fuel, and a boat is being equipped here for service in New York harbor.

Recently the announcement has come of the adoption of oil engines for the 8,000-ton, 12.5-knot freight boats now being built by the Hamburg-American Line. These will be equipped with two 1,500-horsepower Diesel engines built by the Augsburg and Nurnberg works, and if the experiment is successful passenger vessels will be constructed. One American builder, at least, has taken up the Diesel engine for marine work.

The annual Motor Boat Show for 1911, held under the auspices of the National Association of Engine and Boat Manufacturers, will open Tuesday, Feb 21, at noon, and close Saturday, March 4, at 11 P. M. The Show will be held at the Madison Square Garden, New York City, and will be open daily from 9 A. M. to 11 P. M., excepting Sunday.

Advice has been received from Rio de Janeiro that all the ten torpedo boat destroyers built for the Brazilian government by Messrs. Yarrow have now arrived there without the slightest mishap, either as regards the vessels or their machinery. The *Paraná*, the last of these vessels, reached Rio on the 18th of December.

[1] Thermodynamics of the steam engine and other heat engines.

* From an address on gas power development, by James Rowland Bibbins, before the American Society of Mechanical Engineers, December, 1910.

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THE ECONOMICAL WORKING OF RECIPROCATING MARINE ENGINES AND THEIR AUXILIARIES.*

BY D. B. MORISON.

Never in the history of steamship owning has competition rendered it so difficult to earn an adequate return on invested capital as during the past few years, and as coal consumption is an important factor in the economics of a steamship, the present would seem to be a particularly opportune time for reviewing the systems on which main engines and their auxiliaries are worked, in order to elucidate by proposition and discussion the methods that favorably affect commercial results.

It is also appropriate that this question should be dealt with by an institution such as ours, for the reason that the membership includes not only engineers of acknowledged repute as designers and constructors, but also engineers who superintend the working of the machinery of large fleets, and whose opinions are based on prolonged practical experience.

Freedom from breakdown and minimum cost of upkeep are so imperative for successful ship management that marine engineers often hesitate to depart from standardized methods, but if this tendency be carried to excess, in these keenly competitive times, there is a danger that the traditions of apparently successful practice may be insidiously responsible for perpetuating systems of working which are technically unsound and commercially wasteful.

Considerable attention is now being given to the influence of vacuum on the steam economy of triple and quadruple marine engines, and as there appears to be diversity of opinion on the subject among marine engineers, it is well worth investigation.

The usual and traditional practice is to carry a low vacuum in the condenser, because it produces a high temperature of air pump discharge water, this practice being associated with the assumption that any vacuum above, say, 25 inches in the condenser is a source of waste in the steam economy of the engines, while a few inches less make no material difference, because the feed water becomes so much hotter.

In considering this question it must be remembered that from 15 to 20 percent more steam is generated in the boilers of a steamship than is supplied to the main engines, this amount being used in the various steam auxiliaries. If an auxiliary high-pressure engine, such as a fan engine or a steering engine, exhausts into a condenser, about 80 percent of the heat in the steam supplied to the engine is lost in the condenser, and if the engine exhausts into low-pressure receiver of the main engines, this percentage loss is approximately the same. In the latter case, however, the compound principle is introduced and the power developed by the steam ought to be obtained with more economy, but as considerable water is discharged into the receiver with the exhaust steam, and is often allowed to pass through the engine without being trapped, it is very questionable indeed whether much actual steam economy results from the arrangement. This is of very minor importance, however, compared with the fact that, if the heat in the exhaust steam from the auxiliaries can be absorbed by the feed water, the 80 percent, instead of being wholly wasted in the condenser, is wholly utilized by being returned to the boiler.

I need not deal at length with the quantity of steam used by the auxiliaries on shipboard, in view of the excellent paper on that subject recently read before the Institution of Engineers and Shipbuilders in Scotland by Mr. C. F. A. Fyfe, of Liverpool, but for purposes of illustration the following estimates may be taken as approximating the quantities used under average conditions at sea in a semi-passenger steamer of 5,000 indicated horsepower and a cargo steamer of 1,500 indicated horsepower.

TABLE I.—SEMI-PASSENGER STEAMER, 5,000 I. H. P.

Estimated steam consumption, 14 lbs. per I. H. P. per hour = 70,000 lbs. per hour.
Pressure maintained in exhaust steam receiver = 2 lbs. per square inch.

HEAT UNITS AVAILABLE IN THE EXHAUST STEAM AND WATER DRAINAGE FROM AUXILIARIES.

Auxiliaries.	Pounds Per Hour.	Temperature.	B. T. U.
Evaporator steam at 6 tons per 1,000 I. H. P. per 24 hours	2,800	218	2,304,000
Water drainage from evaporator coils	3,360	259	870,240
Water drainage from I. P. casing discharged by water trap, estimated at 3 percent at 50 lbs. pressure	2,100	298	625,800
Steering engine exhaust	1,000	218	1,180,000
Independent feed pump exhaust	950	218	1,121,000
Independent circulating pump exhaust	1,800	218	2,124,000
Fan engine exhaust	1,300	218	1,534,000
Electric light engine exhaust	800	218	944,000
	14,110		11,703,040

Vacuum in condenser .... 28 25 ins.
Temperature of feed water discharged by air pump .... 87 degrees

BEFORE MIXING.

B. T. U. in feed water = 70,000 × 87 .... = 6,090,000
B. T. U. in auxiliary exhausts and drains .... = 11,703,040

Total B. T. U. .... = 17,793,040

AFTER MIXING.

$$\text{Temperature of feed water} = \frac{17,793,040}{(70,000 + 14,110)} = 211 \text{ degrees}$$

TABLE II.—CARGO STEAMER, 1,500 I. H. P.

Estimated steam consumption, 14 lbs. per I. H. P. per hour = 21,000 lbs. per hour
Pressure maintained in exhaust steam receiver .... = 2 lbs. per square in.

HEAT UNITS AVAILABLE IN THE EXHAUST STEAM AND WATER DRAINAGE FROM AUXILIARIES.

Auxiliaries.	Pounds Per Hour.	Temperature.	B. T. U.
Evaporator steam at 7 tons per 1,000 I. H. P. per 24 hours	980	218	1,156,400
Water drainage from evaporator coils	1,176	259	304,584
Water drainage from I. P. casing discharged by water trap, estimated at 3 percent at 50 lbs. pressure	630	298	187,740
Steering engine exhaust	380	218	448,400
Electric light engine exhaust	300	218	354,000
	3,466	...	2,451,124

Vacuum in condenser .... 28 25 ins
Temperature of feed water discharged by air pump .... 87 degrees

BEFORE MIXING.

B. T. U. in feed water = 21,000 × 87 .... = 1,827,000
B. T. U. in auxiliary exhausts and drains .... = 2,451,124

Total B. T. U. .... = 4,278,124

AFTER MIXING.

$$\text{Temperature of feed water} = \frac{4,278,124}{(21,000 + 3,466)} = 175 \text{ degrees}$$

The highest temperature water the ordinary single acting marine ram feed pumps will draw with the usual small head is 170 degrees. But if the head is increased as by an elevated direct contact heater, an independent float controlled feed pump will deal with the water at as high temperature as exhaust steam at a pressure slightly above atmospheric can heat it, so that in both the above examples it is possible to raise the entire feed water to a temperature exceeding the pumping limit by condensing among it exhaust steam from the auxiliaries, and this can be accomplished in association with a high vacuum in the condenser.

The all-important question, therefore, is, what is the influence of high vacuum on the steam consumption of triple and quadruple marine engines? I have very carefully examined data published by the leading authorities on this subject, and there is complete agreement that in a triple and quadruple engine having suitably designed and proportioned low pressure cylinder ports and exhaust passages the power of the engine increases

* Paper read before the North East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne, November, 1910. Appendices to the paper will be published in the March issue.

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and the consumption of steam per brake horsepower decreases with approximate uniformity up to the highest vacuum that can be reasonably carried on a steamship, the rate depending on the ratio of expansion and the number of cylinders in which the expansion is effected; the order in economy in reciprocating marine engine practice being compound, triple, quadruple.

It is unnecessary to set forth all the supporting evidence, but reference may be made to the classical research on this question carried out by that eminent investigator, the late Mr. Willans, in which he definitely proved that in his central valve compound engine the consumption of steam per brake-horsepower decreased with increased vacuum at the rate of fully 1 percent per inch up to 27 inches, which in those days was considered a high vacuum for compound engines and was the high limit of the experiments.

Dr. Mellanby has also favored me with the results of vacuum tests (Appendix A) made on the compound engine at the Technical College, Glasgow, and which confirm the experiments made by the late Mr. Willans.

In order to ascertain the latest practice of the builders of land engines, I asked Mr. R. K. Morcom if he would communicate to our Institution the results of one of his firm's triple expansion engines, and I am greatly indebted to Messrs. Belliss & Morcom for the complete report of an engine trial, as set forth in Appendix B. It is worthy of record that every engine manufactured by this company is thoroughly tested under all loads by a trained staff and with the whole equipment necessary for obtaining the greatest accuracy, the methods employed being those recommended by the Institution of Civil Engineers Committee for steam engine and boiler trials.

Broadly, Mr. Morcom shows that in a Belliss triple-expansion high-speed engine the increase in steam consumption per brake-horsepower is at the rate of 1.77 percent per inch of decrease in vacuum from 28 inches down to 21.5 inches, which were the high and low limits of the tests.

With a view of meeting the objections of those marine engineers who hesitate to be guided by land engine results, I recently presented to Armstrong College a new low-pressure cylinder with enlarged ports and passages for the quadruple marine type engine on which so much valuable research work has been carried out in the past, and we are once again indebted to Professor Weighton for kindly offering to test the effect of this cylinder on the College engines under varying vacua when arranged as three-cylinder triples and four-cylinder quadruples. The cylinder was only fitted a few days ago, so that the exact results will be given by Professor Weighton at our next meeting, but the preliminary tests afford confirmatory evidence of the economy obtainable with high vacuum both in triples and quadruples.

It is difficult to obtain absolute accuracy from marine engines, but through the courtesy of the owners and their superintendents I am able to include in Appendices C, D, E the results of three representative types of steamships the engines of which which were designed for high vacuum, namely:

(1) Steamship *Indrabarah*, Australian twin screw frozen-meat steamer, with triple expansion engines of 5,000 indicated horsepower, by Richardsons, Westgarth & Co., Ltd.

(2) Steamship *Anglo-Patagonian*, cargo steamer, with quadruple expansion engines of 2,000 indicated horsepower, by Messrs. The North-Eastern Marine Engineering Co., Ltd.

(3) Steamship *Djerissa*, cargo steamer, with triple-expansion engines of 1,100 indicated horsepower, by Messrs. The Central Marine Engineering Co., Ltd.

The results are as communicated, the original logs are on the table and all the particulars were obtained with great care. On referring to the Appendices, it will be seen that the records in each case are exceptionally good, and as the Contraflo system of condensing and temperature regulation was fitted in each of the ships, it is clearly evident that the economical possibilities were realized and that the system contributed to the general excellence of the performances.

For the purposes of this investigation the points of interest are the vacua carried in the condensers and the pressures recorded on the low-pressure diagrams. Broadly, on voyage conditions in each of the three ships a condenser vacuum of 94 percent, or 28¼ inches (barometer 30 inches), can be carried in sea water of 60 degrees and 91 percent, or 27¼ inches vacuum in sea water of 80 degrees, and at these vacua the pressures recorded in the low-pressure diagrams are approximately 13 pounds and 12½ pounds, respectively, below the atmospheric line. The low-pressure diagram (Fig. 6) is representative of what can be obtained on an ordinary cargo boat at full power and was one of a series sent home by the chief engineer. The condenser vacuum was 27½ inches, the revolutions 60 per minute, and a pressure of 13 pounds is recorded below the atmospheric line. On the trials of the steamship *Indrabarah* the revolutions of the engines were 90 and the vacuum 28¼ inches, and yet under these high-speed conditions the pressure on the low-pressure diagram was 13 pounds below the atmospheric line, so that within the range of ordinary practice the design and proportions of the low-pressure ports, passages and valves present no difficulty.

It is needless to dogmatize on these results, but there are many hundreds of steamships in which the condensers cannot carry more than 20 inches to 22 inches in the tropics, and in which there is no provision for the utilization of the heat in exhaust steam. If these condensers had been designed to carry 27 inches in the tropics, and if the engines had been suitably proportioned and the feed-heating arrangements adequate, the saving would unquestionably have been approximately 10 percent. There are, therefore, economic possibilities in reciprocating marine engines that have been allowed to remain latent, but which, nevertheless, afford definite opportunities for materially decreasing the coal bill and thereby increasing the profit-earning power on the capital invested in steamships.

The value and effect of vacuum have hitherto been so casually considered by marine engineers generally that it is difficult to ascertain from a ship's log what vacuum has actually been carried on a voyage, and it is still more difficult to ascertain the correct vacuum by consulting an ordinary vacuum gauge in an engine room. It is for this reason probably that trial trip data often include vacua observations so impossible as to reflect either a considerable elasticity of conception or a total disregard for natural laws.

In the absence of an acurate mercury column and such stability of ship as will enable a correct observation to be taken, I have found that to record the temperatures in, say, two places along a condenser top is preferable to reliance on the average vacuum gage, and chief engineers should always include these temperatures in their logs. All that is necessary is the permanent insertion of small brass tubular pockets in the condenser top in which the thermometers are placed among water or, preferably, mercury, and when the temperatures are recorded the corresponding vacua may be ascertained from the usual tables. This involves a slight inaccuracy, however, as the tables are based on the pressures and corresponding temperatures of water vapor and not of a mixture of air and water vapor. But as the amount of air at the top of a condenser above the tubes is, under normal conditions, very small indeed compared with the amount of water vapor, the inaccuracy is negligible and the method is certainly far more reliable for sea service than the indications of an ordinary vacuum gage. Records should not be taken for this purpose lower down in the condenser among or below the condenser tubes, because of the gradual increase in air pressure, there-

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fore the temperature readings should be strictly confined to the exhaust pipe and the condenser top.

Since the publication of my investigations on surface condensers in 1904 and the paper read by Professor Weighton before the Institution of Naval Architects in 1906, the principles underlying efficiency have been better understood than previously. There are evidences that appreciation remains latent in some cases, but a perusal of Professor Weighton's paper and a comparison of the practice then and now will conclusively show that engineers generally are greatly indebted to him for a research which has proved of world-wide service.

While I am fully conversant with the possibilities of condensers having a relatively small amount of tube surface and a great amount of water passing through the tubes, such, for example, as are now permitted in warship practice, my long experience in mercantile marine engineering enables me to express my conviction that the warship proportions sometimes advocated for condensers on mercantile steamships fitted with reciprocating engines are not conducive to commercial success. The first essential in any condenser is such a disposition of the surface as will result in the greatest over-all efficiency, but the mere fact that a condenser has a large surface per horsepower is no criterion of its condensing capacity, because much of it may be ineffective, as is the case in the majority of the marine condensers at present in use. It is the treatment of the air in a condenser which is so vital to its efficiency, and from this point of view that condenser is the best which provides the air pump with air at maximum density.

Air pump efficiency is in effect a governing factor in any condensing plant, and although in turbine installations the quantity of air leaking into the system may and should be very small, yet in ordinary reciprocating engines it is normally considerable, and it is folly to assume that the tightness which can be obtained by careful tuning up on the trial trip will continue to be maintained under average working conditions at sea. Tropical sea water has also a highly prejudicial effect on air-pump capacity by reason of the smaller difference in temperature of the water flowing through the tubes and the aerated vapor outside the tubes in the lower part of the condenser. For example, with a vacuum of 28 inches and sea water at 50 degrees, there is a temperature difference of 50 degrees, whereas with a vacuum of 27 inches and sea water at 85 degrees there is a temperature difference of 30 degrees only, or 40 percent less. This physical fact is largely responsible for the great fall in vacuum that invariably takes place in the tropics, and so universal is this fall that marine engineers accept its evil consequence as inevitable; but they are by no means inevitable and can be overcome in an extremely simple manner.

Condensers and air pumps are interdependent, in that both must be efficient in order to produce the best available results. For stable conditions the amount of air entering a condenser in a given time must be the same as the amount withdrawn by the air pump in the same time, otherwise air would accumulate in the condenser and the vacuum would fall. Under all conditions there must always be air in every condenser, but its non-conducting properties are so very detrimental that in order to obtain the highest efficiency of heat transmission through the tubes the quantity of air which remains in a condenser should be reduced to an absolute minimum. The condensers shown in Figs. 1 and 2 are designed with this object.

Fig. 1 is a condenser for a torpedo-boat destroyer. It is cylindrical in section and is fitted with air-concentrating plates, so arranged that the velocity of the incoming steam drives the air uniformly towards a very narrow outlet, where it is very highly concentrated and densified. Another result of the guide plates is that much of the water of maximum temperature formed in the upper part of the condenser is caught on the plates and is prevented from producing undesirable effects lower down.

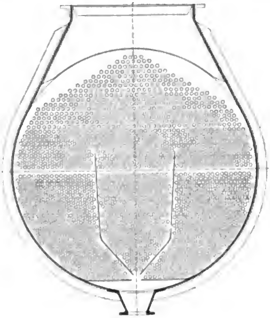

FIG. 1.

Fig. 2 illustrates one of the main condensers for the turbine steamer *La France*, built by Messrs. Chantiers de L'Atlantique, St. Nazaire, and containing 21,000 square feet of tube surface. This condenser embodies a special devaporizing compartment and a water-charged receiver in the base of the condenser, to which further reference will be made.

Fig. 3 illustrates a condenser having a temperature regulator, and Fig. 4 its application to the engines of the steamship *Tamele*, owned by Messrs. Elder, Dempster, of Liverpool, and as the vessel trades in very hot waters the condensing plant enables a vacuum of 27 inches to be maintained in sea water of 90 degrees.

Although independent air pumps are necessary in turbine ships, yet in reciprocating engines the single air pump worked

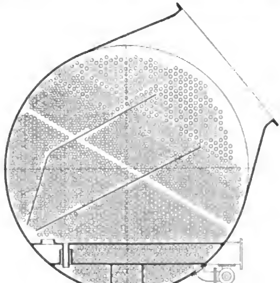

FIG. 2.

by levers from the main engines is still the standard practice, and long experience has proved it to be simple and reliable, requiring but little attention at sea and little cost in upkeep. This practice still prevails, even in the largest steamships, and it is of interest to note that the steamship *Balmoral Castle*, which has one of the latest and finest examples of reciprocating engines afloat, still retains the air pumps driven by the main engines.

The air-withdrawing capacity of any reciprocating air pump of given size depends on the difference between the vacuum that can be produced in the pump barrel on its suction stroke and the vacuum in the condenser. But if water of condensation entered the pump at the temperature corresponding to the vacuum in the condenser, it would obviously boil as soon as the pump bucket commenced its suction stroke and the re-

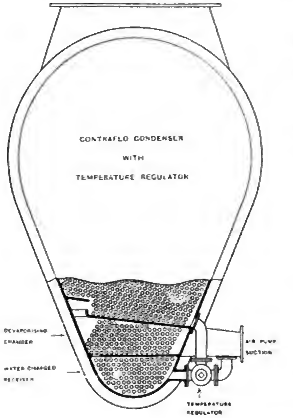

FIG. 3.

sultant vapor, by filling the barrel, would impair the inflow of air from the condenser. If, on the other hand, the water entering the pump were so cold that it did not boil during any portion of the vacuum-producing stroke of the air pump, then the vacuum produced in the barrel would be much higher than in the condenser and the flow of air into the pump would be a maximum. Therefore, an air pump can be rendered very flexible in air-withdrawing capacity by temperature, and if there are means for controlling the temperature, then the air-withdrawing capacity of a single pump can be regulated in accordance with the quantity of air to be withdrawn. The condenser illustrated in Fig. 3 contains a divided-off receiver in its base, which is always completely filled with water of condensation. At a distance above this water receiver is a diaphragm which catches the water of condensation formed in the condensing chamber above it. There is a pipe connecting the top of the water collecting diaphragm and the water receiver, and in the pipe there is inserted a two-way cock or valve, one way leading to the air pump suction pipe and the other to the water receiver. If there is a clear way between the water-collecting diaphragm and the water receiver, all the water of condensation passes through the receiver and is reduced in temperature before it passes into the air pump, the flow through the receiver being caused by the head represented by the distance the water-collecting diaphragm is above the receiver top. If, on the other hand, there is a clear way between the collecting diaphragm and the pump, all the water of condensation passes at a maximum temperature into the pump. The temperature of the pump, and therefore its air-withdrawing capacity, is under complete control by the partial or the full use of the temperature regulator, and extended experience has demonstrated that by this simple apparatus the vacuum can be raised in the tropics by from 1½ inches to 3 inches and often more, depending on the amount of air prevailing, and, at the same time, the air pump discharge water is kept at the highest temperature consistent with the maintenance of the highest available vacuum in the condenser.

Although manufacturers may fit abnormally large air pumps with the object of maintaining vacuum in the tropics, a considerable fall is inevitable in high temperature sea waters, unless the temperature of the air pump can be reduced below what is possible with the standard designs now in use. The temperature regulator naturally decreases the size of air pump necessary in all temperatures of sea water, but, in my opinion, an air pump driven by the main engine should in the mercantile marine be of sufficient size to deal with the normal amount of air when in sea water from 55 to 60 degrees, without the assistance of the temperature regulator. In such waters, therefore, the temperature regulator is very helpful when abnormal air leakage occurs, but in tropical temperatures it becomes a necessity, even with normal air leakages.

Referring again to the condenser designs fitted with air concentrators, it has now been shown that the withdrawing effect of an air pump can be greatly increased by reducing its temperature. But its function is to withdraw air, and it will withdraw air in maximum quantity only when the condenser delivers that air to it as free as possible from water vapor. Therefore the interdependence of air pump and condenser is obvious and the action of the one so influences the action of the other that both must be correctly designed if the available results are to be realized.

There are three accepted methods by which heat in exhaust steam can be absorbed by feed water, namely:

1. By steam nozzles submerged in a body of feed water on the suction side of the feed pump.

2. By the ordinary water-shower system in an elevated direct-contact heater on the suction side of the feed pump.

3. By a tubular surface heater on the discharge side of the feed pump.

For the purpose of this investigation let it be assumed that the condensing plant of a steamship fitted with reciprocating engines is able to maintain under voyage conditions 28¼ inches of vacuum in sea water of 60 degrees and 27¼ inches vacuum in sea water of 80 degrees, and that the water discharged by the air pump is 10 degrees below the vacuum temperature, or 87 degrees and 102 degrees respectively.

Fig. 4 shows one illustrative arrangement of the 1,500 indicated horsepower cargo boat proposition already referred to on page 57. The feed pumps are of the ordinary ram type, driven by the main engines, and if fitted with suction valves and passages suitably proportioned they will deal with water up to a temperature of 170 degrees without trouble. The water discharged by the air pump passes into what is known as a cascade feed heater and filter. Fig. 5 shows this apparatus in detail. The air pump discharge water flows into the first compartment, in which free oil, if there is any, floats on the surface and can be scummed off periodically. The water then

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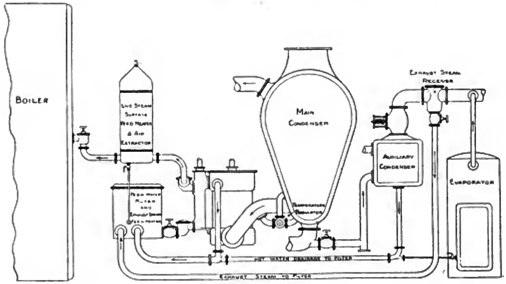

Fig. 4.

passes into a heating reservoir fitted with exhaust steam nozzles, thence it flows through a filter box into the final suction chamber, which is usually fitted with a float controlled valve, so as to prevent the feed pump from drawing more air than is actually required for cushioning purposes. Some air is necessary, and it can be admitted in controllable quantity by shifting the valve in the usual manner, but it is futile to expect the best available results either in boilers or engines if this air is allowed to pass into the boilers and back through the engine into the condenser. If there is a tubular heater on the pressure side of the feed pumps it should always be fitted with an air discharger, and if there is no such heater then the air vessel should be fitted with an air discharger. Fig. 7 shows a simple device for that purpose. The air, on passing from the air vessel, is discharged into an air collector of preferably conical form, so that at its base the inward and upward velocity of flow is much greater than the downward and outward flow. Air accumulates at the top, whence it can be discharged continuously through a small cock leading to the hotwell or filter, thus preventing the loss of the small quantity of water that flows out with the air.

The particular design of heater and filter (Fig. 5) was prompted by a desire to obtain a simple apparatus in which exhaust steam could be utilized (*a*) to heat a body of feed water quickly and (*b*) to afford an easy means for its filtration. In practice it is much favored by engineers at sea, as it gives them an excellent opportunity of watching the condition of the feed water as influenced by the use of an excessive quantity of oil or oil of inferior quality. All the exhausts from the auxiliaries, as well as the steam from the evaporator, discharge into a receiver, and between the receiver and the auxiliary condenser is an ordinary spring valve, loaded when at sea, to say, 2 pounds per square inch above atmosphere. Steam from the exhaust receiver flows direct to the heating nozzles in the heater and reference to Table II shows that it contains sufficient heat to raise the temperature of the feed from 87 to 175 degrees. But the pumping limit is 170 degrees,

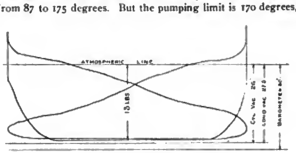

Fig. 6.

so that a small proportion of the available heat must be sacrificed. Of the total available heat, however, no less than 95 percent can be utilized for heating the feed water with a condenser vacuum of 28¾ inches and ordinary ram feed pumps.

There are two ways of dealing with the small amount of surplus heat. If the valve between the exhaust receiver and the heater is closed down a little, the surplus will flow into the auxiliary condenser. But it can perform a more useful function, as by opening the temperature regulator (Fig. 3) and allowing a portion of the water of condensation to pass through the water-charged receiver the temperature of the water discharged by the air pump can be so reduced that all the exhaust steam will be condensed in the heater without the pumping limit of 170 degrees being exceeded. This method increases the available capacity of the air pump for withdrawing air and is useful, even in low temperature sea water, if conditions are such that increased capacity is necessary. Now, suppose the vessel to be in tropical waters of 80 degrees, with a condenser vacuum of 27¼ inches and an air pump discharge

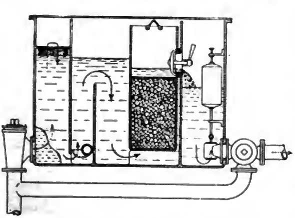

Fig. 5.—Cascade Feed-Water Heater and Filter.

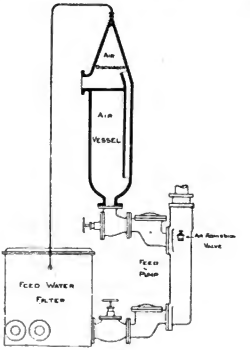

FIG. 7.

temperature of 102 degrees. If all the exhaust steam is condensed among the feed water, its temperature would be raised to 187 degrees or 17 degrees above the pumping limit, so that in this case 83 percent of the available heat is utilized. But under these conditions the air-withdrawing capacity of the air pump should be at the maximum possible, so that all the water of condensation can with great advantage be passed through the water receiver (Fig. 3) and the air pump discharge water so lowered in temperature that it will absorb all or the greater part of the surplus heat.

A live steam heater is shown in the illustration on the discharge side of the feed pumps, but its influence on economy does not come within the scope of this paper.

Fig. 8 illustrates a diagrammatic arrangement of the 5,000-horsepower proposition. In this case the feed pumps are independent and are supplied with water under control from an elevated direct-contact heater in the usual way. Reference to Table I will show that the heat in the exhaust steam and water drainage is sufficient to raise the temperature of the entire feed to 211 degrees under the conditions set forth, but as the heater is under atmospheric pressure the limit of temperature is about 207 degrees to 210 degrees, a temperature which is well within the pumping limits of the independent feed pump, so that in this case 98 percent of the available heat is utilized. At 27¼ inches vacuum the surplus heat is a little greater, but can be dealt with by the use of the temperature regulator as already explained.

It will be evident that the steam from the auxiliaries is somewhat oily, and this is especially the case with the deck machinery, so that if this particular arrangement is used in port it is very advantageous if the direct-contact feed heater is fitted with an oil separator. For port use the water from the feed tank has to be discharged into the elevated heater by an independent pump, which can conveniently be fitted near the filter tank and regulated by a float controlled valve therein.

Fig. 9 shows an arrangement having a tubular heater on the discharge side of the feed pumps. Both at sea and in port the auxiliary exhausts flow through this heater into the auxiliary condenser and thence into the filter tank. As the temperature of the water passing through the feed pumps is raised by water drainage only, it is so much below the pumping limit that no head on the suction side is necessary.

When using deck auxiliaries in port many engineers prefer the auxiliary condenser to be under a moderate vacuum. Fig. 10 shows a simple apparatus for that purpose. A centrifugal pump is employed for circulating sea water through the condenser, and on the same shaft is another small centrifugal pump which draws water from the filter tank and discharges it through a kinetic air ejector and again into the tank in continuous circulation. When this apparatus is applied for port use to the arrangement in Fig 9, with the surface heater

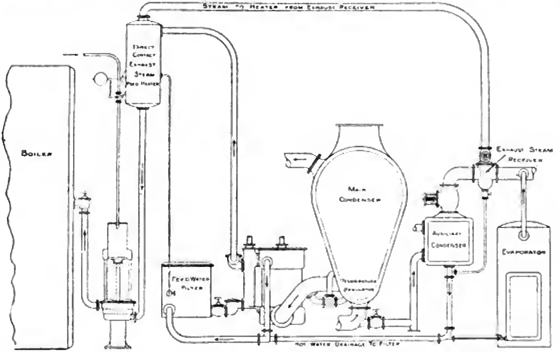

FIG. 8.

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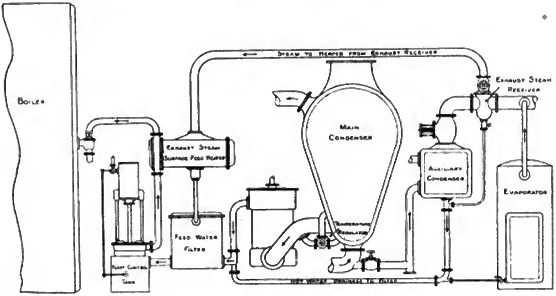

FIG. 9.

on the discharge side of the feed pump, the feed water is drawn from the filter tank by an auxiliary feed pump in the ordinary manner, but when applied to the arrangement in Fig. 8 for port use, and when the main engines are stopped, the water from the filter tank has to be discharged into the elevated direct-contact heater. For this purpose the pressure in the discharge pipe to the kinetic air ejector is maintained sufficiently high to force the water up into the contact heater. The amount of water discharged to the heater is, of course, equivalent to the amount condensed in the condenser, and its flow is regulated by a float control valve in the filter tank.

In such an arrangement the temperature obtainable is within a few degrees of the temperature corresponding to the vacuum carried, but as the heater, when of the direct-contact type, must be at such a height that the influence on the vacuum will not interfere with the satisfactory working of the feed pump, the vacuum should be moderate and should be controlled by the use of a spring valve, which admits air when the desired limit of vacuum is reached.

In all these arrangements the supply of exhaust steam from the steering engine, the ash hoist, the electric light engine and any auxiliary donkey that may be in temporary use is somewhat intermittent and irregular, but as the evaporator provides a considerable proportion of the entire low-pressure steam it can with great advantage be fitted with an automatic regulating valve, so that whenever the pressure in the exhaust receiver exceeds the assumed limit pressure of 2 pounds the steam supply to the evaporator coils is throttled and the supply of generated steam is immediately decreased. In this way the steam supply to the exhaust steam feed heater can be rendered uniform, notwithstanding that some of the auxiliary engines work irregularly or intermittently.

These calculations afford incontestable proof that the feed water in any steamship can be heated up to pumping limits by the available auxiliary exhaust steam; so that to ignore the economical possibilities of high vacuum in the engines and to work at a low vacuum in the condenser with the sole object of obtaining a high temperature of air pump discharge water, and then to throw away heat by deliberately discharging exhaust steam into the condenser because the feed water is already too hot to absorb it is, in my opinion, a system of working marine machinery that involves a considerable and continuous loss of available profit to the shipowner throughout the life of the ship.

The subject under consideration is one that directly appeals to the superintendent engineer, as while he cannot produce results beyond those which the machinery he controls is capable of giving, yet it is obviously his object to obtain initially such a design of machinery as is capable of yielding maximum

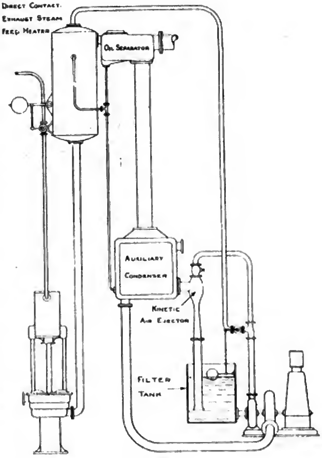

FIG. 10.

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results, and then to work it so that his owners are placed in the best position for achieving maximum commercial success.

I therefore trust that, in the interest of engineering progress, the contributions to the discussion will be so liberal as to afford a solution to the question as to whether it is, or is not, commercially advisable to adopt a higher range of vacuum in reciprocating engines on shipboard than is at present customary, in combination with the heating of feed water by the exhaust steam from the auxiliaries.

THE GYROSCOPE FOR MARINE PURPOSES.*

BY ELMER A. SPERRY.

The uses of the gyroscope at sea fall properly under four general divisions: First, in affording means for resisting and preventing rolling of vessels or even rolling and controlling their motions at will; second, its use as a marine compass; third, for holding automobile torpedoes to their course; fourth, for artificial horizons in connection with observations at sea. There are two other uses which may be noted, that of recording the motions of ships, and also the use of a small gyroscope in controlling the oscillation of large active gyroscopes for purposes of preventing rolling motions of the ship in their inception, and thus holding the ship against rolling. The first three only will be treated briefly in this paper.

Previous to the introduction of the gyroscope, there have been three methods of steadying ships which afforded resistance to roll. "The oldest steadying gear," as pointed out by Sir John I. Thornycroft, "was probably the sail, though not originally intended for that purpose." He goes on to say "that the extended use of steam is depriving passenger vessels of this ancient steadying gear and causing increased rolling. For comfort at sea, we require in our ships some device that will afford resistance to roll, the need being an increasing one."

Lord Kelvin has measured angles of roll in crossing the Atlantic of 40 degrees each side of the vertical, giving a total angle of motion in a single roll of 80 degrees.

The early work of Froude, his co-laborers and successors, in applying athwartship tanks for prevention of rolling is well known. These, together with rolling ballast and the great moving weight of Thornycroft himself, all fall under the head of moving the center of gravity of the ship in attempting to balance the wave effect and prevent rolling.

About this time bilge keels were introduced and their characteristics are quite well understood, being effective only in heaviest rolling. Quite large bilge keels were found to equal about three-fourths of the surface hull and keel action for all angles of roll. The comparison between bilge keels and 1 percent of water ballast in athwartship tanks is interesting. Very large keels were found to be only one-eighth as effective at 3 degrees roll from the vertical, one-fourth as effective at 5 degrees roll, only equaling at 12 degrees roll, and being three times as effective at 18 degrees roll. They are also known to increase materially the resistance, skin friction and motive power required in all weathers. Sir John I. Thornycroft introduced a method of anticipating the rolling by the means of a controlling mechanism compounded of many active features involving a short and a long pendulum, a retarding device and a cataract all organized to co-act, these were operated on the floating link principle, a moving ballast being operated by heavy hydraulic machinery in the hold of the ship.

It is more than probable that the true engineering significance and the enormous power of the gyroscope were first discerned in this country; that is, observations concerning it were first made here in connection with early torpedo work.

The most extensive use of the gyroscope to-day is probably the automatic steering gear in Whitehead torpedoes. This gear is simply used for the purpose of lateral guiding of the torpedo and holding same to a straight course. This little gyroscope has a secondary ring which may precess—it offers positive resistance to any effort to turn it from its course, and this resistance is used to operate valves and, through a secondary motor, the rudders. This use originated with Obrey, an Austrian naval officer.

FIG. 1.—THE SEE BAR, THE FIRST STEAMSHIP EQUIPPED WITH A GYROSCOPE.

Our own member, Mr. Leavitt, engineer of the E. W. Bliss Company, of New York, and inventor of the Bliss-Leavitt torpedo, has greatly increased the efficiency of the "gyro" gear of torpedoes, as he has greatly improved the torpedo itself. Figuring from the increased speed and radius of action, he has increased the power factor of the old Whitehead torpedo twenty times and without materially increasing the air pressure carried. He accomplished this by a wonderfully bold piece of engineering; that is, by automatically burning a fuel directly in the pressure air current, thus greatly increasing its temperature. The reciprocating engine of the Whitehead is replaced by a pair of little Curtis turbines. It should be remembered that every doubling of the absolute temperature doubles the volume, and whereas he starts out with a small amount of air, he reaches the turbine with an immense quantity of air, under the requisite pressure, enormously increasing the power generated, an exceptionally interesting piece of engineering!

The Leavitt directing gyroscope is small, and he has increased its accuracy by unloading the base ring; instead of

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1910.

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asking the base ring to do the work of moving a valve, he cuts the duty required down to about one-hundredth of that required in the Obrey gear, and makes it give a simple directive factor to an extremely small pivoted pawl at the instant the pawl is otherwise perfectly idle.

Dr. Schlick has done much in connection with the gyroscope. He is a noted engineer of Hamburg, Germany. It is to Dr. Schlick's genius that we largely owe the vibrationless reciprocating marine engine. This engineer has gone further in the installation of large gyroscopes for steadying ships than any other. His gyroscope is of the passive type. He is a practical engineer, and at first called to his assistance a number of other engineers and mathematicians and designed the first machine.

In Germany, in 1909, Engineer Dr. Frahm had succeeded in overcoming one of the reasons for eliminating the water chambers from the old English men-of-war—that was, the noise of the hundreds of tons of water rushing from side to side, which is said to have been intolerable—by using an inverted siphon. The trouble with this arrangement is that the central opening has to be of such a character as to cause the movement of the water to be synchronous with the boat's period; that is, in addition to the simple gravitational factor of the water the kinetic energy of the rushing water must be utilized; while the boat in still water has a fairly uniform period, and the movement of the water in the arrangement can be made to conform to a given period, however, in rough seas, the boat is not periodic, varying a great deal. I have seen automatic diagrams of rolling where the period varied from seven seconds to seventeen seconds. Now when the flow of this great quantity of water gets out of synchronism it becomes a menace, and makes the boat roll more and behave worse.

The great engineer, Sir John I. Thornycroft, of England, did much valuable work in attempts to overcome the last-named difficulty. He placed a great moving weight on a vertical axis which could move as a pendulum in the hold of the ship. An equipment of hydraulic apparatus was provided for swinging this weight from side to side. By this means the center of gravity of the ship could be changed at will. The weight was about 5 percent of the total displacement of the ship, but it was governed by the controlling apparatus mentioned above, in such a way that he succeeded admirably in anticipating all the needs of the ship up to the capacity afforded by this moving weight. The weight had the power of tilting the ship just 2 degrees either side of the vertical when swung to its extreme lateral positions. In sea trials of this arrangement, Sir William White states that it reduced 18 degrees of roll to 9 degrees. To eliminate wind and weather conditions the boat was made to sweep through an entire great circle in heavy seas. This was the first attempt to steady a ship by a controlled reactionary force. The difficulties encountered with this, the water tanks and all other gravitational methods, are that each pound of weight is enabled to do the work of only 1 pound, and the weights and auxiliary machinery required have been thought to be prohibitive; and, furthermore, the weight, when on one side or the other, constitutes a persistent unbalancing or listing force, whereas the gyroscope is enabled to deliver stresses pure and simple without disturbing the balance of the boat or introducing any such list whatever. The problem of preventing rolling of ships at sea has been attacked by a great many engineers.

Last year, while in Hamburg, Germany, I saw the latest arrangement by Engineer Frahm, installed on some naval vessels for the Russian government now being built with his arrangement for steadying ships, involving enormous tanks amidships, which will contain from 350 to 400 tons of water, through the rushing of which, back and forth, a part of the true periodic roll will be extinguished, but only a part and only when periodic. The eminent authority, Dr. Schlick, states with reference to this arrangement that it will become a positive menace and cause excessive rolling when the ship's oscillation falls out of period, which it invariably does in a storm. This, however, is interesting, as showing the great desire to prevent rolling of ships and especially war vessels.

The gyroscope, on the other hand, is not limited to any particular period of the boat; it simply responds to whatever motion the ship has—synchronous or non-synchronous. The question is often asked: Why is the gyroscope better than a moving weight in a ship for roll quenching? Barring the matter of list produced by the changes of center of gravity of the ship by the moving weight, the reason is perfectly apparent when you recall the magnitude of the stresses obtainable from a small machine. Every pound in the rotating mass of the gyroscope can easily be made to do the work of from 150 to 200 pounds, and directed in any desired line or plane, whereas, when we use water or any other form of moving weight, each

FIG. 2.—MODEL USED BY JOHN MACFARLANE GRAY TO DEMONSTRATE THE TRUE ENGINEERING PRINCIPLE OF THE GYROSCOPE. ORIGINAL NOW IN KENSINGTON MUSEUM.

pound represents a pound only, and can do the work of only a pound, and only in a vertical direction.

The gyroscope is probably the only device in the world by means of which stresses and also energy may be transferred "around a corner," so to speak. With the gyroscope it is possible to create and maintain a very powerful fulcrum in space effective for the heaviest kind of mechanical duty.

Now on board ship there is one factor that is stiff and is now available, and that is the fore-and-aft stability of the ship. In the gyroscope, for the first time, we have the means of rendering it possible to reach out and transfer this stability around a corner, so to speak, to the athwartship plane and thus hold the ship against rolling. We can do this with a surprisingly small mass, because, as I have said, every pound in that mass can be made to do a very large amount of work, owing to the velocity that may, at low cost, be impressed upon it.

A primary motion on the part of a body—for instance, the slow athwartship or rolling motion of a ship—exerts gyroscopic forces upon any vertical spinning shaft and in a fore-and-aft direction. These forces tend to dampen the rolling motion, but only feebly, and the fore-and-aft reaction, owing to the absence of motion, does not at all. It is a part of the general plan to so utilize this force as to make it create extremely large reactions athwartship or in the proper direction to be effective. This is accomplished by the ingenious yet simple expedient of mounting the aforesaid vertical shaft in a pivoted frame so that it can tilt and utilize the primary fore-and-aft reaction to cause the axis of the spinning mass to tilt fore and aft. This motion is of much higher velocity than the angular

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motion of the vessel which produces it. By means of this tilting motion an entirely new gyroscopic force is set up, again at right angles as in the first instance, but now to the plane of tilt (fore and aft) which brings it back to the original athwartship plane just where needed; and, what is equally important, the reaction is in a direction exactly opposed to the roll of the ship which primarily called it into action, as well as this whole chain of phenomena which we have thus traced through a complete cycle of 180 degrees of angle, and also through an enormous augmentation of righting moment and stabilizing power.

The passive type of gyroscope fails to respond to all the smaller angles. It responds freely to the large ones or wide angle oscillations, but either does not respond at all or moves very slightly with the smaller oscillations, as stated. Not responding, it cannot, of course, control or extinguish these smaller oscillations. It being desired, especially in connection

FIG. 3.—MODEL OF SPERRY GYROSCOPE USED TO DEMONSTRATE DIFFERENCE BETWEEN ACTIVE AND PASSIVE TYPES.

with improvement in conditions for gunnery on battleships and war vessels generally, that the gunner should operate if possible from a level gun platform, it therefore becomes desirable to act on these smaller oscillations of roll of the ship so as to completely extinguish them and hold the ship on a practically even beam. This especially as now all the larger war vessels are designed for broadside service and volley fire. The gunner, therefore, is compelled to keep an absolutely true and incessant aim upon the target. If the ship is rolling much or little this is a more difficult task. Again, the recoil of the volley fire throws the boat over and sets up rolling, and it is the duty of the gyroscope to extinguish and prevent all rolling disturbances, from whatever source. As we have seen, the lesser angle rolling cannot be taken care of by the passive type of gyroscope. We must rely upon the active type. By this means the full angle operation of the gyroscope is secured where necessary, independently of the amount of motion, or, in fact, any motion whatever, on the part of the ship, and is therefore in readiness to deliver to the boat stresses which are equal and opposite to those received by the boat from any source and prevent them from causing the boat to roll.

It is interesting to note that when the boat is held free from motion, as by the delivery of stresses equal and opposite to balance the wave effort, no power is required to actuate the gyroscope other than to overcome inertia and friction, which is almost negligible. When the roll is being suppressed and the boat is moving then the boat is doing work upon the gyroscope, and it then becomes the province of the actuator to emplace the oscillations of the gyro properly with reference to those of the boat, and at such angular velocity as to best suit the conditions, structure and mountings.

The work of Sir John I. Thornycroft for preventing rolling involved changing the center of gravity of the vessel, and thus introduced an additional disturbing and unstabling element which required additional treatment; his device involved a great moving weight running as high as 5 percent of the total displacement of the boat, and a very large amount of hydraulic machinery for handling these weights and a considerable amount of motive power for operating them. But with the active type of gyroscope, we find that a small part of 1 percent of the displacement of the ship will perform a very substantial service, down to the point of practically fully extinguishing the rolling. By the use of this device there is entire absence of any shift of the center of gravity of the vessel, and its stability remains unchanged. The sizes, weights, speeds and location of a gyroscope for this purpose are among the points which have been canvassed in tests carried on at the Washington navy yard during the past year.

Experiments were made with a working model of a 26,000-ton battleship of the super-Dreadnought class, with 5 feet metacentric height and eighteen seconds period of roll, capable of rolling through a total arc of 60 degrees; means were provided for autographically recording all motions, both of the ship's model and the gyroscope, upon same. The gyroscope was operated both passively and actively; means were also provided for emplacing the discharge of the active gyroscope variously with regard to the ship's oscillation, so that the effect of different combinations might be studied. Many other auxiliaries were provided, one of which permitted the actual velocities of the gyro wheel to be counted while in operation. This was accomplished by the stroboscopic apparatus of Capt. D. W. Taylor, similar to that used by him in his investigations of propellers under service conditions; in fact, both the ingenuity and reliability of performance of the model ship and the auxiliaries are directly due to Capt. Taylor and his assistants at the Washington navy yard. By means of this very complete equipment studies and records have been made and charts of performance prepared and other valuable data accumulated, much of which is new, as many of the observations, we believe, were never before undertaken. The investigations with the active type of gyroscope are in a new line of research; the results obtained are important in point of much more perfect control of the ship's roll than heretofore possible.

Capt. Taylor has prepared a very full report upon this work, forming a part of which is a 40-page appendix, in which he treats the question in a most masterly manner under some sixteen heads. In this most unique and valuable work, Capt. Taylor has given an original mathematical treatise on practically all the phases and bearings of this question, including an original investigation of the underlying phenomena of the gyroscope itself. It is of the greatest value to this important art that its problems should have come under the observation and been reviewed by so able a mathematician, experienced in all branches of experimental research, and fitted by long training to judge of the practical bearings of the results extending, as does this experience, to the very largest undertakings and structures in marine work. It is to be hoped that the author himself may be prevailed upon to give the society a paper including this valuable treatise.

The practical effect in operation of the active type of gyroscope is to secure a large reduction of weight over and above that possible with the passive type. With the passive type with the smaller angles of roll, the gyroscope would have to be large enough so that its small angles of response would

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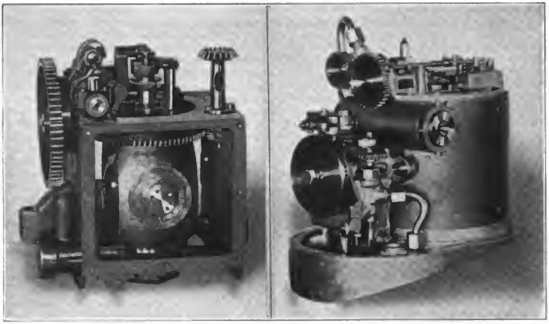

FIG. 4.—TWO TYPES OF LEAVITT GYROSCOPE USED IN THE BLISS-LEAVITT TORPEDO.

develop the required energy for extinguishing or still further reducing the roll, complete extinguishment being impossible; whereas with the active type the full 180 degrees oscillation of the gyroscope is always available, where required, for the extinguishment of large or even the smallest angles of roll as necessary. Thus an extremely small machine, taking advantage of the larger angles, between twenty and thirty times as large, is sufficient to accomplish this purpose.

Fig. 5 illustrates three curves, one at the top giving the number of oscillations of the ship's model before it was brought to rest by the natural friction, having been originally tilted to 25 degrees to one side of the center. The shorter or central curve illustrates the number of oscillations of the model with the gyroscope acting passively or on Dr. Schlick's plan, the several rolls of smaller magnitude at the end being omitted where the passive type of gyroscope failed to respond; and a still shorter curve at the bottom shows the number of oscillations of the ship in being brought to rest, absolute freedom from motion being possible by the same gyroscope when operated actively. These are among the interesting results reached in the investigations referred to above.

When the motive power of vessels changed from an upsetting force to one almost exclusively of forward thrust, the design of ships underwent quite radical changes in connection with lines affecting the stability, decreasing this factor and favoring decreased resistance, aiding the attainment of higher speeds. Now that stability may be imparted to a structure of naturally small righting moment, and, as is well known, even to structures in unstable equilibrium, it is possible that we are on the eve of even more radical changes in design. Ships may now be designed that are practically free from those ballistic qualities which favor rolling structures to which unequal sea pressures easily impart motion need no longer be employed, as a comparatively small gyroscope which can easily be present in duplicate may very readily hold them practically free from rolling motions in such a way that ordinary seas will have little or no effect upon them, while an exceptional wave will have only a temporary effect. It has been suggested in connection with such vessels that they need not pitch if of sufficient length; be this latter fact as it may, it is apparent that a point has now been reached and a situation created with reference to the resisting and prevention of rolling and motion of ships at sea, to say the least, is interesting in many quarters. I heartily commend this subject to those who are interested in providing safety and comfort to passengers at sea, and as also preventing deterioration of certain classes of freight; for instance, live stock is known to suffer heavy depreciation in

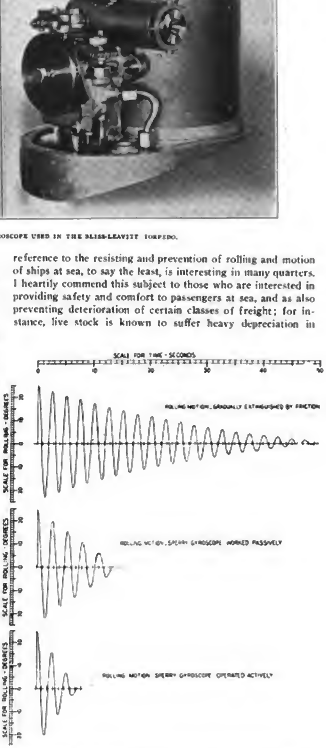

FIG. 5.—DIAGRAMS SHOWING RELATIVE EFFECT OF ACTIVE AND PASSIVE GYROSCOPES.

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stormy weather. This is entirely outside naval uses, especially as related to gunnery, trimming ships to secure level gun platform, suppression of recoil from broadside firing, and other uses.

It is evident from what we know that the early workers were hampered by too close adherence to the earlier treatment of statical stability, and the direct effect of wave slope, together with some other elementary factors, rather than the more practical considerations of the effect of movements of the ship, stresses involved, etc.

In 1904 Dr. Schlick presented a paper before the Institution of Naval Architects. Accompanying this paper in the form of an appendix is a mathematical treatise of the theory of the gyroscope and its application to steadying ships. There seems, however, to be little in this treatise which we find useful in the practical application of the gyroscope, especially the active type of gyroscope to ships. The eminent authority, Capt. Taylor, in his report on this subject states of this treatise that it is a very elaborate mathematical theory, but that it largely ignores practical considerations.

The problem is a comparatively simple one, namely, of holding the ship against rolling by neutralizing with the gyroscope each disturbing influence as it reaches the ship while availing ourselves of all the aid possible through the design of the hull and disposition of the masses. With this end in view we do not yet know the best relation between these two factors. With the last adjusted to best fit the new conditions it is believed that the gyro-steadying plant of the active type will be well within practical limits of space, weight and cost. Especially is this true when compared with the practical results of its operation. A great many ships as they now stand could, with profit, utilize the gyro-steadying gear of this class, which is at present available, and some important installations are now being contemplated. In this connection it is interesting to note that the weight of an active gyroscope for each degree of roll-quenching power on a modern battleship would be about one-tenth that of the submerged armor displaced, and cost much less, this being outside of the very important consideration of having the entire ship under control, either automatically to extinguish roll or at the will of the commander, with its many evident advantages.

Referring to the use of the gyroscope as a compass, it is interesting to note that the possibility was first brought out in 1852 by Foucoult, who, after many attempts, succeeded finally in making up an apparatus so delicate and beautifully constructed as to demonstrate the working of the instrument in the short period of duration of spins of a small disc, the observations being taken through a telescope, the directive factor being only a fraction of that of the magnetic needle, with this difference, however, that magnetism or the location and variations in the positions of the magnetic meridian have nothing whatever to do with its directive feature, and, in fact, it points to exact geographical north, not to magnetic north.

About this time Foucoult took this apparatus to England, and there aroused the greatest enthusiasm in scientific circles by exhibiting it in operation to the Royal Society. Hopkins in America, associated with the *Scientific American*, in 1878 made a small electric-driven gyroscope by means of which better and more persistent results were obtained. More recently, attempts have been made by a German firm to use mercury floats for sustaining the rotating wheel constituting a gyrostat, which, in this instance, runs at the enormous speed of between 22,000 and 23,000 revolutions per minute, which has been considered by many to be impractical. Those familiar with the use of mercury in its mechanical and also electrical applications usually find it very unsatisfactory. At best it is a volatile liquid, subject to many changes with differences in temperature, and, which is worse, is also subject to the phenomenon known as "sickening," which affects the surface and the mercury, and for some distance under the surface, altering its mechanical behavior and also its viscosity. The best engineering practice has for some years avoided the use of mercury, drawing away from its use in every possible way, and especially where electrical connections were involved, and substituted, in their stead, simple mechanical methods which are free from these serious objections. Working in this line I have found simple details by means of which the whole gyroscope proposition is reduced to a strictly mechanical basis, easily within the comprehension of all and containing no unknown quantities and correspondingly easily dealt with. In the cases where the gyroscope is employed as a battle compass, the apparatus is placed below decks, and small instruments about the size of an ordinary compass are distributed in different positions on the ship, giving the exact indications of the gyroscopic compass itself.

My work has extended to the point where action of such instruments can be controlled from the gyroscopic compass and distributed as desired, the indications being accurate to a very small fraction of a single degree. Many observations have been made indicating that they are accurate to thirty-six hundredths of an entire circle. The battle compass as it is mounted on an artificial ship gives all changes of heading, as well as automatic continuous roll and pitch to which the compass is continually subjected. Both roll and pitch may be varied at will as to angle and period.

Among the points never before realized is the automatic correction of the northerly or southerly component of vessels' speed at sea, this correction being made between the gyroscopic compass and its transmitting member, in such a manner that the indications received by the navigator and elsewhere about the ship are thus absolute and maintain true geographical north. It is felt that the navigator has now at hand a most desirable aid and one that greatly simplifies his work. It will be understood that this type of compass is not affected in the slightest degree by the steel of the ship or cargo, nor any magnetic disturbances in either; neither should shifting cargo, turning turrets or gun-fire disturb its accuracy or reliability, nor is it affected in the slightest by those disturbances technically known as deviation or variation.

Rulings of the Office of the Supervising Inspector-General of the United States Steamboat Inspection Service.

The Taylor Water Tube Boiler Company of Detroit, Mich., in a letter dated November 2, 1910, called the attention of this Bureau to an evident contradiction in Section 20, Rule II, General Rules and Regulations, which section reads in part as follows:

"Hard brass, bronze * * * may be used in the construction of all fittings up to and including 12 inches in diameter, and for all pressures not exceeding 300 pounds per square inch, except that it will not be allowed where the steam reaches a temperature of 400 degrees F. * * *, and stated that:

"Inasmuch as the temperature of saturated steam at 235 pounds is 400 degrees, this paragraph seems to carry a contradiction, and we would therefore ask if it would be permissible for us to use brass or bronze globe valves and unions up to 2 inches in size for these boilers."

This Bureau, in a letter dated the 5th instant, replied in part as follows: "Your statement that saturated steam at 235 pounds pressure has a temperature of 400 degrees Fahrenheit is practically correct * * *."

"As the object of the rule was to limit the use of these fittings to a temperature of 400 degrees Fahrenheit, you are informed that you cannot use the fittings in question for steam

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pressures of more than 235 pounds, and the service generally will be advised of this decision."

With reference to that part of Section 20, Rule II, General Rules and Regulations, under the head of Cast Steel, Semi-steel, etc., which reads:

"Screwed bonnets on cast iron valves are positively prohibited," the Supervising Inspector General, in a letter dated November 7, 1910, advised that "the rule is plain and means just what it says, and there is no distinction whatever in the use of a valve on a water line or steam line. The rule *prohibits* the use of a cast iron valve with a screwed bonnet, and if such a valve is found in use it must be removed at once."

With reference to Section 28, Rule II, General Rules and Regulations, which reads:

"On all boilers built after July 1, 1896, a stop cock or valve shall be placed between all check valves and boiler and between all steam and water pipes and the boiler.

"All boiler connections of over 2 inches in diameter, except the connections for safety valves, shall be permanently flanged and bolted directly to the boiler. Where the connecting point on the boiler is of circular form, distance pieces shall be allowed in order to square the point of attachment of the flanged fittings, but no such distance piece shall be allowed to exceed 6 inches in length on its shortest side," the local inspectors at Detroit, Mich., in a letter dated November 4, 1910, stated:

"We enclose herewith a blue print showing one method of attaching the auxiliary stop valve, which shows a cast steel distance piece about 3 inches in length on its shortest side, riveted to the boiler; to this distance piece is bolted a cast iron tee about 12 inches high, the safety valve being bolted to the top opening of this tee, and on the side of this tee is bolted the auxiliary stop valve leading to the small engines throughout the ship.

This method of attachment is used for the purpose of using one opening in the boiler for both the safety valve and the auxiliary steam valve, and we ask if such method of attachment can be allowed, or whether the auxiliary stop must be attached to the boiler at a separate opening, properly reinforced and with the required distance piece."

This office, in reply thereto, in a letter dated November 7, 1910, stated that:

"This appears to be good practice, and in my opinion is not prohibited by the rule which you quote and which governs this question. If this 4-inch valve were really a *boiler* connection it would have to be bolted directly to the boiler, and would not be allowed to meet a nipple or other fitting, except that if fitted to a circle it would be allowed to meet a distance piece as provided by the rule.

It is *not* attached directly to the boiler, and hence it can meet the fitting as you describe it and which I think makes a good job. I would much rather see this tee made of cast steel, but inasmuch as we allow cast iron for fittings when properly stamped and made in accordance with the prescribed formula, we have no authority to require anything better."

Referring to the last paragraph of Section 28, Rule II, General Rules and Regulations, which reads:

"All boiler connections of over 2 inches in diameter, except the connections for safety valves, shall be permanently flanged and bolted directly to the boiler. Where the connecting point on the boiler is of circular form, distance pieces shall be allowed, in order to square the point of attachment of the flanged fittings but no such distance piece shall be allowed to exceed 6 inches in length on its shortest side," the Supervising Inspector General, in a letter dated November 7, 1910, advised the local inspectors at Detroit, Mich., that "The rule in question does not apply to safety valve connections."

TEST OF A MOSHER MARINE BOILER.

By an order issued by the Navy Department, Washington, a board of naval officers, made up of Commander C. W. Dyson, Lieutenant-Commander J. K. Robison and Lieutenant W. G. Diman, met at the works of the Mosher Boiler Company, Ossining, N. Y., to witness the evaporation tests of one of the boilers built under contract for the United States ships *Kearsarge* and *Kentucky*.

The object of the test was to ascertain whether the boiler was capable of evaporating an amount of water into dry steam equivalent to 11 pounds from and at 212 degrees F., per hour, per pound of combustible, when burning coal at the rate of 40 pounds per square foot of grate. Also to ascertain the evaporation from and at 212 degrees F. per pound of combustible at rates of combustion of 15, 25 and 35 pounds per square foot of grate, respectively.

The tests started at 8 A. M. Nov. 1, and continued without interruption until 8 A. M. Nov. 5, when they were completed, each of the four tests thus occupying twenty-four hours.

DESCRIPTION OF THE BOILER.

The boiler in question is known as type B in contradistinction to type A, which is used in the torpedo boat destroyers *Lamson* and *Smith*, as well as various other vessels. It consists of one large steam drum connected by means of curved tubes to a semi-circular water drum having an arched tube sheet. Two large diameter down-comers, one at each end of the steam drum, connect to a return tube on each side and form a junction at the rear end to the water drum, thereby constituting a self-contained unit. The boiler rests on steel saddles, casing and grate-bar bearers being built up and connecting to it. The boiler furnace, from the grate-bars to the tubes and drums, is lined with special firebrick. The baffling of the gases is accomplished in a manner quite similar to that adopted in the Babcock & Wilcox marine boiler, thus forming a first, second and third tube pass within which the gases traverse before the up-take is reached. Unlike the boiler mentioned, however, the gases in the Mosher boiler enter the tube nest near the steam drum and leave at the opposite or water drum end. This arrangement insures a positive circulation of water and steam within the tubes at practically any rate of combustion, but invites a possible short circuiting of air entering the furnace, which, if so, would result in impaired combustion of the gases within the tube nest. The boiler tested was full size, being one out of the lot intended for installation in the *Kearsarge* and *Kentucky*, and had the following dimensions:

Heating surface	3,980 square feet.
Grate surface	91.25 square feet.
H. S. ÷ *G. S.*	43.6
Diameter steam drum	48 inches.
Water space	222 cubic feet.
Steam space	101 cubic feet.
Number of generating tubes	883
Diameter of generating tubes	2 ins. No. 8 B.W.G.
Average length of generating tubes	8 feet 5½ inches.
Total weight of boiler, inclusive of water	91,551 pounds.
Weight per square foot *G. S.*	1,003 pounds.
Weight per square foot *H. S.*	23 pounds.
Steam pressure	180 pounds.

ARRANGEMENT OF TESTING PLANT.

The boiler was erected in a practically air-tight house, furnished with air locks used when the test room was under pressure. There was an overhead platform, from which observations of the weighed water, steam pressure and stack pressure were made. The regulation of the steam pressure was also performed here by manipulating the stop valve forming the connection between the main steam pipe on the boiler and the bleeder to the atmosphere. Safety valves and calorimeter were also placed above this platform.

Forced draft was produced by a Buffalo Forge Company fan, driven by a belt transmission from a single-cylinder reciprocating engine. The blower was located outside the boiler room, discharging into it diagonally towards the rear of the boiler, whereby continuous ventilation of the fire room was obtained.

The feed-water entered at about the center line of the steam drum, and was heated to a high degree by first passing through a multi-coil Reilly feed heater. Steam from the boiler was used as heating medium in the feed heater, which was fitted with a continuous recording temperature gage.

The feed pump was located just outside the boiler room and close to the circular feed tank, into which was discharged the water weighed in each of the two weighing tanks, placed on platform scales immediately above on the raised platform previously referred to.

Calibrated thermometers were placed, one in the feed line on the discharge side of the heater as close to the boiler as was practicable, the other in the suction pipe from the feed pump to the feed tank.

The fire-room temperature was measured by a thermometer placed in front of the boiler under the boiler grating. A continuous-pressure recording gage was placed on the steam line, and a Taylor Cambridge electric pyrometer was fastened on the wall of the boiler-room, where connection to it was effected by means of metallic rods, which were inserted at different points through the side of the boiler whenever readings were taken. A nitrogen pyrometer was placed in the flue to obtain the temperature of the gases.

An Ellison multiplying draft gage was placed on the opposite side of boiler room, connections being made through the dusting doors of the boiler casing by means of a long pipe attached to rubber tubing. An ordinary U-tube was placed near the smokestack to obtain the draft at this point.

An Orsat gas analysis apparatus was located within the fire-room near the rear end of the boiler, samples of the gases being taken continuously and records made at frequent intervals. As the gas was drawn off continuously, very close average gas conditions were obtained. A Barrus throttling calorimeter was fitted on the steam pipe between the boiler and the safety valves, and was in continuous operation during the entire test.

WEIGHING OF COAL AND WATER.

The platform scales for weighing coal were placed outside of fire-room. The coal was placed in barrows arranged to give net weights of 250, 200 and 150 pounds, in order to facilitate tabulation of the weights of the two kinds of coal used, viz.: Pocahontas and Somerset.

The water was taken from the city main and delivered into two cylindrical tanks placed on separate scales and weighed. By means of quick-opening valves it was discharged into the calibrated feed tank placed directly below. The height of the water in this tank was noted at the beginning and end of each test.

MOISTURE IN STEAM AND COAL.

The moisture in the steam was determined from the temperature readings taken at definite time intervals during each test, and the average temperatures obtained by calibration of the calorimeter at the completion of the tests. The moisture in the coal was obtained by laboratory tests made with samples collected at definite times during the tests.

COAL USED AND METHOD OF FIRING.

It was found necessary to use, in connection with the Pocahontas coal obtained purposely for the test, as certain proportion of Somerset coal, in order to more readily break up the clinkers which spread over the grate, partly stopping up the air spaces when using Pocahontas alone. The slag formed by the Pocahontas coal seemed to accumulate about the ash of the Somerset in such a way as to enable dislodging by slicing the clinkers without too much trouble.

The method of firing adopted was the so-called alternate system, consisting of spreading the coal evenly over the grates, with regular time intervals between each firing and a certain number of shovelsful fired at each door. These varied between two to six, depending upon the rate of combustion. The thickness of the fires varied from 4 to 6 inches at the front and between 6 and 10 inches at the rear.

The ashpan was hauled at the end of one test and the beginning of the next; the amount was weighed and corrections made for moisture.

The proportions of coal used were as follows: First test, 2 Pocahontas to 1 Somerset; second test, 5 Pocahontas to 2 Somerset; third test, 5 Pocahontas to 1½ Somerset; fourth test, same as third, except that for the last four hours Pocahontas coal was used exclusively.

RESULTS.

Test No. 1, at 15 pounds coal per square foot of grate per hour, began 8 A. M. Nov. 1, and finished at 8 A. M. Nov. 2. Weather clear; the compartment was open. The rate of evaporation from and at 212 degrees F. per pound of combustible was 12.09 pounds of water into dry steam.

Test No. 2, at 25 pounds coal per square foot of grate, began 8 A. M. Nov. 2, and finished at 8 A. M. Nov. 3. Weather clear at beginning, then cloudy and rainy: the compartment was closed, with an average air pressure of 1.04 inches of water. The rate of evaporation, figured on same basis as test No. 1, was 11.58 pounds of water into dry steam.

Test No. 3, at 35 pounds coal per square foot of grate, began at 8 A. M. Nov. 3, and finished at 8 A. M. Nov. 4. Weather, rainy; compartment was closed with an average air pressure of 1.65 inches of water. The rate of evaporation, figured same as before, was 10.85 pounds of water into dry steam.

Test No. 4, at 40 pounds coal per square foot of grate, began at 8 A. M. Nov. 4, and finished at 8 A. M. Nov. 5. Weather rainy during first half, then clear. The compartment was closed; fan in operation, with an average air pressure in the fire-room of 1.62 inches of water. The rate of evaporation, figured same as before, was 11.048 pounds of water into dry steam. The actual amount of coal burnt per square of grate was 39.91 pounds.

Difference between pressure in fire-room and draft in flue for the four tests was 0.23, 0.64, 1.58 and 1.8 inches, respectively.

Average moisture in coal used for the four tests was 3.31, 2.23, 3.31 and 3.06 percent, respectively.

The average percent of refuse in dry coal was 8.54, 7.15, 5.68 and 5.84, respectively.

The proximate analysis of the fuel used gave:

	Somerset. Percent.	Pocahontas. Percent.
Fixed carbon	71.53	75.68
Volatile matter	14.01	19.67
Moisture	4.57	2.34
Ash	8.09	2.30
Sulphur	1.60	.72

Calorific value of coal by calorimeter per pound of combustible: Somerset = 15,968 British thermal units, Pocahontas = 15,464 British thermal units.

After completion of the tests the boiler was opened up and examined and found in good condition.

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NEW DRY-DOCK OF THE TOLEDO SHIPBUILDING COMPANY.

A large dry-dock, involving some unique features of construction, has recently been built at the yards of the Toledo Shipbuilding Company, Toledo, Ohio. The dock is 100 feet by 700 feet, and is designed to accommodate the largest vessels operating on the Great Lakes. It is built throughout of concrete, and there is in conjunction with it a building berth located on one side of the dock, so that vessels can be side-launched directly into the dock. This is the first time that such an arrangement has been carried out, and its advantages, of course, are obvious. The building berth, with its gantry crane, the dock walls and portals are built entirely of steel and concrete. The only timber used is in the pile foundations, the floor system and the temporary end of the dock, which is designed to be lengthened should it ever become necessary to provide for ships longer than the 600-foot class.

This new dock is built on the site of an old wooden dock, which was 50 feet by 150 feet. The entrance is irregular in outline, because the dock and harbor line are not at right angles. Its dimensions are 114 feet 7 inches along the harbor line, 37 feet across the west end, 30 feet across the east end, and it has a depth of 27 feet. The clear portal entrance dimensions are 94 feet and 82 feet across the top, and still levels respectively with a depth of 21 feet 6 inches. These dimensions will admit any boat now in use on the Lakes, or which is likely to be constructed for some time to come.

The photographs and drawings show the nature of construction and the general arrangement of the dock relative to some of the shops in the yard. A complete description of the dock appeared in a recent issue of the *Engineering Record*, from which the following is taken: The dimensions of the dock proper are 78 feet width along the floor sill line, 95 feet width face to face of dock walls at mean water level, and 659 feet length from the dock side of the portal to the end along the center line. The floor of the dock has a pitch of 6 inches from either side to the center drain, and a drop of 3 feet 3 inches in the total length. The east dock wall is of uniform section from end to end, with a footing 2 by 14 feet and wall 14 feet across the base, 3 feet across the top and 25 feet 6 inches high. The top of the west wall, which is the launching side, is necessarily level, so that the wall section varies in height from 22 feet 6 inches at the portal to 19 feet 3 inches at the far end. The footing is uniformly 2 feet by 14 feet and the top 4 feet 2 inches. The walls rest on firm blue clay and 20-foot piling. The piling rows are spaced 5 feet and the piles about 4 feet.

Both walls have sets of four steps at every alternate 10-foot sections for shoring, and have the necessary sheaves for bilge block chains. In addition, the west wall has large cast iron snubbing posts set flush with the wall top and face for 40 feet, and malleable iron pedestals every 10 feet for supports to the 9-inch channel stringers carrying an A-frame track.

VIEW OF NEW TOLEDO DRY-DOCK UNDER CONSTRUCTION.

The timber floor is carried on the clay and on piling. White oak 12-inch by 12-inch caps run lengthwise of the dock, and every 10 feet 6 inches carry 14-inch by 14-inch yellow pine sills level from wall to wall. Short 14-inch by 14-inch white oak sills carry intermediate sets of keel blocks. The long sills carry 3-inch by 18-inch white oak slides, and on these the bilge blocks have their bearing. The 2-inch overhang of the 18-inch planks serves as a grip for the bilge block anchors. The bilge and keel blocks are built up with 12-inch by 12-inch and 14-inch by 14-inch timbers drifted together. The 3-inch oak plank flooring is laid between the sills, having a pitch of 6 inches toward the center to facilitate drainage.

The end of the dock is construeted of timber, in order to simplify the matter of lengthening if such action should be deemed necessary in the future.

The building berth has introduced an entirely new feature in dock construction, in that it is entirely of reinforced concrete. It has a width of 79 feet; the full length of the dock. Concrete ways are located every 10 feet and concrete cross-tie beams every 7 feet 6 inches, the whole supported by 30-foot

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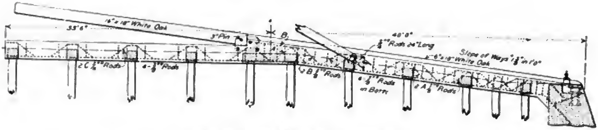


DETAILS OF REINFORCED CONCRETE BUILDING WAYS.

pile foundation. The ways have a section of 24 inches by 27 inches, reinforced with six and eight ⅞-inch plain bars and 7/16-inch stirrups.

The ways have a rise of 3 feet in the 40 feet next to the dock, and in this part heavier reinforcement is placed to take care of the launching strain due to the motion of the sliding boat. The concrete cross-tie beams have reinforcement of eight 9/16-inch plain bars and ⅜-inch stirrups. Trigger lugs

GATE OF NEW DRY-DOCK.

are cast on the ways on the side away from the horizontal center line of the berth. An 11-foot 3-inch by 3-foot 5-inch by 10-foot concrete rudder well is provided near the south end of the berth.

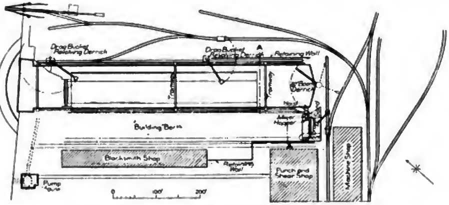
It was necessary to construct a cofferdam and in connection with the excavation to remove the old wooden dock. The tearing out of the old dock timbers was started on March 15, 1909, and the new dock was made ready for a boat Dec. 18, 1909. The general layout and design were prepared by Mr. A. V. Powell, M. Am. Soc. C. E., of Chicago. The design of the steel work, reinforced concrete ways and gate was worked out at the shipbuilding company's engineering department under the direction of Mr. C. B. Calder, general manager. Mr. Harry C. McClure acted as inspector for the company. The work was executed by the A. Bentley & Sons Company, of Toledo, Mr. C. O. Lasley, Assoc. M. Am. Soc. C. E., being engineer.

TWIN-SCREW MOTOR YACHT JOYEUSE.

One of the most successful boats designed for use as a gentleman's yacht during the past season is the twin-screw craft *Joyeuse*, designed by Messrs. Cox & Stevens, of New York, and built by the Pusey & Jones Company, of Wilmington, Del., for Mr. Henry W. Savage, of New York. The principal dimensions are: Length over all, 98 feet; beam, 16 feet; draft, 4 feet 6 inches.

The motor power consists of two six-cylinder, air-starting Standard engines, with a nominal horsepower of 100, but which develop better than 125 horsepower apiece, and give a speed of at least 15 miles an hour. The engines are situated amidships, and are in a compartment separated from the rest of the vessel by heavy steel watertight bulkheads, without any openings in them whatsoever; this compartment also contains the gasoline supply, which is of 1,500 gallons, carried in three copper tanks of 500 gallons each. The engine compartment contains in addition an electric light plant of sufficient capacity to light the boat throughout, including a large searchlight.

The general appearance of the boat is pleasing, her freeboard being moderately high, and the vessel being of flush-deck type, with bulwarks which tend to reduce the apparent height of the deckhouses, of which there are two. The forward house is used as a music room, and the after-house is the dining room; this arrangement being decided upon for the reason that the owner's quarters are forward and the crew aft. Two pole masts are carried, on which sail can be spread when



PLAN OF TOLEDO DRY-DOCK, SHOWING CONTRACTOR'S EQUIPMENT IN PLACE.

VIEW OF COMPLETED DRY DOCK AND REINFORCED CONCRETE BUILDING BERTH, WITH GANTRY CRANE.

desired, these masts and the stack being so arranged that they can be taken down in passing under canal bridges.

The construction of the hull of the vessel is of steel, sufficiently strong to make the boat a durable one, and not so heavy as to overload her; this form of construction being adopted for the reason that it gives much more available space below for quarters than as if the vessel were built of wood. In addition to the steel bulkheads enclosing the engine room, there is a forward and also an aft collision bulkhead, so that the hull is well sub-divided for protection against collision.

The deck houses and all the skylights, hatches, hand rails, etc., are of mahogany, the deck itself being of white pine, all the deck fittings being of bronze, and all appointments of every description being of the best possible character. The owner's room is just forward of the engine space, and separated from it by a double bulkhead to reduce the noise from the engines. This room extends the full width of the vessel, and is 10 feet in length. In finish this room is of satinwood, handsomely paneled, and furnishings consist of a large double berth on the port side, with a wardrobe forward of same, and on the starboard side a writing desk, bureau and seat, which

INTERIOR OF THE DOCK, SHOWING KEEL AND BILGE BLOCKS IN PLACE.

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may also be used for stowage space. On the after end of this room, on the starboard side, a 7-foot sofa is placed against the bulkhead, and on the port side, completely shut off from the stateroom, is a lavatory; this portion of the room being so arranged by an ingenious layout of pillars and columns so as to make a very attractive appearance and at the same time give the owner a great deal of comfort.

FIG. 1.—MOTOR YACHT JOYEUSE, DESIGNED FOR HENRY W. SAVAGE BY COX & STEVENS.

On the starboard side of the passage the space underneath the stairs is utilized as a storeroom, having in it a berth that in an emergency can be used for a valet. On the port side of the passage, opposite the stairs, is a large bathroom, having a 5-foot 6-inch tub, wash basin, toilet and linen locker; this room being tiled floor and having a wainscoting tiling also. Forward of the bathroom on the port side is a single stateroom, with a built-in berth, bureau and seat, a similar stateroom being opposite this room on the starboard side. At the end of the passage and opening into it, the space forward of the two single rooms just mentioned is utilized as a large stateroom, having on the port side a double built-in berth and bureau, and on the starboard side a wash basin, wardrobe and settee. All these rooms are finished in Colonial style, with mahogany furniture, doors and trim, the balance being white enamel finish with egg-shell gloss, handsomely paneled.

FIG. 2.—AFTER DECK.

FIG. 3.—SMOKING ROOM, LOOKING FORWARD.

The forward house, to which reference has already been made, has at its forward end a stairway on the starboard side leading to the quarters below, and on the port side upholstered transoms, which can be used as berths in an emergency, and otherwise form comfortable seats. In the after end of this house is a piano and writing desk. This house is of very liberal dimensions, being 9½ feet wide and 16 feet long, and forms a very comfortable lounging space. The finish inside and out is of carefully selected mahogany, handsomely paneled, and the color scheme of the upholstery is green, making a very pleasing combination.

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PLAQUE PRESENTED TO REAR ADMIRAL MELVILLE ON HIS SEVENTIETH BIRTHDAY.

The after-house is the same breadth as the forward house, and is 16 feet in length. The forward part of this house is utilized for a pantry, and contains an ice-box, dish rack, sink, glass cupboard, dumbwaiter to the galley, which is below, and has on the port side a recess, partitioned off, forming the entrance to the engine-room. The pantry is finished in mahogany, and the floor tiled with interlocking rubber tiling. This room communicates by swinging doors to the dining-room, which is in the after portion of the house. The only fixed furniture in the dining-room is a very handsome Colonial sideboard in the forward end, there being a round extension table, capable of accommodating twelve persons when fully opened, and the necessary number of mahogany dining chairs.

On deck there is ample room for the owner and his guests, the deck being exceptionally clear and free from obstructions. The vessel is navigated from on top of the forward house, there being an awning over this house, so that it makes a very comfortable place for the owner and his guests as well as for the helmsman. This vessel is also very fully equipped in each department, the outfit of boats including a 16-foot motor boat, with a speed of 8 miles an hour, and also a 14-foot dinghy or service boat.

The yacht has attracted wide interest on account of her variation from the conventional design of yachts, and while Messrs. Cox & Stevens have turned out a boat that is entirely unique, many of the little details and conveniences show careful thought on the part of Mr. Savage, who is not only an ardent yachtsman but a sailor of long experience.

The unusual flexibility and reliable performance of the boat's engines on her maiden trip from Wilmington to New York, through the canal, is a matter of comment. The ease with which she handled in and out of canal locks, at times when absolute stopping and starting of the engines was necessary, was a source of great satisfaction. Later on, in deep waters, during a period of very heavy weather, her performance was equal to that of boats twice her size—the full, flaring bow keeping her practically dry through the worst of it, and her roll being remarkably easy.

The first steamboat ever built in Venezuela was launched November 6, 1910. The vessel is of 61 tons displacement.

Tribute to Rear Admiral Melville.

Tuesday, the 10th of January, being the seventieth birthday of Rear Admiral George W. Melville, engineer-in-chief of the United States navy, retired, a few of his friends, with very little preliminary notice, recognized the occasion by presenting him an engraved plaque. At the top was a picture of the *Columbia*, at the bottom a picture of the Melville reducing gear, and at the sides badges of the Grand Army of the Republic and the Loyal Legion. The photograph shown herewith gives a very excellent idea of the appearance of the plaque. Accompanying this was an engraved address of congratulations with the names of the ninety-six contributors.

Rear Admiral Melville was for sixteen years engineer-in-chief of the United States navy. During this time he was responsble for new designs of machinery for about one hundred and twenty vessels of all classes, including twenty-four battleships and forty-one armored vessels of all kinds. The aggregate horsepower was close to a million and a quarter. One of the most notable triumphs of his professional career was the use of triple screws on the cruisers *Columbia* and *Minneapolis*, while to-day his development of reduction gearing for marine steam turbines bids fair to solve one of the most important engineering problems of the day.

New Offices for International Marine Engineering.

The increased demands put upon us for office facilities have necessitated our moving into much more spacious quarters, and, beginning Feb. 1, our offices in the "Whitehall Building," 17 Battery Place, New York, will be in the recently-completed addition to the building in rooms 934 and 935. We shall have considerably more floor area and better facilities in

THE NEW WHITEHALL BUILDING, WHERE "INTERNATIONAL MARINE ENGINEERING" IS PUBLISHED.

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every way for expediting business. On the picture shown herewith the four office windows facing the west have been marked to locate the new offices. The rooms extend back across the greater part of the north end of the building. As we command a view of New York harbor, the Statue of Liberty, and all of the shipping passing in and out, we invite our friends to call and not only inspect our spacious new offices but also enjoy the view from our windows.

SHIPBUILDING IN 1910.

According to figures published in the Glasgow *Herald*, the total tonnage of vessels, including warships, built in the world in 1910 was 3.6 percent greater than that built in 1909. In the United Kingdom there was an increase of 13.4 percent; in the United States an increase of 25 percent, and in Japan an increase of 11.1 percent. Most of the other important shipbuilding countries suffered a marked decline. In Germany the total tonnage, including warships, built in 1910 was 21 percent less than that built in 1909. In France there was a decrease of 17 percent; in Italy a decrease of 9.8 percent; in Russia a decrease of 16 percent; in Belgium a decrease of 12.2 percent, and in Holland a decrease of 29 percent. The figures are as follows:

	1910.		1909.		Increased Tonnage Built Percent.
	Tons.	I. H. P.	Tons.	I. H. P.	
Scotland	420,250	624,268	427,325	628,310	−1.6
England	752,136	861,031	633,299	708,383	18.8
Ireland	167,102	137,730	120,904	123,750	38.2
U. K. totals	1,339,488	1,623,029	1,181,528	1,470,443	13.4
Colonial	24,077	9,237	17,425	6,419	38.1
United States	351,369	304,689	281,271	213,770	25.0
Germany	217,748	303,937	277,155	414,647	−21.0
Holland	124,115	86,919	174,920	72,901	−29.0
France	110,276	170,010	132,877	186,860	−17.0
Japan	60,192	96,638	54,154	52,204	11.1
Italy	36,075	62,600	40,030	62,719	−9.8
Norway	32,998	30,890	32,216	22,533	2.4
Austria-Hungary	32,121	29,796	55,196	70,680	−41.8
Belgium	15,302	26,965	17,429	1,306	−12.2
Denmark	11,922	10,758	11,952	10,306	−0.2
Sweden	9,733	21,940	7,095	23,400	37.2
Other countries	10,319	3,545	10,274	8,595	0.4
Grand total	2,375,735	2,780,953	2,293,522	2,616,752	3.6

A comparison of the work done in the principal shipbuilding centers of the world is shown by the following:

	Vessels.	Tons.	I. H. P.
The Clyde	258	392,302	593,840
United States	151	351,369	304,689
The Tyne	81	236,588	272,991
Germany	310	217,746	303,937
Tees and Hartlepools	86	187,306	115,975
The Wear	58	173,673	124,205

As was the case last year the largest tonnage launched by any one concern during the year was by Harland & Wolff, at Belfast. The leading shipbuilders in the order of tonnage launched during the year are given below:

	Vessels.	Tons.
Harland & Wolff	8	115,861
American Shipbuilding Co. (7 yards)	17	79,598
Russell and Company	12	66,462
Swan, Hunter and Wigham Richardson	16	65,326
The Great Lakes Works	9	56,908
William Gray and Company	13	51,917

The most important launch of the year was that of the White Star liner *Olympic* at Belfast, as described in our December issue. This vessel, it will be recalled, was of 45,000 tons. The next largest vessel launched was the *France*, 23,000 tons, of the Compagnie Generalé Transatlantique, building at the Atlantic Works, St. Nazaire, France. Other large vessels launched during the year included the Cunard *Franconia*, 19,150 tons, by Messrs. Swan, Hunter & Wigham Richardson; the *Edinburg Castle*, 13,326 tons; the *Maloja*, 13,000 tons, and the *Themistocles*, 11,500 tons; all by Messrs. Harland & Wolff.

In the United States, where the most pronounced increase in shipbuilding occurred, the total tonnage of merchant vessels built in 1910 was 332,719. This, as compared with the 207,309 gross tons built in 1909, is an increase of 61.3 percent. The most significant fact connected with this satisfactory increase was the large amount of merchant tonnage built on the Atlantic coast. The gross tonnage of steel steamships built on the Atlantic and Gulf coasts (108,436 tons) was 102 percent greater than in 1909. Only twice in the last ten years have these figures been exceeded—once in 1902 and again in 1907. Both of these years, however, were years of exceptional prosperity in the shipbuilding industry. On the Great Lakes the increase in the gross tonnage of steel steamships during the last year as compared with 1909 amounted to 70.7 percent.

A large number of vessels of 6,000 and 7,000 tons gross were built by the American Shipbuilding Company, as well as many freighters of 3,000 and 4,000 tons. On the coast the greatest volume of merchant work was done at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. The output of this company included four ships of over 6,000 tons each for the Southern Pacific Company; two passenger and freight steamers of 5,425 tons for the Ocean Steamship Company; two freighters of 4,100 tons for the San Francisco & Portland Steamship Company, two Isherwood framed freighters for the A. H. Bull Company, New York, and the oil carrier *J. A. Chanslor* of 4,938 tons. Three steamships of over 6,000 tons were built by the Maryland Steel Company, at Sparrows Point, Md., for the American-Hawaiian Steamship Company. This company also delivered two modern bay steamers. The New York Shipbuilding Company, of Camden, N. J., built two colliers of over 4,000 tons each for the coastwise Transportation Company, Boston, and the principal merchant work at the Fore River Shipbuilding Company, Quincy, Mass., included a 3,800-ton freighter for the Union Sulphur Company, New York, and a molasses steamer of 4,711 gross tons, for the Cuba Distilling Company, besides the magnificent steam yacht *Aloha*, built for Commodore James, of the New York Yacht Club. Two new Wilson Line steamers were built by the Harlan & Hollingsworth Company, Wilmington, Del., and this company also turned out the steamer *Northland*, 3,282 tons, for the Maine Steamship Company. A large part of the work done by coastwise shipyards, however, exclusive of warship construction, consisted of smaller craft, such as tugs, car floats, ferryboats, river steamers, yachts, trawlers, etc.

During the year the battleship *Delaware* was completed by the Newport News Shipbuilding Company, and the *North Dakota* by the Fore River Shipbuilding Company. Eight destroyers were also completed, one by William Cramp & Sons, one by the New York Shipbuilding Company, two by the Bath Iron Works, two by the Newport News Shipbuilding & Dry Dock Company, and two by the Fore River Shipbnilding Company. The Fore River Shipbuilding Company also delivered two submarines. The warships now under construction in the United States include four first class battleships with another one soon to be laid down; nine destroyers with contracts in hand for six more, and nine submarines with three others contracted for but not yet laid down. In addition to this there are 27,000-ton battleships building for the Argentine government at the yards of the Fore River Shipbuilding Company and the New York Shipbuilding Company, as well as a number

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of government vessels building at Cramp's for the Cuban navy.

Shipbuilding in the United Kingdom during 1910 was distributed as follows:

	1910.			1909.		
	Vessels.	Tons.	I. H. P.	Vessels.	Tons.	I. H. P.
The Clyde	358	392,392	593,840	354	403,137	610,985
The Forth	17	9,385	5,935	17	9,224	8,100
The Tay	15	5,982	7,800	11	8,074	8,590
Dee and Moray Firth	60	12,491	16,698	36	6,840	10,635
The Tyne	81	236,688	272,991	112	199,207	262,996
Tees and Hartlepools	86	187,305	116,975	46	122,733	69,025
The Wear	59	173,673	124,205	57	132,633	95,556
Royal Dockyards	4	52,621	....	6	46,812	....
Mersey to Solway	95	41,835	144,801	92	55,228	164,950
The Humber	77	28,033	42,710	72	24,414	35,375
The Thames	142	11,532	30,680	96	7,053	11,618
English Channel	93	11,373	128,969	104	9,920	68,101
Bristol Channel	56	9,178	700	57	5,399	762
Ireland	...	167,102	137,730	...	120,904	123,750

It will be noticed that, with the exception of the Clyde and the Mersey to Solway districts, there was a substantial gain in all parts of the United Kingdom. The decrease on the Clyde was due very largely to labor troubles, which resulted in the shipyard lockout, and does not give a true indication of the condition of business. On the whole, the amount of work turned out on the Clyde has been very satisfactory, and, in view of the large number of orders which are now in hand, the prospect is exceedingly good. There has been a falling off in warship tonnage, although in one case, that of the Fairfield Shipbuilding Company, a record was made by building complete seven destroyers within the year. Also at the Clydebank yard of the John Brown Company, a cruiser and three destroyers were built, which is also a good showing. The Fairfield Shipbuilding Company have to their credit the production of the largest total indicated horsepower of engines of any firm in the United Kingdom, although Messrs. Harland & Wolff approach very closely their figures. The largest merchant vessel built on the river during the year was the *Roturua*, 11,130 tons. This vessel is also notable as the third vessel to use the combination of reciprocating and turbine engines. At present there is an enormous tonnage of both naval and mercantile shipping in hand on the Clyde, and the coming year should prove a record breaker. The placing of the contract for the Cunard Line's new mammoth liner with John Brown & Company is the most important order for merchant ships now in hand.

Nearly all English shipyards report a revival in trade and good business prospects for the coming year. On the Tyne are building the Cunard steamer *Franconia*, at the yards of Messrs. Swan, Hunter & Wigham Richardson; the battleship *Hercules*, at Jarrow; cruiser *Weymouth*, at Elswick, and three destroyers at Hebburn. Messrs. Swan, Hunter & Wigham Richardson have to their credit the largest tonnage launched on the Tyne during the last year. On the Wear, a district which suffered severely during the recent depression, the shipyards have been extremely active during part of the previous year, and have a good volume of business on hand for the coming year. The largest merchant work is being carried out at Sunderland, where two vessels for Norwegian owners are being built which will have a carrying capacity of 12,500 tons each. As previously stated, the Mersey to Solway district showed a decrease in the total tonnage built in 1910, and this is largely due to the fact that no large warship was launched during 1910. A large amount of engine building was carried out, however, and for the coming year a contract has been placed at Barrow for a Japanese *Dreadnought*. Here also a British cruiser is being built. The British Admiralty have also placed an order for a first class battleship at Birkenhead.

The foregoing review, although brief, is sufficient to show the general revival in shipbuilding which has occurred in Great Britain and America during the last year, and when it is noted that according to Lloyd's statistics the total work now on hand in Great Britain is 20 percent greater than was the case a year ago, it is evident that the prospects for the coming year are very good.

Launch of the Arkansas.

The United States battleship *Arkansas* was successfully launched at the yards of the New York Shipbuilding Company, Camden, N. J., Saturday, Jan. 14.

The *Arkansas* is 562 feet long over all, 554 feet long between perpendiculars, 93 feet 2½ inches breadth on load-waterline, with a mean draft of 28 feet 6 inches. The full-load displacement will be 27,243 tons; the normal displacement, with two-thirds supply of stores and fuel and full supply of ammunition, 26,000 tons, and the estimated displacement on trial, 26,000 tons. The ship is to be driven by Parsons turbines on a four-shaft arrangement, which it is estimated will

THE LARGEST BATTLESHIP AFLOAT.

develop a total of 28,000 shaft horsepower, giving the vessel a speed of 20½ knots. A bunker capacity of 2,500 tons is provided and 400 tons of oil fuel will also be carried. The boilers are of the Babcock & Wilcox watertube type.

The armament of the vessel will consist of twelve 12-inch guns mounted in pairs in turrets on the center line of the vessel, and twenty-one 5-inch rapid-fire guns for defense against torpedo-boat attack. There will also be four 3-pounders, two 1-pounder semi-automatic guns, two 3-inch field pieces and two .30-caliber machine guns. Two 21-inch submerged torpedo tubes complete the armament.

The construction of the *Arkansas* was authorized March 31, 1909, and the contract with the New York Shipbuilding Company was signed Sept. 15, 1909. The keel was laid Jan. 25, 1910, and the ship will be completed May 25, 1912. The contract price of hull and machinery was $4,675,000 (£963,000). She is being built under the supervision of Naval Constructor J. G. Tawresey.

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$761.59 SAVED WITH THREE OUNCES OF VANADIUM STEEL

A TWO years' test of Vanadium against ordinary steel in a large railroad shop shows an actual saving of $761.59 on a single item—a flue cutter weighing three ounces. In one year 1049 carbon steel cutters were used to cut 145,444 flues,—in the next year 68 Vanadium steel cutters cut 152,578 flues. The average number of tubes cut with the carbon steel tool was 139, the average for the Vanadium steel, 2,244. The cost of the carbon steel cutter per hundred flues was 54 cents, compared with 1-6/10 cents per 100 with the Vanadium steel tool.

THIS means that there has been a revolution in making steel—what we call steel is a relic of the past compared to the new Vanadium Steel. In final cost Vanadium Steel is the cheapest high-duty metal known. In actual service it is the strongest, toughest, most elastic and longest lived steel that can be made.

In workability it melts, welds, rolls, forges, stamps and machines like ordinary steel. It is made in many types for many uses; you can buy it from any reputable steel maker; it costs less than ordinary steel, service considered.

Vanadium Steel means safety, economy, vitality, strength and service. Specify it, use it, save money by it and guarantee your product and your profits on it.

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MARINE ENGINEERS

SHOULD SPECIFY THESE METALS—

VICTOR VANADIUM

BRONZE CASTINGS

This Bronze composition is particularly adapted for Modern Marine Service, and is rendered tough, strong and uniform by the incorporation of Vanadium, which is considered the greatest of all scavenger alloys, imparting to the metal greater wearing qualities. This bronze is ten per cent lighter in actual weight than any other bronze casting of the same pattern.

These castings can be forged.

The structure is close and clean, capable of withstanding high pressure for valve service.

A cylinder 9-16 of an inch thick, three inches in diameter and fifteen inches long has been subjected to a pressure of nine thousand pounds.

TENSILE STRENGTH on 1" Section:

56000 to 65000 lbs. per square inch.

ELASTIC LIMIT:

22000 to 34000 lbs. per square inch.

This metal is used in submarine vessels in Japan, Austria, Russia and every vessel of this type in the United States.

VICTOR VANADIUM

NON-CORROSIVE SILVER METAL

This Metal is non-corrosive and is particularly useful for sea-going service.

It finishes to a silver color and takes a high polish whose lustre can be maintained quite readily by simply rubbing, adding greatly to its usefulness and effect as ornamental hardware for marine use

It is an ideal metal for propellers, for it withstands salt water and all vegetable and mineral acids, nitric acid excepted. It is of great strength and toughness and should be used for valves and couplings for fire apparatus on account of its non-corrosive qualities, in place of nickeled castings, as nickel finally peels off, and this metal not being plated, cannot peel.

TENSILE STRENGTH:

66000 lbs. per square inch.

ELASTIC LIMIT:

36000 lbs. per square inch.

This metal will be found indispensable to marine service when once used.

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PITTSBURGH, PENNA.

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PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Air-Pump Troubles.

One of the contractors of an English insurance company has stated that about one-third of all engine accidents are caused by air pump fractures, and every engineer knows that air pumps, with their valves, seats, etc., give the most trouble. The valves are of either india rubber, fiber or brass. India rubber valves are incapable of withstanding high temperature water, so that they seldom last long; fiber valves are better, but the best are brass valves, especially if made of Kinghorn metal. With brass valves, the vacuum in the condenser falls away by leakage rather quickly after the stopping of the engine. With fiber valves this action is not so quick, and with rubber valves there is little leakage. If the valves are placed vertically, they must always be of india rubber (for instance, such is often applied for circulating pumps), as brass or fiber valves do not work well in this position.

The quality of fiber used for valves must be very good indeed. Some are very untrustworthy, as they swell when the valve becomes wet. Such an occurrence happened on board the tug *M. C.* The fiber valves of the air pump, which was connected to a jet condenser, were flat and, as is usually the case, there was not very much space around the valve. After some months' running, the vacuum became very poor, the pump was dismantled and it appeared that all valves had swelled, the bucket valve becoming 7/8 inch larger in diameter and about 1/8 inch thicker. The ring space around the valve had become very small and the lift was too slight. Therefore, the resistance of the passing water had become too great for the guard to stand and this had broken in four pieces.

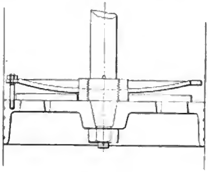

FIG. 1.

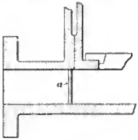

FIG. 2.

Another valve guard was made (Fig. 1), not flat, but curved. A smaller thickness of fiber was taken and in addition the guard was secured to the piston by four studs, so that it could not bend or break. This fiber was of much better quality and when wet it bent with ease. After these repairs, the valves gave no further trouble and they have lasted for a reasonably long time.

It is not good practice to have foot valves of air pumps made of fiber. Brass valves are better for this purpose, as sometimes these valves remain open a moment and then fall down; thus giving a disagreeable shock in the pump, which is heard from time to time. When such a foot valve is replaced by a brass one the shock is eliminated.

It often happens that when the air pipe from the top of the hot well is led overboard and is bolted at the ship's side to a non-return valve, the feed pump does not work and the feed water is taken overboard with the air. The cause of this is that, when in the single acting pump the bucket is rising and the air lifts the non-return valve, the rush of air is such that a partial vacuum is formed in the pipe. The water in the hot well is sucked up into the waste pipe and with the falling stroke of the pump it is discharged overboard. If a small tube is placed in the waste pipe and led upwards, the air may go back and the feed pump will perform its duty again. In this small pipe a cock must be placed, and also in the pipe from the under side of the hot well. When the engine stops, these cocks must be shut so that the vacuum cannot fall back.

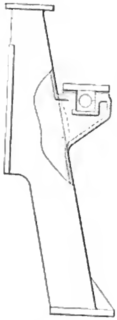

FIG. 3.

The packing of air pump pistons is often very inefficient. In some types of pumps grooves are turned in the piston, but these water seals are scarcely sufficient. In ordinary pumps, rope packing is much used, but the best packing is formed by small brass springs. These must lie against the cylinder with very little tension, so that they can never break; since if they should break they would do much harm in the pump.

In one case known to the writer, where a triple expansion

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engine was installed, it was impossible to get any vacuum in the condenser; and it appeared that the air pump did not pump water, either. The valves were taken out but were found in good order; then it was thought that the pump base was burst, but this did not seem to be the case; finally one of the men suggested that perhaps no hole had been made in the packing between the condenser and the air pump flange. Therefore, the pump was taken off, but the packing was found in good order. It was now found, however, that in the pump base was cast a thin wall (Fig. 2), caused, presumably, by the shifting of the core when cast. The water and air could not flow towards the air pump, so that it was impossible to get any vacuum. This wall was taken away and then the pump worked satisfactorily.

For the design of pump gear, the pressure on the pistons is taken as 30 pounds per square inch, and with this pressure the stresses of the parts are taken rather low. It might happen, however, that this pressure would be taken too low, as the following will show:

In the tug *W* there was placed a compound engine with a jet condenser of the ordinary type with the air pump placed behind the low-pressure column. The pump was driven from the low-pressure crosshead by cast steel levers (Fig. 3). The bracket for the bearing was cast to the after column. When the tug was towing in very low water, the screw touched a large stone and three of the four blades were torn off. At this moment the engineer was on deck, and as the fireman did not know anything about the engine there were four or five minutes when the engine raced tremendously and the air pump made a terrible noise. When the engineer succeeded in stopping the engine, a sharp knock was heard, and the whole bracket fell down and was moved up and down by the final revolutions of the engine. The pump crosshead was bent and also had to be renewed. The boat was towed to the engine works, where a new column was ordered, with the bracket made stronger.

To prevent accidents of this kind, some engine works make the bolts for the pump links very weak so that they will break before any other part. Some reserve bolts are then supplied and a few hours' work putting in a new bolt will repair the break.

D. K.

A Little Comparison.

A great difference exists as regards the procuring of "tickets," or licenses, for marine engineers in America and in England. In America, a man must be a citizen before he can even go before the Inspectors to pass for his license. He must show a reasonable period of time of his connection with engine work. An engineer must be licensed before he can have charge of a large plant, and it cannot be wondered at that an employer wants some security on his engines and boilers, as anyone without a knowledge of machinery might apply for and succeed in getting a job in connection with such, with disaster to everybody and everything.

In Great Britain, on the other hand, a man of any nationality can apply for permission to "get his ticket." Three grades are in force there: second, first and extra chief's. The latter is only tried for by engineers to prove their superior knowledge, and is in no way bound to be got by the engineer to obtain the highest positions on any boat. The second engineer's certificate entitles him to take any position up to and below that of second engineer, while the first allows him to take complete charge over engines and boilers, as chief engineer. It often happens, of course, that the low grade certificate engineer holds the first-class ticket, or license, and is only waiting his turn for promotion.

A man may get permission to sit for his examination, on condition that he has served five years in a machine shop and twelve months at sea, or three years in a shop and three to four years at sea, as sea time counts only one-half that of shore time, until the candidate has "put in five years," apprenticeship or its equivalent.

If he fulfills the conditions he must pass an examination in arithmetic, engineering subjects, and drawing, and then if these are passed he has to satisfy the inspector that he can answer various questions put to him orally—a test which lasts from one-half to two hours.

As there are no examinations for stationary engineers in England, of course they do not require a license for such a job, but a great preference is given to a marine engineer holding his certificate when a position is open over his dry-land brother who is not so fortunate as to have "followed the sea."

Hank.

A Repair to a Broken Slide Spindle Gland.

When a junior goes to sea he is sometimes apt to be more trouble than good, and an instance of this sort occurred on board a vessel making a long voyage where a junior, whose strength was in excess of his wisdom, broke a piece completely off a slide spindle gland, owing to hammering the gland up in order to drive the packing in, as he was repacking the gland.

Fig. 1 shows the shape of the fracture, and it will be seen that a segment of the flange was knocked completely off. In order to repair this an iron ring was made of slightly smaller

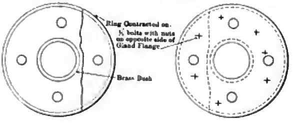

Fig. 1. Fig. 2.

internal diameter than the outside diameter of the flange. This ring was heated up to redness, and after the broken piece of the flange had been put back into place the ring was slipped over and contracted on by cooling. In order to make a thoroughly strong job of the repair a piece of ⅜-inch plate was cut to the same size as the gland flange, and holes cut in it for the spindle and studs of the gland to pass through; ⅜-inch holes were then drilled through the gland flange, and the plate was secured by ⅜-inch tap bolts and nuts both to the gland flange and to the broken piece (Fig. 2). In this way the repair, which was at first regarded as temporary, was made strong enough to become a permanent job and the gland is still in service.

Thomas Beach.

A Ship on Fire at Sea.

Probably one of the most trying experiences which any marine engineer could encounter is to have to devise some means of coping with fire on board his vessel. The means for fire fighting are, of necessity, found to be of an inadequate description on board the majority of cargo vessels unless the fire happens to be discovered at a very early stage, and much then depends upon the ingenuity of the men on board as to whether they will bring their vessel and cargo home to port in safety. Most owners of vessels do the best they can to provide means for subduing a fire, but in the nature of things the chances on board a vessel are very much in favor

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of the fire. On one ship, which loaded cotton at Galveston in the United States, a fire was discovered in one of the holds when the vessel was about a week out of port on its way to Liverpool. Very shortly after the fire was discovered the decks above the fire began to warp with the heat. As soon as the outbreak was discovered the engineers on the vessel tore down a few pipes from the connections in the engine room, broke the joints in the deck steam pipes and cut three holes in the deck above the fire in the hold. The pipes from the engine room were then fitted to the deck steam pipes, and steam was turned on to the fire in this way. At the same time the ship was turned ronnd and steered for Halifax in Nova Scotia. The steaming of the hold in this way kept the fire down considerably and made the combustion a slow one. But things got gradually worse, and the firemen could not steam the ship, inasmuch as extra feed often had to be put on. This was necessary owing to loss of water, as the steam to the hold, of course, gave back no fresh water to the boiler. The donkey boiler was set away, but it soon became salted and after three days it was found to be leaking all over. Moreover, the main boilers were also starting to leak. In order to keep the density down, the boilers had to be blown down very frequently, and this involved extra feed over and above the loss occasioned by the fire.

After 12 days the vessel managed to reach Halifax, when it was possible to obtain steam from the shore. Even then, it took another 14 days in order to get the fire put out entirely, and after everything was over, the ship's decks, over the fire, were warped into a series of corrugations, just like a lot of small hills and hollows. After the necessary repairs to the boilers, which were considerable, and when the burnt cargo had been got rid of, the vessel started again for Liverpool and got home safely and the owners of the vessel gave the engineers a very handsome recognition of their service in connection with their fight against the fire. Fireman.

High-Pressure Cylinder Side and Bottom Knocked Out.

The steamship "A——" was on a voyage from London to Glasgow, when the above accident happened. She was a ship of 1,600 tons net register, with compound engines of 220 nominal horsepower and cylinders 40 inches and 71 inches in diameter, respectively, with a stroke of 36 inches. She was about half way on her voyage and just off the coast of South Wales, when the bottom and side of the low-pressure cylinder were knocked out. The cylinder cover was broken and the piston was split into five pieces; the low-pressure piston rod was twisted and bent in a most extraordinary manner; the high-pressure piston rod was broken through one of the cross-head bolt holes; the valve gear of both engines was bent and strained seriously, owing to the pieces of the broken cylinder getting among the valve gearing; and a lot more damage was done which could not be ascertained while we were at sea.

The engineers then started and disconnected the engine, and, after a lot of work, the high-pressure engine was started and the remaining 300 or 400 miles were made and the vessel reached port safely. Considering the defective state of the high-pressure rod, and that the whole of the waste steam was discharged into the engine room, rendering it almost inaccessible, some credit, I think, is due to the chief engineer and his staff for their coolness and hard work in such an emergency.

Upon examination of the damaged machinery, after the vessel had reached port, it was found that the whole bottom had been knocked out of the low-pressure cylinder, a large piece of it, several square feet in area, had been driven out among the machinery and valve gear, several pieces weighing from 40 to 90 pounds had been thrown to different parts of the engine room and between the high-pressure eccentric rods. The stuffing box gland was also broken and rendered useless, the after side of the cylinder, at the middle of its length, was also forced out, causing a large rent; the cylinder was cracked down through the valve casing face, showing daylight through the aperture.

The accident is considered to have been due to the priming of the boilers under steam, owing to their small diameter. They were double ended, with a steam drum placed horizontally between them and running through the uptake, this drum was filled with gulps of water without warning, which was carried over into the engines before any precaution could be taken to slow the mdown; it was afterwards decided to fit a drain cock on the drum, which gave the engineer a chance to clear out the water periodically.

F. J. S. N.

Trouble with the Feed Pump.

There is nothing more harassing to an engineer in charge of a vessel than to find parts of his auxiliary machinery always going wrong, and in one vessel considerable trouble was caused throughout a voyage owing to the erratic behavior of the feed pumps.

After making an examination of the lifts of the valves and doing everything possible to find out the cause of the trouble, the conclusion was arrived at that the source of trouble must be something wrong with the main check valve. This it was imagined was possibly "jambed" or was "gagging." For this reason the boilers were fed for the remainder of the voyage by drawing the water from the hot well by means of the donkey pump and filling into the boilers by way of the donkey checks. There were two boilers on board this vessel, but in neither case was it possible to get the feed properly adjusted, even with the main check valves full open, the feed-water just overflowing and running into the bilges.

By using the donkey pump as already explained, the vessel was brought home to port and there the boilers were opened out. On examination it was found that the internal pipes fitted within the boiler to carry the feed-water up inside had been perforated throughout their lengths with small holes. These holes had, during the voyage, become filled np, and this was the cause of all the trouble. The engineer who discovered what was wrong got a cross-cut chisel and joined all the holes together, making long slits in the pipes, and there was no further trouble from this source.

It will be found in marine work that internal pipes in boilers, except those which fit to the scum-cocks, are nothing but a source of trouble and are of very little use. When they are attached to check valves they are apt to corrode and fall off, and when this happens the feed-water, which is cold in comparison with the water already in the boiler, is sometimes projected against the combustion chamber plates, and these are consequently so much weakened at the point where impinging takes place that they frequently give out at this point. For this reason the matter is of more than secondary value.

H. P. Rolfe.

A Broken Winch Valve Spindle.

Owing to the constant wear and somewhat rough treatment which ships' deck winches receive, there is frequently a good deal of trouble through unexpected breakdowns, and it may be of interest to record a repair which was made on a winch valve spindle of mild steel which was broken in service. It is not claimed that this is the most perfect repair that could have been made; as a matter of fact an unnecessary piece of work

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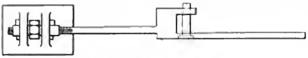
was done, which will be pointed out later. As one learns, however, just as much from mistakes as perfect work it is worth while drawing attention to the repair as it actually occurred.

The sketch shows a view of the winch valve spindle and the valve itself, illustrating exactly where the valve spindle was broken through. This was brought about either by the way the nut constantly shook upon the spindle or by the corrosion of the spindle itself at the portion within the brass nut, probably due to electrolytic action. The repair was made as follows: The parts were taken adrift and the holes in the ribs on the back of the valve were filed out large enough to allow a piece of tube to pass through. This tube was screwed inside over its entire length with a ¾-inch thread, and the tube was next screwed upon the length of the spindle, the broken piece then being screwed into the tube so as to meet the long end. For some reason or other the hole in the nut was also filed out



VALVE WINCH SPINDLE.

to allow the tube to pass through, and the nut was placed in position between the two ribs before the tube was threaded through the large holes in the ribs. There is no reason why this should have been done, as the nut was of no use after the repair was finished, and the engineer who did the work and who could not explain why he troubled with the nut was considerably chaffed about the wasted time. As the breakdown occurred at night, however, when the ship was discharging her cargo, there may be some excuse for a mistake of this kind.

In order to keep the tube and spindle in proper position with relation to the valve two cotter holes were cut right through the tube and spindle, as shown in the sketch. These cotter holes were made by drilling three ¼-inch holes close together and then chipping through the metal between them with a cross-cut chisel. The cotters, which were then driven in through the tube and spindle, bore close up against the ribs at the back of the valve, and thus held the valve rigidly in its proper position. This repair lasted throughout the whole voyage without giving any more trouble, and due credit must therefore be given to the engineer who did the work.

S. I. Brown.

Temporary Repair of a High-Pressure Slide Valve Spindle.

In a vessel which was steaming between the Tyne and Genoa, a breakdown occurred in connection with a high-pressure slide valve spindle, which, as it is fairly typical of the unexpected occurrences which the marine engineer meets at sea, may be of interest to other readers.

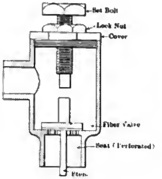
For some considerable time it had been noticed that the threads on the spindle were somewhat worn, allowing too much play to take place between the valve and its nuts, but it had been considered that this could go on for some little time longer before overhaul and repair. On the occasion of the accident, however, the threads on the spindle and those of the nuts were completely stripped, and this left the valve independent of the spindle. While the latter would work up and down the valve was fast against the face on the steam chest and the engine naturally stopped at once. As it was necessary to get the ship into port as quickly as possible temporary means were adopted to remedy the defect. The slide valve spindle was taken out and four holes were drilled along the length of the spindle side by side, and by cutting the metal away between the holes and filing up, a hole was made for a cotter about ⅝ inch thick by 3 inches wide. This was driven in above the nuts and held them in place, the cotter being secured by means of a ¼-inch split pin. The steamer was enabled to finish the round voyage with this repair, and on arrival home the threads on the spindle were cleaned up and new nuts were made. The cotter had, however, proved its efficiency so well that it was decided to keep it in place as an extra safeguard against any slacking back or stripping on the nuts, and for this reason it is described here, as it may be of use to other men in charge of marine engines.

An Ice-Making Experiment.

Much ice is used on a modern passenger transatlantic liner, and most of this is made on board. The ice-making process is often a source of worry, for the ice must be "clear" and not cloudy. The presence of air bubbles in the water as the freezing process is going on causes the ice to turn out cloudy. This is taking it for granted that the water is as pure as can be procured. The ice is made either in a pail by the cold-air system or by the "rocker" principle, which comprises a number of wedge-shaped cans filled with water and immersed in cold brine, and kept rocking slowly by a motor to expel the air.

In a case where the ice was made by the latter method trouble was experienced with the ice coming out cloudy. The cans were all tested to make sure they were tight and were regalvanized, but still with the same result. Something had to be done, for the ice was for table use. The cans were usually filled with a 1-inch rubber hose; but this was a sure way of making air bubbles, especially if the hose did not reach the bottom of the can, so we devised the following to overcome this:

One of Lewis's Patent Pet Valves, shown fully in the sketch, was bound on to a common broom handle and the rubber hose fastened to it, as shown. The water used was first boiled in



LEWIS'S PATENT PET COCK.

PET COCK IN PLACE.

one of the cooking boilers and allowed to cool; it was then allowed to flow through to the pet cock, which was held down in the can, upright, by the broom handle. The stem under the fiber valve protruded beyond the end of the body of the cock about ¼ inch, almost the same lift being allowed the valve, and the action of all depended on this stem, as the same had to be pushed against the bottom of the can to allow the water to enter the can, thereby ensuring that the outlet for same was as low as it was possible to get.

When all the cans were filled, twelve in number, the brine was allowed its flow and the motor started. When made the ice, though not exactly perfect, was a good improvement upon the batches previously made by the same rocker when filled direct from the hose, proving that the main trouble was that otherwise useful fluid—"air."

M. J. L.

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Progress in Marine Engineering and Naval Architecture.

The year 1910 has been productive of no startling or unlooked-for developments in either marine engineering or naval architecture. Continual progress has been made, however, along lines which have been more or less firmly established by previous development. As we have predicted in previous issues, no attempt has been made to build large merchant ships of extreme speeds, but the question of speed still remains an important one in certain types of naval vessels. The construction of a large number of turbine-driven destroyers and battleships which, on trial, have nearly all exceeded their designed speeds, in some cases by several knots, emphasizes the capacity of the steam turbine for generating large powers when forced to the limit. Greater perfection has been attained in the design of condensing apparatus in the last few months, and perhaps it is largely due to this reason that better results are continually being obtained with steam turbines, both as regards economy and the development of high powers per ton of machinery weight. Since the question of speed has been largely confined to warship construction, the use of steam turbines in merchant ships has not increased with any great rapidity. Only comparatively few merchant vessels have been completely equipped with steam turbines during the last year, and, in spite of the good results obtained in certain intermediate types by the combination of reciprocating engines and low-pressure turbines, this arrangement is adopted only in a few cases. The excellent results obtained during the year with the steamer *Vespasian,* which is fitted with Parsons turbines and spur reducing gear, whereby the water consumption of the vessel for all purposes was decreased 10 percent below the most economical results obtained with reciprocating engines, argue very strongly for the adoption of this mode of propulsion in cargo vessels of moderate speed. The results which will be available in a few months from the United States collier *Neptune,* which is being fitted with Westinghouse-Parsons turbines and the Melville-Macalpine reducing gear, will give additional data regarding the efficiency of this method of propulsion which, if expectations are met, will undoubtedly do much to advance the cause of the steam turbine. Aside from speed, there is one characteristic of merchant vessels which has developed remarkably during the year, and that is size. The construction and successful launching of the White Star Liner *Olympic* are but the beginning of an era of construction of vessels of immense tonnage, though of moderate speed. It is quite likely that orders for more vessels of this type will soon be forthcoming.

At the beginning of 1910 sweeping claims were made for the immediate development of oil and gas engines for marine purposes, but up to date developments in this direction must be sought largely within the confines of experimental laboratories and workshops. Much experimental work has been done to good purpose, however, and, from present indications, the coming year, or at least the immediate future, will witness a remarkable development in this direction. The activity of a number of British and Continental engine builders in the development of a practical two-stroke, double-acting, reversible Diesel engine has resulted in orders being placed for a number of vessels to be propelled by such engines; the average power, however, is comparatively small. Extensive experiments have been made with single cylinders developing large powers; but the results have, so far, not been made public, nor have any practical designs yet appeared involving these characteristics. Apparently less attention has been given to the development of suction gas plants than to the oil engine, but moderate-sized plants of this type are now under construction in America. One of 300 horsepower, the engine being of the four-cylinder, four-cycle, inclosed crank-case type, is already completed, and another, developing 500 horsepower on two shafts, will be completed in the spring. The increased activity which is manifest in

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the development of the oil engine will undoubtedly have a good effect upon the development of the internal-combustion engine using producer gas, and, as the results obtained with the earlier installations become better known and the difficulties and disadvantages are gradually overcome, the installation of these plants in comparatively large sizes will be a matter of course.

Internal-combustion engines for motor boats and small commercial vessels have reached a high state of efficiency, and the designs for small power boats themselves, particularly those for cruising purposes, have attained a high degree of perfection. This branch of marine engineering has developed in America to a greater extent than elsewhere, due to the great demand for boats of this type. The influence of long-distance ocean racing has been very beneficial, and, as a result, motor boats, varying in size from 40 feet to 100 feet over all, have been turned out which combine exceptional qualities of seaworthiness and reliability. The engines, for the most part, are of the four-cycle, single-acting type, and, until some cheaper fuel than gasoline (petrol) is available, it is doubtful if the double-acting engine will be much in demand. The field of the small internal-combustion engine is not necessarily restricted to specially designed motor boats, but, as we have frequently pointed out, there is an adaptation which has attractive possibilities from a financial standpoint, and that is the use of internal-combustion engines operating on some cheap or moderate-price fuel for use as auxiliaries in large sailing vessels. The usefulness of sailing vessels as cargo-carriers in competition with tramp steamers has gradually lessened in recent years, simply because the sailing vessel cannot be relied upon to maintain a schedule, whereas the power-driven boat, although more expensive to operate, can be depended upon to maintain a certain average speed. The use of auxiliary power in large sailing vessels would place them upon an equal footing with the tramp steamer, as far as the maintenance of an average speed is concerned, and would give them a decided advantage, since the power required would be small and the engine would be needed during only part of the voyage. The successful use of oil engines in English fishing boats and trawlers is a development which at least points the way towards the re-establishment of the sailing ship in commercial navigation.

Improving the Economy of Reciprocating Engines.

Mr. Morison's paper on the "Economical Working of Reciprocating Marine Engines and Their Auxiliaries," which we print elsewhere in this issue, merits the careful attention of both sea-going and superintending engineers. The author's recommendations relate to the proper vacuum for reciprocating engines and the disposal of the exhaust from the auxiliaries so as to improve the economy of steam consumption. He states that there are hundreds of vessels now operated in tropical waters where the best vacuum obtained is from 20 to 22 inches, and it is not considered worth while to attempt to obtain any better results, although if the engines and condensing apparatus had been suitably designed to carry a vacuum of 27 inches in the tropics and the feed heating arrangements had been adequate, a saving in steam consumption as great as 10 percent might have resulted. In view of these facts, he considers that there are economic possibilities in reciprocating engines which have been allowed to remain latent, and, while considerable attention has been given to means for obtaining higher vacua in the effort to improve the economy of steam turbines, the possibility of a similar gain in the case of reciprocating engines seems to have been overlooked. In the author's opinion, the design of the engine itself offers no hindrance to the use of a high vacuum if the proper cylinder proportions and adequate exhaust ports and passages are provided, and he quotes the results of tests to show that the power increases and the steam consumption per brake-horsepower decreases with approximate uniformity up to the highest vacuum that can reasonably be carried on a steamship. After pointing out that the air-withdrawing capacity of an air pump may be regulated by varying the temperature of the pump, he describes a simple form of temperature regulator to accomplish this. With the assurance, therefore, that a high vacuum can be obtained even in tropical waters, and that the economy of triple and quadruple-expansion engines will be directly increased thereby, he turns to the disposal of the exhaust from the auxiliaries, which constitutes about 15 to 20 percent of the total steam generated in the boilers, and shows how about 95 percent of the heat which it contains can be returned to the boilers by using it to heat the feed-water to the limit at which the ordinary ram feed pump will work. This arrangement of condensing and feed heating apparatus obviously involves important economic advantages, and it will well repay investigation by any engineer who is in the habit of working with a low vacuum in the condenser simply to obtain a high temperature of air pump discharge water and who then throws away heat by exhausting the auxiliaries into the condenser, because the feed-water is already as hot as can be handled by the feed pumps.

There are, however, other considerations involved in the problem which must not be overlooked. For instance, the amount of circulating water required in obtaining a high vacuum is vastly more than is necessary for a low vacuum, and the power required to pump this extra water will be considerable. Thus, in making any changes to improve the economy in steam consumption of the main engines, any possible increase in the amount of steam required by the auxiliaries should be carefully investigated, to see that a positive increase results in the over-all efficiency of the plant.

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Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS.

	Tons.	Knots.		Dec. 1.	Jan. 1.
Florida	20,000	20¾	Navy Yard, New York......	83.7	86.7
Utah	20,000	20¾	New York Shipbuilding Co..	92.2	94.5
Arkansas ...	26,000	20½	New York Shipbuilding Co..	53.6	55.4
Wyoming ...	26,000	20½	Wm. Cramp & Sons.........	46.2	48.6

TORPEDO-BOAT DESTROYERS.

Sterrett	742	29½	Fore River Shipbuilding Co..	99.0	100.0
McCall	742	29½	New York Shipbuilding Co..	96.2	99.1
Burrows	742	29½	New York Shipbuilding Co..	96.0	96.3
Warrington..	742	29½	Wm. Cramp & Sons.........	91.2	92.7
Mayrant	742	29½	Wm. Cramp & Sons.........	90.3	91.3
Monaghan ..	742	29½	Newp't News Shipbuilding Co.	55.5	61.7
Trippe	742	29½	Bath Iron Works............	81.2	87.0
Walke	742	29½	Fore River Shipbuilding Co..	73.3	77.6
Ammen	742	29½	New York Shipbuilding Co..	79.9	82.0
Patterson ...	742	29½	Wm. Cramp & Sons.........	54.4	57.9

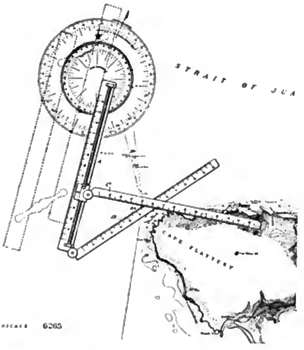
SUBMARINE TORPEDO BOATS.

Seal	....	....	Newp't News Shipbuilding Co.	72.9	73.7
Carp	....	....	Union Iron Works..........	74.0	78.3
Barracuda ..	....	....	Union Iron Works..........	75.0	78.2
Pickerel	....	....	The Moran Co..............	68.0	71.0
Skate	....	....	The Moran Co..............	68.0	70.9
Skipjack	....	....	Fore River Shipbuilding Co..	62.2	74.9
Sturgeon ...	....	....	Fore River Shipbuilding Co..	64.3	71.8
Tuna	....	....	Newp't News Shipbuilding Co.	46.7	47.6
Thrasher ...	....	....	Wm. Cramp & Sons.........	23.0	36.0

ENGINEERING SPECIALTIES.

A Fogometer.

An instrument has been devised by W. J. Smith, Maritime Building, Seattle, Wash., for accurately determining a ship's position (both as to the bearings of and the distance from a lighthouse, etc.) in foggy weather by the use of wireless telegraph and sound waves. The instrument depends for its operation upon the relative velocities of wireless and sound



waves. If a wireless station sends a "wireless" simultaneously with the regular sound signal used during fog, the time interval in seconds between the tick of the wireless instrument on board the ship and the moment when the sound signal reaches the ear, multiplied by 1123 and the result divided by 6080, will equal the distance of the ship from the lighthouse where the signals were given, and the ship will be somewhere on the arc of a circle, at that distance from the shore station. Now, if the ship be run on her course for a certain distance by log, and her position again determined by wireless and sound, she will again be somewhere on the arc of a circle at a distance from the shore station corresponding to the last observation. These observations furnish data for the three sides of a triangle, by means of which the exact position of the vessel can be determined. If the vessel and wireless station are equipped with submarine signalling apparatus, this can be used instead of the usual fog signal, using, of course, different constants in the calculation.

The Fogometer consists of three scales, one of which (A) is laid parallel to the course of the vessel, and which is graduated to show the distance traveled by the vessel between observations and two hinged scales, one of which (B) is mounted at one end of the fixed scale and the other upon a sliding block, so that it can be set to the distance traveled by the vessel. These two movable scales are graduated to correspond to the distances of the vessel from the shore station, as found by the two sets of observations. By placing this instrument on the chart, parallel to the ship's course, and properly adjusting the scales to the values found, the position of the vessel is shown at once.

Shore stations may be called upon to dispatch sound and wireless waves simultaneously, at intervals as desired, during fog, and by this means the navigator can determine his position with considerable accuracy.

Williams Spark Plug Wrench.

J. H. Williams & Company, 150 Hamilton avenue, Brooklyn, N. Y., have just placed on the market a ½-inch spark plug wrench which involves a concentration of service, in that the tool has a "box" end adapted for use as a ½-inch spark plug

wrench and an "open" end suitable for tire lugs, ⅜-inch United States standard cap screws, ⅜-inch A. L. A. M. standard nut and cap screws and 9/16-inch set screws. The tool is drop-forged from steel, and has been designed for convenience and reliable service about automobiles, motor boats, internal-combustion engines, etc.

The Ingram Fuel Oil Burner.

Recent interest in fuel oil as a source of power for marine and stationary plants has brought into the market numerous devices of more or less merit for converting the crude oils and residuum used for this purpose into a highly combustible gas or vapor at the furnace. As is generally the case in the development of a new field in engineering, the natural tendency has been to the extremes in design. On one hand, there are a number of burners that are very effective in bringing the oil to a highly combustible state, but they are so complicated with intricate and delicate parts as to render them impracticable for the severe usage to which they must necessarily be subjected; while, on the other hand, there are numberless so-called burners with claims to simplicity whose sole function is to inject the oil into the furnace regardless of its efficient combustion.

In Figs. 1 and 2 is shown the Ingram burner, which it is claimed combines both simplicity and efficiency. It will be noted that the number of parts has been reduced to the minimum; all moving parts entirely eliminated, and that there are no restricted oil passages that are not readily accessible for cleaning. It is of the class of burners commonly known as the outside-mixer type, and is exempt from the clogging, due to

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carbonization and foreign substances in the oil, so common to those of the inside-mixer type. On a recent trial trip of a vessel fitted with burners of the inside-mixer type one Ingram burner was installed for comparison. While raising steam to get under way the burner was adjusted and was not altered until the vessel returned to her dock, while all the other burners were constantly being relighted from the Ingram. This vessel is now installing a complete outfit of Ingram burners. They will atomize with either steam or air, and it is claimed are highly efficient over a very wide range of pressures on both the oil and the atomizing agent. The finished burner, as put on the market, is shown in Fig. 1. It was the aim of the inventor, through several years of experimenting with fuel oils, to produce a burner of the maximum efficiency at the least cost and one which would require little attention from the operator.

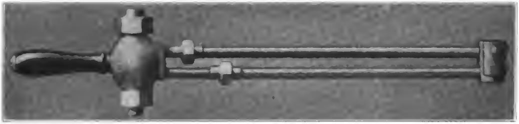


FIG. 1.

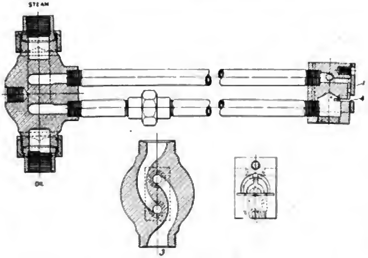


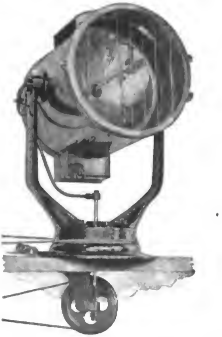
FIG. 2.

The patents for the Ingram burner are owned and controlled by the Ingram Fuel Oil Burner Company, of Newport News, Va., who are supplying the demands of the trade, and they are manufactured for them by the Newport News Shipbuilding & Dry Dock Company, whose established reputation for careful workmanship is carried out in the construction of these burners.

Carlisle & Finch Searchlights.

Searchlights are coming into such general use for steamships, yachts, and even launches that no boat is now considered complete unless equipped with one of them. They are made in a great many different sizes, from the smallest 7-inch yacht lamp to the large 60-inch naval projector, the most common sizes being 7 inches to 24 inches diameter, which are found on vessels of the United States navy, vessels of the United States Engineer Department, coasting steamers, river steamers, etc. The Carlisle & Finch Company, 234 East Clifton avenue, Cincinnati, Ohio, have long been connected with this particular industry, being among the first to recognize the value of the horizontal carbon arc.

This company has given particular attention to developing a thoroughly practical line of searchlights that will require little attention, and that will always be ready and reliable. The type shown herewith is used extensively on Western river steamers, where the light is placed at the forward end of the boat, and its motion controlled by the pilot in the pilot-house. The lamp is provided with both horizontal motion and vertical motion, each of which is controlled by separate cables.



A Small Brooke Motor.

J. W. Brooke & Company, Ltd., Lowestoft, have recently brought out a small 3-horsepower two-stroke motor, running with magneto ignition, which is particularly suitable for use in small ship's dinghies and pleasure boats, where convenience is of more importance than speed. This motor is designed for reliability, and extensive preparations have been made by the manufacturers for producing them at low cost. The power developed is 3 horsepower at 900 revolutions per minute. There are many good features about the motor, chief of which is the skew-driven magneto with a single wire from the magneto machine to the sparking plug, and an automatic carburetor with only the throttle adjustment on it.

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Svea Caloric Engine.

In our issue for August, 1905, we described briefly the Svea caloric engine, which is an internal-combustion engine operated by hot air. The air is heated from below, a volume of cool air being split up into thin sheets, and then passing over heated plates at a predetermined velocity absorbing the heat radiated from these plates. A 2-horsepower engine with cylinders 4.25 inches diameter and 4.875 inches stroke has recently been tested with the following results: Pressure, 40 pounds; temperature, 450 degrees F.; revolutions per minute, 200; indicated horsepower, 2.4; brake horsepower, 1.7; fuel per brake horsepower, 4.9 pounds. Considering the fact that a steam engine of the same size would probably require from 10 to 15 pounds of fuel per horsepower-hour, the Svea engine shows remarkable economy. It is estimated that in a 100-horsepower engine of this type, designed for a pressure of 250 pounds at a temperature of 700 degrees F., an economy of 1 pound of fuel per horsepower-hour or less would be obtained. This engine is controlled by the Svea Caloric Engine Company, 119 Nassau street, New York.

Rope Tests.

In order to determine the amount of variation in the behavior of specimens of manila rope a large number of tests have been made recently by the Plymouth Cordage Company, of North Plymouth, Mass. Twenty-two samples of 3-inch manila, each specimen the product of a different manufacturer, were compared as to weight per unit of length and average tensile strength. The results were plotted with the Plymouth Cordage specimen used as a standard, and the percentage variations either plus or minus of the different samples figured from this standard.

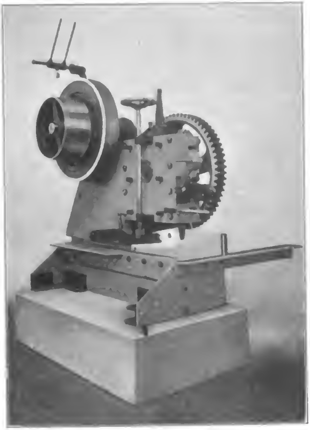
The extent of these variations is remarkable, the weights varying from minus 0.6 percent to plus 22.6 percent, with an average deviation of plus 7.85 percent, while the variations in strength were even more striking, ranging from plus 2.5 percent to a minimum of minus 43.7 percent. The average strength deviation from the Plymouth specimen was minus 14.6 percent. Not only is the extent of these deviations from a given standard surprising but also the fact that there seems to be no logical relation between the shape of the weight curve and that of the strength curve. In many cases the latter rises when the former shows a depression and vice versa.

A very evident lesson which these results points out is that there is room for considerable work in the matter of standardizing the production of rope so that size and weight will give more indication of the amount of strength to be expected from a sample. How shall anyone be able to foretell the load that may safely be carried by a 3-inch manila rope when the specimens tested in this series showed results varying all the way from 9,010 pounds for the maximum to 4,946 for a minimum, with the remaining samples scattered promiscuously over the area between? If rope is purchased with its strength based upon the minimum, which would naturally be a safe method, it is likely to have a maximum strength, in which case it could well be of smaller size, while if the average value was taken it may possibly be considerably weaker than has been figured upon, with a consequent shorter life.

It certainly seems that the standardization of rope making should be made the object of rope makers everywhere, and the work of the Plymouth Cordage Company in this series of tests is an important step in the right direction.

A New Pels Splitting Shear.

Henry Pels & Company, 90 West street, New York, exhibited at the recent Brussels Exposition a splitting shear which has added features of interest, among them being knives of extra length, a patented stripper with a very large bearing surface, and an adjustable gage and guiding pin. These aid materially in reducing the difficulties met with in dealing with heavy plates of large dimensions, and greatly increase the speed of cutting.



The construction of the product of this concern is well known to the trade. The frame is built of one, very heavy, rolled, open-hearth steel plate, reaching in the largest machines a thickness of 6 inches. The tangent and straight channels are milled out of the frame, and the fact that these channels are smooth and without fillets, it is claimed, makes the passing of the plates through the shear an easy proposition.

The tool is built in eight sizes, the smallest dealing with steel up to 3/8 inch, and the largest taking care of plates 1½ inches in thickness. The illustration shows a machine of medium size, which is capable of cutting plates up to ¾ inch in thickness and of unlimited length and width. The knife is 20 inches long, and it is claimed will shear at a single stroke a ½-inch plate 18 inches wide. The frame is 5¼ inches thick, and is guaranteed to stand up under the severe strains of cutting at the highest capacity continually with ease. Only 6 horsepower is required to drive the machine, and it weighs approximately 6,000 pounds.

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and is guaranteed to stand up under the severe strains of cutting at the highest capacity continually with ease. Only 6 horsepower is required to drive the machine, and it weighs approximately 6,000 pounds.

Beloit Lever Splitting Shears.

Slater, Marsden & Whittemore Company, Beloit, Wis., have on the market a line of splitting shears designed for cutting plates from ¼ inch to ½ inch thick by hand. The shears are operated by a lever, but the lever works from the back of the machine, so that the operator is out of the way when cutting large sheets. The bodies are offset so that when splitting

large sheets the metal will pass through freely. The knives are adjustable and reversible, giving four cutting edges. They are also easily removed for sharpening. In the machines designed for cutting ¼-inch and ⅜-inch plate the knives are 6½ inches long, and for cutting ½-inch plate the knives are 7 inches long.

COMMUNICATION.

Simpson's Rule for Beam of a Vessel.

Editor International Marine Engineering:

Referring to the letter by "H" in your January issue, in which your correspondent directs attention to formula 14 on page 45 of "Simpson's Naval Constructor" (D. Van Nostrand Company), I beg leave to state that in the first edition of this book the large vincula embracing the two first terms was omitted in printing, but was corrected in the second edition, which gives the formula:

$$B = \sqrt{\left[M - d\left(\frac{5\alpha - 2d}{6\alpha}\right)\right] \times \frac{d}{m}}$$

Had your correspondent traced the genesis of this formula by referring to Nos. 7 and 17 on the same page, and compared these with pp. 12-15, he would readily have noticed the omission referred to. The formula is a combination of Normand's approximate formula for the height of center of buoyancy, and the approximate formula for *B. M.* expressed so as to give the required breadth of waterline corresponding to a given metacentric height. G. Simpson.

New York.

TECHNICAL PUBLICATIONS.

The Mechanical World Electrical Pocketbook for 1911. Size, 4 by 6 inches. Pages, 270. Figures, 68. London, 1910: Emmott & Company, Ltd., 20 Bedford street, W. C. Price, 6d. net.

This book is a companion volume to the "Mechanical World Pocket Diary and Year Book" which is reviewed in this issne. As has been the custom in previous years, the book has been thoroughly revised and brought up to date by the addition of new material. Among the important additions to the book this year are tables of current densities; permissible temperature rise; percentage losses in electrical machinery; units of illumination; current consumed by incandescent lamps; life of glow lamps; depreciation allowance; etc. Some of the sections which are briefly treated in this book are considered more fully in the Pocket Diary and Year Book and readers are referred to that volume for information on such subjects.

Nautical Technical Dictionary for the Navy. English, French, German and Italian. Volume II.; Part II. Size, 6¼ by 9¼ inches. Pages, 1,115. Pola, Italy, 1910: Mitteilungen aus dem Gebiete des Seewesens. Price, 20/10.

This is the second volume of a dictionary which gives in detail, in four languages, all technical expressions relating to nautical maritime science, and information connected therewith. It includes that part of the alphabet from L to Z. The dictionary is arranged in two ways; first, alphabetically with English and French words in sequence; and second, systematically, according to the similarity of the technical application of the words. The authors have used the greatest care to search out the correct technical meaning of every nautical and technical expression, so that the book may be valuable for reference to magistrates when trying maritime cases where seamen of all nations have to be dealt with. The value and usefulness of the book is apparent and its accuracy can be vouched for by the large number of distinguished collaborators who assisted in the preparation of the volume.

The Indicator Handbook. Part I. Fourth Edition. By C. N. Pickworth. Size, 5 by 7¼ inches. Pages, 142. Figures, 93. New York, 1910: D. Van Nostrand Company, Price, $1.50.

Little needs to be said regarding a book which has been before the pnblic for such a long time, and which has been so favorably received by practical engineers. The present edition, however, has been enlarged and extensive revisions have been made where necessary. Recent improvements in the manufacture of various types of indicators have necessitated changing that part of the book devoted to the description of different instruments. A new chapter has been added which is devoted exclusively to a consideration of the indicator for oil engines; also descriptions and illustrations of reducing gears for gas engines are included, while optical indicators, pressure indicators, etc., are also considered. This work has long been recognized as a very complete and practical treatise on the steam-engine indicator, and we are pleased to find that the additions are fully as comprehensive and accnrate as the original matter.

The Mechanical World Pocket Diary and Year Book for 1911. Size, 4 by 6 inches. Pages, 422. Figures, 94. London, 1910: Emmott & Company, Ltd., 20 Bedford street, W. C. Price, 6d. net.

This is the twenty-fourth year of publication of this pocket book and each year the contents are enlarged and brought up to date. Some thirty-two pages have been added to the present volume and, by careful revision and condensation of some of the more permanent contents, space has been afford-

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ed for the introduction of a very large amount of new matter. Particular attention is directed by the publishers to an important chapter on the shapes, speeds and feeds of cutting tools, with supplementary sections dealing with milling cutters and twist drills. Additions have been made to the section on wheel gearing and entirely new sections on standard screw threads, high-speed steel and its treatment, annealing, hardening and tempering, and the constructive details of gas engines, have been added. There are also new tables and data on marine boilers, riveted joints, etc., and a table of steam fittings has been included, together with several additions to the tables of weights and measures. Taken all in all, this book provides a convenient and valuable reference book for marine engineers.

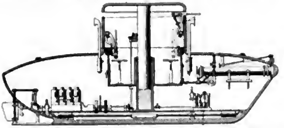
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

971,676. SEMI-SUBMERGED SUBMARINE GUNBOAT AND TORPEDO BOAT. HARRY HERTZBERG, OF BROOKLYN; ABBOT A. LOW, OF HORSESHOE, AND MAURICE J. WOHL, OF NEW YORK, N. Y., ASSIGNORS TO ABBOT A. LOW, OF HORSESHOE, N. Y.; HARRY HERTZBERG, OF BROOKLYN, N. Y., AND MAURICE J. WOHL, OF NEW YORK, N. Y., TRUSTEES.

Claim 1.—A submarine vessel, having a conning tower projecting upward therefrom, and a bucket shaped bottom secured at the base of the conning tower within and walling off the interior of the tower from the



remainder of the interior of the vessel, said bucket-shaped bottom being depressible so as to afford free access to the interior of the conning tower. Six claims.

971,699. REACTION PROPELLING MECHANISM. WILLIAM SOLOMON, OF CHEYENNE, WYOMING.

Claim.—In a propelling device for vessels, an air reservoir, a plurality of reaction tubes, separate ducts leading from said reservoir each connected to one of said tubes, valves in said ducts having their ports disposed at angles to each other, a common stem whereon all of said valves are mounted whereby the ducts will have the respective valves open and closed in succession, a prime motor, an air compressor actuated by the prime motor, and an operative connection between the prime motor and valve stem to rotate said stem as the engine operates. One claim.

972,064. GYROSCOPICALLY-CONTROLLED TORPEDO-FIRING APPARATUS. CLELAND DAVIS, OF THE UNITED STATES NAVY.

Claim 1.—The combination with a torpedo carrying an explosive charge, of a gyroscope mounted in said torpedo, and means actuated by

said gyroscope for firing said charge when the torpedo is deflected through a predetermined angle from its original course. Four claims.

973,772. VESSEL-LOADING ALARM. JAMES GEDEON, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-THIRD TO CHARLES L. BROWN AND ONE THIRD TO ROBERT D. MANSFIELD, BOTH OF CLEVELAND, OHIO.

Claim 1.—In a vessel loading alarm, the combination of a stand-pipe located within the hull of the vessel and communicating with the water outside of the hull, a vertical tube therein open at the bottom, a windlass for adjusting said tube with relation to the draft of the vessel, electrical terminals within said tube, an arm pivotally connected to one of said terminals, a float suspended from said arm, and adapted to raise the arm into contact with the other terminal when the water level reaches a predetermined height with relation to the vessel. Two claims.

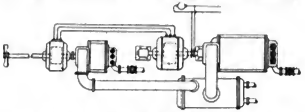
973,774. MEANS FOR INCREASING TENSION OF GASEOUS PROPELLANTS FOR TORPEDOES. MAX GLASS, OF VIENNA, AUSTRIA-HUNGARY.

Claim 1.—In a torpedo, means for increasing the tension of a gaseous driving fluid, comprising a coil through which said driving fluid passes, an acetylene burner arranged axially within said coil for heating the same, an acetylene generator mounted on the inner face of a wall of the torpedo and means for feeding said burner therefrom. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

26,246. PROPULSION OF SHIPS. THE BRITISH THOMSON-HOUSTON COMPANY, LTD., LONDON.

By this invention the propeller is driven in a forward direction by means of an electric motor supplied with current from a generator driven by a relatively high-speed turbine, the driving in the reverse direction being effected by a relatively low-speed turbine connected directly or



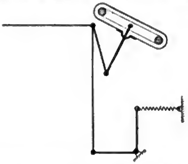
through gearing to the propeller shaft. By using a separate turbine solely for reversing purposes the turbine-driven generator and motor are always kept in the proper phase relation, and powerful and effective agencies are always available for propelling the ship in either direction.

26,812. HOPPERS FOR LOADING STEAMERS. W. H. BAUMANN, NEWCASTLE-ON-TYNE.

The objects of this invention are to prevent breakage of the coal being fed down the chute and to save time and labor during trimming. To this end, the hopper is made in sections connected telescopically. The lowermost section has connected to it two chains which pass through eyes upon the intermediate sections, the upper ends of the chains passing around drums rotatably mounted in the mouth of the hopper. Means are provided for rotating the shaft so as to wind in the chains and raise first the lowermost and then the intermediate sections as required by the progress of bunkering.

27,687. MAINTENANCE OF THE EQUILIBRIUM OF VESSELS, ETC., BY GYROSCOPIC ACTION. R. SCHERL, DRESDEN, GERMANY.

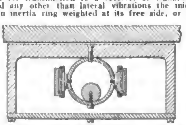
Patent No. 21,843-1909, to this inventor, describes the application of means for accelerating the speed of precession of a gyroscope in order to diminish the oscillation of the carriage, and in patent of addition, No. 27,590-1909, the additional forces acting on the gyroscope are made dependent in value on the speed of precession. In the present invention



the servo-motor acts on the gyroscope frame through an elastic medium 12, under the influence of which the point 6 is moved upward, and which exerts a moment on the gyroscope that, when the lever lengths 3 and 4 are equal and the oscillations about point 13 small varies nearly with the distance apart of points 14 and 6. The latter, however, is influenced by the to-and-fro action of the servo-motor whereby the moment exerted by spring 12 is varied so that the additional moment acting on the gyroscope is controlled by the servo-motor.

25,191. SUBMARINE SOUND SIGNALING. J. GARDNER, FLEETWOOD.

By this invention the ship's sides are employed as diaphragms to collect vibrations for transmission to a receiver or signaling device. In order to avoid any other than lateral vibrations the microphones are mounted on an inertia ring weighted at its free side, or it may be cut



there. A resistance may also be included in the circuit to damp longitudinal vibrations. A device at each side of the ship is connected by a switch with a telephone circuit, or, with a relay for visual signaling, so that the microphone transmitting the stronger vibrations may be used.

7589. PROPELLER. F. BROUSSOUSE, LIEGE, BELGIUM.

Each main blade of the propeller is provided with one or a series of auxiliary directing blades, each series comprising one or more elements fixed on the boss, *en echelon* on the same side as the acting face of the main blade, and their pitch is less than that of the main blade, decreasing from one directing blade to the other. With this propeller a progressive deviation of the section of fluid is secured, the eddies and dead water produced by ordinary screw propellers being avoided.

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TRADE PUBLICATIONS.

AMERICA

A handsomely printed and illustrated catalogue on ball bearings has been published by the Hess-Bright Manufacturing Company, Philadelphia, Pa. A free copy of this catalogue, 580-A, will be sent to any of our readers upon application to the company.

A 280-page catalogue will be sent free to any of our readers upon request by the William Powell Company, Cincinnati, Ohio. This catalogue should be in the hand of every marine engineer and ship owner. It lists valves of all kinds, lubricators of many styles and a large number of similar marine specialties.

A neat vest-pocket size diary for 1911 has just been published by the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa. Besides containing the usual space for daily memorandums throughout the year there are a large number of useful tables on various subjects of interest to boiler makers, engineers and other professional and technical men. Among these are tables of the Melville-Macalpine reduction gear, analyses of heating value of American coals, statistics of power plant duty, and a great deal of information regarding electric lights. One of these diaries will be sent without cost to any of our readers on application.

"Automatic Controlling Valves" is the title of a catalogue published by the Ideal Automatic Manufacturing Company, 125 Watts street, New York. This catalogue should be in the hands of every engineer and ship owner, and a copy will be sent free to any of our readers on application. "The Ideal automatic pump governor is an oil-controlled, piston-actuated, pressure-controlling valve for governing pumps working under a specified pressure pumping air, oil, salt or fresh water, ammonia, etc., and is so sensitive in its operation that the slightest break in the pressure will immediately start opening the valve, thereby supplying steam to the pump. The Ideal governor will prolong the life of the pump by it not doing unnecessary work, causing unnecessary wear and tear and useless waste of fuel, as would be the case if the pump was equipped with a relief safety by-pass valve. For marine uses the Ideal governor is the only pump governor that has ever been approved by the National Board of Supervising Inspectors of Steam Vessels and by the United States navy, and may be used aboard ship on the salt water fire pumps, salt water sanitary pumps, feed-water pumps, fresh water pumps, pumps for hydraulic purposes and ash pumps. For stationary or land uses the Ideal governor is adapted for all kinds of pumps, including elevator pumps, turbine step-bearing pumps, automatic fire sprinkler systems, ammonia compression engines, compressed air or gas machines, hydraulic apparatus, fire engines, hydraulic rams, or, in fact, any apparatus requiring an automatic pressure controller."

Boiler makers' tools are described in Catalogue No. 27, just issued by the J. Faessler Manufacturing Company, Moberly, Mo. This is an unusually handsomely-printed and illustrated booklet of 32 pages, and it will be sent free to every one of our readers upon request. Roller flue expanders, sectional beading expanders, flue cutters, patch-bolt countersinking tools, etc., of every description are description are described and illustrated in this pamphlet. The J. Faessler Manufacturing Company will ship stock tools, or make up a reasonable number of special tools for any responsible party subject to sixty days' free trial, with the distinct understanding that unless the tools prove satisfactory they may be returned at the manufacturer's expense. "Faessler boiler makers' tools first appeared thirty years ago. Ever since we have specialized on this one line. We have studied every phase of the steel question, utilized every advance in metallurgy and have equipped our shops for the most approved methods of machining and thermal treatment. Our complete facilities for producing the strongest, most durable and most efficient parts, enable us to make tools that stand the hardest knocks of all-year-around service. The Faessler tools are the recognized standard, and have justly earned their good reputation is well evidenced by their use in United States government service, in leading American railway and contract boiler shops and in every civilized country on the globe. If you are already our customer, you appreciate the truth of these statements. If you are not, we hope you will investigate carefully the tools listed on the following pages, read our guarantee and trial offer on page 32 of our catalogue, and then let us figure on your requirements. We are always ready to advise prospective customers to their best interests, and we solicit inquiries on any matters pertaining to our product.

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Among the great variety of hydraulic tools and machinery made by the Watson-Stillman Company, and described in its catalogue, 188 Fulton street, New York, is a forcing press made with 18-inch by 24-inch platens and for 60 or 100 tons pressure. The crane bracket and beam at the right permit the work to be picked up from the truck, swung onto either bracket shelf and shoved onto the platen with little exercise or loss of time. The shelves being removable, can be taken off for jobs where they would be in the way.

The 1911 catalogue of the Bantam Anti-Friction Company, Bantam, Conn., is upon our table. As usual Mr. W. S. Rogers, president, engineer and publicity director of the company, has stepped outside the beaten path of machinery catalogue builders and given us something new. The illustrations of the various types of roller and ball bearings are printed in colors, thus giving the user a distinct idea of the quality of material going into the make-up of the bearing, besides adding to the beauty of the pages. The dimensions and prices of the different kinds of bearings are concisely stated. Many new types and forms are shown, while the excellent half-tone on the first page shows the prosperous growth of the works of the company during the past five years. Every purchasing agent, as well as engineering drawing room, should have a copy of it.

Tube Cleaners for steam boilers, condenser, heaters, etc., are the subject of Bulletin No. 32, published by the Roto Company, Hartford, Conn. "Economy, safety and durability of steam boilers depend on keeping the tubes clean and free from boiler scale. For best results there must be actual contact of the water with clean and polished metallic heating surface of the boiler tubes. Roto tube cleaners are the best, quickest and cheapest. They combine the most powerful, reliable and durable motors with the most effective scale removing tools, suited to every condition and kind of boiler scale. We are specialists in this line. We make all kinds of tube cleaners, nothing but tube cleaners and the best tube cleaners made. Our entire factory is devoted to the manufacture and constant improvement of tube cleaning devices. We are independent of all trusts, and we control all the most important patents on tube cleaners. Roto appliances include air-driven, steam-driven (condensing) and water-driven tube cleaners for cleaning all types of boilers, condensers, heaters, evaporators, etc., with either straight or bent tubes. Roto cleaning heads, for heavy scale and light scale, are constructed to get full practical benefit from the great speed and power of Roto motors used to drive them. Economy of fuel (due to cleaner boilers) and large saving in cost of boiler cleaning are reported by users of Roto tube cleaners. We get many repetition orders from large power companies for Roto cleaners same as last for use in their other power houses."

"Economical Fire Room Methoda" is the title of a pamphlet published by the B. F. Sturtevant Company, Hyde Park, Mass. This is a reprint of an article published last year from *Power and The Engineer*. The results shown in the foregoing article have seldom, if ever, been equaled regularly in any boiler plant. And this fact naturally turns one's attention to the design and equipment, for although the intelligent and conscientious work on the part of the operatives contributes in no small way to its success, with an improperly designed or equipped plant, their work would be of small avail. In the first place, this plant was not designed or built after the hit-or-miss fashion. It is the result of the most careful and painstaking study on the part of the men who know—men who understand power plant engineering, men who received their education in the school of experience. The designers had as their goal the construction of a power plant that would generate power at the lowest possible cost per horsepower—a boiler plant that would secure every possible heat unit from the fuel and utilize it for generating steam. Every detail of design and construction was carefully considered from every point of view. Economizers were installed to further increase efficiency by utilizing the waste heat of the flue gases. It was necessary that these economizers be of just the proper proportions in regard to heating surface and storage capacity to reduce the gases and raise the water the maximum temperature, and the high transmission rate mentioned in the foregoing article was the result. So successful were these economizers in reducing the temperature of the gases that chimney draft was made impractical because of the enormous proportions of a stack necessary to create the proper draft at this low temperature. Mechanical draft was therefore determined upon in place of a chimney, and as experience with many similar installations had proven that the induced type of draft was most successful in connection with economizers, this type was installed."

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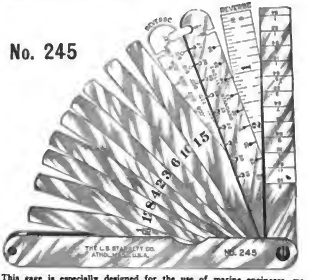
No. 245



This gage is especially designed for the use of marine engineers, machinists and others desiring a set of gages in compact form.

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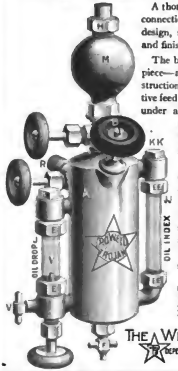

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THE MITSU-BISHI DOCKYARD AND ENGINE WORKS.

The Mitsu-Bishi Company, of Japan, under the presidency of Baron Hisaya Iwasaki and the vice-presidency of Baron Koyata Iwasaki, having its headquarters at Tokyo, owns two shipbuilding and engineering works, one at Nagasaki and the other at Kobe. The company is sole licensee for manufacturing Parsons' marine steam turbines and turbo-generators in Japan, China and Korea. The following brief description will afford a means of judging of the equipment and capacities of the two plants.

THE NAGASAKI WORKS.

The Mitsu-Bishi Dockyard and Engine Works is one of the oldest and largest shipbuilding and engineering establishments in Japan, if not in the East. It is not only one of the largest, but it is equipped with the most varied tools for the production, without subcontracting, of every type of ship, machinery and boilers for land and marine use, steel girders, steel buildings and electrical machinery. Its specialties are Parsons' marine steam turbines and turbo-generators, Stone's manganese bronze castings and Morison's Contraflo condensers.

Many shipbuilding firms are content to construct the more important items of the ship, depending to the fullest extent upon outside establishments, where particular items of work are specified. The principal commendation for this practice is that there is less capital involved in the plant, consequently less loss incurred during the periods of depression which recur regularly.

The Mitsu-Bishi Works, on the other hand, like Barrow or Clydebank Works of Great Britain, is laid out with the object of doing the maximum of work upon any ship, purchasing from outside sources only the materials and those articles which may be termed "proprietary" items, where inventions and patents are largely involved. The advantage in this case is that there is not only economy in production under one management, but there is less likelihood of the separate items being delayed in delivery, and therefore interfering with the consecutive progress of the building of the ships. Moreover, there is no better way for the Mitsu-Bishi Works to adopt than this system, for, although Japan is rapidly advancing, the supplementary industries for ship and engineering works are yet in their infancy, and therefore cannot be depended upon for the best work.

GENERAL VIEW OF SHIPYARD AND DRYDOCK NO. 1, AT NAGASAKI

HISTORY OF THE WORKS.

The works has a very interesting history of its own, it was founded by the "Shogun" Government in 1856. Dutch engineers were employed, and the necessary machines and gears for commencing the works were imported from Holland. A portion of jetty, where the giant crane now stands, was constructed then by means of an old-fashioned diving bell of Dutch make, which apparatus still remains in the works in memory of the founders. Work was then carried on only in a very small scale for repairing small steamers owned by the "Shogun." At the Restoration the works came under the control of the Public Works Department and were very much extended. In 1871, a large dry dock at Tategami, now called No. 1 dock, was constructed, and the patent slip at Kosuge, then owned by a British merchant, was purchased, and from time to time the works were considerably developed. In 1883, a wooden steamer named *Kosuge Maru*, of 1,500 tons gross,

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was built as a forerunner of the shipbuilding industry in Japan.

In 1884, on the abolition of the Department of Public Works, the establishment and the various subsidiary works connected with it were purchased by the Mitsu-Bishi Company, who started this branch of business with only 800 men, and three years later the first iron steamer, of about 206 tons gross, the *Yugawo Maru*, was built, followed by three steel steamers, *Chikugogawa Maru*, *Kisogawa Maru* and *Shinanogawa Maru*, each about 700 tons gross, also a steel steamer, *Suma Maru*, of 1,592 tons gross, was built in 1895, which was considered then as an epoch of the shipbuilding industry of the works. But the true development dates from the termination of the Chino-Japanese War. In 1896 a great stimulus was given to the growth of shipping and shipbuilding in Japan by the enactment of the Navigation Encouragement Law and the Shipbuilding Encouragement Law. About this time the Nippon Yusen Kaisha first organized its European line, and decided to build six steamers of 6,000 tons each. The construction of one of these steamers was undertaken by the works, and it was finished in 1898. This was the first large steamer built in Japan, but subsequently many large vessels were built, including turbine transpacific liners of 13,500 tons, destroyers, despatch boats, etc. On the other hand the Mitsu-Bishi Company has kept the works from time to time supplied with the most improved appliances and gears. A number of staffs were despatched to the European engineering centers, to learn up-to-date methods of construction and organization of engineering enterprises, and a number of British experts were engaged as technical advisers and instructors. Immediate returns were considered as of secondary importance, the whole aim of the firm being to equip an establishment of which Japan might be proud both in workmanship and in business integrity, so that it has now grown to the position of being the most important works in the Far East. The accompanying tables afford some evidence of the work done during the last 12 years by this company.

TABLE I.—ANNUAL PRODUCTION OF THE MITSU-BISHI CO. DURING THE LAST TWELVE YEARS.

Year.	No. of Vessels.	Engines.	Gross Tons	I. H. P.	Average No. of Workmen per Day.
1898	4	4	7,703	4,225	3,430
1899	12	12	4,007	3,189	3,558
1900	13	9	11,617	13,519	3,792
1901	6	6	7,194	6,238	5,209
1902	9	6	15,807	17,336	5,193
1903	8	8	13,078	11,463	5,658
1904	7	5	11,859	12,082	5,292
1905	9	7	12,973	12,731	6,745
1906	13	11	10,031	22,735	5,871
1907	4	4	7,859	23,519	9,660
1908	4	4	23,332	36,417	9,011
1909	4	4	29,596	33,379	5,703

TABLE II.—NUMBER AND GROSS TONNAGE OF VESSELS DOCKED DURING LAST TWELVE YEARS.

Year.	Dry Dock.		Slip.	
	No. of Vessels.	Gross Tonnage.	No. of Vessels.	Gross Tonnage.
1898	84	254,009	19	3,539
1899	95	272,146	29	9,042
1900	103	260,209	32	9,271
1901	111	283,977	30	10,013
1902	76	177,418	31	10,121
1903	47	133,840	20	5,295
1904	65	155,279	26	6,271
1905	117	352,758	22	7,776
1906	97	385,834	26	8,167
1907	90	243,808	17	3,928
1908	39	135,606	17	3,672
1909	57	148,102	13	1,657

GENERAL ARRANGEMENT OF THE WORKS.

The establishment is situated on the inner harbor of Nagasaki and extends along almost the whole length of the western shore of the harbor, having a water frontage of about 8,000 feet, and covering an area of over 114 acres, with numerous workshops and dry docks equipped with all the latest and most up-to-date machine tools and appliances for shipbuilding, engineering, drydocking and electrical engineering work. There are powerful hydraulic and electrical installations, as well as pneumatic plants for the lighter class of work in riveting, calking, chipping, etc.

The works may be said to be constituted of four principal sections, viz., shipbuilding yard, engine works, drydocks and slip.

The shipyard at Tategami, which is at the outer end of the harbor, has seven building berths, ranging from 240 feet to 700 feet long, and an annual output capacity of over 30,000 tons. The mold loft, scrive boards, plate and angle-bending shops, plater's machine shops, smith shop, galvanizing shop and machine shop are arranged in this yard. The joiners', cabinet makers', polishing and woodworkers', upholstery department and others associated with shipbuilding are all laid out contiguous to the building yard and on a very extensive scale, and furnished with the latest and most improved equipment.

The engine works at Akunoura, which is at the inner side of the harbor, covers a large area and embraces erecting and fitting shops, the boiler shop, machine shop, turbine shop, electric shop, blacksmith shop, coppersmith shop, pattern and foundry shops, etc. Most of these are adequately fitted with electrically-driven overhead cranes of different capacities.

Between the shipyard and engine works there are three dry docks, the largest of which can accommodate vessels up to 714 feet on the keel, 84 feet beam and 34 feet 6 inches draft, making it one of the finest and largest graving docks in existence at the present day.

A patent slip, capable of lifting ships up to 1,000 tons gross, is situated on the other side of the harbor, opposite the shipyard.

ADMINISTRATIVE DEPARTMENT.

The administrative department, or main office, is situated at Akunoura and on the main entrance to the engine works in three blocks of substantial brick building.

The basement of the front block contains the mess room for draftsmen, and boiler room for steam heaters. The first floor has the board room, private office of the general manager, and corresponding and secretarial office and the telephone room. The second floor is entirely occupied by the estimate engineer's office, involving purchase, estimate, counting and general statistical departments. On the floor above is situated the drawing office for admiralty work. It is 84 feet by 31 feet, and has an accommodation for 25 ship draftsmen and 25 engine draftsmen. The basement of the left wing contains the main time office, book and cashier department, the first floor has the main engine drawing office, which is 69 feet by 47 feet, with an accommodation for 110 draftsmen, and the second floor has the ship drawing office, with accommodation for 42 draftsmen. Each drawing office has a large fireproof safe at one end of the office, in which the drawings are all classified and stored. The floor above includes a completely equipped photographic department, with six large sun-printing frames and one Hall's continuous electric copier. The basement of the right wing contains the work's police department and engine work's time office, while on the first floor there is a series of offices for admiralty overseers and other superintendents.

It may be mentioned here that there is a second ship drawing office at the shipyard, which is 120 feet long by 40 feet broad, containing the detail and decorative departments; in the former the smith work, castings and all fittings are dealt with, while in the latter all decorative features of the ship

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KOBE PLANT. VIEW OF SEA FRONT FROM NORTHEAST.

are worked out. These two departments are specially situated in the shipyard, so as to be contiguous to the ships under construction and to the joiner and cabinet maker's, upholstery and decorative painter's work shops. This office has an accommodation for 60 draftsmen and is equipped with a photographic room and a large fireproof safe. Therefore the ship drawing office has a staff of 127 draftsmen in all under the charge of the chief ship draftsman, who also has charge of the experimental tank.

The engine works manager has an office close by the main office, and in the same building there is an electrical engineer's drawing office, with an accommodation for 15 draftsmen.

The shipyard manager has an office in Tategami, with a time office in the vicinity. There are also a number of rooms for Lloyd's surveyors, government surveyors and shipowner's superintendents in the same building.

A system of telephonic communication is in use throughout the works, so that vast as is the establishment, its organization overcomes any of the disadvantages of distance. There is a regular method of storing the materials in readiness for the various sections.

THE BUILDING BERTHS AND LAUNCHING GROUND.

In describing the works it may be more interesting to review the departments and plants in the order of their use and importance in the building of the ship rather than to adopt an itinerary method. The works have seven building berths, as follows:

	Feet.
No. 1. Berth for vessels up to	680
No. 2. Berth for vessels up to	700
No. 3. Berth for vessels up to	580
No. 4. Berth for vessels up to	460
No. 5. Berth for vessels up to	340
No. 6. Berth for vessels up to	300
No. 7. Berth for two vessels up to	240

Several of them have been constructed with a view of supporting the concentrated weight due to modern warships.

As regards the length, only a small quantity of drags and checks will be required for sending afloat the largest vessels, as there is plenty of harbor space at the end of the building berths. The berths are well equipped with powerful jib cranes at frequent intervals, capable of lifting weights up to 3 tons on board during construction. There are several locomotive cranes throughout the yard, ranging from 5 to 3 tons. They are also used for stocking ship plates and angles, etc., from the lighters, and for subsequently lifting them from the racks and passing them to the tracks for conveyance to the plater's sheds, etc. To facilitate the conveyance of materials there are in the yard over 2½ miles of rails.

SHIP PLATERS' AND FITTERS' DEPARTMENT.

Dealing with the separate departments, one naturally begins with the mold loft, where the work of construction is begun in the case of all ships. The length of the loft is 380 feet, and its width 70 feet, the roof being of light steel principals, with corrugated iron on the purlins, with ample daylight admitted by the glazed top and sides. The space below the loft is used partially as a scrive board, and partially as a plater's machine shop.

In the frame-bending shop, which is about 140 feet square, there are two angle furnaces, each 66 feet long, and one plate furnace 30 feet long, and two angle beveling machines, with about 4,800 square feet of cast iron blocks for setting the frames as well as the scrive boards for laying them out.

NAGASAKI ENGINE WORKS, SHOWING 150-TON GIANT CRANE.

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The plater's machine shops, which cover an area of over 54,070 square feet, are equipped with 14 punching and shearing machines, ranging up to tools which shear 1½-inch plate and punch 1½-inch holes in the same thickness, while the gap is 36 inches, enabling plates 6 feet wide to be worked on. There is one hydraulic manhole punch capable of working holes 28 inches by 20 inches. There is a large hydraulic flanging machine for setting plates for the keel and garboard strakes, as well as for stiffening flanges in bulkheads; it is capable of dealing with plates up to 24 feet and up to a thickness of 1 inch. There are three bending rollers dealing with plates up to 25 feet long. The planing machines number eight, and are all of considerable capacity. For straightening there is one mangle, with solid steel rollers, taking plate 6 feet wide and 1 inch thick. There are also a plate scarphing machine, joggling machine, hydraulic bar cutting machine, etc. There are nine countersink drilling machines. Almost all of the tools in this shop are of British make, and the majority of them are worked from shafting driven by electric motors.

The beam-bending shed is 90 feet long by 35 feet broad, and in it there are one beam-bending and punching machine, two beam-bending machines, one beam-bending and angle-cutting machine, one angle and channel-cutting machine, two cold iron saws, etc., all operated by electricity.

The iron workers' shed is on the south side of the yard, and contiguous to the building berths; it is 85 feet long by 65 feet wide, containing one angle-cutting and plate and angle-planing machine, one countersink drilling machine, one plate-bending and straightening machine, two plate-straightening and flattening machines, two punching and shearing machines, etc.

The blacksmith shop, which is 262 feet long by 40 feet broad, contains 35 smith fires, the blast being supplied by three Root's blowers; there are 10 steam hammers ranging up to 20 hundredweight, and one 5 hundredweight steam striker, also three rivet-making machines, the largest of which is capable of turning out 3 tons per 10 hours.

The angle smith shop is 175 feet long and 40 feet broad, and contains 28 fires, with two centrifugal fans driven by electricity.

The galvanizing shop is adjacent to the blacksmith shop. The building is 110 feet long and 40 feet wide. There are five zinc baths, the largest being 22 feet by 2 feet 2 inches by 5 feet, one refining furnace and four water baths.

The machine shop is placed contiguous to the building berths. The shop is 140 feet long by 60 feet broad. There are 14 drilling machines of varied type, also the same number of lathes of varied type. Other machines include a boring and turning machine, shaping machine, slotting machine, milling surface planing machine, cold iron band sawing machine, Selber patent screwing machine, screw-cutting machine, bolt and nut-screwing machine, lag-screwing machine and emery grinding machine, etc. The machinery in this shop is driven by two electric motors, each of 40 brake-horsepower.

GENERAL VIEW OF MACHINE AND ERECTING SHOPS AT NAGASAKI.

WOOD-WORKING DEPARTMENT.

As can readily be imagined, in an establishment which sends out first class passenger steamers the wood-working department is very extensive. The whole timber department occupies about 5 acres of ground, about one-third of which is covered in with drying sheds. The timber for the joiner department is accommodated in sheds covering 3,800 square

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yards. The buildings for deck stowage cover 1,760 square yards.

The saw mill is situated at the extreme north end of the shipyard. The building is of light, wooden structure, measuring about 100 feet long by 70 feet broad. The log department is fitted with three vertical saw frames. In the reconversion and resawing of the wood, the principal machines used are two four-side planing machines, one circular saw endless band sawing machine, reciprocating cross-cut saw and dowel-making machine, etc. In the saw room there are two saw-sharpening machines and one band saw sharpening machine. The majority of the machinery in the mill is driven by electricity.

The joiners, cabinet makers and polishers are accommodated in a two-story building, situated at the side of No. 1 dock. It covers a working space of 80,440 square feet. The collection of wood-working tools is complete and representative of best British practice, including circular saw bench, three endless band saws, scroller fret saw, planing machine, power and hand-feed planing machine, three planing and jointing machines, scraping machine, eight molding machines of various types, dove-tailing machine, five sandpapering machines of different types, buffing machine, two tenonning machines, five mortising machines, rounding machine, two wood-turning lathes, wall-drilling machine and emery grinding machine, etc. The machinery is driven by four electric motors of 146 total brake-horsepower.

The carpenters' shops, which are on the other side of No. 1 dock, cover an area of 18,750 square feet, and contain planing, molding and drilling machines, also an endless band saw, all driven by electricity.

THE GRAVING DOCKS AND SLIP.

There are three graving docks and one slip. No. 1 dock is the one nearest to the shipyard, then No. 3 and No. 2; they are all constructed of granite, and the slip is at Kosuge. It may be mentioned here that No. 1 dock was constructed by the former owner, but was lengthened by the present proprietor in 1895.

The following are the principal dimensions of docks:

NO. 1 DOCK.	
Length on keel blocks........	510 feet
Breadth at entrance on top.....	89 feet
Breadth at entrance on bottom	77 feet
Depth of water on blocks at ordinary spring tide.........	26 feet 6 inches
NO. 2 DOCK.	
Length on keel blocks........	350 feet
Breadth at entrance on top.....	66 feet
Breadth at entrance on bottom	53 feet
Depth of water on blocks at ordinary spring tide.........	24 feet
NO. 3 DOCK.	
Length on keel blocks.........	714 feet
Breadth at entrance on top....	96 feet 7 inches
Breadth at entrance on bottom	88 feet 7 inches
Depth of water on blocks at ordinary spring tide.........	34 feet 6 inches

The patent slip is capable of lifting vessels up to 1,000 tons gross, the length of rail is 750 feet, with a width of 30 feet.

THE ENGINEERING DEPARTMENT.

We may now turn to the engineering department, which is arranged at the northern part of the works. The machine shops, which cover an area of about 23,150 square feet, contain 124 lathes, 3 turning and boring machines, 5 screwing machines, 5 cutting-off machines, 1 nut-tapping machine, 1 bolt-turning machine, 1 stud machine, 9 planing machines, 7 shaping machines, 6 slotting machines, 1 keyway cutter, 32 drilling machines, 3 centering machines, 1 cylinder boring machine, 3 boring machines, 2 oil groove cutting machines, 15 milling machines, 1 nut side-facing machine, 2 band sawing machine, 1 circular sawing machine, 16 grinding machines.

Of the above special mention should be made of one electric-driven quadruple-geared crankshaft turning lathe, having a height of centers of 54 inches, and a length of bed of 42 feet, admitting between centers 27 feet 3 inches; two treble-geared shafting lathes, each having a height of centers of 20 inches, and length of bed of 36 feet 6 inches, admitting between centers a length of 28 feet, these having a common center line, when combined together are capable of turning up to 68 feet 6 inches; one electric-driven vertical cylinder boring machine, capable of boring cylinders up to 100 inches in diameter, one electric-driven double-headed universal horizon-

OPENING OF GRAVING DOCK NO. 3, AT NAGASAKI.

tal drilling, boring, tapping, studding and milling machine commanding 10 feet vertically and 20 feet horizontally, with spindle 5½ inches in diameter, also one horizontal and vertical planing machine having a horizontal stroke of 21 feet, and a vertical stroke of 18 feet, driven by 25 brake-horsepower motor.

The machine shop is equipped with one 20-ton, one 15-ton and three 5-ton electric overhead traveling cranes.

The turbine shop, which is 243 feet by 102 feet, contains 4 lathes, 1 turning and boring mill, 2 planing machines, 1 slotting machine, 1 turbine machine, 1 turbine blade-cutting machine, 4 drilling machines, 1 turbine cylinder boring machine, 1 turbine blade-nicking machine, 1 turbine packing strip cutting machine, 1 special dove-tail milling machine, 1 special milling device, 5 turbine blade-tipping machines. Special features among the above machinery are one large electric-driven quadruple-geared double-bed lathe for turbine rotor turning, having a height of centers of 68 inches, which may be raised to 79 inches by using a lever, and a length of bed of 51 feet admitting between centers a length of 36 feet; one electric-driven pit-planing machine capable of planing 36 feet in length, 14 feet 6 inches in width and 7 feet 6 inches in height. One electric-driven turbine cylinder boring machine, to bore up to 13 feet, and one electric-driven powerful slotting machine having a stroke of 48 inches.

The machinery in this shop is all driven by electricity. There are two 50-ton and one 60-ton electric overhead traveling cranes.

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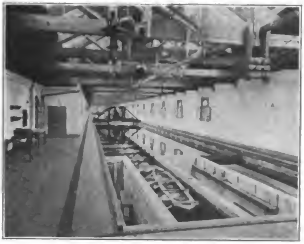
ERECTING SHOP AND MACHINE SHOP.

The building is 67 feet 11 inches by 116 feet 2 inches, and is very lofty. There are three main bays, which are occupied respectively by the electric shop, erecting shop and fitting shop. The erecting shop has sufficient space to erect three twin sets of 8,000 indicated horsepower triple-expansion engines simultaneously, and is equipped with one 30-ton and one 20-ton electric overhead traveling crane. The fitting shop is equipped with one 10-ton crane of the same type.

The water testing and "shrink-on" work shop, which is 80 feet by 130 feet, is equipped with a complete set of pumps and gear for water testing and shrinking-on work, and 20-ton electric overhead traveling crane.



EXPERIMENTAL TOWING TANK AT NAGASAKI.

BOILER SHOPS.

The boiler shops are situated in juxtaposition to the turbine shop, the buildings cover an area of 53,282 square feet of ground, and are divided into four sheds, one for machine work, one for boiler construction, one for hydraulic riveting and the other for flanging. There are several very powerful tools, notably one 125-ton hydraulic riveter, with an 8-foot gap, served by a 40-ton hydraulic crane; one 150-ton hydraulic flanging machine, with 4-foot gap; one vertical plate-bending roller, to deal with a plate 11 feet 6 inches wide and 2 inches thick; one electrically-driven boiler shell drilling machine, which can take one double-ended boiler up to 16 feet in diameter and 18 feet in length, or two single-ended boilers, each of 12 feet 6 inches long, with a diameter of 16 feet; one two-spindle boiler shell drilling machine, to deal with boilers up to 16 feet in diameter and 18 feet in length; one four-spindle boiler shell drilling machine, to deal with boilers up to 16 feet in diameter and 23 feet 6 inches in length; one electrically-driven lever punching and shearing machine, with an angle cutter capable of punching 1½-inch holes through 1½-inch plate, shears 1½-inch plate and cuts angles 6 inches by 6 inches by 1 inch, with punch gap 36 inches and shear gap 33 inches, and a one-edge planing machine capable of planing plates up to 30 feet horizontally. Besides the above special features of this shop are one large 30-ton portable hydraulic riveter, with 7-foot gap and one oval and round hole cutting and marine boiler flange and flue turning machine, to take boiler end plates from 7 feet 6 inches to 17 feet in diameter, and one portable electrically-driven drilling and boring machine. As for conveyance, the shop is equipped with four 40-ton and one 7-ton electric overhead traveling cranes, two 5-ton hydraulic wall cranes and eleven hand wall cranes, ranging from 1 to 5-ton lifts.

The engine works smith shop, which is 375 feet by 60 feet, is a light steel structure, with twenty-three single hearths, five double hearths and seven forges, arranged in rows on either side of the building, and with nine steam hammers ranging from 1¼ tons to 7 tons arranged in the center line. There are 5-ton, 10-ton and 20-ton air furnaces. The shop is equipped with twelve cranes ranging 1½ tons to 20 tons. There is also one steam-driven plate-shearing machine.

THE COPPERSMITH SHOP.

A temporary building, 144 feet long by 72 feet wide, is equipped with one hydraulic pipe-bending machine, one upright drilling machine, one horizontal radial drilling and tapping machine, one flange rolling, straightening and circular cutting machine, one punching machine, one capstan lathe, one hack saw, one air hammer, one plate-bending roll, one pipe-threading machine and one shearing machine. There are twelve hearths, the blast being supplied by a Root's blower, with a 31 brake-horsepower electric motor, and capable of supplying 640 cubic feet of air per minute.

FOUNDRY.

The foundry is situated to the north of the machine shops. It consists of two main parts, the iron and steel foundry and the brass foundry. The iron and steel foundry is 310 feet long by 102 feet wide. The equipment includes a 2-ton Siemen's steel gas furnace, four cupolas, with a casting capacity of 50 tons, one annealing furnace and three drying furnaces, each 20 feet long and 16 feet wide, and one sand mill. Two 15-ton and one 30-ton electric overhead traveling cranes and fourteen 3-ton radial cranes are distributed conveniently. There are six molding pits, the two largest being 25 feet by 30 feet by 7 feet and 20 feet by 20 feet by 12 feet, respectively.

The brass foundry is 100 feet long by 102 feet wide, containing two Stone's manganese air furnaces of 8 and 5 tons capacity, with a molding pit 12 feet by 12 feet by 7 feet on the iron and steel foundry side, so that the heavy overhead cranes in the iron and steel foundry may be utilized for this pit. There are six brass crucibles of forced draft and four of natural draft, each of 200 pounds, and two drying ovens. There are eight radial cranes of 3 tons each distributed over the foundry. At the corner of the brass foundry there is a core shop.

FLOATING DOCK NO. 2, AT KOBE.

The foundries are entirely self contained, molding boxes and plates, core bars and core irons, etc., are all made in the same place. Adjoining the foundries there are the requisite stores for metal, sand, furnace coal, coke, etc.

The pattern shop, which is a brick building, 180 feet long by 70 feet wide, is equipped with one circular and one band saw, one planing machine and four wood lathes, all driven by electricity. The first floor is used for stowing the patterns, there is also at the back a spacious pattern store for stowing large old patterns.

On the jetty for shipping engines and boilers, etc., from the engine works, there is a 150-ton Titan type giant crane, by Messrs. Applebys & Company. It consists of a square tower, 136 feet 3½ inches in height and 40 feet square at the base, carrying a large roller path on top, upon which a horizontal jib having a total length of 239 feet 9¾ inches is supported. The long arm of the jib has a total radius of 156 feet 6 inches. The work is also provided with a 30-ton floating shearlegs.

GENERAL VIEW OF THE TURBINE SHOP AT THE NAGASAKI PLANT.

EXPERIMENTAL TANK.

The plant includes a splendidly equipped ship model experimental tank, designed by Mr. Archibald Denny, of Dumbarton, and which is practically a reproduction of the Clydebank tank, which was fully described in volume XIV of International Marine Engineering. The waterway extends for 430 feet, of which 380 feet is deep, varying from 12 feet 6 inches at the north end to 12 feet at the south end. The breadth is uniformly 20 feet. The tank carriage is electrically driven, the trolley wiring being on the Ward Leonard system. The tank carriage, with its apparatus and model cutting machine and other accessories for the tank work, was constructed and supplied by Messrs. Kelso & Company, Glasgow.

POWER PLANT.

Electricity is used on an extensive scale, not only for the lighting of workshops, sheds, the interiors of ships under construction, and of the yard generally, but also for the driving of the machine tools. The central power house at Akunoura, is fitted with two 500-kilowatt turbo alternators, direct coupled to Parsons turbines; one 500-kilowatt direct-current generator, coupled to a Willans patent central valve engine; two 100-kilowatt direct-current dynamos, coupled to the same type of engines; two 225-kilowatt direct-current dynamos, coupled to a McIntosh vertical cross-compound engine, one 300-kilowatt direct-current dynamo, coupled to a three-phase induction motor; two 25-kilowatt dynamos, coupled to one three-phase induction motor and used for ship lighting, and a 100-kilowatt booster or motor generator, which is used for charging the secondary batteries, whose capacity is 3,000 ampere hours. Steam is supplied by seven Babcock & Wilcox boilers, which also serve as destructors, being used for disposing of the sawdust, shavings, etc., from the various woodworking shops and the rubbish collected from the interiors of ships under construction.

The sub-station at Tategami shipyard is fitted with two 200-kilowatt rotary convertors and six 75-kilowatt transformers, and converts from 3,450 volts alternating current to 250 volts direct current.

Arc lamps are used principally for outside illumination and in the interior of the larger sheds and shops. Incandescent lamps are used in all the woodworking departments and offices and for all bench work. They are also adopted for the internal lighting of ships during construction. Adequate hydraulic and pneumatic power plants are installed.

The works are supplied with a modern apprentice school, hospital and club house for the benefit of the workmen.

THE KOBE PLANT.

The Kobe plant of the Mitsu-Bishi Dockyard & Engine Works was begun in August, 1905, and after various prepara-

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tions for reclaiming the land, constructing the breakwater, etc., had been done, No. 1 floating dock of 7,000 tons lifting capacity, built at the company's Nagasaki works, was towed into the basin, but to meet the growing business an extension on a large scale soon became a matter of urgent necessity, and before the second anniversary the keel blocks for No. 2 floating dock of 12,000 tons lifting capacity were laid down, and also some permanent steel buildings for work shops were in the course of construction. The works have steadily grown, until at present they are fully equipped with the latest machine tools and appliances, mostly of English make, suitable for the construction of a vessel of 10,000 tons.

The plant is situated on the western shore of the harbor of Kobe, and just northward of the Wada-Misaki lighthouse at the entrance of the port, and it has been laid out on a liberal scale, covering an area of about 82 acres in order to provide room for expansion. The sea frontage is more than 5,000 feet long, and a part of it is reserved for shipbuilding berths suitable for the simultaneous construction of seven vessels of over 500 feet in length; and on the north of the building berths there is a basin having an area of about 13 acres, protected by a breakwater of masonry work 1,000 feet long, leaving an opening for the entrance from the north, the opening being naturally sheltered by the shore of Hyogo, which lies at a distance of a little over half a mile.

Along the basin a masonry quay wall was constructed for the purpose of mooring vessels under repairs or when fitting out. A 100-ton steel tripod shearlegs has been lately erected on the foundation laid on the quay wall; and there are four strong mooring buoys outside the breakwater, forming a safe deep-water anchorage; and as the establishment is connected with Wada branch line of the Imperial Government Railway the works occupies a unique position in the harbor in reference to communication with both land and sea.

The principal work shops, which are equipped with electric power and light, and are inter-connected by railway tracks, which are also in connection with the government line, include machine and erecting shops, shipyard machine shops, blacksmith, boiler, carpenter, pattern, coppersmith's, electrical machinery and bending shops, brass and iron foundries, mold loft and sawmill.

There are two power houses, in one of which are two generators of 100 and 150-kilowatt capacities each, driven by Parsons steam turbines, and in the other a 450-brake horsepower Cockerill gas engine, driving one 300-kilowatt generator built in the works, the gas being supplied by a Mond gas producer of 800-brake horsepower capacity, which will also supply gas to the furnace in the blacksmith ship.

Finally, in concluding this description, it will be interesting to British and American readers to know that both in the Nagasaki and Kobe works the specifications and wording in drawings, books, charts, forms, orders, etc. in fact every bit of writing in the establishment is in English, besides a greater portion of the correspondence. Indeed it is rather curious to notice a workman carrying out the work to the letter with a drawing worded entirely in English, while he is unable to quote a simple intelligible sentence.

We are informed by Messrs. William Mills, Ltd., Atlas Works, Sunderland, of an inaccuracy in the description of this firm's engaging and disengaging boat gear in our article entitled "Life Saving at Sea," issue of October, 1910. The article states "This apparatus enables the boat to be released before it is water borne." An important feature claimed by the manufacturers is that this gear cannot be disengaged until the boat is in the water and very nearly water borne.

Repairs to end plates and other parts of boilers where grooving or cracking occurs can effectively be made by the oxy-acetylene process of welding.

THE ECONOMICAL WORKING OF RECIPROCATING MARINE ENGINES AND THEIR AUXILIARIES.*

BY D. B. MORISON.

APPENDIX A.†

The following are the particulars of some experiments conducted upon the steam engine in the Laboratory of the Glasgow and West of Scotland Technical College, with the object of ascertaining what effect an increase in vacuum has upon its steam consumption and horsepower.

The engine is a horizontal cross-compound, the high-pressure and low-pressure cylinders being 12 inches and 21 inches diameter respectively, with a stroke of 30 inches, and in the case of these tests there was no receiver between the high-pressure and low-pressure cylinders.

The admission and exhaust valves are of the drop-piston type, and during the trials the admission pressures and the points of cut-off in both cylinders were as far as possible kept constant.

The revolutions of the engine were also maintained at a constant rate by altering the brake resistance for the different conditions of vacuum. The low speed of revolution, 80 per minute, is accounted for by the fact that the trials here presented were part of another series. Had the engine been run at its normal speed, 110 revolutions per minute, the steam consumption per horsepower per hour would have been less.

The cylinders are not in any way specially designed for working with a high vacuum, but are of ordinary design suitable for the moderate vacuum usually expected in this type of compound engine.

It will be seen that as the vacuum increases both the steam used per hour and the brake-horsepower increase. It is easy to see why the horsepower should increase, but the effect of vacuum upon steam consumption is rather more difficult to understand. With increased vacuum there is a remarkable fall in the pressure and consequently in the exhaust pressure in the high-pressure cylinder. Due to this fall of pressure there are three separate ways in which the steam per stroke is increased. In the first place the weight of steam enclosed in the high-pressure clearance volume at compression is diminished, and so an extra quantity of fresh steam per stroke is required to make up for this diminution. The difference between the high-pressure steam chest and exhaust pressure is increased and consequently there is an increased amount of valve leakage. Also the mean temperature of the cylinder walls is lowered and there is more initial condensation. With a triple or quadruple expansion engine the effect upon the high-pressure exhaust pressure would be much less marked, and consequently there would be little increase in the steam used per stroke or per hour with increased vacuum. It was determined from the experiments that by raising the vacuum from 20 inches to 28 inches the steam consumption decreased 22 pounds to 20.3 pounds per hour per brake-horsepower, a diminution of 1.7 pounds per brake-horsepower hour over a range of 8 inches of mercury.

This is equivalent to a decrease in the steam consumption of 7.8 percent over the range mentioned, or an increase in economy at the rate of practically 1 percent per inch increase of vacuum in the condenser from 20 inches to 28 inches vacuum.

The temperature of the air pump discharge has been ignored, but it is obvious from the foregoing that in the case of a marine engine considerable economy may be gained even in a two-stage compound engine by working with a high vacuum and heating the feed by means of the auxiliary ex-

* Concluded from the February issue.

† Communicated by Prof. A. L. Mellanby, D. Sc., of the Glasgow and West of Scotland Technical College.

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haust steam which otherwise would go to the condenser direct, and the economy resulting from the application of this system to triple and quadruple engines would, of course, be much greater.

It should be noted that the above experiments relate only to the particular engine tested and the results would not compare with those obtainable from a marine engine specially designed for obtaining the highest economy from high vacuum. The low-pressure cylinder indicator diagrams taken from this engine are shown in Fig. 15.

APPENDIX B—THE EFFECT OF VACUUM UPON THE STEAM ECONOMY OF TRIPLE-EXPANSION HIGH-SPEED ENGINES.*

The observations detailed in the following notes were made during the official steam consumption trials of a triple-expansion high-speed engine.

The primary object was to ascertain the extent to which the economical performance of the engine could be influenced by reducing the exhaust pressure.

The engine used for the purpose of the trials was one of eight similar sets intended for dynamo driving and designed to develop a normal full load of 1,080 brake-horsepower when running at 250 revolutions per minute. Forced lubrication was supplied for crank shaft and motion work bearings, the leading dimension of the engine being as follows:

	Inches
Diameter of high-pressure cylinder	18½
Diameter of intermediate-pressure cylinder	27
Diameter of low-pressure cylinder	40
Stroke of pistons	20

Piston valves throughout.

During the period of the trials the engine was exhausting through a short range into a surface condenser having motor-driven circulating pump and steam-driven Edwards air pump.

The consumption of steam at the various vacua was carefully measured by weighing the water discharged by the air pump, in accordance with the method recommended by the Institution of Civil Engineers' Committee on Steam Engine and Boiler Trials.

All the conditions were kept as constant as possible throughout, with the single exception of the degree of vacuum.

During each trial indicator diagrams were taken from all cylinders, in order that the mean pressures might be ascertained, as well as for purposes of comparison.

Every care was taken in connection with the weighbridge measurements, the apparatus being so located as to permit of one observer weighing the exhaust while keeping the tachometer and dynamometer steel-yard in full view.

In these circumstances any variation in either the brake load or the revolutions per minute would at once be detected, so that the figures obtained must correspond very closely to actual values.

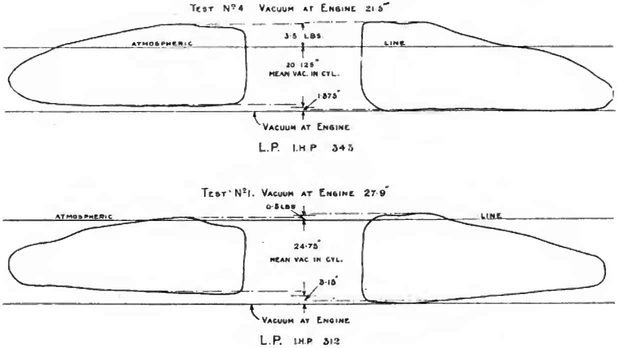

FIG. 12.—L. P. INDICATOR DIAGRAM TAKEN DURING SPECIAL TRIALS FOR EFFECT OF VACUUM ON STEAM CONSUMPTION.

All the readings and diagrams were taken with the engine developing the full load of 1,080 brake-horsepower.

Four steam consumption tests were made, and the results are given in the tabulated statement on page 99 from which the relative influence of vacuum variation will readily be seen.

The indicator cards reproduced above are photographed from the original diagrams (see Fig. 12).

Preparatory to making the first trial, the dynamometer was adjusted until the steel-yard "floated" at the correct load. The exhaust connections were then examined in order to suppress any possible source of air leakage, the vacuum at the engine being brought up to 27.9 inches. (Barometer, 30 inches.)

When the conditions were constant, the steam consumption was carefully measured, indicator diagrams being taken from all cylinders, and the various pressures and temperatures noted at regular intervals.

On the completion of this trial, the vacuum was reduced until the condenser pressure rose to 26.8 inches vacuum, when a further steam consumption test was taken along with diagrams and other data. Additional tests were made at 25.8 inches and 21.5 inches vacuum.

* Communicated by Mr. R. K. Morcom, M. I. M. E. (Messrs. Belliss, Morcom & Co., Ltd.)

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The comparative figures relating to these trials are given in the tabulated statement on page 99.

From this statement it will be seen that by raising the condenser vacuum from 21.5 inches to 27.9 inches, the steam consumption was reduced from 14.15 pounds per brake-horsepower per hour to 12.55 pounds, a saving of 1.60 pounds per brake-horsepower hour, or approximately 11.3 percent. The corresponding increase in vacuum being 6.4 inches, the steam consumption of this engine per brake-horsepower would appear to increase at the rate of, say, 1.77 percent, for each reduction of 1 inch in the condenser vacuum.

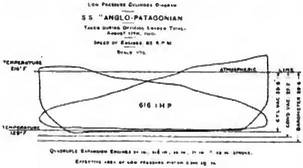

FIG. 13.

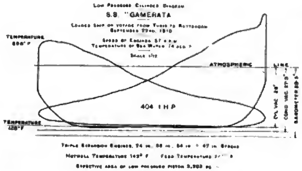

FIG. 14.

The tabulated statement is corrected for differences in degree of superheat.

Referring to the low-pressure cylinder indicator diagrams (see Fig. 12) and tabulated statement (page 99), it will be seen that the vacua given are those corresponding with the condenser pressures obtaining at the time cards were taken. For an increase in condenser vacuum of 6.4 inches the low-pressure cylinder power fell from 343 to 312 indicated horsepower, a reduction of 31 indicated horsepower, or at the rate of, say, 4.85 indicated horsepower per 1 inch additional vacuum.

If the engine had no governor, the increased vacuum would be productive of (1) higher speed, (2) greater total steam consumption per hour, (3) augmented power output.

Usually with expansion governing, the power developed by the low-pressure cylinder for a given total load would not increase for a reduction in the terminal pressure, because the earlier cut-off in the high-pressure cylinder would generally more than neutralise any such tendency.

In the case of this particular set, the shaft governor controls the engine both by throttling the steam and varying the cut-off, to accomplish which the slide valve has inclined ports, and may be rotated automatically so as to vary the lap.

As the percentage cut-off in the high-pressure cylinder may be directly read from a suitably divided indicator plate attached to the expansion gear, the cut-offs at high and low vacua were noted, the readings being given in the tabulated statement.

At the low vacuum (21.5 inches) the mean cut-off in the high-pressure cylinder was .45, at high vacuum (27.9 inches) the cut-off was automatically reduced to .4. As the diminished cut-off would necessarily be accomplished by a closing of the throttle valve (both motions being taken from the one lever), the relative position of the cut-off gear affords interesting and conclusive proof as to the absolute effect of increased temperature range upon the steam consumption of this engine. Even if the weight of steam used had not been ascertained by careful measurement, the position of the cut-off gear and governor valve would have roughly indicated the steam economy consequent upon the higher vacuum.

This may be further verified by an inspection of the low-pressure cylinder indicator diagrams (see Fig. 12), from which it will be noted that the receiver pressures are very considerably higher at a vacuum of 21.5 inches than at 27.9 inches, an effect consequent upon the relative positions of throttle valve and expansion gear at constant brake load and revolutions per minute. This further explains why the low-pressure power does not necessarily fall off with increased back pressure.

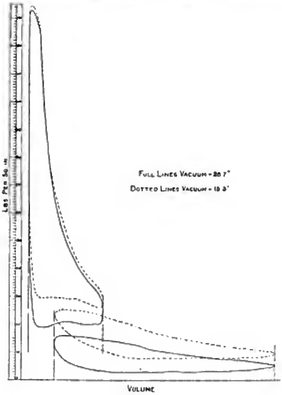

FIG. 15.

In making the trials, outlined in the foregoing, every care was exercised with a view to accurate determination of the economy in steam due to higher vacuum.

The brake used was a Froude water dynamometer, and as the engine ran at full load throughout, the brake conditions were such as to be constant in a degree quite exceptional in commercial engine testing.

Two Crosby indicators were employed, the cocks being screwed directly into the top and bottom ends of the cylinder. These instruments were carefully cleaned and oiled, all the diagrams being taken by the same observer. The drums were driven from stout piano wires kept in tension by a stiff spiral spring.

The vacuum was measured on a mercury column which was checked against an absolute pressure barometer.

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EFFECT OF VACUUM ON THE STEAM CONSUMPTION OF A 1,080 B. H. P. QUICK REVOLUTION BELLISS TRIPLE EXPANSION ENGINE.

These trials were made at a steady load of 1,080 B. H. P. and at 250 revolutions per minute, the water being measured at air pump discharge.
Cylinder diameters, 18½", 27" and 40", stroke, 20".

Test number	1	2	3	4
Steam pressure at engine's stop valve (pounds per square inch gage)	188	186	186	188
Steam pressure at engine's stop valve (pounds per square inch gage) at H. P. chest	183	180	185	183
Indicated horsepower—H. P.	451	461	431	416
Indicated horsepower—I. P.	266	353	369	390
Indicated horsepower—L. P.	312	320	323	343
Indicated horsepower—Total	1,129	1,134	1,123	1,149
Steam temperature, degrees Fahr.	474	455	478	482
Superheat, degrees Fahr.	91	73	95	99
Cut-off in H. P. cylinder	0.4	......	......	0.45
L. P. initial pressure from diagrams (pounds gage)	0.5	......	......	3.5
Vacuum at engine, inches	27.9	26.8	25.8	21.5
Steam consumption, pounds per B. H. P. hour, actual	12.7	13.2	12.83	14.16
Steam consumption, pounds per B. H. P. hour, corrected to 100 degrees Fahr. superheat	12.55	12.68	12.74	14.15

APPENDIX C.*

The following data, obtained from the T. S. S. *Indrabarah*, owned by Sir Thomas Royden, Bart., and built to our designs, may be of interest.

This vessel has just completed her first outward passage to Australia fully loaded.

The vessel is of the three-shelter deck type of the following dimensions:

Length between perpendiculars..470 feet
Breadth extended .... 58 feet
Depth molded .... 43 feet to shelter deck

and has been built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at Wallsend-on-Tyne, and engined by Messrs. Richardsons, Westgarth & Co., at their Hartlepool Engine Works. Her total displacement at a load draft of 28 feet 10¼ inches is 17,025 tons.

She is insulated for the carriage of cargoes of chilled and frozen meat, and is fitted with a compound duplex CO_2 machine (the size of which appears later) capable of dealing with an insulated capacity of 292,380 cubic feet.

Her engines are of the twin-screw triple-expansion type, each having cylinders 22 inches, 37 inches, and 62 inches, with a stroke of 45 inches, and are capable of indicating 5,000 indicated horsepower at 95 revolutions per minute; there are four single-ended boilers fitted with forced draft having a total heating surface of 11,192 square feet and working at 200 pounds pressure per square inch.

The design of these engines is based on the principle that the most economical and efficient results will be obtained by the adoption of such cylinders as will enable the engines to be run at their full-designed power without linking up and at a high piston speed; with the Contraflo system of high vacuum and temperature regulation in combination with cylinders provided with suitable proportions of steam and exhaust passages.

The installation of engine-room auxiliaries is unusually large; this comprises independent feed pumps, feed filter, feed heater, evaporator, distiller, dynamo, sanitary pump, fresh water pump, two centrifugal pumps, two fan engines, ballast pump, refrigeration circulating pump, telemotor steam-steering gear, as well as the CO_2 machine, which has cylinders 16 inches and 29 inches diameter by 21 inches stroke, all of which are in daily use.

The propellers are of bronze, and of the solid type.

On trials the vessel attained a speed of 14 knots on a six-hours' run at a draft of 18 feet mean and a displacement of 10,209 tons. The indicated horsepower was 4,850 and gives an Admiralty coefficient of 272, which is remarkably high for a vessel of this type.

In considering the result from the point of view of economical consumption for the speed obtained, it must be borne in mind that the model to which the ship was built has proved to be particularly good.

On the first outward passage the vessel attained a mean speed from London to Melbourne of 12.46 knots on an average draft of 26 feet 3 inches, or a displacement of 15,300 tons and an indicated horsepower of 4,600 at mean revolutions 85.2, the Admiralty coefficient being 260.

The best day's run was 325 nautical miles in twenty-three and a half hours or 13.8 knots, the Admiralty coefficient being 350.

The coal supplied was North country "Mickley" unscreened, giving about 11 percent ash, and the total consumption per twenty-four hours, including all auxiliaries, was 66.33 tons or about 1.34 pounds per indicated horsepower per hour of North country coal, equal to 1.23 of best Welsh coal, a result which is, in our opinion, very remarkable, having regard to the large number of auxiliary engines taking steam from the main boilers, and which, if deducted, would bring the rate of consumption per indicated horsepower for the main engines only to an exceedingly low figure.

The most striking feature of the indicator cards is the high vacuum shown in the cylinder, the exhaust line being within about 2 inches of the condenser vacuum up to a condenser vacuum of at least 28 inches.

The low-pressure ports and exhaust passages were carefully proportioned to insure a low resistance by giving a clear and unrestricted passage for steam without excessive clearance or pockets for its lodgment.

In conclusion, we would state that we attribute the economical running of the above engines to the following causes:

(1) High vacuum and ability to maintain it in high temperature sea water.

(2) Utilising the exhaust steam from the auxiliaries to heat the feed water up to the maximum temperature at which it can be dealt with by the feed pumps.

(3) The provision of such a capacity of cylinders and boilers as will enable the boilers to provide ample steam at full power without being unduly pressed, and as will enable the engines to run at their full-designed power and mean pressure without being linked up as is common in marine practice.

(4) Comparatively high piston speed.

The above results were obtained, not under the artificial conditions of a trial, but under sea steaming condition, and during a first voyage, which makes them all the more worthy of notice.

APPENDIX D—QUADRUPLE EXPANSION ENGINES AND HIGH VACUUM.*

The advantageous extension of temperature range being a leading characteristic of the quadruple engine, the lower limit of temperature is obviously a most important factor, especially when it is remembered that the upper limit of temperature remains constant at constant boiler pressure. Therefore, the question of vacuum arises, since, other things being equal, it is upon the vacuum that the temperature range will depend.

Quadruple machinery designed to work normally at a high ratio of expansion will necessarily give a relatively small mean pressure, so that in such circumstances successful operation may be readily prejudiced by imperfect vacuum. If the quadruple be worked at the highest vacuum to which the engine will respond, then there ensues a low condenser temperature. Such need not, however, produce a low temperature of feed,

* Communicated by Messrs. W. Esplen & Sons, consulting engineers, 31 James street, Liverpool.

* Communicated by Mr. R. J. Quelch, M. Inst. C. E. (Messrs. Lawther, Latta & Co.)

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VACUUM AND TEMPERATURE READINGS TAKEN BY THE CHIEF ENGINEER OF THE S.S. "CAMERATA."

ON VOYAGE FROM TUNIS TO ROTTERDAM, SEPTEMBER, 1910.

Date.	Vacuum Inches.	Temperature at Top of Condenser Degrees Fahr.	Circulating Water Inlet. Degrees Fahr.	Temperature on Suction Side of Feed Pump.	Temperature on Discharge Side of Feed Pump.
Sept. 21 ...	27½	110	74	142	239
,, 21 ...	27½	110	74	143	239
,, 22 ...	27½	110	74	143	240
,, 22 ...	27½	110	74	143	240
,, 23 ...	27½	111	75	143	240
,, 23 ...	27½	110	74	142	240
,, 24 ...	27½	110	71	141	240
,, 24 ...	27½	109	68	142	240
,, 25 ...	27½	109	68	143	239
,, 25 ...	27½	110	67	142	239
,, 26 ...	27½	109	66	141	239
,, 26 ...	27½	109	66	141	239
,, 27 ...	27½	108	63	141	238
,, 27 ...	27½	108	61	141	238
,, 28 ...	27½	108	62	142	238
,, 28 ...	27½	108	63	142	239
,, 29 ...	27½	108	62	141	238
,, 29 ...	27½	107	61	140	238
,, 30 ...	27½	107	60	140	238
,, 30 ...	27½	106	59	140	238

if the auxiliary exhausts are condensed by the air pump discharge water.

In order that the most economical results may be obtained from quadruple and other multiple expansion marine engines, provision ought to be made for the maintenance of the requisite vacuum throughout the voyage, particularly at high expansion ratios. In this connection engineers are apt to forget that, so far as temperature range is concerned, variation in boiler pressure is of much less consequence than variation in exhaust pressure. It is uneconomical to work quadruple expansion engines at low vacuum; moreover, the means of condensation ought to be such that the exhaust pressure may be kept constant throughout tropical voyages. Generally, therefore, the maintenance of boiler pressure and of vacuum should be regarded as equally vital to successful practice in quadruple expansion engines.

It may be in point to refer to the quadruple engines of the *Anglo-Patagonian*, built to my designs and specification by the North-Eastern Marine Engineering Company, Ltd. These engines are 24 inches, 34½ inches, 49 inches, 71 inches by 48 inches stroke. The boiler pressure is 220 pounds per square inch. The condenser is of the Contraflo type, with temperature regulator, and the boiler feed pumps deliver the feed water through the tubes of a surface feed heater into which all available auxiliaries exhaust. On the occasion of the official loaded trials—Aug. 17, 1910—the total temperature range within the cylinders actually reached 203 degrees F., the higher limit of pressure being, say, 225 pounds absolute and the lower limit 2.16 pounds absolute. This is a very unusual result, particularly as the lower limit of temperature corresponds with the mean back pressure in the low-pressure cylinder, and not with the absolute condenser pressure. A low-pressure cylinder diagram taken during these trials is reproduced herewith (see Fig. 13).

The dimensions of the *Anglo-Patagonian* are: Length between perpendiculars, 403 feet; molded breadth, 52 feet; molded depth, 29 feet 1½ inches. The official loaded trials were taken with some 8,550 tons of bunker coal and stores on board, the vessel displacing about 12,120 tons. At this displacement the mean speed was 10.35 knots.

It ought perhaps to be added that the order of the results will be conditioned by the extent to which high condenser vacuum is maintained concurrently with high feed temperature.

APPENDIX E—TRIPLE EXPANSION ENGINES OF THE DJERISSA CLASS (LA TUNISSIENNE STEAM NAVIGATION CO., LTD.).*

There are three ships in the Djerissa class—the *Djerissa*, *Camerata*, and *Boukadra*, each of these vessels having a deadweight carrying capacity of about 6,200 tons on a displacement of approximately 8,800 tons.

The length between perpendiculars is 350 feet, the extreme breadth 50 feet and the depth molded 25 feet 11½ inches. The engines are triple expansion 24 inches, 38 inches and 64 inches by 42 inches stroke, with two boilers, 13 feet 6 inches mean diameter by 11 feet 6 inches long. The pressure is 180 pounds and the boilers work under forced draft.

ABSTRACT FROM THE LOGS OF THE S.S. "CAMERATA." VOYAGE FROM NEWPORT TO ORAN.
MEAN POWER THROUGHOUT THE VOYAGE 1,080 I.H.P.

Date.	Pressure of Steam.	Inches of Vacuum.	Temperature		Revolutions per Minute	Coal.			Distance		Average Speed per Hour	Slip per cent.	Buckets of Ashes per Day
			Feed to Boilers.	Sea.		Tons	Cwts.	Description.	Propeller.	Observed.			
1910.													
Oct. 15	175	27½	212	61	57	15	10	Welsh	173	166	8·9	4	75
,, 16 ...	175	27½	210	61	56	17	0	,,	219	158	6·54*	28	118
,, 17 ...	175	27½	211·5	62·3	57	17	0	,,	223	194	8·0	13	123
,, 18 ...	175	27½	211·3	63	57	17	10	New-castle	223	225	9·3	nil	119
,, 19 ...	175	27½	211·6	65	57	17	0	Welsh	222	220	9·2	1	120
,, 20 ...	175	27½	211	67·3	57	17	0	,,	220	230	9·7	nil	116
,, 21 ...	175	27½	211	69·6	57	15	10	,,	186	182	9·1	2	78

* Strong wind and high sea, shipping water.

Coal used was of a fairly good steaming quality, rather fast burning and dirty. About 80 per cent. small. Clinker easily removed from bars and did not seem destructive to bars. The small cakes very well and does not run through the bars. Ash and dirt about 21 per cent.

The engineers are instructed to maintain high condenser vacuum and heat the feed by means of drainage water and vapor from the various cylinder and receiver drains, evaporator and feed heater coil drains, etc.

It is found that, notwithstanding the comparatiely high vacuum, the temperature of the hot-well water may be raised to the limit permitted by the feed pumps which are of the plain ram type driven from the main engines.

Service records from each of these steamers show that the vacuum within the low-pressure cylinder is from 25 inches to 26 inches, the condenser vacuum averaging from 27 inches to 27½ inches, when the steamers are on their regular Mediterranean service in sea water temperatures up to 77 degrees.

* Communicated by Mr. A. Walker, M. I. N. A. of Messrs. F. Strick & Co.)

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ABSTRACT FROM THE LOGS OF THE S.S. "BOUKADRA." VOYAGE FROM BARRY DOCK TO NAPLES.
MEAN POWER THROUGHOUT THE VOYAGE 1,085 I.H.P.

Date	Pressure of Steam.	Inches of Vacuum.	Temperature.		Revolutions per Minute.	Coal			Distance.		Average Speed per Hour.	Slip per cent.	Buckets of Ashes per Day.
			Feed to Boilers.	Sea.		Tons.	Cwts.	Description.	Propeller.	Observed.			
1910.													
Sept. 13 ...	180	28	224	63	59	9	10	Welsh	128	123	9·18	4	34
„ 14 ...	180	27	218	64	59	17	0	„	231	225	9·32	2·5	117
„ 15 ...	180	27	218	64	59	17	0	„	231	219	9·08	5	101
„ 16 ...	180	27	222	66	59	17	0	„	230	214	8·91	7	95
„ 17 ...	180	27	222	71	59	17	0	„	229	219	8·75	8·7	75
„ 18 ...	180	27	218	71	59	17	0	„	227	219	9·24	3·5	66
„ 19 ...	180	27	215	75	59	17	0	„	227	204	8·59	10	78
„ 20 ...	180	27	218	76	59	17	0	„	227	195	8·21	14	76
„ 21 ...	180	27	216	72	59	17	0	„	227	214	9·02	5·7	80
„ 22 ...	180	27	220	76	59	17	0	„	227	203	8·55	10·5	79
„ P.M. ...	180	27	220	76	59	7	15	„	103	93	8·58	9	28

The coal used was Welsh Through of medium quality. Good steaming and slow burning. About 70 per cent. small made a heavy clinker which sticks to the fire bridges and is difficult to remove. The small cakes. Ash and clinker, 17 per cent.

The condensers (Contraflo type) have temperature regulators, and the hot-well water is passed through an air-discharging surface feed heater, so that in addition to being deærated, the feed water enters the boilers at a temperature of from 215 to 240 degrees F.

The arrangements are carried out with a view to providing the utmost simplicity, thereby minimizing the demand on the labor available.

Representative log abstracts are attached from which the general performance of each steamer may be estimated. Variation in the feed temperature as between either of the ships is due to there being means available whereby water from the bottom of the boilers may be circulated through the feed heater coils instead of steam.

A schedule of temperatures taken on the *Camerata* is also attached, together with a recent low-pressure cylinder diagram from the same steamer (see Fig. 14).

The average power maintained by the three ships is about 1 080 indicated horsepower, so that the engines are working at considerably less than the normal full load corresponding with the given dimensions. In these circumstances the system followed is to fully open all boiler and engine stop valves, running with maximum pressure in the high-pressure receiver and reduced cut-off.

The readings tabulated were, of course, taken during the respective watches and are subject to the margin of error which is normal to determinations made at sea.

It might be added that in these vessels the air and circulating pumps, as well as the boiler feed pumps, are all driven by levers from the low-pressure crosshead.

ABSTRACT OF LOGS OF THE S.S. "DJERISSA." VOYAGE FROM DUNSTON-ON-TYNE TO BARCELONA.
MEAN POWER THROUGHOUT VOYAGE 1,060 I.H.P.

Date.	Pressure of Steam.	Inches of Vacuum.	Temperature.		Revolutions per Minute.	Coal.			Distance.		Average Speed per Hour.	Slip per cent.	Buckets of Ashes per Day.
			Feed to Boilers.	Sea.		Tons.	Cwts.	Description.	Propeller.	Observed.			
1910.													
Aug. 21 ...	170	27½	212	60	58	8	10	New-castle	51	53	8·4	nil.	20
„ 22 ...	180	27½	212	60	61	20	10	„	236	220	9·1	7	114
„ 23	180	27½	224	63	58	18	0	„	228	192	7·9	15	116
„ 24 ...	180	27½	223	62	58	16	0	„	227	182	7·5	19	116
„ 25 ...	180	27½	224	65	58	17	10	„	228	201	8·3	11	107
„ 26 ...	180	27½	224	67	58	17	0	„	225	173	7·2	23	110
„ 27 ...	180	27½	226	68	58	17	0	„	225	217	9·0	3·5	108
„ 28 ...	180	27½	228	67	58	17	0	„	223	218	9·1	2·2	107
„ 29 ...	180	27½	236	74	58	17	0	„	223	214	9·0	3·8	107
„ 30 ...	180	27½	138	77	58	17	0	„	223	213	9·0	4·5	110
„ 31 ...	180	27½	138	77	58	12	5	„	179	159	8·6	8·0	81

The coal used was Newcastle, quick burning, with 80 to 85 per cent. small. A good deal runs through the bars, which helps to form the large percentage of ash.

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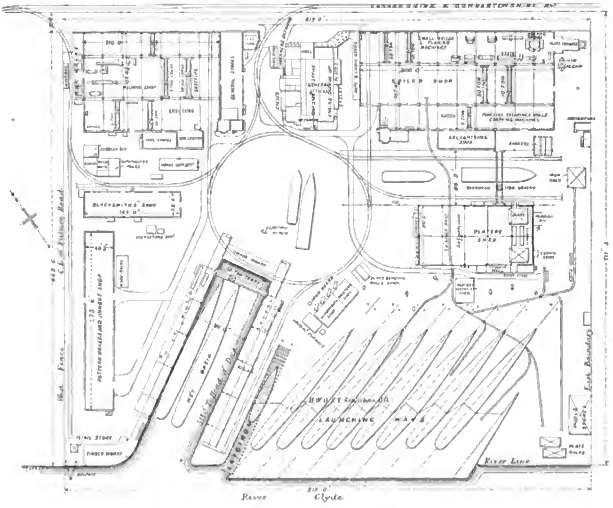
THE WORKS OF MESSRS. YARROW & COMPANY, LIMITED, SCOTSTOUN, GLASGOW.

When a few years ago Messrs. Yarrow & Company, Ltd., decided to move their works from the Thames at Poplar to Scotstoun on the Clyde, an opportunity was offered to layout and construct one of the most up-to-date and best-equipped shipyards of its size in the world. Numerous natural advantages influenced the choice of Scotstoun as the site for the new yard, such as its excellent railway facilities, its economic possibilities as a labor market, its proximity to the iron and coal districts, the depth and width of the Clyde at this point, and the proximity of the Skelmorlie measured-mile trial course, which is now recognized as the only reliable mile on the British coast over which to test vessels of exceptionally high speeds.

The general arrangement of the works is shown in the plan, Fig. 1. It comprises an area approximately 820 feet by 700 feet, and includes engine and boiler shops, a blacksmith shop, a pattern makers and joiners' shop, the platers' shed, a covered-in fitting-out dock with adjacent sheds for pipe fitters, etc., together with eight building slips and the necessary store rooms, offices, etc. Electric power is used throughout the works, it being supplied by the Clyde Valley Power Company in the form of three-phase alternating current, twenty-five cycles per second at a high voltage, which is reduced to 400 volts by static transformers. As the firm wished to use a considerable number of continuous-current motors, which had been installed in their works at Poplar, an electric sub-station was installed at the plant, consisting of two motor generators, which can be run in parallel. Each machine is rated to give continuously 1,190 amperes at 210 volts. The alternating-current motors are each 365 horsepower at 485 revolutions per minute. Decided preference was also expressed for direct current on the ground that inverted arc lighting would give the best satisfaction for the general offices. It is expected that if additional power is required alternating-current motors will be installed as necessary. Electrically-driven pumps are provided to supply power to the various hydraulic tools. The pumps were furnished by the Leeds Engineering & Hydraulic Company, Ltd., Leeds, and the motors by the British Westinghouse Electric & Manufacturing Company, Ltd., Manchester.



PLAN OF THE YARROW SHIPYARD ON THE CLYDE.

Turning to the plan of the works, Fig. 1, it is seen that the general offices are located in the center of the north side, with the boiler shop to the east and the machine shop to the west. Mr. Yarrow's office is, as it were, the center of gravity of the whole yard, and consequently secures the minimum distance for him to go to see any member of his staff or for them to come to see him. The building berths and fitting-out basin are, of course, located at the water's edge, with the platers' shed immediately in front of the launching ways.

GENERAL VIEW OF THE NEW SCOTSTOUN WORKS OF MESSRS. YARROW & CO., LTD.

Between the platers' shed and the boiler shop is a space which is served by an overhead 7-ton crane of 85 feet span, by Messrs. Broadbent, of Huddersfield, traveling on a gantry, which is 330 feet long. This space is used for the construction of shallow draft steamers which are built by Messrs. Yarrow in sections for export. The boats are erected on shore at this place previous to shipment.

The facilities for handling material have been most carefully worked out, so as to provide for a minimum amount of handling and transporting. All of the shops are thoroughly equipped with overhead traveling cranes carefully designed for the loads which they have to lift, and the entire yard is served by a narrow-gage railway system, which is used largely for carrying material from the angle and plate racks to the platers' sheds and various machine tools. In the covered-in fitting-out basin material is handled by means of a 50-ton traveling crane, supplied by Messrs. Applebys, Ltd., Glasgow and Leicester.

The two most important shops in the yard are the boiler and machine shops. The boiler shop is the largest, being 300

THE MACHINE SHOP.

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feet long by 153 feet wide. It is divided into three bays, one 50½ feet wide, served by one 20-ton and one 10-ton crane at a height of 40 feet 6 inches above the floor level. The center or erecting bay is 65 feet 4¼ inches wide, served by one 50-ton and one 10-ton crane at the same level as in the north bay. The south bay is 36 feet 4 inches wide, and is served with one 5-ton crane located 25 feet 6 inches above the floor level.

The machine shop is 210 feet long and 153 feet wide, and is also divided into three bays, one 37 feet 1 inch wide, served by a 5-ton traveler; a middle bay, 65 feet 1¼ inches wide, with a 5-ton crane at a height of 30 feet above the floor level; a 50-ton crane at 41 feet 8 inches above the floor level, and a south bay, 50 feet ⅜ inch wide, served by a 20-ton and 5-ton crane located 30 feet 6⅜ inches above the floor level.

The design of these shops, which was carried out by Sir William Arrol & Company, Ltd., is an excellent example of modern engineering workshop construction. The buildings are of the self-supporting steel frame type, with 9-inch brickwork built into the frame work to form the outer walls. The roofs of the boiler and machine shops are of the cantilever type, supported by internal cross girders at the ridges, which in turn are rigidly secured to the gantry columns placed 30 feet apart, the whole being covered with ¼-inch glazing. On account of the glazed roofs, light painted steel work and white-washed walls, the shops present an exceptionally pleasing appearance, and are far more comfortable for the workmen than the old type of dark, grimy building.

The platers' shed is 180 feet long by 90 feet wide and 18 feet 6 inches high. In it are located the furnaces and machine tools used in connection with the hull construction. No very large tools are installed, as most of the vessels built by Messrs. Yarrow & Company are of medium size, such as torpedo boat destroyers, shallow draft river boats, fast launches, etc. The machine tools include plate punches, shears, plate bending rolls, joggling rolls, large emery grinders and drilling machines. These are all motor-driven. Among the somewhat unusual tools are a high-speed saw for cutting rolled sections cold, which was supplied by Joseph T. Ryerson & Son, Chicago, and a Britton plate-stretching machine for pulling thin plates in order to take the buckles out. This work was formerly done by hammering, which is usually a long and laborious process. Most of the plates are drilled by compressed air by means of ordinary pneumatic drills, suitable arrangements being made for carrying out this work economically and expeditiously.

The equipment of the boiler shop includes some special tools for building the well-known type of Yarrow watertube boiler. Furnaces are provided, of suitable size, to heat the plates which form the steam and mud-drums of the boilers, as these are all bent hot. The tube plates of these boilers have to be thick in order to compensate for the amount of metal cut away in drilling, and the sides of the tube plates are reduced so as to correspond with the thickness of the wrapper plates. This work is done in a Hugh Smith planing machine, which has a maximum stroke of 28 feet. This machine also planes the plate edges and reduces the tube plates to the required thickness in the way of butt straps, and it can also plane the sides of the water-pocket tube plates and steam-drum tube plates. A special Buckton planing machine is also provided for planing tube plates for steam drums and water pockets after they are pressed to shape. The stroke of this machine is 18 feet, and it takes a width of 5 feet 6 inches and

THE FITTING-OUT DOCK.

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a height of 6 feet. The steam drum tube plates are bored and turned in a special boring machine, supplied by Messrs. F. Berry & Sons. A special vertical boring mill for machining steam drum ends and water-pocket ends was also supplied by the same firm. The holes in the tube plates are all drilled through jigs. There are four multiple-spindle drilling machines, supplied by Messrs. Joshua Buckton & Company, and an oval hole-cutting machine for manholes, furnished by Messrs. G. & A. Harvey. The riveting plant consists of one 13-foot gap machine and an 18-foot gap machine of Messrs. Henry Berry & Company's make. Pressures of 20, 40 and 60 tons on the rivet can be secured with both of these machines.

In the machine shop are many tools from English, American and Continental builders. These include Buckton planing machines, Asquith radial drills and lathes by Lang, Harvey, Muir, Hulse and Archdale. There are lighter automatic machines by Messrs. Pratt & Whitney. Prominent among the American machines are noted Niles Tool Company lathes, Pond radial drilling machines, Brown & Sharpe milling machines, Sellars tool grinders and the Diamond Machine Company's emery grinders. Among the tools supplied by Continental firms are a surfacing lathe from the Oerlikon Company.

Mention has already been made of the covered-in fitting-out basin, which is supplied with a 50-ton traveler overhead. The total length of the runway is 323 feet and the crane is 56 feet above high-water mark. The roof for the basin is 275 feet long, of the cantilever type, completely glazed. The basin is dredged to a depth of about 14 feet at low water, so that the vessels will float at all stages of the tide. The depth of water in the river in front of the launching ways is 23 feet at low water, and the width of the river is about 500 feet, so that there is ample room for launching purposes. On either side of the covered-in basin are wharves covered by lean-to roofs, under which are located plumbers and pipe fitters' shops.

For the special class of work of which Messrs. Yarrow have made a specialty the layout of the works is such that beyond a doubt it should secure for the firm the very lowest cost of production.

THE MARINE STEAM ENGINE INDICATOR—XIX.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

THE EXHAUST LINE.

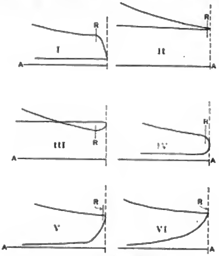
In order that the piston may begin its return stroke without unnecessary resistance, it is desirable that the pressure of the working steam be reduced to that of the condenser, receiver, or exhaust pipe by the time the crank pin crosses the dead center. To accomplish this result it is necessary in most cases to open the exhaust before the dead center position is reached, the exact point depending on the rotative speed, ratio of expansion, type of valve gear and other conditions.

The line *DE* of Fig. 95[1] is the *exhaust line*, and shows an ideal set of conditions for an engine turning at slow rotative speed. Diagram I of Fig. 104, is a close approach to the exhaust line of Fig. 95. This diagram was taken from the high-pressure cylinder of a compound pumping engine, and shows nearly a maximum card area at the "toe" with a minimum back pressure at the beginning of the return stroke.

Diagram II shows an exhaust line from the high-pressure cylinder of a triple-expansion pumping engine. This is also ideal. The expansion line is carried almost to the counter-pressure, and the exhaust opens at the proper time to realize minimum back pressure at the beginning of the stroke.

With engines turning at moderate rotative speeds engineers have found it expedient to close the exhaust before the end of the stroke, in order that a steam cushion may form and thus bring the reciprocating parts gently to rest and do away with shock on the bearings and other connections at the time the motion of the piston reverses. While it is well to keep the card area as large as possible, with any given point of cut-off, it is useless to delay release or exhaust opening until the end of the stroke when compression is used to form a cushion and for the following reasons:

In studying indicator diagrams one is very apt to form the habit of thinking of the steam events on one side of the piston



A=Atmospheric Line
R=Point of release
FIG. 104.

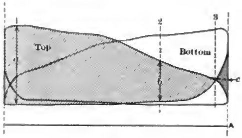


FIG. 105.

only, as this is all that is necessary to consider in ordinary diagram analysis. But when we come to figure on actual piston loads and their effect on the connections and bearings the pressures on both sides of the piston must be kept in view.

A little thought will make clear the fact that the actual load on the piston at any point is the difference between the *forward* or steam pressure and the *back* or exhaust pressure. Thus in Fig. 105—considering the down stroke only—the forward pressure at 1 is equal to the length of the ordinate *a* between the steam line of the top card and the exhaust line of the bottom card. At 2 it is equal to *b*; at 3 the forward and back pressures are equal, and the load on the piston is zero.

For every piston position to the right of ordinate 3 the back pressure exceeds the forward pressure, the effect being to resist the movement of the piston and bring the reciprocating parts to rest without shock. The magnitude of this opposing pressure is measured as described for the forward pressure. To make the diagram clearer the area representing the forward pressure is filled in with widely spaced hatching and the counter-pressure area with fine hatching.

The reason for not delaying release until the end of the stroke will now be clear.

In the diagram Fig. 105, if release had been so delayed the

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[1] September, 1910, issue.

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expansion line would have continued to *c*, and the greater part of the counter pressure caused by compression would have disappeared.

Further, if the exhaust is opened before the end of the stroke it helps towards a good exhaust opening at the beginning and middle of the return stroke, as will be shown when we come to consider valve setting. If expansion is carried too far by reason of a very early cut-off a loop will be formed, as shown in Diagram III, of Fig. 104. This is a bad condition. The loop creates a counter pressure in addition to that caused by compression, and what is worse it reduces the temperature of the cylinder below the average exhaust temperature.* If the valve is late in opening—on a slide-valve engine—the exhaust is cramped and diagrams like IV., V. and VI. will result. Another condition which will cause a bad exhaust line is wet steam. Steam in a wet state is less easily expelled than when dry, and is one of the indirect causes of the great loss of efficiency due to the presence of water in suspension in the steam.

* On some voyages it is necessary to run slowly for several hours in order that a "land fall" will be made during the hours of daylight. In such cases the engineer who wishes to keep his coal consumption down will reduce the revolutions by an early cut-off in the high-pressure engine, using the cut-off screw in the rock-shaft arm. If this is not enough, the rock shaft itself is partially rotated with the reversing engine, linking or "notching up" all of the engines at once. If this procedure causes loops in the diagrams, the cut-offs are too short. The links should be run out just enough to avoid the loops and the throttle used to regulate the revolutions.

(To be Continued.)

PLANT OF THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY.

150-TON REVOLVING CRANE.

The plant of the Newport News Shipbuilding & Dry-Dock Company, which is located at Newport News, Va., on Hampton Roads, has, by virtue of its location, many advantages which are not possessed by other large shipyards. The yard represents an investment of $15,000,000 (£3,080,000), covers nearly one hundred and twenty acres, and has a water frontage of half a mile. The arrangement of the yard is the result of a most carefully perfected plan to have all the work on a ship from its design to its completion absolutely progressive. The material enters at one place, and, as it is handled, moves steadily forward to its final destination without, in any case, retracing its steps.

The buildings, most of which are brick structures, cover about twelve acres. The shops are so grouped as to permit the advancement of the work. They are connected by railroad tracks, so that material which is handled by the company's locomotives may be expeditiously transferred from shop to shop or from shop to shed, etc. A double track connects the works with the main line of the Chesapeake & Ohio Railroad. There are about seven miles of standard gage railroad track, covering various portions of the shipyard.

A battery of eight large marine Scotch boilers, working at a pressure of 120 pounds per square inch, supplies steam for power purposes. There is an electric plant with a capacity of about 2,500 kilowatts and four air compressors capable of compressing a total of 9,000 feet of free air per minute to a pressure of about 100 pounds per square inch. There is also a hydraulic plant of large capacity for supplying power to the hydraulic tools. The entire shipyard, including shops, wharves and dry-docks, is lighted by electricity.

There are two departments in the yard—the hull department and the machinery department. These, in turn, are subdivided into smaller ones, each under the supervision of an experi-

GENERAL VIEW OF THE NEWPORT NEWS SHIPYARD.

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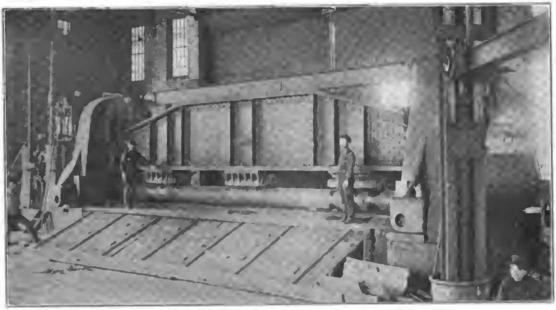
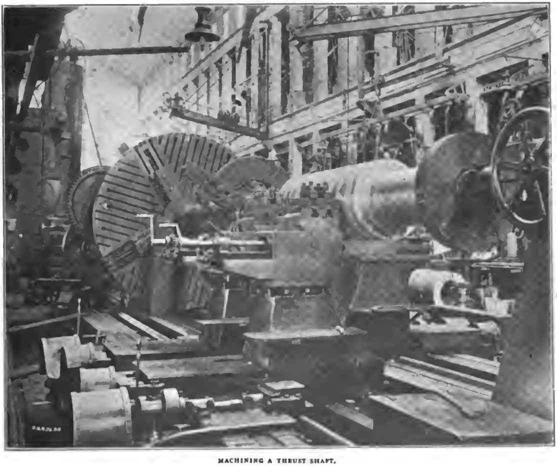


LARGE PLATE-BENDING ROLLS.

enced foreman. The departments are so arranged with relation to one another that the material may be transferred from one to the other by the shortest route. One group is formed by the ship shed, framing shed, etc.; another by the machine, boiler, blacksmith, copper and outfitting shops, and a third by the joiner and pattern shops, lumber sheds and saw-mill. The piers and drydocks also have the necessary shops and tools located adjacent to them to facilitate the carrying on of repair work.

In the framing shed there is a large manhole punching machine, capable of punching a hole 27 inches by 18 inches through plates nearly an inch thick. All work in and about the



MACHINING A THRUST SHAFT.

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framing shed is handled by electric cranes. In the ship shed, which is near the framing shed, there are 32-foot bending rolls, guillotine shears, shear blade grinders, cold saws, countersinking machines, a 32-foot planer, 16-foot bending rolls and numerous smaller tools. The second floor of the building is used as a mold loft.

Adjacent to the ship shed is the bending shed, containing furnaces where bars of iron 70 feet long can be heated for bending. The building berths, on which new vessels are laid down, are located near these shops, the berths being served by cantilever cranes. There are five of these cantilever cranes, three of which handle material for two ships simultaneously under construction on either side of its trestle. This company was the first in the world to utilize this type of crane for shipbuilding. With two exceptions, all of these cranes are operated by electricity. There are six locomotive cranes which also handle and transport material.

The machinery department includes one of the largest and best-equipped machine shops in America. The building is 100 by 560 feet and contains planers 36, 60, 84 and 120 inches in length; also an immense wall planer which requires a 50-horsepower motor for its operation. The heavy machine tools are located in the main part of the machine shop and in the galleries are the brass working machines. All material is handled by electric traveling cranes, the largest having a capacity of 50 tons.

The rigging loft, boiler, blacksmith, joiner, copper, ship carpenters and other shops are all fitted with modern up-to-date machinery. In the blacksmith shop there are steam hammers, ranging from 600 to 6,000 pounds. Forced draft is employed for the forge fires.

A CORNER IN THE MACHINE SHOP.

Two important auxiliaries in the yard are a 150-ton electrically-operated revolving derrick and a set of shear legs of 100 tons capacity. The yard is well provided with dry docks, there being two about 593 and 537 feet extreme length, respectively, and one with an extreme length of 804 feet. The latter is built of timber with a masonry entrance, the masonry being constructed on a concrete foundation that rests on piles and timber superstructure. In connection with it is a pumping plant, comprising three main centrifugal pumps of 100,000 gallons capacity per minute each, and two drainage pumps with a capacity of 12,000 gallons per minute. The main pumps are driven by electric motors of 1,000 horsepower each at 500 volts. It requires about one hour and thirty minutes to pump out one of the smaller docks, and about two hours and fifteen minutes to empty the larger one.

On the water front there are seven large piers, one of which is 900 feet long: the fitting-out basin is 900 by 500 feet and has a depth of water of about 40 feet.

100-TON SHEAR LEGS.

In addition to the shops in the yard, the company operates a large foundry for steel and iron castings and for brass work. The foundry is connected with the main works by the company's railroad, and is but a short distance from the main works. All the machinery in the foundry is operated by electric motors supplied from the main power house at the shipyard.

THE SHIPBUILDING AND ENGINEERING WORKS OF MESSRS. GIO. ANSALDO-ARMSTRONG & COMPANY.

In 1853, when the Kingdom of Sardinia was undergoing an economic transformation, the small compartment of Piedmont was brought into prominence by new railway facilities and immediately entered upon a new industrial era. Mr. Carreur, then Prime Minister, saw the necessity of an adequate mechanical establishment which would be able to carry out the large projects then under way, and, utilizing a modest contract shop, established at Sampierdarena, near Genoa, since 1846, he formed the Gio. Ansaldo Company, entrusting the management to Mr. Ansaldo, who was at that time a prominent professor of mechanical engineering.

The shops of the new company were at the time the best equipped in Italy, and, as early as 1854, they supplied the first

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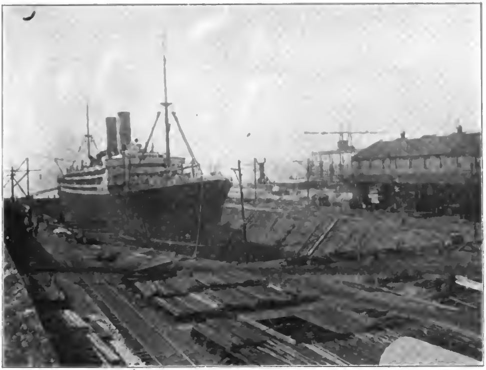
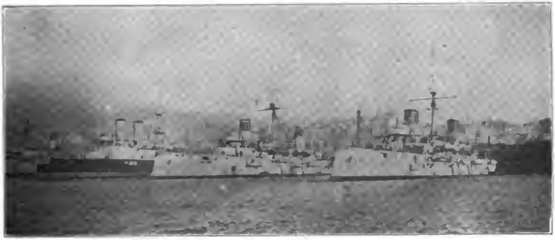
two locomotives for the Piedmont railways. In connection with locomotive building, Messrs. Ansaldo made a specialty of the construction of other materials for railway use, and also of marine engines and boilers and marine repairs. In 1867 these works undertook the construction of the large engines for the Italian iron clad *Palestro*, and subsequently also the engines for the two ships *Staffeta* and *Mariantonio Colonna*. The reputation of the firm for marine work was enhanced by turning out the stem and stern post forgings of what were then the largest battleships, the *Duilio*, the *Dandolo*, *Italia* and *Secpanto*. In 1870 the works were increased by the addition of a small shipyard where the royal naval vessel *Staffeta*, the lake steamer *Venbano* (which is still in service) and the freight steamer *San Gottardo*, together with a large number of smaller ships, were built.



DRYDOCK AT NEWPORT NEWS.

In 1883 the concern passed into the hands of the Bombrini Bros., and a new impulse was given to the industry. In 1866, in order to provide more room for the engine works, it was found necessary to transfer the yard to Sestri Ponente, which is two miles from Sampierdarena. Again, in 1886, it was found necessary not only to enlarge the shops but also to have new ones erected, and to establish a foundry for brass and special metal work at Coruigliano. Here also was established a steel foundry and a large shop for building special naval electrical machinery. At the same time there was erected in the harbor of Genoa, as an adjunct to the shipyard, a large shop for the completion and equipment of vessels after their launch, and, finally, on account of a contract for refitting and repairing some vessels of the Turkish navy, the Messrs. Ansaldo established a shop, with an Italian staff of



WAITING FOR REPAIRS AT THE ANSALDO YARD.

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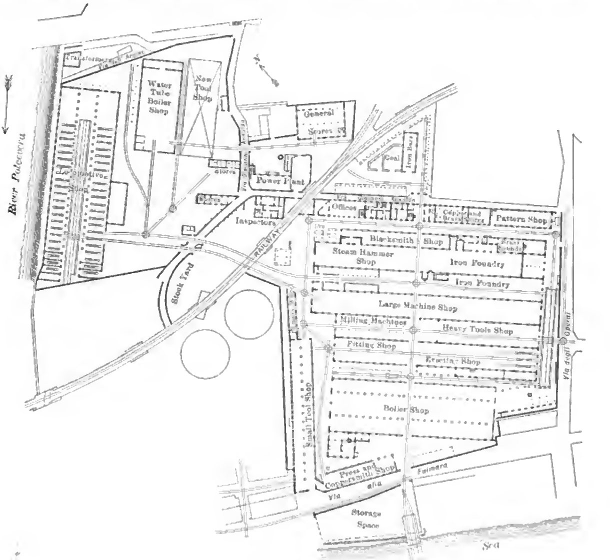
workmen, in the Imperial shipyards at Constantinople. In 1903 the business passed from the control of the former owners into the hands of Messrs. Gio. Ansaldo-Armstrong & Company; the late Commodore Ferdinando Maria Perrone was then general manager of the company, and it was largely due to his efforts that the Italian naval industry was brought to its present state of imporance. At present the firm employs about 5,000 workmen.

THE WORKS AT SAMPIERDARENA.

The numerous shops which comprise these works occupy at present a covered area of about 12 acres and an open space of about 8 acres. They include a pattern shop, foundry (iron and brass), large turning and machine shop, lathes, boring and milling machine shop, small tool shop, brass machine shop, boiler shop, fitting shop, emery wheel shop, locomotive erecting shop, large erecting shop, laboratory, hydraulic press and coppersmith shop, watertube boiler and sheet iron shop, and, finally, the blacksmith and steam hammer shop.

All of the shops are furnished with electric power at 220 volts. Electricity is also used for lighting, current being provided at 120 volts. Electric drills and pneumatic tools are used extensively. All of the large machine tools in the different departments are driven by individual electric motors, and the smaller tools are arranged in groups connected to electrically-driven shafting. A power station is located within the works, but in the immediate future power is to be supplied by a private company situated 50 miles from Sampierdarena. Alternating current at 66,000 volts will be transmitted from this station to the works, where it will be transformed to a lower voltage to drive a motor generator designed to supply direct current at 220 volts.

Railway connections are provided between the works and the sea, so that large boilers, castings, forgings, etc., can be lifted and carried directly to the harbor of Genoa, or to the shipyard at Sestri Ponente, or shipped directly on board the vessels by means of a 120-ton floating pontoon.



PLAN OF THE ANSALDO YARD.

The equipment of the works includes about a thousand machine tools of every description, ranging from the heaviest steam hammers to the most delicate laboratory apparatus. Most of the company's machine work and casting is done at this plant, the principal production consisting of locomotives, boilers of all kinds and the propelling and auxiliary machinery for both naval and mercantile vessels. At present there is

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PANORAMIC VIEW OF THE SHIPYARD AT SESTRI PONENTE.

under construction the propelling machinery for the battleships *Giulio Cesare*, *Leonardo da Vinci* and *Contedi Cavour*. Each of these plants consists of 24,000 shaft horsepower of Parsons turbines. There is also nearing completion turbines for the *Quarto* of 25,000 shaft horsepower, the 12,500 indicated horsepower reciprocating engines of a new twin-screw Turkish cruiser, the 1,150 indicated horsepower reciprocating engines of the twin-screw tank steamer *Eridano;* the 1,850 indicated horespower reciprocating engines of the twin-screw tug *Titano*, also reciprocating engines for twelve torpedo boats of 2,700 indicated horsepower each, one set of Parsons turbines for a 2,700 shaft horsepower torpedo boat, the machinery for which is to be arranged on three shafts, and one set of Bergmann turbines for a 2,700 shaft horsepower torpedo boat, all of which are being built for the Italian Government. Further, there are two sets of reciprocating engines of 6,000 indicated horsepower for a Chinese destroyer. The firm also

HEAVY TOOL SHOP.

has a contract for seventy-two locomotives, to be finished before June.

The foundry for steel castings at Coruigliano supplies all the requirements of the main works at Sampierdarena for the locomotives, turbines, marine engines, etc. Recently an addition has been made to this plant to accommodate another 25-ton gas furnace installation. The electric shop at Coruigliano occupies a ground area of about 2¼ acres and makes a specialty of electric gear for use on board ships, such as hoisting appliances, winches, windlasses, etc.

THE SHIPYARD AT SESTRI PONENTE.

This yard occupies an area of about 25 acres and has a water frontage of 1,650 feet. There are five building berths, capable of accommodating the largest vessels which are built at the present time. Three other wooden slips are used for the construction of medium-sized vessels. For smaller boats, such as torpedo boats, destroyers, etc., covered berths are provided. The entire plant is thoroughly equipped with modern machine tools electrically operated. Alongside the building berths are located all of the shipbuilding tools, such as punches, shears, drills, countersinking machines, beam

IN THE FITTING SHOP.

PORTION OF TURNING AND MACHINE SHOP.

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benders, plate-bending rolls, etc. The mold loft covers an area of about 15,000 square feet.

A notable example of the class of work turned out at this yard is the *Garibaldi* type of cruiser, which was duplicated five times by this company for foreign nations. One of these vessels was the *Cristobal Colon*, of Spanish-American War fame. As an indication of the speed with which work is turned out, the armored cruiser *Kasuga* was laid down March 14, 1902, and launched October 22 of the same year. Her sister-ship, the *Nisshin*, was also built in the same rapid time. When these two cruisers were sold to Japan they made the voyage from Genoa to Yokosuka, with an inexperienced crew, at a higher rate of speed than has ever been maintained by any other armored vessel in so long a voyage. Upon their arrival in Japan the boilers, engines and all parts of the ship were found to be in good condition, so that they immediately went into service in Admiral Togo's squadron.

There is now under construction in this yard the battleship *Giulio Cesare*, 21,500 tons, 24,000 shaft horsepower and 22.5 knots speed; one Turkish cruiser of 12,500 indicated horsepower; one tank steamer of 11,000 indicated horsepower; one tug boat of 1,850 indicated horsepower; eight torpedo boats for the Italian Government and one Chinese destroyer of 6,000 indicated horsepower. For the construction of the battleship *Giulio Cesare* one set of electric cranes was installed on each side of the building berth.

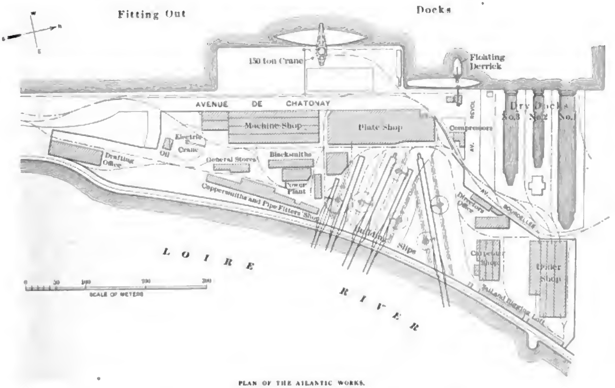
THE FITTING-OUT SHOPS IN THE HARBOR OF GENOA.

This shop serves as a complement to the works at Sestri Ponente; for although, if necessary, merchant ships can be launched complete at the latter place, with their engines and boilers installed ready for service, nevertheless naval vessels, especially large cruisers and battleships, require a large amount of work after launching, such as the fitting of armor plates, turrets, guns and various auxiliaries. This shop has been installed for the purpose of doing such work. The shops occupy a total area of about two acres, four-fifths of which are covered in. It is completely equipped with modern tools for the special work which is required. A part of the equipment includes tug boats, floating pontoons and berths for lifting and shifting heavy weights, and also a powerful dredge for harbor excavation.

FORGES AND CHAUTIERS DE LA MEDITERRANÉE.

This yard was established in 1857 at La Seyne, near Toulon. It includes a shipbuilding yard at La Seyne and engine shops at Marseilles. There are also other slips and engine works at Havre, but they are less important. Both yards are equipped with facilities for building any type of vessel and large numbers of vessels for both mercantile and naval work have been constructed not only for French owners but also for foreign navies, including Brazil, Chili, Greece, Japan and Russia. Prominent among these may be mentioned the *Czarewitch*, of 12,932 tons, which, at the time of her construction, was a very noteworthy battleship, largely on account of the new features embodied in her design, which were a distinct advance over anything then in use in other navies. The principal feature was the anti-torpedo protection, which is similar to that which is to-day found in battleships of the *Danton* class, the German *Dreadnoughts*, and the new Argentine battleships building in America.

The main establishment of this company at La Seyne has a frontage of 3,900 feet on the Toulon roads. At the center of the yard is a fitting-out dock, 443 feet long and 115 feet wide, with sufficient depth to accommodate the usual type of vessel built. The main offices are in a large building facing the fitting-out dock, where ample room has been reserved for the drafting staff, which consists of about 150 men. There are seven building slips, two of which have an available length



PLAN OF THE ATLANTIC WORKS.

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of 657 feet. They are built of masonry, and material is hoisted on to the slips by powerful pivoted electric cranes.

PLATE AND ANGLE SHOPS.

This department includes a large plate shop, 443 feet long, with two parallel bays, each 99 feet wide. The shop is served by eight overhead traveling cranes which operate at a speed of 262 feet per minute. One bay is designed for laying out plates and the other for fitting-up purposes. Close by is the plate yard, which is served by a high-speed traveling crane, so that material is handled quickly and cheaply. Above the plate shop is the mold loft, which is unusually large, being 443 feet long and 99 feet wide. The machines installed in this shop include, besides the punching and shearing machines, radial drills, planers, metal saws, etc.; five large planing machines, three hydraulic presses, a large manhole punch, all of which are electrically-driven and arranged so as to facilitate the progress of work through the shop.

Near this shop is the angle iron shop and small blacksmith shop. The equipment includes three large angle iron furnaces capable of taking bars 72 feet long. There are also four large hydraulic presses for bending beams and several metal saws, including one circular saw capable of cutting bevels.

CARPENTER SHOPS.

The woodworking department, which includes a covered area of 4,000 square feet, is situated at a distance from the other shops in order to minimize the danger from fire. The plant includes a carpenter shop, sawmill, joiner shop, model shop and lumber shed. The woodyard, which is 525 feet long, is served by an electrically-operated overhead crane, 85 feet wide, with a working speed of 262 feet per minute.

In the sawmill are six band saws and the usual equipment of woodworking tools.

GUN AND ARMOR SHOPS.

This department includes the forge, fitting-out, electrical, locksmith, coppersmith, tool and galvanizing shops. The total area of this group is 8,900 square feet. The forge shop has a length of 290 feet and a width of 82 feet. It contains seven steam hammers, one of 4 tons, one of 2 tons, three of 1 ton and two ½-ton machines. There are also two heating furnaces and seventy small forges.

The fitting-out shop is divided into three bays, each 295 feet long, one 82 feet wide and the other two 40 feet wide. These are served by three electric overhead cranes, the largest of which has a lifting capacity of 35 tons. The first bay is devoted to small machine work and gear work, and its equipment includes about ninety machine tools, such as turning lathes, boring, countersinking, tapping and planing machines, etc. The principal lathes have been especially designed for handling large pieces of machinery and are capable of dealing

SHIP SHED, NORMANDY YARD.

THE BOILER SHOP.

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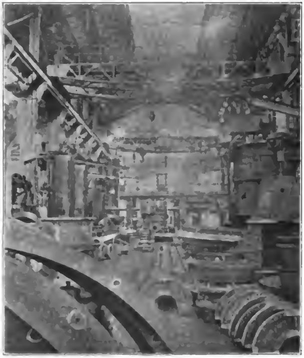
with pieces 39 feet 4 inches long by 23 feet diameter. The other two bays are intended for the fitting out and erection of engines.

TURBINE DEPARTMENT.

When it was decided that the battleships of the 1900 programme should be driven by Parsons turbines, this company obtained the rights for building this type of machinery, and a special shop was erected for doing the work. The shop is 363 feet long, 148 feet wide and is divided into two bays, each 74 feet wide, having an available height of 55 feet 2 inches. One bay is devoted entirely to the building of the principal parts of the turbines and rotors and is served by three overhead traveling cranes, one of 30 tons capacity and the other two of 10 tons each. The second bay is used for fitting up the turbines and is served by two overhead cranes, each of which has a capacity for lifting 60 tons. These cranes may be connected to deal with weights heavier than that.

After the turbines are ready for shipment they are loaded on a special car of 130 tons carrying capacity, on which they are carried to the fitting-out dock, where they are installed by a 150-ton floating crane. The tools in the turbine shop include a horizontal lathe weighing 180 tons, driven by a 60-horsepower electric motor, which is capable of dealing with pieces 56 feet 2 inches long and 16 feet 5 inches diameter. There is also another horizontal lathe weighing 180 tons, which can handle pieces 48 feet long and 11 feet 10 inches diameter. It is driven by a 60-horsepower motor. Another horizontal lathe, weighing 120 tons, can handle work 46 feet by 6 feet 2 inches. The latter is driven by a 40-horsepower motor. A vertical lathe, weighing 250 tons, is installed, which deals with work 22 feet 6 inches diameter and 26 feet 4 inches high. This machine is operated by a 60-horsepower motor, and it may also be used as a boring machine. There is a vertical lathe driven by a 25-horsepower motor for cylinders 13 feet 10 inches diameter and 5 feet 7 inches high. All of the above-named machines use high-speed steel tools exclusively, and special furnaces have been installed for dealing with these tools.

SLIP TOWER CRANE. ATLANTIC WORKS.



TURBINE SHOP. ATLANTIC WORKS.

BOILER SHOP.

The boiler shop has been so arranged as to meet the requirements demanded in the construction of modern marine cylindrical boilers. It is 394 feet long, 140 feet wide, divided into three bays. The center bay, 66 feet wide, is served by two overhead electrically-driven cranes, which have a clear runway from one end of the shop to the other. One of these cranes has a lifting power of 100 tons and the other 25 tons. The two wing bays are served by the same number of cranes, but these cranes have a lifting power of only 10 tons each. This shop has a capacity of 2,000 tons of boilers per year. The machine tools include special equipment for the building of watertube boilers. There are four plate-bending rolls, eleven punches and shears, two beveling machines, two triple boiler shell drills, two radial drills, four hydraulic presses, two hydraulic riveting machines, one of 130 tons power, which is served by a hydraulic crane of 35 tons lifting power. There are also two portable riveting machines, four steam hammers, etc.

This plant was the first one in France to install portable pneumatic tools, and at present there are no less than 150 pneumatic drills, riveting, chipping and calking hammers, requiring in all 400 horsepower, in daily use. The equipment of the yard also includes four floating cranes of 15, 45, 80 and 150 tons lifting power respectively. The material is handled throughout the yard by steam-traveling cranes operating on railroad tracks. Part of the power for the shops is supplied the company's own power stations by turbo generators and part by an outside company.

The annual meeting of the Institute of Naval Architects will be held on Wednesday, April 5, and continue through the two following days in the hall of the Royal Society of Arts, John street, Adelphi, London, W. C.

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St. Nazaire Shipbuilding and Engineering Company, Ltd.

The yard has a frontage of 2,950 feet on the River Loire, and on the opposite side of the yard is the Penbouet Dock, so that the plant is exceptionally well situated for shipbuilding purposes. Railroad connection with the State and Orleans railway, together with the exceptional dock facilities, insures the cheapest and most expeditious means of receiving material and shipping finished work.

There are five building slips at the Atlantic yard, all of masonry construction, the largest of which is available for ships up to 700 feet in length, and the smallest for ships 394 feet in length. As the climate in this section is not very severe the building slips are not covered in, and ships are launched according to the cradle method. The slips are served on both sides by electrically-driven tower cranes of a noteworthy type. They are 105 feet high, with an acting radius of from 47 feet 7 inches to 72 feet. They are capable of lifting 4 tons at 72 feet and 8 tons at 26 feet. The lifting apparatus is driven by a 30-horsepower motor, and the movement of the cranes along the rails is accomplished by a 15-horsepower motor. The jib of the crane is actuated by a 5-horsepower motor. The cranes have a speed along the rails of 23 feet per second and are capable of lifting a weight of 8 tons at a speed of 29 feet per minute. These cranes permit very easy, rapid and cheap handling of materials. The slips are provided with electricity and compressed air and hydraulic plants to facilitate riveting, drilling, etc.

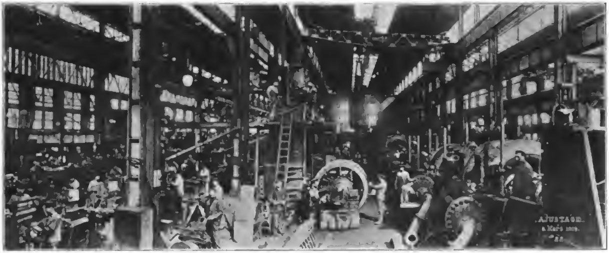
PLATE AND ANGLE SHOPS

These shops occupy an area of 115,000 square feet. The main shop is in front of the slips and is 578 feet long and 180 feet wide, divided into three bays, which are served by overhead traveling cranes. Hydraulic cranes serve the thirty principal machine tools, which have been arranged in such order as to avoid loss of time and confusion in handling materials. The shop contains three planing machines for plates 10 feet wide and 1 inch thick, hydraulic punching machines of 250 tons capacity, one garboard machine dealing with plates up to 1 inch thick and three rolling machines for 5/16-inch material.

The angle iron shop contains the angle iron heating furnaces as well as the furnaces where material is annealed after having been worked into shape. These furnaces are capable of taking bars up to 82 feet long, and large floor space with special machinery for doing the bending is provided. There are three bar-bending machines besides the necessary metal saws, etc. The annealing furnaces are large enough to accommodate the largest pieces which can be reheated without deformation. Special openings are provided in the furnaces to enable the workmen to note the appearance of the metal while it is being heated. When the pieces become cherry red the fire is extinguished and the pieces are left in the furnace without admitting cold air until they are cooled to normal temperature.

THE MACHINERY DEPARTMENT.

The engine department includes a forge shop, fitting-up shop, coppersmith shop and tool shop. The large forge shop is 197 feet long by 48 feet wide. In it are installed sixteen hammers, ranging from 500 pounds to 1,323 pounds. The coppersmith shop, including the galvanizing and pipe shop, is 263 feet long and 42 feet wide. A hydraulic press is used for bending pipes and a hydraulic accumulator is used for testing pipes and fittings. The fitting-out shop has an area of 85,000 square feet and is divided into four bays, served by six overhead cranes, which have a maximum lifting power of 50 tons. There are no less than 130 machine tools in this shop, the most important of which are the lathes, capable of dealing with work 52 feet 6 inches long and 13 feet 2 inches diameter. The part of the shop reserved for building and erecting turbines has an available height of 52 feet 6 inches; it is served by overhead traveling cranes, having lifting powers of 50, 30, 25 and 10 tons each. When it is necessary to lift a complete turbine these cranes are connected and a load of 100 tons is easily handled. The turbine part of the shop is the largest department. Among the modern tools installed there are a horizontal lathe, capable of handling work up to 2 feet 6 inches long; three horizontal boring machines dealing with 49 feet 3 inches; a vertical planing machine capable of handling work 23 feet long and 20 feet high; a horizontal boring machine with two sets of tools, etc.



THE ERECTING SHOP.

The part of this shop which is used for erecting purposes is 263 feet long, 66 feet wide and 49 feet 3 inches high. Here were erected the 30,000-horsepower engines of *La Provence*, as well as the 37,000-horsepower engines for the armored cruiser *Ernest Renan*. At the time of writing there are under construction the 40,000-horsepower Parsons turbines for the *France*, and until recently the 22,500-horsepower turbines for the battleships *Diderot*, *Condorcet* and *Mirabeau*.

CARPENTER SHOPS.

The carpenter and joiner shops are located at the opposite end of the yard, in order to remove as far as possible any liability of damage by fire. One building, 270 feet long and

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109 feet wide, contains the carpenter shop, cabinet-making shop and the lumber store rooms. Among other tools are to be found a band saw for squaring timber and lugs and a four-side planing machine. An overhead crane is provided for handling material. In the joiner department there are thirty-one machine tools.

BOILER SHOP.

The boiler shop is located at the north end of the yard and is practically new, as it was only a few years ago that the shop was partially destroyed by fire. As it stands to-day, the building is 427 feet long and 210 feet wide, divided into four bays, served by eight overhead electrically-driven cranes operating at a height of 40 feet above the ground level. These cranes are capable of lifting weights from 10 to 70 tons at a speed of 16 feet 5 inches per second. The principal machine tools include two rolling machines, one of which is vertical, capable of dealing with plates 1⅝ inches thick and 11 feet 6 inches wide. Five punching and shearing machines for drilling boiler shells; two quadruple drilling machines for front end tube plates, nine rotary drills, three hydraulic presses for flanging plates, three hydraulic riveting machines, giving a maximum pressure on the dies of 160 tons; one portable hydraulic press and two steam hammers. Besides the necessary tools for building the ordinary type of Scotch marine boilers there are the necessary special tools for building watertube and locomotive boilers. The largest boilers made in this shop are those for the *France*, which are 21 feet 4 inches long and 17 feet 9 inches diameter, weighing 100 tons each.

EQUIPMENT DEPARTMENT

This department includes the sail and rigging loft, lifeboat shops, etc. The mold loft is at the south end of the yard and is 289 feet long and 72 feet wide. The pattern shop has an area of 1,500 square feet.

Power is delivered to the different shops from a central power station, where are installed three sets of dynamos actuated by steam turbines and reciprocating engines aggregating 20,000 indicated horsepower. The entire yard is lighted by electricity. The compressed air plant, which contains three air compressors, is situated just outside the yard. All heavy pieces, like turbines, turrets, boilers, etc., are loaded on special cars in the shops, and are then carried to the Penhouet dock quay, where they can be lifted off by a set of tower cranes. There are three of these cranes, one of which has a lifting power of from 150 to 180 tons, one of 80 tons and one of 30 tons. The large tower crane, which is electrically-driven, is 164 feet high above the level of the quay. It is capable of lifting a load of 150 tons at a speed of 3 feet 6 inches per minute, or a load of 60 tons at a speed 7 feet 7 inches per minute. The shear legs are 82 feet high and deal with loads up to 80 tons, while the other crane has a capacity of 30 tons.

Close by the yard, as is shown in the plan of the works, are three drydocks, one of which is 427 feet by 42 feet 8 inches by 13 feet 4 inches. The second is 551 feet by 59 feet by 24 feet, and the third is 738 feet long, 124 feet 10 inches wide and 30 feet draft. These docks are a valuable addition to the equipment, both on account of their capacity and their convenient location at the entrance to the yard, which insures that the maximum efficiency can be obtained at the cheapest cost.

THE NORMANDY YARD.

In this yard are six building slips, together with large shops containing electrically-driven machinery. The yard is connected with the Western and State railways, and on the river front there are provided wharves where large pieces of machinery, etc., can be loaded or unloaded by aid of large shear legs. Without going into the details of the equipment of this yard, it is sufficient to note that it is designed specially for the building of hulls of cargo and passenger boats up to 10,000 tons.

THE BRITISH BATTLE CRUISER LION.

The new British cruiser *Lion* is the most notable ship of war which has ever been built. She is no less than 700 feet long over all and 86 feet 6 inches in extreme beam, and her size may very well be compared with the *Lusitania*, which is 762 feet in length and 87 feet 8 inches in breadth. The displacement of the *Lion* at a mean draft of 27 feet 9 inches is 26,350 tons. She is of the all-big gun type of high-speed turbine cruiser, and in design marks a bold departure from the Invincibles of 1908, which were considered to be the last word in fast cruisers. The *Lion* will have a sea speed of 28 knots, which should be equal to a smooth-water speed of 30 knots. Her dimensions are given in the following table, in comparison with those of the *Invincible:*

	Lion.	*Invincible.*
Length, B. P.	660 feet 0 inches	530 feet 0 inches
Length over all	700 feet 0 inches	562 feet 0 inches
Breadth, extreme	86 feet 6 inches	78 feet 6 inches
Draft, mean	27 feet 9 inches	26 feet 6 inches
Displacement	26,350 tons	17,250 tons
I. H. P., designed	70,000	41,000
Speed, designed	28 knots	25 knots
Armor belt	9¾ inches	7 inches
Main battery	8—13.5-inch guns	8—12-inch guns
Secondary battery	24—4-inch guns	16—4-inch guns
Torpedo tubes	5—21-inch	5—18-inch
Coal capacity	3,500 tons	2,500 tons
Total cost	£1,950,000	£1,530,000

The *Lion* will be propelled by four screws, actuated by Parsons turbines. The turbines are designed to give 70,000 horsepower, and are placed in two compartments, separated by a center line bulkhead, watertight from keel to protective deck. The machinery is so arranged that there is in each engine room one high-pressure and one low-pressure main ahead turbine, one cruising turbine, one high-pressure and one low-pressure astern turbine. The high-pressure ahead and the high-pressure astern turbines will drive the outer shafts, while the cruising and the low-pressure ahead and low-pressure astern turbines will drive the inner shafts. There are four propeller shafts, with one three-bladed propeller on each, and the propellers are of manganese bronze, cast solid. The two outer ones are placed about 20 feet forward of the two inner propellers, and they are all arranged to turn outboard when the ship is going ahead. Steam will be generated in forty-two watertube boilers, arranged in seven groups of six each. The fuel capacity is about 3,500 tons, and this will give the ship a wide range of action. The engine rooms will be provided with the most up-to-date auxiliary machinery, including main circulating engines, main air pumps, evaporators, distillers and fire and bilge pumps. The propeller shafts pass through the hull and are exposed for a considerable length, each shaft being supported in very large cast steel struts of the "A" pattern, without any out bossing of the hull. The stern has a very long overhang for housing the two rudders, which are of the balanced type, and unsupported outside the hull. This double rudder system of steering has proved a great success, and is being adopted in all the latest English battleships.

The *Lion* was set afloat at Devonport Dockyard on Aug. 6, 1910. The difference between the original "battle cruisers" and their successor is almost incredible. The mounting of the main battery is entirely novel. Four guns are paired on the center line forward, the second two firing over the first two; then come the single tripod mast and two funnels. The third pair of guns, also on the center line, is between the second and third funnels, and the last pair of guns is mounted aft in the usual way. There will be a short mast behind the third funnel for signaling. The secondary battery will be mounted in the superstructure, and there will be a notable absence of bridges. The diagonal arrangement of placing the 13.5-inch turrets has been abandoned in this ship.

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BRONZE CASTINGS

This Bronze composition is particularly adapted for Modern Marine Service, and is rendered tough, strong and uniform by the incorporation of Vanadium, which is considered the greatest of all scavenger alloys, imparting to the metal greater wearing qualities. This bronze is ten per cent lighter in actual weight than any other bronze casting of the same pattern.

These castings can be forged.

The structure is close and clean, capable of withstanding high pressure for valve service.

A cylinder 9-16 of an inch thick, three inches in diameter and fifteen inches long has been subjected to a pressure of nine thousand pounds.

TENSILE STRENGTH on 1" Section:
56000 to 65000 lbs. per square inch.

ELASTIC LIMIT:
22000 to 34000 lbs. per square inch.

This metal is used in submarine vessels in Japan, Austria, Russia and every vessel of this type in the United States.

VICTOR VANADIUM
NON-CORROSIVE SILVER METAL

This Metal is non-corrosive and is particularly useful for sea-going service.

It finishes to a silver color and takes a high polish whose lustre can be maintained quite readily by simply rubbing, adding greatly to its usefulness and effect as ornamental hardware for marine use

It is an ideal metal for propellers, for it withstands salt water and all vegetable and mineral acids, nitric acid excepted. It is of great strength and toughness and should be used for valves and couplings for fire apparatus on account of its non-corrosive qualities, in place of nickeled castings, as nickel finally peels off, and this metal not being plated, cannot peel.

TENSILE STRENGTH:
66000 lbs. per square inch.

ELASTIC LIMIT:
36000 lbs. per square inch.

This metal will be found indispensable to marine service when once used.

WRITE FOR CATALOG

VANADIUM METALS COMPANY
FRICK BUILDING
PITTSBURGH, PENNA.

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A TWIN-SCREW OIL BARGE.

The Harlan & Hollingsworth Corporation of Wilmington, Del., have designed and built for the Pure Oil Company of Philadelphia a twin-screw power lighter for coastwise and canal service. The vessel is 100 feet over all, 93 feet on the waterline, 23 feet beam molded, 12 feet 6 inches depth molded, and is designed to carry 90,000 gallons of oil in bulk and, at same time, a deck load of from 250 to 350 barrels of oil on a draft of 10 feet.

The hull is built entirely of steel, the only exception being the pilot house and captain's room. She is divided transversely by eight steel bulkheads. Four compartments are intended for liquid cargo, and one of them is fitted with hatches so that any other cargo can be carried; an expansion trunk is fitted over the first three which carry liquid cargo only; a longitudinal bulkhead divides each hold and each has the necessary manholes, ventilators, sounding holes, etc. The cargo hatches have oil-tight covers, vents and sounding holes. Peak buoyancy tanks are provided at each end of the vessel, the pump room being located abaft the aftermost cargo tank. A 24-inch cofferdam abaft the pump room prevents any leakage of oil from holds, pumps, or gasoline from tanks, finding its way into the engine room, where the pumping, electric lighting and propelling machinery is located.

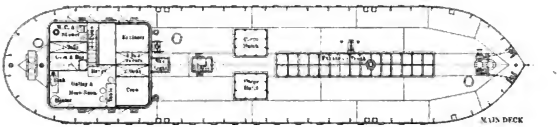
The pumps are of the rotary type and are each driven directly by independent engines located in the engine room, through shafting passing through the cofferdam. The pump room is entered from the deck by a steel skylight booby hatch, having an iron ladder. Deck lights and vents are also fitted over pump room.

A steel deck house is located over the engine room, giving entrance to the latter and also providing accommodation for the engineer, crew, cook, toilet and kitchen. This house has a steel roof. Two down-cast vents, one uptake vent, a steel skylight, with emergency escape and deck lights, are provided for the engine room.

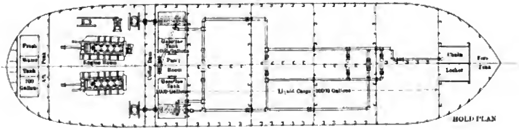
Two independently constructed tanks, each containing 1,000 gallons of gasoline (petrol), are located in the pump room for supplying the propelling, pumping, electric and hoisting engines. An independent fresh-water tank is located in the aft peak and contains 700 gallons. A force pump in the kitchen draws from this tank and fills the auxiliary tanks for the kitchen sink, toilet room and hot-water heater. A deck hand fire pump and a Fairbanks rotary gasoline (petrol) driven deck fire pump are installed, the latter being driven by means of a sprocket-chain attachment from the hoisting engine.

The kitchen is fitted with a range, sink, dressers, mess table and an Ideal heater, supplying hot-water heat to all quarters and the pilot house through suitably-placed radiators.

Metal berths are fitted in all living quarters, with metal lockers for the crew, the officers having wood drawers and desks, the floors being covered with linoleum. The toilet room has an asbestolith floor and is provided with a shower. Brass-framed sidelights are fitted to all rooms in the deck house, pilot house and captain's room, having sliding windows.



MAIN DECK



HOLD PLAN

The pilot house has the usual compass, clock, speaking tube and gong and jingle communication with the engine room, also a hand-steering wheel and drum, with rope leads and purchase blocks to the steering tiller. The rudder is of cast steel of the balanced type, the weight being carried at the main deck, while an extension stock reaches to the tiller at the top of the deck house.

The vessel is equipped with a square-sterned metallic lifeboat, having hinging davits, stockless anchors and anchor crane, towing and mooring bitts, pump brake windlass, fog bell, hose, life preservers, ring buoys, McLaughlin fire pails, etc., as required by the United States Inspection Service. Electricity is used for lighting the vessel, also for the running and towing lights; portables are provided for the holds, etc. A heavy wood pole mast and cargo boom, with stays, shrouds, guys and cargo fall, with the necessary blocks, are provided, also jack and ensign staffs.

The propelling machinery consists of two R. H. and L. H. four-cylinder, four-cycle engines, built by James Craig of New York. The cylinders are 9 inches bore by 10 inches stroke, and are capable of developing between 75 and 100

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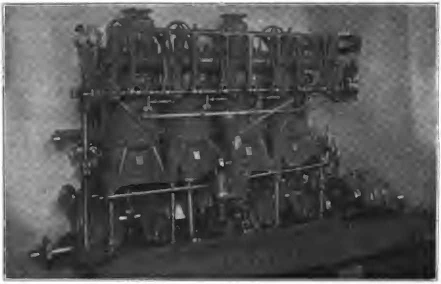
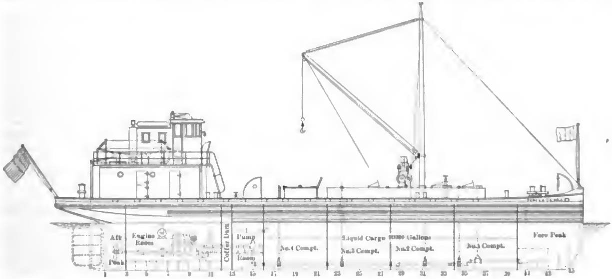
horsepower. The cylinders are separate and mounted on forged steel finished columns. Make-and-break ignition contained in detachable bronze plugs is provided with means for varying the timing of the ignition when engines are in operation. Nickel steel inlet and exhaust valves are contained in the cylinder heads, and all are mechanically operated. Forged



ONE OF THE CRAIG ENGINES.

steel finished crank shafts and connecting rods, bronze rotary circulating water pumps, a bronze governor and hand-control speed device and carburetor, all suitably arranged to properly control the engine speeds, are fitted. The cylinders, cylinder heads and exhaust pipes are properly water jacketed, carefully machined and fitted. These engines are fitted with a very superior and powerful friction reversion clutch and thrust-



bearing outfit. Each cylinder is fitted with an independent cylinder oiler and connections. There is a mechanical oiler and copper tubing for oiling the pistons and wrist pins. There is also provided on the working side of the engines a suitable oiling manifold, valve devices and copper tubing for oiling the main bearings and crank pin boxes. All the main bearings and crank-pin boxes are babbitted with the best genuine babbitt metal, peened, bored and accurately scraped to fit the crank shafts. All the cams, rollers, etc., for operating the inlet and exhaust valves and igniter mechanisms, are made of the very best tool steel finished and hardened.

These engines are designed with a lower main exhaust port, controlled by a mechanically-operated valve device, permitting the exit of the exhaust only, and the valve is closed on the suction stroke of the piston. By this means the heat conditions of the engines are properly attended to, as 90 percent of the heated and burned gases pass out through this lower exhaust port. This arrangement also has the advantage that no valves are opened against any great pressure, and the regular exhaust valves in the cylinder heads are not enveloped by any great heat, also the wear and tear on the valve mechanism is greatly reduced, thereby insuring smoother operation and longer wear of the engines.

The cylinder heads are fitted to the cylinders by means of a recessed joint and copper gaskets, and bolted down by six 7/8-inch-diameter steel studs and nuts. The circulating water passes from the cylinders to the cylinder heads by means of

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copper tubing and special outside connections, thereby eliminating any possible water leakage to the cylinders.

The propeller shaft is of steel, bronze lined, and is supported at its outer bearing by a strut. The propellers are of bronze. Air compressors are arranged and operated by the engine, with suitable air reservoir, whistle and pressure gage, all complete, the exhaust piping and muffler being carried up through an uptake vent abaft the captain's room.

The pumping machinery consists of two rotary pumps of the Fairbanks make, together capable of pumping 30,000 gallons per hour against a head of 30 feet. The gasoline (petrol) engines, which drive these pumps, are separated from the pumps by a cofferdam and are connected directly to the pumps by a driving shaft, passing through the cofferdam. The engines are water-cooled, and are provided with the usual starting devices, mufflers, etc.

The hoisting engine is also of the Fairbanks make, located on deck and protected by a permanent shield. This engine is fitted with a single drum, having an overhauling device, and is capable of hoisting without the aid of a purchase a load of 500 pounds at a rope speed of 150 feet per minute. This hoister, by means of a sprocket-chain connection, can operate a centrifugal deck fire pump, and the anchor windlass also.

The stems of the valves for the liquid fuel suction pipes are carried through the tops of the cofferdams and operated by a wheel. The general layout of the piping is shown in the illustration.

This vessel was designed for a speed of about eight miles per hour, and went into service early in January.

At the annual meeting of the National Marine Engineers' Beneficial Association, which was held in the Planters' Hotel, St. Louis, Mo., Jan. 16 to 20, the following officers were elected for the coming year: National president, William F. Yates, New York; first national vice-president, Art Hyde, Cleveland, Ohio; second national vice-president, George H. Bowen, Port Huron, Mich.; third national vice-president, Charles N. Vosburgh, New Orleans, La.; national secretary, George A. Grubb, Chicago, Ill.; national treasurer, A. L. Jones, Detroit, Mich.

The convention adjourned on the evening of the 20th, to meet at Detroit, Mich., January, 1912.

The Repair of a Worn Plate and a Leaky Joint.

Engineers who are stationed away from home have frequently to encounter a good many difficulties which would be rather outside the experience of those who live and work near our great mercantile marine centers. For one thing, the means and appliances of repair are not available at out-of-the-way ports, materials are very limited, labor is oftentimes unskilled, and, in many cases, time cannot be spared to accomplish more than a makeshift repair. Such a position calls for a considerable amount of independent action and a quick eye to see the possibilities of a most unpromising situation. Such minor matters as, for example, a knowledge of Krooboy's lingo and a working acquaintance of methods of persuasion adapted to the untutored mind, are taken for granted.

As an example of the difficulties which happen in unfrequented ports may be mentioned the case of a plate very badly worn and a joint leaking on a ship's side midway between the load and light waterline. This occurred on a large steam lighter (1,000 tons), and the cause of the trouble was due to the continued rubbing of the lighters against the craft, and also against other steamers. The effect of this was that the rivet heads and the edges of the plate were worn down, causing it to break away at the seam.

This happened when the ship was busy loading. As soon as the leakage was noticed the ship was listed until it was cleared of the water and loading operations had, of course, to be suspended until the leak could be repaired. The opening of the seam extended for about six feet, and it was also seen that the plate was very badly worn locally. In order to effect a repair, a piece of plate about 8 feet long by 2 feet 6 inches wide was obtained and joggled slightly, or given a set along its lengthwise center line. Holes were then drilled in the ship's side where they could best be placed for rivets, and the plate was fitted, marked off and punched with a hand punch. The holes could, of course, have been just as well drilled, as the tackle was available; but it seemed to be a longer job. The plate was then bolted up onto an insertion joint laid along the outside of the ship. After the cargo had been lightened more holes were drilled through both the plate and the ship's side, rivets were secured and a permanent repair was made of the job. Of course, before riveting, after the removal of cargo (at the end of the trip), the insertion joint was removed because in order to make a permanent repair it was necessary to calk the plate at all its edges.

THE MECHANICAL HANDLING OF FREIGHT.*

BY S. B. FOWLER.

STEAMSHIP TERMINALS.

Turning to steamship or water-borne freight terminals we find the same conditions as at railway terminals of too great cost in handling goods, and too little space for the present traffic without even considering the future. The congestion present at a busy pier and the long delays experienced in delivering or receiving shipments are well known. The manager of a large teaming company in New York told me not long ago that a wait of two or three hours at the pier was not unusual, and he had known of instances where a team had waited an entire day and at the end came away without its load.

The excessive costs of handling freight form an important part of the total costs as in railway transportation. The lack of sufficient capacity for handling the merchandise, together with the slowness of manual handling, made slower still by the congestion and consequent rehandling, causes the delay.

Speed in loading and unloading vessels is of the greatest importance, for, differing from railway transportation, the vehicle for carrying freight is one large unit, and all goods must wait until the last box is loaded. The motive power also lies idle during this wait. The motive power in railway transportation is in small units, all of which can practically be in use while cars are being loaded. The interest on the large investment represented by a modern steamship, while idle in the dock a day or so, often is an important factor in the profits of a trip. The steamship terminal differs from a railway terminal in that it is necessarily of less area, and a combination terminal as well. Over the same pier floor is handled all classes of inbound, outbound and transfer freight at the same time.

In the use of machinery at docks this country is far behind Europe. All large ports of Great Britain and of the Continent are well supplied with cranes of one sort or another; some ordinary pillar cranes, other movable cranes along tracks parallel with the pier. Such apparatus, however, does not constitute a true mechanical freight-handling equipment, nor does it perform the operations required of such an installation. Its horizontal transporting movement is rather limited and does not reach inside the sheds. The use of hand trucks at these ports is still practiced extensively.

It has been the custom recently to attribute the great efficiency of these ports and their lower cost of freight handling to the handling machinery there installed. The cranes princi-

* From a paper read before the American Society of Mechanical Engineers, New York, January, 1911.

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pally serve to hoist or to lower loads into the ship's hold, which is done in this country by the ship's tackle. Unless these goods are taken direct from railway cars or placed at once on cars or teams they must be taken away from or delivered to the cranes by hand trucks.

The difference in cost of unloading freight at San Francisco and at Hamburg is only about 10 cents per ton, taking the average of all goods handled at Hamburg. San Francisco has practically no machinery and Hamburg an ample supply of modern cranes. Labor is much cheaper at Hamburg, but even this is not the main advantage. Sixty-two percent of all freight entering the port of Hamburg does not pass over the piers at all. The vessels tie up at moorings in the harbor and transfer their load to so-called Rhine boats, placed alongside, hoisting and lowering with the ship's tackle—the cheapest possible way of transferring merchandise.

At the water terminal the methods of loading are practically two in number: (*a*) Direct transference to vessel from other water craft, railway cars or teams; (*b*) delivery of goods to pier and later transference to vessel. In this country the second method is generally used, direct transference being practically only from lighters used in a transfer of freight from another terminal. The usual operation, therefore, involves a large amount of handling, and much moving of small loads on trucks. Goods received at the pier are transferred to hand trucks, taken to the scales or else measured, then moved to some predetermined location and removed from trucks to be again loaded and trucked to a point where the ship's hoist can reach the load, which is then lowered into the hold. With the substitution of transporting machines much greater loads can be moved from the vehicle delivering and at much greater speeds, taken over track scales and automatically weighed, moving on to the location desired or direct to the ship's hatch, and immediately lowered into the hold. The elimination of manual labor is entire except in removing from cars or teams to the carrier, and if in the latter case the merchandise is loaded on flat boards placed on the bed of the wagons, even this handling can be done away with.

The method of unloading may be either by (*a*) direct transference to the vehicle which will move it from the pier or dock, or (*b*) direct discharge to the pier and later reloading to boat, railway car or team. In the case of coastwise traffic either method may be adopted. On the other hand cargoes from foreign ports must be handled by the second method because of the custom inspection. The advantages of employing transporting machines in unloading is apparent when contrasted with methods now in use.

The planning of overhead trackage for a water terminal is a simpler problem than devising one for a railway terminal, since while it must serve the entire area of the pier sheds as in a freight station it need extend outside only far enough to reach the holds of the vessel. Instead of the outside trackage being designed to allow for delivery or reception of goods from a hundred or more points, the only parts necessary to be reached are the hatches of the vessel, few in number. The direct trackage for reaching the hatches must be movable in a line parallel with the pier, and so arranged that they may be entered from any portion of a permanent track forming a loop or a series of intercommunicating loops, one side of which is outside of the shed.

Steamship freight is generally of larger bulk and greater weight than railroad L. C. L. freight, and necessarily heavier trackage and more powerful transporting machines and hoists must be provided. The consignments, however, are usually larger in quantity and much less sorting and classification is necessary, conditions favorable to the maximum elimination of hand labor. Rehandling by manual labor could practically be done away with, and if a direct transference between vessels and other transporting vehicles were made possible, the mechanical rehandling could be eliminated, since the transporting machine can hoist the load from the hold, carry it to the car or team and deposit it thereon. If necessary to deposit load on shed floor it can later pick it up without further rehandling and transport it to car or team or to vessel and lower it into the hold. The present cost of loading and unloading could be greatly reduced, and the capacity of the terminal increased by the handling of larger unit loads at greater speeds. The capacity could be further increased by a redesign of the terminal.

With a transporting machine stationed on the pier itself, doing the hoisting and lowering of loads, the variation of level due to tides could be ignored, since the cost of hoisting goods a few additional feet has no material effect on costs or time. Upper stories could then be utilized to advantage. As a rule a second floor is used only for warehouse purposes, with the result that all is confusion on the pier floor, due to wagons both receiving and delivering goods. In many cases the pier floor is divided longitudinally into two portions by a pit down the center, in which are placed cars for loading or unloading. Communication between these two platforms is maintained through the cars, and, if there is more than one line of them, by "spotting" them or by movable bridges.

It is suggested in the first place that no teams be allowed on the pier floor. The loads could be received or delivered at the end of the pier by the transporting machine, and the space required for the teams could be utilized for other purposes. It is also suggested that each pier shed be of two floors at least, the upper floor being better adapted for incoming merchandise, since the customs officials will then have the goods on a floor apart from everything. It is evidently as easy to transfer goods to this floor from the ship or to deliver them again to teams or cars as from the first floor. Cars to be loaded can be placed on tracks on the pier between the shed and the pier edge. The lower floor could then be reserved for outgoing freight, and tracks provided for cars to be unloaded. If desired these cars could be easily loaded through hatches in the floor of the second story. As the transporting machinery would operate on overhead tracks the cars inside or outside the shed would offer no obstruction.

It is claimed that the cause of the decline in water transportation is due to the limited facilities for receiving and delivering the goods as well as the costly delays at the terminals. If the installation of machinery and the redesign of terminals can obviate these objections will not both shipper and carrier be the gainers?

In concluding, the writer realizes that the subject has been treated in a general manner only. The problem is a broad one, and consists not merely in the installation of certain machinery, but in the study of the changes such an innovation will make in the entire operation of the transportation system as well as the effects on costs, rates and revenue. It is not simply the adaptation of an overhead, electrically-operated carrier system to the present arrangement of terminals, but rather a redesign of the terminals and a radical change in methods of carrying on the terminal business.

In solving this problem let there first be a realization of what changes mechanical freight handling might make possible, and then abandoning all old ideas and practices to take up the subject as an entirely new problem and work out the solution unhampered by tradition and prejudice. The subject deserves careful study and investigation. Every transportation company could afford, considering the economies that will be effected, to establish a separate department to work out this problem or to employ outside expert services for the purpose. The scope of such investigation and application is not limited to the mechanical and electrical features involved, but requires the services of men also familiar with all phases of the practical transportation problem.

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Just as we were going to press with this issue of INTERNATIONAL MARINE ENGINEERING our editor, Mr. Brown, slipped and fell, so injuring his head that he lay unconscious in the hospital for several days. We, therefore, ask indulgence for any mistakes or oversights which may occur.

The Modern Shipyard.

There is an old and time-worn adage that "clothes make the man," which, though not entirely correct, as we know, has some foundation in truth. The part that has foundation in truth might well be adapted to the modern shipyard by saying, "Equipment makes the shipyard."

That this statement can be questioned is evidenced by some older yards with antiquated equipment that have turned out, and still do turn out, good work economically, despite the equipment, due to the excellence of its management. On the other hand, it is undoubtedly true that other yards, with excellently arranged and modern, up-to-date equipment, sometimes fail to obtain the results expected. In other words, there are instances where equipment does not make the shipyard any more than clothes make the man; a shipyard may be a shipyard in spite of its equipment.

The truth of the adage is that, with equipment of the proper sort, the shipyard has a good start toward the results desired, and with this as a start, combined with intelligent and efficient management, the success of the yard is assured. That is the ideal that all yards are striving for—that is, correct mechanical equipment, combined with intelligent and efficient management. That this ideal is being more nearly attained every day is patent to all of us. The older yards are learning that they cannot attempt to compete with the modernly equipped yard, even with the best of management, without investing in more modern and labor-saving equipment, and the newer and more up-to-date yards are also aware of the fact that their good equipment is only one step in the right direction and, combined with this, they must have the most able management.

With recent demands of naval development and the growing size of merchant vessels, shipyards have required the latest and most efficient machine tools that the manufacturer can produce. The average lay mind scarcely realizes the size of the work that machine tools and other equipment are required to handle. In many instances the work is of such size that it is found easier to bring the tool to the work rather than the work to the tool. For work of this character some really remarkable tools have been designed, in some cases permitting large castings to be accurately machined in many places at one setting, thereby reducing the problem of handling to a minimum.

Elsewhere in this issue will be found descriptions and illustrations of several modern and up-to-date shipyards of various countries. The descriptions, though necessarily short, due to limitations of space, tend to show how shipyards in all corners of the globe are securing equipment and efficiency for handling work that leaves little to be desired. The work of a shipyard is so much more diversified and of a greater magnitude than the ordinary industrial establishment that it is probably impossible to equal them in the matter of standardizations and low costs. The organization and supervision of shipyard economics cannot be reduced to an exact science in repair work, but it is interesting to note how various yards in different countries are each by independent methods reducing the art of shipbuilding, whether it be a steam yacht, freighter, ocean liner or battleship, to as near an exact science as human ingenuity can make it.

The engine and boiler rooms of a modern ocean liner or battleship contain generating equipment that would dwarf any but our largest stationary plants; but this forms a smaller mechanical problem than the machinery by which these are made as well as the machinery by which the vessel itself is made. The success of the modern yard is, in no small measure, due to the marvelous development of machine tools, both in this and other countries, for all classes of work to be found in a shipyard.

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THE CONTROL AND EQUIPMENT OF WATER TERMINALS.*

BY H. MCL. HARDING, CONSULTING ENGINEER.

Waterways are supposed to be public highways, but with the terminals under private and corporate control they are more like toll-roads with a bar and a collector at each end—free between the gates but restricted at the ingress and egress. Channels alone do not give transportation. They are only efficient when combined with adequate terminals, properly equipped with transshipping machinery and storage facilities.

Terminals are as important as channels. In fact it may be said that terminals control the channels; hence the control of the terminals means the control of the waterways. This fact should never be forgotten and should therefore be of no little interest to all civic communities. They should preserve for future public use the few wharves and piers not yet beyond their control, and in addition should further develop the unimproved terminal frontage of harbors, and unused portions of the river bank near cities and towns. Wherever possible terminals should remain in the control of either the city or State or else in a joint harbor commission composed of representatives of each.

It is to be noted that various harbors in Europe are under the control of harbor boards which are public or semi-public organizations and a majority of the directors may be considered as officials who are responsible to the State or public authority. While there is a great variety of harbor management in foreign countries, yet it may be said that with a few exceptions they are under the control of a board selected wholly or in part by the government.

In the United States, the Federal Government has expended, and is still expending, enormous sums annually in maintaining and improving channels, and it seems as though the cities and sections of the State benefited should provide and equip the terminals which afford the only path for the movement of freight to the waterways. Although a large proportion of the water frontage has been diverted from public to private or corporation uses, yet the locations that remain can be made far more efficient by the installation of proper freight handling machinery, which machinery will not only transfer the freight between the vessel and the shore, but also carry it overhead to the hinterland, where there can often be obtained ample room for the receiving of the freight from the shippers, and the storing of freight waiting for railway transportation or for the drays of the consignees. The freight can move equally well in both directions. Back upon this rear land can be erected warehouses and buildings of several stories and freight can be carried by overhead conveying a distance of several thousand feet at less expense than it costs by manual labor to take from the vessel and assort upon the near-by pier floor.

It is well to consider the whole significance of the above statement as to the performance of such machinery. It means that a vessel can be loaded or unloaded in one-half, or less, of the time consumed at present; that as freight does not have to be stored upon the pier, the drays need not come upon the pier or shed floor; that a much smaller pier will do the same amount of work; that there will be an avoidance of congestion; that the expense of handling will be greatly reduced. To sum up, that upon a narrow wharf or pier with a narrow bulkhead it will be possible to more than double the pier capacity and reduce the time of handling to less than one-half. This will increase the efficiency of the pier more than four times.

A roadway at the head of the pier or even railway tracks, even when along the river bank, will not prove any barrier to the transference of freight to or from buildings or space beyond the roadway or tracks, as all movements being overhead the freight can pass above cars or street traffic without any interference and with the greatest economy. It costs but little more by properly designed conveying machinery to transfer freight five hundred feet than it does fifty, and but little more also to deposit the freight in the second or third story of the warehouse than it does in the first. The buildings, however, should be so designed and constructed that the machinery can be installed to the greatest advantage.

It has been the custom almost universally abroad for the cities or government to install this machinery and to charge commerce sufficient for its maintenance. On account of this we see the important ports of Europe equipped with many kinds of machinery, thereby greatly facilitating the transference of all kinds of freight. Machinery, such as a gantry crane, will pick up all kinds of freight of every description, whatever may be the size, shape or weight. Such freight is hoisted from the vessel, placed in the railway cars upon the pier, or else swung upon the platform in front of the sheds.

It is interesting to note that there is not anything which enters into the cargo of the ship, which contains every thing which ministers to the necessities or luxuries of man, which cannot be handled by machinery. While the gantry or jib crane is doing excellent work, its in-reach is limited and it cannot take the freight, assort, carry, deposit and tier it upon any square foot of floor of the pier shed, warehouse, while simultaneously other carriers can be hoisting, conveying and following each other so closely that there would be no waiting or delay. The new installations of machinery do this, effecting a saving of at least seventy percent in labor.

In a paper recently read by Mr. John Llewellyn Holmes, before the Institution of Civil Engineers of London, he states that "In time, dock companies will be expected to provide plants not for discharging and loading but for conveying from and to the ship's side as quickly as possible." That is to say, the freight must be conveyed to and from any portion of any of the receiving sheds or warehouses, even though they be located at quite a distance from the ship's side.

The State or city which owns terminals should equip and own the machinery for thus transferring freight. It greatly increases the efficiency of its property. The ship-owner or lessee cannot be expected to do this except where there is a long lease. Otherwise terminal companies with properly restricted authority should be found for this work.

In the report by Mr. F. W. Cowie, Chief Engineer of the Harbor Commissioners, one of the highest authorities on terminals, it is stated that:

"At a recent engineering convention, one of the most eminent engineering authorities made the statement that the weak point in the railway transportation systems of North America was their terminals and that the most important weakness of the terminals was the lack of freight handling appliances.

"When it is considered that in the Montreal harbor sheds the quantity of actual freight handled annually amounts to over two million tons, it is apparent that any material saving in the cost of handling freight would immediately show beneficial results to the port."

It is to be noted in this report, that Mr. Cowie has already installed freight handling machinery and has recommended the equipment of new piers with mechanical appliances. All important railways have as a part of their transportation systems water terminals.

There are many precedents for city owning and controlling water front terminals. The port of New Orleans extends nearly fifteen miles along the Mississippi River. The State of Louisiana owns practically all the water front with the exception of 4,760 feet, owned by the Illinois Central Rail-

* Many of the facts stated in this article are taken from the Report on Terminals by Herbert Knox Smith, Commissioner of Corporations of the United States.

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way Company, and this is subject to expropriation by the State.

The wharves and sheds at Preso street were built by the New Orleans and North-Eastern Railway. These have been expropriated by the State. The wharves and sheds of the Louisville and Nashville near Erato street have also been expropriated by the State, to be effected in 1915.

The State also owns nearly six miles of public wharves, most of which are covered by steel sheds. The river front of New Orleans is administered by two State Boards. First: The Board of Commissioners of the New Orleans levee, which has a right to acquire land and build levees.

Second: The Board of Commissioners of the Port of New Orleans, that prescribe rules for loading vessels and controls the commerce obtained by the public wharves. The public Belt Railroad Company Commission, a municipal body, has control over the New Orleans public Belt Railroad.

The public wharves are built from the height of the levee outwards. By December 31st, 1909, there were twenty-two public wharves that had been thus constructed.

San Francisco has a water frontage of 4¾ miles for commercial purposes. The total length of the wharfage is over 12 mile exclusive of bulkheads. The sea-wall and the seawall lots are owned by the State of California and are under the control of the State Board of Harbor Commissioners. The entire construction, ownership and control of the piers from the bulkhead line outwards to the pier-head line are in the State through the Harbor Commissioners, who also control and operate the Belt Railroad.

A small proportion of the piers and docks of San Francisco is owned and operated by private individuals or corporations. The Harbor Commissioners are directed to construct and maintain wharves and transshipping facilities and dredge docks as the wants of commerce shall require, and may enact reasonable regulations concerning the management of the property of the State. They fix the rate of dockage, wharfage, cranage of these wharves, etc., and collect the revenues therefrom.

So far as can be ascertained, only two piers along the water front are owned by private parties.

In March, 1910, out of 176 tenancies granted by the Commission of San Francisco on wharves and portions of the seawalls, exclusive of ferry houses and slips, 167 were on a thirty-day tenancy called assignments. These monthly assignments give merely a preferential use of the assigned wharf space, which is open to others when the tenant is not using it. The above system practically results in open wharves along the active water front, available for use by any vessel at rates fixed by the Commission.

The policy of New York City is to own the piers along the water front and to retain them. The present policy is to reduce the length of the leases. Baltimore has also commenced to construct piers and to afford facilities for the unobstructive flow of commerce.

No merchant marine can be effective, even though heavily subsidized, unless the cities provide terminals properly equipped with the latest and most modern transshipping machinery, warehouse with reasonable charges, railway connections, and a proper harbor board to see that no unnecessary charges are imposed upon commerce.

If a vessel cannot quickly find a convenient berth for loading or discharging its cargo, the time lost and the expense of handling the freight greatly nullify other advantages. The ports of Europe are open to vessels of all nations. They are fully equipped with machinery and offer inducements to all to make use of their ports. Even in the same country there is commercial rivalry between its different cities. Bonds are issued for the construction and the equipping with suitable mechanism.

In most cities of the United States there exist paved streets along the water front for freight movements, but the freight cannot get to the water's edge except bp permission of private or corporate interests and upon such terms as they may dictate. If cities can purchase and acquire land for the streets, should not the termini of these streets, being also the terminals of the waterways, be common to all with proper charges equivalent to the taxes on land?

The following quotations briefly sum up the situation:

"The commercial future of the city is dependent upon its port facilities.'

"Transportation efficiency is a terminal problem."

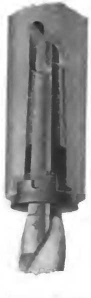
"'He who can most economically and quickly reach the markets of the world can control the commerce of the world. A decrease in transportation expense not only facilitates commerce but creates commerce and manufacture."

ENGINEERING SPECIALTIES.

A New Drive for Flat Twist Drills.

The questions connected with using and driving twist drills, forged or twisted from flat bars of high-speed steel, are probably receiving more attention from mechanics at the present time than any others connected with the use of tools. Although attempts to solve the problem of drive have been numerous—complicated chucks have been designed to hold and drive the rough end of the flat bar of steel; the shank ends of the bars have been spirally twisted and machined to form taper shanks fitting regular taper sockets; more or less cumbersome taper shanks have been soldered or riveted to the shank ends of the flat twist drills—none of these methods has seemed to settle the matter beyond the possibility of further question.

The Cleveland Twist Drill Company, of Cleveland, Ohio, has recently applied for patents on a new device for driving flat, taper shanks that are tapered both on the flat sides and round edges. These shanks are regularly furnished on this company's Paragon flat twist drills, and are driven by sleeves or sockets internally equipped with flat taper holes, accurately fitting the shanks and externally tapered to fit standard taper sockets or spindles. In the case of large diameter flat twist drills having No. 6 shanks, this drive was found to have cer-



tain disadvantages, as it made necessary the use of cumbersome extension reducing sockets to adapt the large taper shanks to the drill press spindles, which seldom have a taper hole larger than No. 6. To overcome this difficulty as well as to provide additional driving strength is the twofold object of the new device.

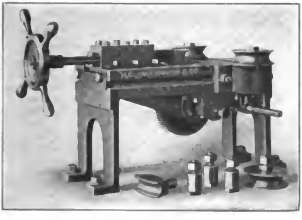
To this end both the No. 5 and No. 6 Paragon shanks have been redesigned the same length as regular taper shanks, the taper on the round edges being regular Morse taper as formerly. When, therefore, this modified shank is inserted directly in the spindle the upper end of the shank is received and driven by the driving slot in the spindle just as is the tang of an ordinary taper shank drill. This alone would constitute a strong and practical drive but for the lack of support the shank would have on its two flat sides at the lower end of the spindle. To provide against the resultant possibilities of vibration and wear between the shank and spindle, and to furnish a powerful additional drive at the lower end of the shank where its cross sectional area is greatest, a new and original type of socket, called the Paragon Collet, has been evolved.

As shown in the illustration the collet consists of two lugs projecting upward from a flattened disc through which is cut a rectangular hole to receive the Paragon shank. The lugs have rounded outside surfaces ground to standard taper and flat inner surfaces tapered to fit the flat taper shank. The groove is provided to receive the point of a drift key in case the collet should stick in the spindle. When the collet is on the shank the combination is practically an interchangeable taper shank with unusually long tang.

The additional drive is provided by means of an extension projecting (upward in the case of vertical drilling) from the circular base of the collet. This projection mortises into a slot cut across the end of the spindle conforming to the standard slots now being put in the spindles of heavy-duty drill presses by several well-known manufacturers. That this tongue-and-groove drive at the large end of the shank is very much stronger than any drive on the tang could possibly be is made evident by a single glance at the figure. The collets without this extension will fit any spindle or socket, and will be furnished to those whose spindles are not fitted with slots when this requirement is plainly specified, but they will, of course, not have the additional driving strength otherwise afforded.

Power Bender and Straightener.

This machine for bending pipe, structural iron, round and flat bars of various kinds and sizes has been developed after considerable experience with different types of mechanical appliances in this field. It is capable not only of bending but also of straightening material in a quick and decidedly efficient manner. Instead of requiring a multiplicity of dies or formers, as in most machines, it is only necessary to have on this machine a set for the different diameters. These may be set in different locations and permit of bending an infinite variety of shapes as well as radii. It is belt driven, with a tight and loose pulley on the shaft. The ram is actuated by an eccentric shaft of small throw and moves with a fixed stroke. The shaft is powerfully back-geared, giving the ram a tremendous power. Sliding in this reciprocating ram is another which carries the former to be used, and this is moved in or out by a screw operated by the hand-wheel. This gives a very delicate means of adjustment in manipulating the work and bending to the exact requirement. Any number of pieces can be bent exactly alike by noting the last position of the hand-wheel. But little skill is required to operate this machine; there is no complication and nothing to do but move the pipe along and turn the hand-wheel to suit the requirements. The formers or resistance studs on each edge of the bed slide in a "T" slot, and "T" slots are also made across the bed so that formers can be fastened therein and thus allow of many different arrangements. The machine is manufactured by H. B. Underwood & Company, 1025 Hamilton street, Philadelphia, Pa.



UNDERWOOD BENDER AND STRAIGHTENER.

Lighting Steamship Piers.

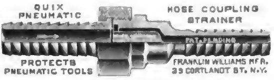
Owing to the nature of the work on steamship piers and the quantity of labor frequently employed, good light is very necessary. Various illuminants have been tried, probably the most recent being the flaming arc lamp, which is used on account of its great brilliancy. An excellent example of such illumination is afforded at the new pier of the Fabre Steamship Company, foot of Thirty-first street, Brooklyn, N. Y. This is probably the largest pier in New York Harbor, 1,476 feet long, 150 feet wide and 35 feet high. Being only one story in height, it is lighted during the day by means of skylights. In the autumn and winter it becomes necessary to make use of artificial light as early as four o'clock, and not infrequently during the day in cloudy weather. The system which has been in operation about three months consists of twenty-four flaming arc lamps, twenty-two of which are hung inside the building and the other two outside. The lamps are in two parallel rows, eleven in each row; are hung about 120 feet apart, and the distance between the rows is 50 feet. Current is taken from a 2,200-volt, 3-phase, 60-cycle alternating-current transmission line, stepped down to 115

PIER ILLUMINATION.

volts by a transformer. The lighting is controlled by five control boxes, so wired that three of them control four lights each and two of them six lights each, the lamps being connected two in series. It was thought at first that the elevated platform would throw such a heavy shadow as to make the proposed plan of hanging the lamps quite impossible, but the lamps, which hang about 50 feet from the platform, throw such a penetrating light as to almost entirely overcome all shadows. This lighting system was furnished by the Western Electric Company, New York.

Quix Pneumatic Hose Coupling Strainer.

In the use of pneumatic tools considerable difficulty is experienced by loose pieces of foreign matter entering the delicate mechanism. To overcome the loss of time and expense caused by this, the "Quix" combination hose-coupling strainer

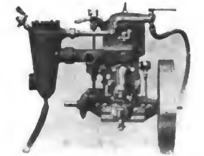


QUIX HOSE STRAINER.

was designed. It is a substantially made brass hose coupling fitted with a renewable wire strainer. This strainer is deep and cup shaped, and has ample area between its sides and the inner walls of the male end of the coupling, so that an accumulation of dirt will not reduce the air passage until the strainer is filled. These strainers are manufactured by Franklin Williams, 39 Cortlandt street, New York.

A New Exhaust Silencer.

The accompanying illustration shows the "Hydrex" exhaust silencer, as adapted to internal combustion engines. It is claimed for this silencer that a clean, free exhaust is obtained



HYDREX ENGINE SILENCER.

without detriment to the free flow of gases. The gases are led out from the cylinders gradually with increasing expansion and completely relieved of their heat by even admixture with cold water vapor until, when exhausted through an opening in the boat side above the water, practically all noise and odor are removed. It is claimed that this device is adaptable to any size or type of motor, with either two or four cycle, and can be placed in any convenient position in the boat. This silencer is manufactured by the Hydrex Silent Exhaust Works, 126 Liberty street, New York.

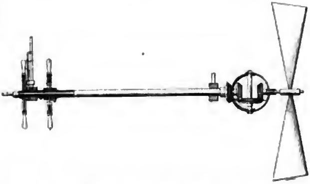
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

974,961. GEARING FOR PROPELLERS. WILLIAM A. HALL, OF LOSS ANGELES, CAL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN AERIAL COMMERCIAL COMPANY, OF LOS ANGELES, CAL., A CORPORATION OF ARIZONA TERRITORY.

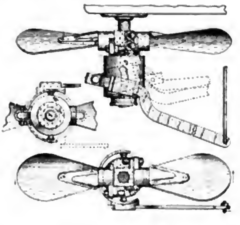
Claim 1.—Two yokes pivoted together, a driven shaft in one yoke, a bevel gear on said shaft, an idle gear carried by one of said yokes meshing with the first gear, a driving shaft journaled in the other yoke, a



bevel gear on the driving shaft meshing with the idle gear, a segment gear on the yoke which carries the driven shaft, an intermediate tube attached to the other yoke, an outer tube, and a gear on the outer tube meshing with the segment gear. Six claims.

975,039. REVERSIBLE PROPELLER FOR BOATS. PERCY W. HODGKINSON, OF ROCHESTER, N. Y., ASSIGNOR TO CHARLES D. CAMP, OF ROCHESTER, N. Y.

Claim 1.—In a propeller for boats, the combination with the blades, of controlling mechanism therefor embodying a pivotally mounted re-



versing yoke arranged wholly in the rear of the blades and on the propeller shaft. Twenty-five claims.

977,976. UNDERWATER EXHAUST AND MUFFLER. JOHN O. SMITH, OF CLEVELAND, OHIO.

Claim 2.—An under-water exhaust fitting comprising a chamber to receive the exhaust, said chamber decreasing in depth as it progresses toward the rear of the fitting, a plurality of tapered ports or openings

along the top of the chamber at each side thereof, a plurality of baffle plates within the chamber and associated with said porta or openings to deflect the exhaust therethrough, and a port or opening in the bottom of the chamber. Four claims.

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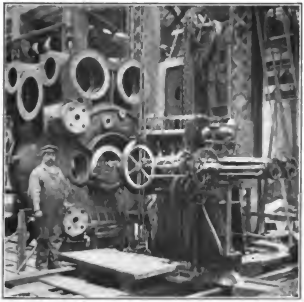
SHIPYARD EQUIPMENT SUPPLEMENT

In the following pages may be found the latest information concerning some of the most useful and efficient tools used in shipyards

With the rapid development of the modern steamship the question of mechanical equipment for shipyards has become a paramount one. The main generating units of some modern ships have a horsepower far beyond any single units built for stationary service. The size of this machinery is, however, not as wonderful as the tool equipment necessary to handle this machinery efficiently and economically. From the structural work of the framing and the plating of the hull to the final installation of the engines, boilers and other mechanism that go to make up the propelling, operating and controlling machinery of the modern vessel, is represented the product of the best and most powerful machine tools that human ingenuity has devised.



NILES-BEMENT-POND HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

The machine and plate shop work is of such size and character as to present an entirely different problem from ordinary machine shop operations. In many cases the work is so heavy that it is found desirable to bring the tool to the work, and for this class of work special tools have been devised that permit the casting to be drilled, bored, or milled, as the case may be, at one setting and with a minimum handling cost. The increasing size of engines, whether reciprocating or turbine type, calls for heavy special tools. In no other industrial establishment can be found such large and diversified numbers of tools, from the foundry to the machine shop, including the smallest of precision tools to the largest-known types of boring mills, lathes, planers, etc., and to the plate shop, with its numerous bending rolls, shears, punches, hydraulic presses, etc., that must be able to handle plates and shapes of the largest-known size. This brief statement clearly shows how closely linked is the shipyard with the machine

NILES-BEMENT-POND HYDRAULIC GARBOARD BENDER.

tool designer and builder, and the following brief mentions give some idea of recently designed shipyard tools:

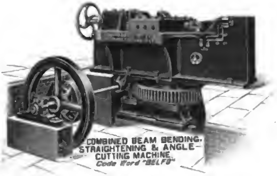
A useful horizontal boring, drilling and milling machine, built by the Niles-Bement-Pond Company, New York and

PERKINS & CO., LTD., POWER HACK SAW.

London, is shown at work on a low-pressure marine engine cylinder. All the facing, milling, boring, drilling and tapping operations on this cumbersome casting are done at one setting.

The wide range of horizontal and vertical adjustment of this type of machine, together with the large number of variable spindle speeds and feeds, makes it indispensable for this class of work.

Heavy plate-bending rolls were installed in the plate shops of the Newport News Shipbuilding & Dry Dock Company by Niles-Bement-Pond Company, capable of bending cold plates up to 32 feet wide and 1½ inches thick or their equivalent.



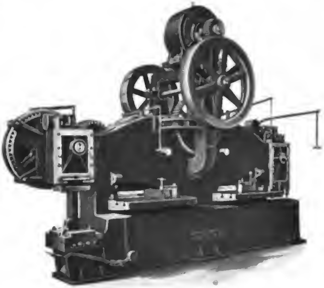
BERTRAM, LTD., BEAM BENDING AND ANGLE CUTTING MACHINE.

They have been used to bend heated nickle steel plate up to 2½ inches thick.

A plate-planing machine is a typical example of one of the fundamental machine tools built for shipyards by the Niles-Bement-Pond Company The heavy power splitting shears to be found in every plate shop cut the plate to the approximate width required, after which the plate planer is relied on to produce a square straight edge. The carriage is driven by a heavy screw, the direction of rotation of which is changed automatically at the end of each stroke. The drive is by wide open and crossed belts on pulleys of large and equal diameter. The tool slides on the carriage are arranged for two tools, which alternate in cutting the plate with the change in direction of the stroke.

A 125-inch crank shaft lathe designed for turning the heaviest crank shafts is another Niles-Bement-Pond tool. It is 26 feet long between faceplate and tailstock center, the diameter of the journal being 17¾ inches and that over the rings 27 inches. The maximum diameter which can be swung over the bed is 125 inches, while 108 inches can be swung over the carriages. This machine is shown at work on the thrust bearing of a large shaft on editorial page, 107.

The Niles-Bement-Pond hydraulic garboard bending machine is capable of turning out a very large variety of plate shop work entering into the construction of steel vessels, such as bending and forming keel plates, garboard streaks, sponsons, deck plates, etc. The machine is capable of exerting a pressure of 200 tons, with a water pressure of 1,500

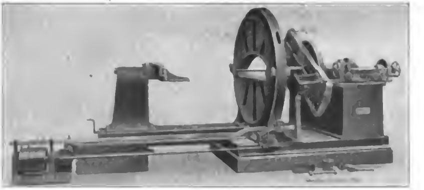


UNIVERSAL SHEAR FOR CHANNELS, ANGLES AND PLATES. MADE BY THE COVINGTON MACHINE COMPANY.

pounds per square inch. Hot plates up to 3 inches thick and the length of the bending beam can be handled. The bending beam will carry one or more forming dies, with a length of 18 feet.

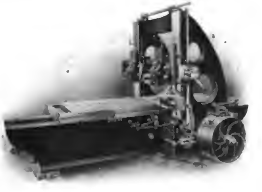
This company sends upon request a 20-page fully illustrated folder of shipyard tools.

A machine that can cut channels and angles is made by the Covington Machine Company, Covington, Va. It is a combination tool. The feature of this shear lies in the combination of four tools in one. It is provided with a coping attachment at one end, a plate shear at the other, and two angle shears in the center of the frame. These angle shears operate at an angle of 45 degrees, thus securing a vertical and horizontal shearing action. Each shear is controlled by its own clutch, and the machine may be operated by different groups of men, all working at the same time without interfering with



GREENWOOD & BATLEY TURNING, BORING AND DRILLING MACHINE.

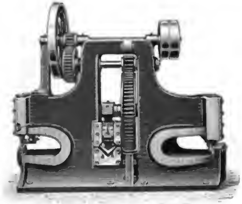
each other. The angle shears in the center have a capacity for cutting channels up to 15 inches by 3/4 inches, and 6 inches



C. REDMAN & SONS 3-FOOT SQUARE PLANING MACHINE.

by 6 inches by 1 inch, or 8 inches by 8 inches by 3/4 inch angles. The plate shear has a capacity for material up to 1 inch in thickness. Channels or angles may be cut either square or at an angle for mitering.

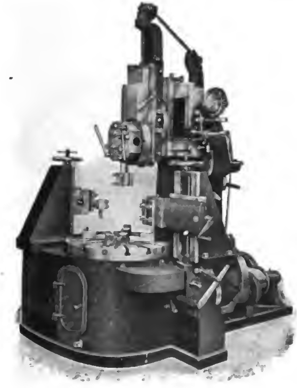
Messrs. Scott Bros., Halifax, have placed another design of punching and shearing machine on the market. It is a beam-bending machine or straightener, combined with punching; punching plates at the one side while bending or straightening T, L, H, U sections at the other end. The machine is capable of punching 1-inch holes through 1-inch plates, with gap 28 inches deep, and at the other side it bends or straightens sections up to 12 inches by 12 inches. In addition the punching side, besides doing ordinary punching, may be arranged for punching section iron with loose interchange-



WARD, HAGGAS & SMITH DOUBLE-ENDED PUNCHING AND SHEARING MACHINE.

able blocks, so that H iron, U or T's may be punched through the webs or flanges.

An improved beam and angle-bending and straightening and angle-cutting machine is made by Messrs. Bertrams, Ltd., Edinburgh. This machine is of the under-driven type, with the gearing beneath the floor. Beams up to 12 inches by 6 inches can be bent or straightened at one end of the machine, and angles up to 8 inches by 8 inches can be cut at the other end. The beam-bending slide carries two bending blocks or hammers, arranged at a suitable distance apart, by which the



G. WILKINSON & SONS VERTICAL TURNING AND BORING MILL.

HENRY BERRY & CO. FIXED RIVETER.

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beams are bent or straightened over a third block, which is adjustable by screw and hand wheel. The other end of slide is connected to a heavy cast steel lever carrying angle-cutting blade, the stationary blades for angle cutting being fitted into a suitable recess in main casting. A tumbler disengaging gear is applied to the angle-cutting lever, so that angles may be easily set in exact position under the blade before being cut off.

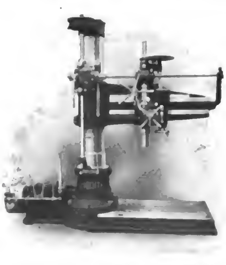
SCOTT BROS. PUNCHING AND SHEARING MACHINE.

A portable hydraulic angle or ship frame bending machine is manufactured by the Leeds Engineering & Hydraulic Company, Ltd., Rodley. This machine is capable of exerting a total pressure of 19 tons and can be made to suit any working pressure. The section to be bent is placed on the floor plate, which is provided with a number of holes; the operator then pushes the machine up to the section, the fixing bolt is dropped in the nearest hole, and the valve, which can be actuated by either hand or foot, is opened to pressure and the ram advances to bend the section into the desired shape.

F. Pratt & Company, Ltd., Halifax, manufacture an improved crank-geared shaper. The ram slides freely in its guide by means of a crank motion, which gives a quick return stroke. Adjusting strips are provided for taking up all wear. The stroke and also the position of the ram can be altered while the machine is running. A graduated rule and indicator is fitted to show the length of the stroke at a glance. Shafts can be passed through the body of machine under the ram for grooving and cutting keyways.

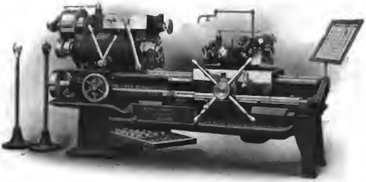
SCRIVEN & CO. ANGLE BAR PLANER.

White's patent angle-bar planer is manufactured by Messrs. Scriven & Company, Leeds. The machine is used for planing off the round edges of angle bars to leave a square edge for calking. It is capable of dealing with any size of angle bars up to 12 inches by 12 inches by 1 inch thick, planing both legs of the



WILLIAM ASQUITH, LTD., RADIAL DRILLING MACHINE.

F. PRATT & CO. IMPROVED CRANK-GEARED SHAPER.


ALFRED HERBERT, LTD., HEXAGON TURRET LATHE.

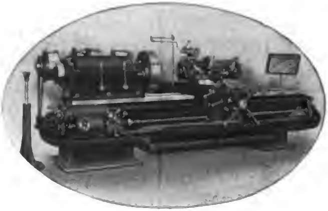
bar simultaneously. The angle bar is fed through the machine by strong steel friction rollers and requires no setting, but can be planed just as received from the rolling mills. The gripping pressure of the feed rollers is obtained by a system of levers operated by strong screw with large hand wheel and safety spring device. All the friction rollers are positively


J. BENNIE & SONS PNEUMATIC RIVETER.

driven by spur gears from one main-driving shaft. Angle-bar planers of the same general design, but with capacity for angles up to 10 inches by 6 inches only, have been in use for many years in the British and principal foreign navy yards, also in many of the most important contractors' yards.

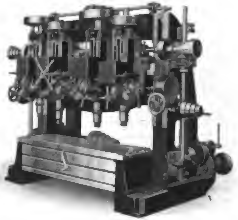
A combined beam-bending angle-cutting and vertical punching machine is built by Messrs. Craig & Donald, Ltd., Johnstone. This type is arranged with the hammers adjustable as to their centers by means of right and left hand screws. The adjustment for the various depth of beams is made from the hand wheel at the end of the machine actuating the gear which lengthens or shortens the moving ram which carries the striking hammer. This arrangement allows for the straightening of the smallest section of bars. For vertical punching a special steel die holder is arranged.

G. Wilkinson & Sons, Keighley, have a new model vertical turning and boring mill made in two sizes, 2 feet 6 inches and


POLLOCK & MACNAB "APOLLO" HEXAGON TURRET LATHE.

3 feet. The chief improvements claimed are the adjustable automatic knock-off for the turret head traverses, the piston-driven feeds, and the method of locking the turret head. There are three tools, all of which can be in operation at the same time.

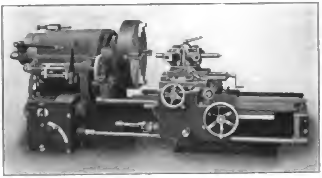
A type of pneumatic riveting machine which has found favor with engineers of the United States is now being manufactured in this country by Messrs. James Bennie & Sons, of Cardonald, Glasgow. The machine, known as the Hanna riveter, made by the Hanna Engineering Company, Chicago, is claimed to be free from certain well-known defects, notably the variation in pressure, and to approximate to the direct-acting hydraulic type in regard to certainty of operation. The design of the machine in this case enables the closing of the rivets to be effected at constant pressure in spite of any slight variation in length, and a further advantage of the machine is that it requires only 80 pounds to 100 pounds pressure, and that the employment of an exhaust pipe is obviated. As compared with the hydraulic machine the consumption of power is stated to show an economy.



WEBSTER & BENNETT DRILLING, TAPPING AND BORING MACHINE.

A high-speed central thrust girder rotary drilling machine is manufactured by William Asquith, Ltd., Halifax. Some of the features of this drilling machine are that the spindle slide is so arranged that the thrust is central, entirely overcoming side-twisting strains, and the slide can be easily and quickly traversed along the arm and securely locked in any position.

Alfred Herbert, Ltd., Coventry, manufacture a hexagon turret lathe especially designed for utilizing to their limit modern cutting tools of high-speed steel on work made from steel, iron or bronze bars. Some of the new features of this turret lathe are the single-pulley head in place of the cone pulley—a so-called "roller steady" turner, which removes the metal much more rapidly than was previously possible, and a feed motion that allows of a quick change of feed.



J. LANG & SONS CAPSTAN LATHE.

NILES-BEMENT-POND PLATE PLANER.

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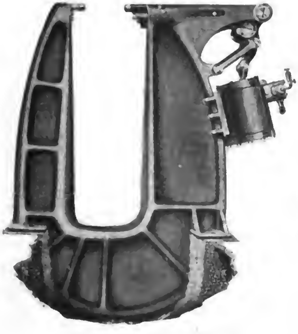
Messrs. John Lang & Sons, Johnstone, make a specialty of lathes, and have recently redesigned their entire line to meet the demands of high-speed steel. One of the special features of these lathes is a variable speed drive that has a gradual progression. With this form of drive the correct speed may be had for turning any diameter within the capacity of the lathe.

A four-spindle drilling, tapping and boring machine is manufactured by Webster & Bennet, Ltd., Covington. This machine is designed for boring two separate pieces of work at once, and for this reason the right-hand pair of heads is independent of the left-hand pair, and the machine is suitable for operating on four separate pieces of work.

Messrs. Perkins & Company, Ltd., Leeds, are marketing self-acting, sliding, surfacing, and screw-cutting lathes, valve seat planing machines, slotting machines, shaping machines, disk grinders, etc. The shaping machine has an automatic variable feed motion, which is instantly reversible, and the toggling is kept horizontal by a sliding tenon.

A machine is manufactured by Messrs. Robert S. Allan & Company, Gateshead-on-Tyne, for core boxes and patterns, as well as all kinds of carving at various angles, half-lapping, molding, raised and sunk paneling, etc. The machine consists of two parts mounted on a common bedplate, the fixed



HANNA ENGINEERING CO. BOILER RIVETER.

pedestal carries the horizontal spindle and is bolted to the bedplate. The second part forms a work carrier and is so designed that it embodies universal movement.

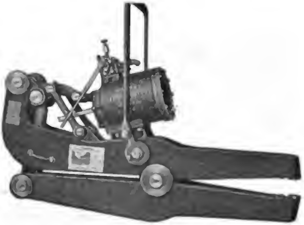
The high-speed planer, manufactured by Bateman's Machine Tool Company, Ltd., Leeds, has two special features—the sliding rack and the flywheel drive. The sliding rack effectually absorbs the shock of reversal in buffer springs, which instantly gives back to the table after the reversals stored momentum. The flywheel drive utilizes the stored energy of the heavy loose pulleys in securing exceptionally prompt reversals of the table.

Messrs. Loudon Bros., Ltd., Clyde Engineering Works, Johnstone, N. B., are builders of a high-speed planing machine from which one or two speeds can be obtained by a belt drive and three or six speeds through a gear box.

Messrs. Davis & Primrose, Etna Engine Works, Leith, are putting on the market a patent-beveling machine. This machine draws the bar out of the furnace and does the beveling when the bar is at its best heat. It smooths down the rough edges of the rivet holes, so that the rivet head gets close up at the neck. The time occupied by the beveling is short, so that the bar when it has left the machine is sufficiently hot to be turned without reheating.

A self-contained high-speed planing machine is built by Messrs. C. Redman & Sons, Halifax. These planers have four cutting speeds, ranging from 30 to 60 feet per minute, the speed changes being made without difficulty when the machine is in operation. This has the advantage of allowing the operator to run the machine at, say, a speed of 50 feet per minute on cast iron where the frailty of the casting makes a light cut at quick speed better than a heavier cut at lower speed, and also for second cuts preparatory for a finishing cut. The speeds are changed from the floor by means of the pulley chain. The change can be easily and quickly made, the rate of return of the toggle remaining constant.

The Hanna Engineering Works, Chicago, Ill., have developed a pneumatic riveter, which operates through a combination toggle and lever action so arranged that the rapidly increasing tonnage developed during the action of the former is maintained practically uniform by the lever action through a



HANNA ALLIGATOR RIVETER.

considerable portion of the stroke. This machine goes through its toggling action during approximately the first 6 inches of piston stroke and carries the die through practically 3½ inches of its travel. At this point the machine has reached its rated pressure and the toggling action is automatically changed to the action which is maintained for the balance of the piston stroke, thereby maintaining the rated tonnage. These riveters are also manufactured by the Clyde Engine Works, Glasgow.

Messrs. Ward, Haggas & Smith, Keighley, Yorks, manufactures double-ended punching and shearing machines driven by double-purchase gearing shrouded to pitch line, pulleys of large diameter, the loose pulley being provided with improved lubricating arrangement, consisting of a hollow perforated bush which runs on the shaft and contains a month's supply of lubricant. In the 1-inch machine the flywheel is supported by an outside standard.

The accompanying illustration shows one of the very latest types of fixed riveters for shipyard, locomotive boiler and similar work, and was made by Messrs. Henry Berry & Company,

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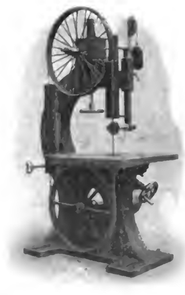
Ltd., of Leeds. The riveter has a gap of 17 feet 6 inches, and has three powers for closing rivets, viz., 33, 66 and 99 tons, and is also fitted with the latest valve arrangement when desired, by means of which the pressure is held on the rivet

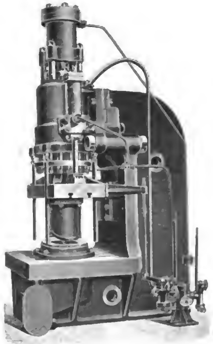


J. SAGAR & CO. IMPROVED BAND SAWING MACHINE.

for a time and cannot be taken off by the operator until it has been on for this period, thus insuring that each rivet gets the full power of the machine. The arms of the machine are of cast steel, and are held together by means of massive forged steel bolts with steel nuts. All the cylinders are gun-metal lined.

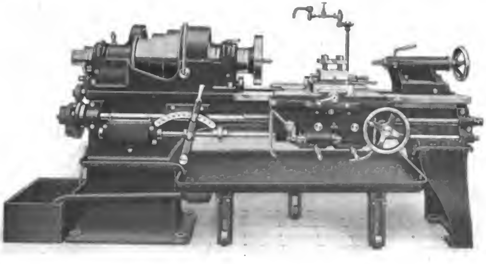
Messrs. Greenwood & Batley, Ltd., Leeds, make a combined machine for drilling, turning, etc., propeller blades, suitable for cutting off the riser or dead head, facing back of flange, turning edge of flange either straight or at any angle up to 45 degrees.

The "Apollo" hexagon turret lathes are manufactured by Messrs. Pollock & Macnab, Manchester. The head stock is of the single-pulley type, with gearing running in an oil bath, and



MUSGRAVE BROS. HYDRAULIC PRESS.

has sixteen direct-spindle speeds from the line shaft. The jaws are in four parts and the chuck itself can be opened or closed while the lathe is running. The automatic feeds are actuated through an apron of the double-frame type, so that the feed wheels and shafts are supported in two bearings and not overhung. A special feature is that the worm drive for the apron has ball thrust, reducing the strain and wear on the feed wheels.



C. REDMAN & SONS SPECIAL LATHE.

International Marine Engineering

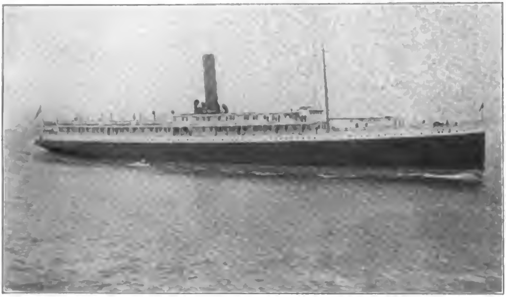
APRIL, 1911.

THE NEW STEAMSHIP MADISON OF THE OLD DOMINION STEAMSHIP COMPANY'S FLEET.

On January 31, the Newport News Shipbuilding & Dry Dock Company delivered from its works at Newport News, Va., to the Old Dominion Steamship Company the new steamship *Madison*, which was built for the latter company's daily passenger and freight service between New York and Norfolk, Va. In dimensions and general design the *Madison* is a duplicate of the *Jefferson*, *Hamilton* and *Princess Anne* of the same fleet, except that a few departures have been made where experience has indicated their advisability. The dimensions of the *Madison* are as follows:

Length over all	373 feet 7 inches.
Length on waterline	359 feet 4½ inches.
Beam, molded	42 feet.
Depth, molded, to hurricane deck	35 feet 6 inches.

The vessel, like others in the coastwise service, is of the hurricane deck type, and in general appearance is similar to the other vessels of the line, except that the shape of the stern is of the bay steamer type and not of the conventional ocean steamship type. This shape of stern was adopted by the owners as being better suited to their particular needs in docking at the terminals. It gives more deck space on the main deck for handling lines, and it also has the advantage of allowing the steam steering engine to be connected directly to the rudder stock.



NEW COASTWISE STEAMSHIP MADISON.

The vessel has a single bottom, three complete decks, and lower deck forward and aft of the machinery space. The entire hull is of steel, but the erections above the hurricane deck are of wood, these consisting of two tiers of deck houses and a shade deck extending from the stern well forward. The main and spar decks are completely plated, the former being a 17½-pound flush plated deck without wood covering, and the latter a 10-pound deck on which a wood deck is laid. The lower deck is laid with a calked wood deck except in the combustible storage space and over the fresh-water tank aft. The hurricane deck also has a calked deck forward of the over-all hatch, while aft of the latter there is a canvased deck. For the lower, main and spar decks the beams are of channel section, fitted generally on alternate frames. For the hurricane deck bulb angle beams are fitted on every frame in way of the calked deck, and wide-spaced angle beams with intermediate wood carlins are fitted in way of the canvased deck. Bulb angles are used for the transverse frames, and are spaced 24 inches centers throughout, extending from the center line to the main and hurricane decks alternately, except for a distance of 60 feet from the stem, where all frames extend to the hurricane deck. Reverse frames of angles are fitted across the top of the floors from bilge to bilge, and are doubled in the engine and boiler spaces. There is a flat plate keel, doubled throughout. The shell plating is fitted with raised and sunken strakes, with the heavy sheer strake located at the spar deck level, and the two strakes above of light scantlings. The vessel is subdivided by five watertight bulkheads.

The general arrangement of the *Madison* is well illustrated on the deck plans accompanying this article. From them it will be noted that there are passenger staterooms on the spar, hurri-

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cane and shade decks, the total number of regular first class staterooms being seventy-six, each fitted with two berths. On the spar deck forward of the boiler casing further accommodations are provided for sixty-four first class passengers in thirty-one staterooms. These staterooms are fitted up exactly the same as the regular staterooms, but the bulkheads enclosing them are made in portable sections, as these rooms are only used during the season of heavy passenger traffic. At other times this entire structure is removed from the vessel and stowed on shore. This space then becomes available for freight, or it may be used for the transportation of deck passengers, 276 portable standee berths having been supplied for use therein; or it may be used for carrying horses, portable horse stalls having been provided. Forward of this space in a separate compartment accommodations are provided for sixty steerage passengers; the berths in this space are portable standee, so that when desired they may be removed and the space used for freight. Forward of the steerage space in two separate compartments are provided permanent berths for second class passengers, there being accommodations for twenty-seven men and twenty-four women. A cabin for second class passengers is provided in a separate house on the hurricane deck, with stairways to the sleeping quarters.

Throughout the regular first class quarters all public spaces, passages, alcoves, etc., are finished in paneled mahogany, the latter wood being used exclusively for inside hardwood finish. In laying out the joiner work, consideration was given to the location of electric fixtures, radiators, etc., so that these fittings form an integral part of the design, the panels being arranged to suit. Special panels are fitted overhead in all the principal public spaces and in the captain's room. From the deck plans it will be noted that the main dining saloon is located on the spar deck, just aft of the engine casing, with a stairway at its after end leading up to the social hall on the hurricane deck. Directly aft of the dining saloon there is a lounging space, wherein are located a piano, bookcase, library table, etc. Abreast of this lounge there is a single row of staterooms on each side, three of the rooms having their interiors and ceilings paneled with composite board. Aft of the lounge, staterooms are fitted in double rows, and at the extreme after end there are the principal toilets, a bathroom, and a mahogany companion leading directly to the open hurricane deck. All staterooms on the spar deck, and those on the hurricane deck aft of the engine casing, have their doors opening from alcoves; the remaining staterooms have doors opening out on deck. An attractive feature in the upper saloon is a dome extending the full length of the saloon. The first class smoking room is located on the shade deck forward of the boiler casing, and forms a handsome apartment. It has a buffet attached, direct access to a toilet room and the wireless room, and has an inside stairway leading to a lobby on the hurricane deck. In the after end of the shade deck house there is located a dining room and also a smoking room for the use of colored passengers. In all the first class quarters and officers' rooms the exposed hardware is anti-corrosive, non-tarnishing white metal. The lavatories in all permanent rooms drain overboard. All first class toilets have mosaic tiled floors. Hard wood floors are laid in the smoking rooms, colored dining saloon, captain's room and officers' mess room. The decking in the first class dining room is finished bright.

MAIN STAIRWAY STEAMSHIP MADISON.

In the line of cargo-carrying facilities the *Madison* is equipped with all that the extensive experience of the Old Dominion Steamship Company has found to be suitable for their particular requirements. As customary in the coastwise service, most of the freight is handled by trucks through cargo ports. Of the latter there are four on each side between the main and

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spar decks and two on each side between the spar and hurricane decks, the main deck ports fitted with sliding watertight doors and the spar deck ports with hinged doors. Freight is also handled through an "over-all" hatch in the hurricane deck forward by means of two derrick booms on the mast. In the main deck, which is the principal freight deck, there are six hatches, of which three are arranged in pairs and fitted with freight elevators, each of which is operated by a vertical double 7-inch by 7-inch engine. For use with the derrick booms there are located on the spar deck two dobule-cylinder reversible link-motion 8¼-inch by 10-inch hoisting engines, the latter being also used in connection with a cargo crane at the hatch on the deck below. There are in all seven cargo cranes at the different hatches on the main deck, for the operation of which there are three 6¼-inch by 8-inch double-cylinder winches. On the lower deck aft of the engine room a special compartment, from which all wood is eliminated, is provided for the carriage of combustible stores. This compartment is fitted up with smothering pipes and sprays, as required by the United States Steamboat Inspection Rules. Another compartment for combustible stores is provided on the spar deck aft.

In the line of hull machinery, aside from that already mentioned, there is a steam windlass driven by a 9-inch by 10-inch double-cylinder engine, the windlass located on the hurricane deck and the engine on the spar deck. A capstan on the hurricane deck is also driven from the windlass engine. On the spar deck aft there are also two capstans, driven by an 8-inch by 8-inch double-cylinder engine. For the steam steering gear there is a Williamson patent differential steam steering engine, 7 inches by 7 inches, direct connected to the rudder stock and operated from the pilot-house by a hydraulic telemotor, as well as from a steering stand on the shade deck aft. The electric plant, located on the spar deck abreast the engine room, consists of two 30-kilowatt direct-connected generating sets. In the equipment may be noted eight 24-foot lifeboats, stockless anchors, an 18-inch searchlight and a wireless telegraphy outfit. The "Rich" fire indicating and extinguishing system is also fitted.

The propelling machinery consists of a triple-expansion engine and four Scotch boilers, fitted with heated forced draft. The main engine has cylinders 26½ inches, 44 inches and 74 inches diameter, respectively, and 54 inches stroke. All cylinders have separate liners, and are fitted with piston valves, of which there are two on the low-pressure and one each on the other cylinders. The valves are worked by Marshall gear, and the direct-acting type of steam reversing gear is fitted. The condenser forms part of the engine framing, and an Edwards air pump and two bilge pumps are worked from the low-pressure crosshead. All other pumps are independent. A feed heater is fitted. The propeller is a solid four-bladed one of cast steel.

The four main boilers are located in a single compartment, with a fore and aft fire-room, and are connected to one stack. Each boiler is 14 feet 3 inches diameter by 12 feet 5 inches long; has three 44-inch corrugated furnaces with separate combustion chambers, and is allowed a working steam pressure of 190 pounds. The total heating surface is 9,428 square feet, and the grate surface 242 square feet. For the forced draft there are two 72-inch Sturtevant blowers with direct-connected 6½-inch and 11-inch by 6-inch compound engines. These blowers are located in the boiler casing at the spar deck level, and discharge through air-heating boxes, provided in the uptakes, to the different ash pits. Special air supply ducts are fitted for the blowers, and a suction is also provided from the cargo space, thus providing an exhaust system of ventilation for the latter. Bloomsburg feed-water circulators are fitted to the main boilers.

A donkey boiler of the locomotive type, 7 feet diameter by 12 feet long, built for 150 pounds steam pressure, is located on the main deck level between the engine and boiler easings.

The hull and machinery of the *Madison* were built under special survey of the American Bureau of Shipping, with their highest classification for vessels in the coastwise service. The vessel is designed to maintain an average sea speed of 15¾ knots in service.

ONE OF THE SALOONS

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TWIN-SCREW YACHT LIEN-CHING.

A twin-screw yacht has recently been built to the order of Prince Tsai Tsun, head of the Chinese Imperial Naval Board, by the Kiangnan Dock & Engineering Works at Shanghai, China. The order was placed on the eve of Prince Tsai Tsun's departure for Europe a year ago with the Naval Commission that visited Great Britain, France and Germany, returning via Siberia early this year.

The principal dimensions are as follows:

Length overall	173 feet
Length on waterline	150 feet
Breadth molded	25 feet
Depth to shade deck	20 feet
Draft, mean	9 feet
Displacement	500 tons

The yacht has a cut-water stem, elliptical stern, and is schooner rigged, with two pole masts. As she is a fast boat, her lines are very fine, and with her graceful shear she presents a very smart appearance. She has been built to meet the requirements of the Chinese Naval Board.

There are six watertight bulkheads, which, together with the bunker bulkheads, subdivide the vessel into eight compartments. To insure rapid handling, the deadwood has been cut away, enabling the vessel to make the complete turning circle, both engines full speed ahead, in a diameter equal to less than twice her own length. Provision is also made to receive six guns for saluting purposes. Bilge keels are fitted for about two-fifths of the length of the vessel amidships.

GENERAL ARRANGEMENT.

There are three decks—the lower, main and shade decks. The shade deck forms a splendid promenade for passengers, extending, as it does, all fore and aft, with little deck obstruction. The boats are of the navy pattern, with extra heavy davits to receive naval launches when required. The boats are fitted, permitting them to be chocked fully inboard, or along the extreme edge of the deck. There is also a searchlight platform fitted to the foremast. Amidships on the shade deck there is a composite deckhouse, which not only contains the entrance hall leading to the main reception room, with a grand staircase to the main deck, but which accommodates the navigating officer. The roof of this deckhouse forms a spacious flying bridge, upon which have been placed a chart cabinet, brass steering standard twin telegraphs and standard compass; the bridge being used exclusively for navigating purposes. An observation deckhouse has been fitted aft on the shade deck over the imperial reception rooms, with a private staircase leading to the saloon. The floors of the deckhouse on the shade deck are covered with interlocking rubber tiles of pale blue and white. The sides or walls of the deckhouse are paneled in polished mahogany, and the ceilings and beam moldings are in paneled pine, painted a dull white with edging of gold.

Below on the main deck is a large steel deckhouse given over to the exclusive apartments for the Prince and containing his bedroom, bathroom and lavatory, his private reception room and saloon, pantry, secretary's room, servants' quarters, etc. The rooms are all arranged adjoining, giving easy access. The clerestory roof, with a dome skylight of beautiful design with stained glass, with the Prince's coat-of arms, serves to aid the natural overhead light, besides having a decorative effect and affording ventilation to the whole deckhouse. The floor is covered with thick interlocking rubber of a pleasing shade of green, and to relieve the plain ground Chinese rugs of the rarest fabrics of very elaborate design are installed. The walls of the Prince's apartments are finished in paneled Japanese dark colored oak, in bold designs, with carved capitals of cherry blossoms. The ceiling is of paneled pine, inlaid with lincrusta of a pale green color. The upholstery is of a rich, warm red silk, with window and door curtains richly embroidered to match, the whole combination making a pleasing and artistic effect.

Forward and around the engine and boiler casing are officials', officers' and crew's galleys, also the officers' mess room and deck staterooms. The forward part of the 'tween decks, on the main deck, contains the entrance to the dinning saloon below; with ladies' and gentlemen's lavatories on the wings at the after end, with two double doors, giving access to the main reception room. The reception room extends from side to side of the vessel and has six bays, which permit of being converted into living rooms at short notice if desired. The lounges, of the high-backed and wide type, are upholstered, as already described. Gun and revolver racks are arranged at sides of the staircase to the dining saloon. Arranged forward of the reception room is a ladies' boudoir, neatly arranged with carved writing tables and revolving chairs, lounges with handsome tables, with ancient carvings and comfortable easy chairs of fine rattan work and upholstered in keeping with the other furniture. Immediately below this, on the lower deck, is situated the guests' dining saloon, arranged with three large tables and handsome revolving chairs, capable of seating over thirty people. This saloon is neatly paneled and finished in white and gold, with the usual elaborate capitals and carved cornice moldings. The feature of this saloon is the airy, light and neat appearance it presents, although situated on the lower deck. Abaft this saloon are two roomy four-berth cabins for use of official deputies, finished in mail boat fashion; forward, the pantry is arranged and fitted with all modern utensils, and a trapway is arranged from the pantry communicating with the cold chamber.

NEW STEAM YACHT BUILT IN CHINA.

On the lower deck aft are the cabins for officers and engineers, finished in pine and situated behind the engine room, with double staircases, thus insuring a current of air in the passages. The petty officers are berthed in teak bedsteads, and the sailors and firemen are berthed, naval fashion, in hammocks.

The fore-and-after peaks are arranged for water ballast, and the fresh-water tanks are placed in the hold and lower 'tween decks, having a capacity of 1,500 gallons. The sanitary tank is placed above on the shade deck over the casing.

The galleys are large and complete with all modern utensils. The sanitary fittings throughout the vessel are of the best make. Each compartment or stateroom has an outlet and inlet ventilator placed at opposite ends, and with over thirty

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small portable ball socket fans distributed in the public rooms the foul air is exhausted.

MACHINERY.

The machinery consists of two sets of vertical triple expansion engines, 10 inches, 16½ inches and 26½ inches diameter, with a stroke of 18 inches, indicating about 900 horsepower. There are no pumps on the main engines of any kind, all cylinders are separate castings supported on steel-turned columns. The condenser is common to both engines, and is of steel plate, with the usual composition tubes and tube plates.

Main feed pumps in duplicate are of Weirs' latest type, with float tank and feed heater, the air and circulating pumps are independent of special design constructed by the builders. Tank, bilge and sanitary service pumps of the duplex type are fitted to suit the requirements.

The shafting is of Siemens-Martins' mild ingot steel, forged by the builders from ingots supplied by Messrs. Thos. Firth & Sons, Sheffield.

Two cylindrical multitubular Scotch boilers are installed, designed for a working pressure of 180 pounds per square inch, with Howden's system of forced draft on the closed ashpit system. The coal bunkers have a capacity of 130 tons.

The engine room telegraphs are of the Chadburn type and are fitted, in addition to the marine loud-type speaking tubes, with connections to various important stations.

The machinery for working the ship includes a combined steam and hand windlass made by the builders, and a steering engine fitted in the wheelhouse below the flying bridge, being also made by the builders. There is a complete installation of electric light. The power plant is capable of generating and supplying light equal to about 6,200 candle power, and for all signal lamps, fans, etc.

On trial the vessel made a mean speed of 13.597 knots with natural draft, and 14.26 knots with forced draft. During the trials the weather was unsettled, as a typhoon was in the vicinity and a strong wind was blowing, which considerably retarded the speed.

ENGLISH SHALLOW-DRAFT AMAZON STEAMERS

BY FRANK C. PERKINS.

Figs. 1 and 2 show the design of the steamer *Paso de San Lorenzo*, and its deck equipment as it sailed from Southampton recently. It is one of five vessels of somewhat unique feature, built for the Amazon trade.

These new South American shallow draft boats are destined to open up the interior of Argentina—particularly the rich region through which flow the Parana, Uruguay and Paraguay rivers. The resources of this country have been but feebly tapped hitherto, and it is the culmination of the general desire of influential Argentinas that the benefits should be reaped by their own country, which has seen the formation of the company Marina Mercante Argentina, for whom the vessels have been built.

It is stated that these five steamers have a very large carrying capacity on small draft, a load of not less than 730 tons being provided for on a draft of only 8 feet. The dimensions of the *Paso de San Lorenzo* are 220 feet length by 33 feet breadth, with a displacement of about 1,200 tons. The machinery comprises two sets of inverted triple-expansion surface condensing Thornycroft type engines, steam being supplied by two marine type return tube boilers. It is said that a speed of 10 knots mean is guaranteed, but this was exceeded very considerably on the official trials. The first boat actually ran at 11¼ knots as a mean of six runs on the Admiralty course at Stokes Bay, carrying the full load of 730 tons. The hull is built throughout of Siemens-Martin steel, and several powerful winches are installed on each ship, to facilitate handling the cargo, which, being timber principally, has had to be provided for by specially large cargo hatches. An electric lighting plant has been provided, and it is stated that the other

DECK OF THE PASO DE SAN LORENZO.

AMAZON RIVER STEAMER PASO DE SAN LORENZO.

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arrangements are such that the boats are particularly adapted for working in the very hot climates to be met with in the northern portions of the rivers.

It is understood that the first few vessels have steamed out to Buenos Aires without incident, though an exceedingly rough passage was made by the *Paso de Obligale* from Southampton to St. Vincent. Nevertheless, the whole journey occupied thirty-four days, the coal consumed being 40 tons less than was anticipated, and working out at the very economical figure of 1.87 pounds per indicated horsepower. The subsequent vessels, with more favorable weather, have reduced the time for the journey by several days.

SOME RECENT MISHAPS TO VESSELS.

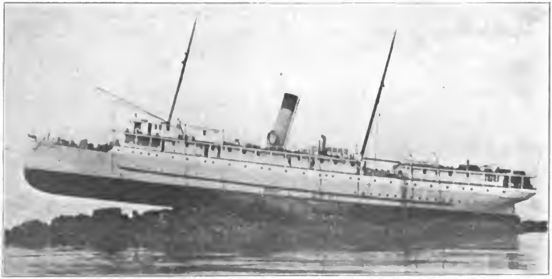
The steamer *Northwestern*, of the Alaska Steamship Company's fleet, ran ashore in False Bay, San Juan Island, at 2:40 A. M., Dec. 2, while bound from Seattle for Cordova. She took the ground at full speed, bringing up finally with her stem against the cliffs, twisting up her shell plating and breaking the stem bar. Her draft stranding was 19 feet 5 inches aft and 14 feet forward. At high water she lay aground for 50 feet forward, from which point the water gradually deepened to 8 feet under her heel, which took the ground at low water. Forward she was full of water, in the forepeak and No. 1 hold; the after-hold and engine and boiler rooms were dry.

The steamer struck on a shore fringed with rocks, extending shoal for 50 feet seaward. The water deepened rapidly to 30 feet at the stern and to 40 fathoms a cable off. The fractured plating, floors, frames and stembar lay hooked over several boulders forward. The stembar was broken and bent to the 15-foot mark, about twenty shell plates were crumpled, a portion of the keel bar gone, and several hold pillars and orlop deck beams bent. The after portion was apparently intact with the exception of the cross-section between the forehold and fire-room, which was slightly weeping. The diver's report showed a rocky bottom extending 50 feet from the cliffs, outside of which was a shingle bottom, sloping away on a 5 or 6 percent grade from a point 50 feet aft of the stem. From the stem aft for 50 feet the entire bottom was badly fractured and the keel bar gone, but after this the shell plating, stern frame, propeller and rudder were found undamaged. As her position was exposed to the strong winter storms which prevail from the south it required quick and effective work to save her from being broken up.

Salvage operations were conducted under the supervision of Capt. W. H. Logan, special agent for the Salvage Association of London, and Capt. S. B. Gibbs, representing the San Francisco Board of Underwriters. The contract for the work was

WHAT HAPPENED TO THE NORTHWESTERN.

let to the British Columbia Salvage Company. The salvors determined to build a platform or cofferdam to cover the damaged stem completely, and to make it of sufficient strength to take the vessel to Seattle for repairs, a distance of approximately 70 miles. The construction of this cofferdam was carried on simultaneously with the installation of three 10-inch pumps in the forward hold, the discharge of cargo and the transfer of coal to the after end. By Dec. 8 all the cargo, about 350 tons, had been discharged on lighters, dry and in good condition. Part of the general plan was to lay out astern a 4-ton anchor three points on the starboard quarter, with 120 fathoms of 5-inch wire hawser. By the time the cargo was discharged the cofferdam was completed, and about 150 tons of



PRINCESS MAY BEFORE SHE WAS SALVED

coal transferred from the side bunkers to the extreme after end of the 'tween decks.

This work was carried on only with extreme difficulty. Strong winds from the southeast set up a short swell, and in addition the ship's stern was rising and falling with the tide, causing her damaged stem to work up and down over the huge boulders, altering her shape and hindering the workmen at the bow.

The first effort to float the *Northwestern*, Dec. 8, was unsuccessful, and it was demonstrated that she bore too heavily on the rocks forward. This initial attempt to take her off was made by taking a heavy strain on the stern cables, with the tug *William Joliffe* towing and the *Northwestern's* main engines steaming full speed astern.

The next plan adopted was to put the vessel down by the stern and to continue lightering her forward. No heavy weights were left aboard, so 150 tons of gravel were ordered, while coal, estimated at 150 tons, was jettisoned from the forward bunkers. When this coal was out a second attempt to float was made at high tide Dec. 9, but again it proved a failure, as she was still bearing too heavily on the rocks. Jettisoning of coal was continued and the gravel was taken aboard. After careful consideration it was decided to flood the afterhold, and this was done with about 200 tons. The salvors were aware that it perhaps meant success or failure to get the vessel off Dec. 10, as the tides were taking off rapidly and the spring tides would not take place for eight or ten days later. During the interim the *Northwestern* would be in constant danger of being battered to pieces in a storm.

For these reasons supreme efforts were exerted Dec. 10, and they proved successful. The lifesaving tug *Snohomish* had a hawser to the steamer's stern and the tug *William Joliffe* was alongside. A strain was taken on the *Northwestern's* stern cables, and she drew clear of the rocks by the purchase exerted on her own anchors. The *Joliffe* held her one length astern until all moorings were clear, when she started under her own steam for Seattle, convoyed by the tug. This passage was made at slow speed, as it was feared the great strain to which the cofferdam had been subjected might have severely tested its strength. However, the *Northwestern* arrived safely at Seattle, exactly nine days after stranding. She was surveyed in Heffernan drydock, where the accompanying photograph was taken.

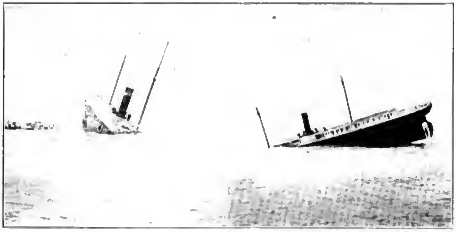
Capt. Logan has also achieved another success in the salvage of the Canadian-Pacific steamship *Princess May*, which went ashore on the north reef of Sentinel Island, Lynn Canal, on Aug. 5. Our photograph shows the difficult position in which this vessel was left by stranding. The photograph was taken at low tide, and at high tide the engine-room and dining saloon were completely filled with water. The stranding of the *Princess May* occurred while she was southbound from Skagway with eighty passengers and a crew of sixty-eight on board.

THE NEWPORT NEWS MISHAP.

No lives were lost and the vessel was successfully salved.

A very interesting illustration of the result of a collision of a wooden vessel is shown herewith. From it one is led to consider whether or not the light superstructure of river and harbor boats could not advantageously be bettered by the use of metal in its construction. The light nature of the woodwork is very noticeable, and the old comparison of "kindling wood" is certainly apt in this case. The three-cornered piece of the hull plating was not punched out, as at first sight might be supposed, but was ripped and crumpled up, as a little study of the illustration will show. The blow by the collision beginning at the forward end, the tearing of plating is indicative of considerable speed of the ramming vessel.

The steamship *Chatham* made an effort to cross over the end of the north jetty in the St. John's River, Florida, with the result shown in the accompanying illustration.



THE STRANDING OF THE CHATHAM.

RANDOM NOTES ON A LAKE FREIGHTER.

BY REAR-ADMIRAL CASPAR F. GOODRICH, U. S. N.*

Doubtless to many of my brother officers this brief article will seem like the proverbial bringing of coals to Newcastle, for they have lived upon the shores of the Great Lakes and have witnessed, if not the birth at least the development of its colossal shipping trade, but the rest of us have never enjoyed this great privilege and our notions, gained through casual report, must be, as my own were until recently, vague in the extreme. Having within the last few weeks enjoyed an opportunity of regarding this fresh-water system at close quarters, it would not appear out of place to lay before my fellows of the Naval Institute the fruits of my inquiries as embodied in notes made on the occasion.

Remembering the saying of the profane old English statesman, that there were lies, blank lies and statistics, I shall only remark that those who are in a position to know estimate the cargo tonnage which passed Detroit and the Sault Ste. Marie in the calendar year 1909, at seventy-two millions, more than three times as much as went through the Suez Canal, and more than twice as much as the total tonnage entered and cleared at the ports of Liverpool and London. Of this amount forty-two million tons were of iron ore brought from Lake Superior to ports on Lakes Michigan and Erie; and seventeen millions were of coal sent north. The balance was lumped under the head of general merchandise, or, as the local expression runs, "package freight." Surely such a vast movement justifies a few words touching the build of the ships that do the bulk of the work and the methods by which they are operated.

In the first place, it must be remembered that the season is ordinarily only eight months long. By the middle of December navigation is closed, to open again about the middle of April. It follows, then, that the most must be made of the period available, hence fairly good speed between ports and the briefest possible delay while at rest are imperative. These conditions having been frankly recognized, dominate the whole scheme. Confining my remarks to the transit of ore, I may point out the necessity at the one end of having that material in readiness on the ship's arrival and so stored as to be loaded into the hold with the utmost dispatch, and, at the other, of discharging it in the least possible time. It is of record that the *W. E. Corey* was, on one occasion, but an hour and a half at Two Harbors from the time of entering until leaving again, having in the meanwhile taken in some 10,500 tons, the exact loading time being thirty-nine minutes. This large cargo was taken out of her in four hours and a half. Such figures seem incredible until the appliances by which they are achieved are examined, when all becomes clear. The *Corey* made thirty-eight trips in one season and transported about four hundred thousand tons of ore.

In some ports a mammoth crane lifts an ore car from the railway tracks, swings it out over the vessel, capsizes it and shoots its 50 tons of ore down a hatch, but usually the ore is held in large bins 30 feet and more above the wharf. From these it is run down in steel chutes about 4 feet wide, semicircular in section, which are invariably 12 feet between centers, a constructional detail that, whether wise or unhappy, must be followed in the spacing of the vessel hatches. However long or short the steamer may be and however wide her hatches, as measured along her midship line, or however broad, measured athwartships, they are exactly 12 (or 24) feet apart from center to center, except where deckhouses intervene to make that distance an exact multiple of twelve.

The discharging apparatus is based on the clam-shell dredge, which is lowered into the hold to grab its charge, then elevated, swung back over the dock and emptied into gondola cars, or into carriers that convey the ore athwart the dock and dump it upon piles where is accumulated the winter's supply for the ravenous furnaces of Pittsburg, Cleveland and South Chicago. The latest shape this device has assumed is shown in the accompanying photograph. The long vertical member is kept vertical at all times by means of the movable levers, which, with the fixed upright, form a parallelogram. This arm carries the buckets, and can be raised or lowered at will. The buckets, moreover, are susceptible of turning in a horizontal plane about their vertical axis. Through these movements the buckets can rake up the ore in a nearly fore-and-aft line, form a heap and then gather up their huge charge of 15 tons at a hoist. The operator is stationed inside the vertical member at its lower extremity so that he descends with the buckets into the very hold of the ship for each load. Everything is done by electricity and so complete is the control that the buckets seem to be almost human as they search the corners of the ship and scrape the scattered ore together before seizing it in

THE J. PIERPONT MORGAN, ONE OF THE LARGEST LAKE CARRIERS.

* The United States Naval Institute Proceedings, No. 136.

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their capacious maws. Locally these machines are called Huletts, after the inventor.

The vessels we are considering are simply floating, self-propelled ore tanks and, as a natural sequence, the entire length is devoted to ore carrying except enough at the stern to contain the boilers, engines and a portion of the crew with their accommodations, and at the bow, more quarters, the wheel house, steam windlass, etc. When looked upon as an adaptation to a specific purpose they are admirable. In their general appearance, the beautiful has been sacrificed to the useful, as this picture of the *J. Pierpont Morgan* will abundantly prove.

The upper deck is flush from forcastle aft, broken only by the transverse hatches (in some cases thirty-six in number) fitted, in the later vessels, with steel covers that are not removed, but which, being telescopic, are simply pulled apart from the midship line by hook ropes taken to winches, the sections sliding over each other and occupying, when thus disposed, but little more room at the outboard end of the hatch than does one section alone. Stout tarpaulins and handy steel battens are always ready, as with us. During the summer they are seldom used, but he is a foolish captain who should fail to batten down securely, on leaving port during the late fall and early winter, for the lake gales come up suddenly and, at times, they are terrific in violence. The loss of certain freighters has been attributed to neglect of this particular precaution.

The engines are habitually triple expansion and the Scotch boiler is still the prevailing type. All lake freighters have but the single screw.

As a rule, the officers and crew are most comfortably quartered. Hammocks are unknown, berths being provided for all.

It is only in length that these vessels can be increased. The draft is inexorably limited by the depth of water at the shallow places between Lake Erie and Lake Superior to about 19 feet and 6 inches. The beam might be somewhat greater than the present maximum of 60 feet, the widest that can pass through the Weitzel (American) or the Canadian Lock at the Sault Ste. Marie,* were it not for the loading and unloading now based on a beam not exceeding 60 feet. To alter these would be so expensive an undertaking that we may believe the width of these ships as firmly fixed by man's own doing as is their draft by nature. These facts account for lengths which appear almost grotesque.

*The Poe (American) lock has gates 100 feet wide.

LOADING ORE BOATS AT LAKE SUPERIOR DOCKS.

STEAMER LOADING AT SOUTH SHORE RAILWAY DOCKS, MARQUETTE, MICH.

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Inside, the scheme of design is governed by the desire to make charging and discharging easy in the extreme. Thwartship bulkheads (except such as to divide the hold into separate watertight compartments) and stanchions are fast disappearing in favor of an arch construction which makes each hold an open box-like tank. The stresses on decks and keelsons, as the top and bottom members of the great fore-and-aft girder, must give the naval architects of the lakes much concern. Not being an expert in these matters I can only suggest that possibly the requisite strength in these respects is secured, in part, by carrying the double bottom well up on each side, and by making the spar-deck plates exceedingly heavy. These vessels survive the short seas on the lakes, but it is questionable whether they could ride in safety the longer waves of an ocean gale.

I noticed no trimming of the cargo, which is left in the comparatively low heaps formed by the dumping process. Experience has doubtless proved trimming to be unnecessary. Fortunately the material is heavy and not easily dislodged, else might a shift, when rolling deeply, prove fatal. The Marquette ores, being mined wet and full of jagged lumps, are thus presumably more stable than the earthy material quarried in the Mesaba region back of Duluth.

STEAMER J. P. MORGAN AT SUPERIOR DOCK, SHOWING UNLOADING MACHINES.

Most, if not all, of these freighters are provided with accommodations for a few passengers, since officials of the owning companies have occasionally to go in them on tours of inspection. During the summer months, a round trip from Lake Erie to Duluth or Two Harbors is extremely enjoyable and is coveted by many, both men and women, who possess, or think they possess, some claim on the owner or shipper. Hence, freighters though they be, they seldom go, at this season, without a full complement of guests. The quarters range from the bare comfort of a plainly furnished sleeping room and a seat at the table, where, often, all mess, except the firemen and deckhands, to handsomely equipped private suites and a separate dining room.

The personnel of the *Zenith City*, in which I was privileged to make the run to Marquette through the politeness of Mr. H. Coulby, the general manager of the Pittsburgh Steamship Company, comprised a captain whose salary may have been about $2,200 (£440) per annum, a first-mate at $130 (£27) per month; second-mate at $90 (£19), four wheelsmen and watchmen at $50 (£10); a steward at $90 (£19), an assistant at $36 (£7 4s.); a porter at $30 (£6); a chief-engineer at $175 (£35); one assistant at $125 (£25); one handy-man at $65 (£13); two oilers and four firemen at $52.50 (£10 10s.); six deck-hands at $31.50 (£6 6s.). This, by the way, is the usual complement. The steward is also the cook, and the food he prepares is the same for everybody, from the captain down. Excellent prog it is too—yet it is related that, on board one ship several years ago, before the introduction of "the open shop" and the defeat of the seamen's labor union, the firemen struck because the potatoes were not mashed. The passengers, in this case, happened to be a husky lot, who pitched in, shoveled coal and so brought the vessel into port.

Punishment is by fines, as it should be.

The men ship for the month, or for the round trip, and are paid by checks signed by the captain. As we have too often found among our recruits in the navy, there seems to be a lack of respect for the obligations of the contract of enlistment on the part of these freighters' crews, who make no bones of enlisting in ports of the lower lakes for the purpose of securing a free passage to Duluth and Two Harbors, where they desert at pleasure and take trains for the wheat fields of the Northwest during the harvest season, when wages are exceptionally high. This remark applies particularly to the deck-hands, whose work is almost *nil* while underway (they stand no night watch), and who are only really busy when in port, attending to the lines for moving the ship from empty bins to full ones or performing other services connected with the operations of loading and unloading.

It may be observed, by the way, that the absence of tide frees moving alongside the wharf from some of the inconveniences experienced in salt water and that frequent bitts on the dock stringer, together with steel lines, with permanent eye splices at the ends, worked from steam winches on the spar deck, reduce this maneuver to its simplest terms—tossing the end ashore, throwing it over a bitt and heaving in. The winches are four in number, two just abaft the Texas deck and two just forward of the after deck-house; two facing to port and two to starboard.

The language of the sea has suffered material modifications in its translation from the ocean to the lakes. For example: "Aye, aye, sir" has given way to "All right," "Ease your helm" to "Slowly," not to mention others equally significant.

Boatswains and their whistles are unknown. Men are called to meals by the "porter" or "assistant steward," who passes along the deck ringing a hand bell. This seems to be quite as effective as the cheery "pipe to dinner" of our service.

Some of the larger companies (the Pittsburgh Company reckons twenty-two barges and seventy-eight steamers in its

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fleet) are gradually introducing customs similar to those on ocean-going craft, such as striking the half-hours on the ship's bell and restricting promotion to men and officers in their own employ. The Cleveland-Cliff Company forbids the latter to appear on shore while attached to a ship in port, except in its prescribed uniform. That an improved *esprit de corps* will be effected by such measures admits of no doubt.

The helpless barge, towed by a collier, is passing out of existence. While an economical method of conveying freight in bulk, as the practice on our Atlantic seaboard abundantly proves, the annoyances attending locking through the Soo and getting alongside of dock, together with the risk of disaster in heavy storms when the freighter's power is barely sufficient for her own needs, have acted as discouragements. It cannot say whether the employment of stout, seaworthy tugs has ever been the subject of practical trial. Doubtless this has been thoroughly studied, or these barges, some of which carry eight thousand tons of ore, would not now be in process of abandonment.

As may be imagined, the storage of provisions and of potable water gives little concern, since the trips are but three or four days in length between terminals and the navigation is in fresh water.

The speed and all distances are measured in statute miles. About eleven miles an hour empty and ten miles when full seem the average.

The engines rarely develop over two thousand horse, which in heavy gales, when the ship is light and largely the sport of the winds, must cause some uneasiness. The latter inconvenience is neutralized by letting water into the double bottoms. The jet condenser is universal. Despite the poor vacuum it yields (say 22 to 24 inches), these vessels are very economical in fuel. The *Peter White*, with 1,560 horsepower, for example, gets one horsepower for 1.7 pounds of coal, and she burns but 270 tons during the round trip of six days, yet she carries 9,000 tons of ore. The *J. E. Upson*, of the same capacity, on the same coal expenditure, develops 1,950 indicated horsepower, and makes 12 miles an hour when light.

There are numerous instances of coal consumption of 1.6 per horsepower and even less.

An automatic feed replaces the water tender.

Electric lighting is the rule.

Naturally, external corrosion of the hull and fouling, the banes of our existence, are unknown. The interior of the vessel is either red leaded, as with us, or is coated with a special black mineral oil, which has proved both cheap and effective.

The steering engine is commonly placed under the wheel. It is, however, also found in the engine room—a better location, of course. I heard some complaint of the telemotor by which this engine is controlled from the pilot-house, and I gathered the impression that captains, as a rule, prefer to have the steering engine directly under their feet.

The handling of these long craft gave me a favorable impression of the skill of their captains. A tug was used at Ashtabula in getting clear of the dock and out into the open lake, but neither the captain nor I thought this assistance necessary on that occasion, however valuable when the wind is blowing fresh. At Marquette we ran alongside the wharf as easily as possible and tied up at once. I could have wished more difficult conditions in order to observe better the captain's dexterity, although I have no doubt of his successfully meeting any requirements.

Of navigation, properly speaking, there is no trace on the lakes, for land is in sight the greater part of the time, and determining the ship's position by astronomical methods is quite unknown. The nearest approach is in ascertaining the compass error by the sun's shadow, his true azimuth being taken from tables. On the other hand, coasting and piloting obtain. In the former operation I did not notice the strict keeping of the run, as is customary with us, and the plotting of the ship's place on the chart, from time to time, by means of cross bearings, bow and beam bearings and the like. Probably this precaution is thought unnecessary, so frequently do the captains pass over the same ground. That a risk is incurred by not following our deep-water practice I am disposed to believe. The time is always recorded in the log when certain well-known headlands, etc., are abeam, together with the reading of the engine revolution counter dial. The log book is most simply kept. It contains but the barest story of the run. There are no divisions into watches, and several days' proceedings may appear on one page. The columns are marked as follows, viz.: Date, time, place to place, distance off, time from last place, upper compass, lower compass, on the left-hand page; wind weather, revolutions last six hours, revolutions, place to place, remarks, on the other. Temperature and barometer heights are absent and the remarks column is mainly a blank.

In piloting these captains are at their best. So far as my observation went they are masters of this art. Much has been done by the Lighthouse Board to make the passages over difficult points absolutely safe; lighthouses, beacons and buoys abound. In narrow places the channel is marked by buoys on either hand, which are lighted at night. It is only a question of keeping between them. Indeed, once entered there seems to be no more difficulty in getting through than of walking down Fifth Avenue. Then, too, under the River and Harbor Acts the government has already spent some fifty millions of dollars (ten million pounds) in removing obstacles, building locks at the Soo and in cutting long straight channels miles long, sometimes through dry land, to replace the tortuous navigation previously encountered. Again, these artificial waterways are, not infrequently, two in number, that vessels may not meet in narrow waters—a double-tracked road, so to speak. In addition to the buoys, they are provided with range targets and lights, leading when in line directly down the axis of the channel and furnishing incidentally a rigidly exact method of finding the compass error on that particular heading. A convenient blank book suitably ruled is in use by these captains for entering the observed headings by the standard and steering compasses at no less than sixteen such localities on the Detroit and the St. Clavis Rivers and twenty-one on the St. Mary's River between Lakes Huron and Superior. There can be no excuse for ignorance of the local deviation. Verbal communication between the pilothouse and engine room is usually by telephone. Signals to the latter are most frequently by the ordinary engine-room telegraph, now gradually replacing the small steam whistle once exclusively used. The latter is still retained for cases of breakdown in the telegraph.

A stout trolley wire, carrying a boatswain's chair, is stretched between the bridge and after deckhouse. Its value when the spar deck is swept by a heavy sea needs no explanation. This appliance is obligatory. Its need was made clear (in 1905) when a certain steamer, the *Mataafa*, of the Pittsburgh Steamship Company's fleet, having run ashore in a violent storm, all her crew stationed aft were lost through inability to reach the bow, for there is no passage-way between the ends of the vessel below the upper deck.

Speaking of weather, the late fall and early winter are apt to exact a heavy toll, especially on Lake Superior, with its rock-bound coast, lack of sea room and paucity of refuge harbors. In some seasons the wrecking of steamers and destruction of life are almost appalling. I am confident that some of this is needless, that it might be avoided if captains realized the possibilities which reside in good ground tackle skilfully managed. While very deep, say two hundred fathoms in parts, Lake Superior has a clay bottom with a gradual

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slope towards the shores. Remembering what anchors did for our blockading fleet, were I caught in a menacing Lake Superior gale, I would shackle both chains to one anchor, and lower the latter down to extreme scope—about 180 fathoms. It would first act as a drag to keep the bow towards the sea, then it would touch the bottom with increased efficiency, finally it would catch in this best of holding ground and eventually bring the ship up long before she struck the reefs. The captains with whom I discussed this matter thought well of the proposition (for the originality of which I disclaimed any credit) and said they would adopt it on the first opportunity. One, Captain Murphy, of the *Peter White*, stated that he had tried it once, but a defective link parted and he was obliged to battle for safety with his engines alone.'

Locking through the "Soo" is an interesting operation and performed with great despatch. Two locks are in use on the American side and one on the Canadian. There are no charges. A third and still larger lock is building by our army engineers. The difference in level between Huron and Superior makes a lock imperatively necessary. Doubtless the fact that the lakes' people are accustomed to this unavoidable process accounts for their general approbation of locks at Panama, a feature in our trans-isthmian canal as unnecessary as it is deplorable.

The return to Lake Erie I made on board the *J. E. Upson*, Captain J. G. Wood, through the politeness of Captain Wm. Morton, manager of the Wilson Transit Company of Cleveland. The steamer herself is among the larger of her kind, but not among the largest, having thirty hatches, while the maximum is thirty-six. She is, therefore, 72 feet shorter than the *J. Pierpont Morgan*. I found her captain alert and competent, as well as a thoughtful host, and her accommodations almost luxurious.

Speaking in general terms, I should say that the lake captains are quite as skillful in their more restricted employment as our battleship captains are in theirs, which embraces so much larger variety of incidents. Greater praise could not be given. From among the number of these fresh-water sailors excellent men can be drawn to help us out in time of war, for their intelligence is of a high order and they can quickly learn what is not, at present, of their experience.

Some surprise I felt in the absence of turbine engines in these freighters. Doubtless these may arrive some day provided the screws do not project so far from the midship line as to embarrass the operation of getting alongside the docks.

Nor has oil burning been attempted in spite of the proximity of the heavy oil field of Lima and of the advantage of eliminating the fireman, just now well in hand, but liable at any moment to prove, as of old, the source of infinite trouble.

The charts in use, while accurate, presented one feature which is not free from danger. The courses from place to place, as marked, appeared to me, in some instances, to shave the headlands or outlying reefs altogether too closely. In clear weather this is no drawback, but in fogs or thick weather a slight deviation from the correct magnetic heading might run a vessel ashore. It may be argued that a captain ought to disregard the chart course under such circumstances and give the next obstacle a wider berth than a mile and a half. Quite true; but a safer plan, according to my view, is to prescribe a course which will carry the vessel in good water at all times and yet leave a comfortable margin for error, for, being given on a government publication, it is naturally followed by the captain, who looks upon it as official.

It is hoped that my random notes may be found readable, if not profitable, by my colleagues of the naval service. In these days of marvelous and rapid development one never knows when some little scrap of apparently unrelated information may "come in mighty handy."

STABILITY OF MERCHANT VESSELS.

It sometimes happens that a vessel which is tender at the completion of her loading in the river is observed to become still more so when she reaches the open sea, although no weights have been moved on board. It is a little difficult for the non-technical mind to grasp the statement that this rather mysterious happening is the result of the vessel having in sea water, say, 5 or 6 inches less draft than in fresh, owing to the greater density of the former. It is usual to consider that increase of freeboard will lead to increase of stability, and in general it does so, but only at considerable inclinations from the upright position. In the neighborhood of the upright, if the vessel is of the usual merchant type and approximately at load draft, and if there has been no accompanying fall in the center of gravity, the stability will be decreased.

The change in a vessel's condition, however, due to the passage from fresh to salt water, cannot be great, and in most cases would probably be unnoticed. But during a voyage, and particularly towards its close, a vessel of small stability to begin with might evince unmistakable and even alarming symptoms of instability, although there might have been no change in the disposition of weights beyond that due to the consumption of the bunker coal, to which cause the new state of things must therefore be ascribed.

The burning out of the bunkers might affect the stability adversely in two ways:

1st. By causing a rise in the position of the center of gravity.

2d. By causing a fall in the position of the transverse metacenter.

The first would happen if lower bunkers alone were consumed and no adequate trimming were done; and the second if the vessel were of normal merchant type, and, at the start of voyage, were at full load draft. Thus such a vessel, although with considerably more freeboard at the start, might not only be in worse case as regards stability, but might even be in iminent danger of actually capsizing. It is probable that many losses at sea, otherwise mysterious, might be ascribed to this cause. It seems to the writer that too much light cannot be shed on this subject, and, in particular, that shipmasters in command of vessels which have special features in regard to stability should have these carefully explained to them.

Most commanding officers are aware of the danger there may be in consuming only lower coal, and make arrangements by which upper bunkers are trimmed into the lower as these become depleted; or if this cannot be done, use upper coal simultaneously with lower. Not many, however, are probably aware of the effect of reduction in the draft in the neighborhood of the load line, although in certain cases this alone might be sufficient to produce instability.

It has occurred to the writer that if a simple formula could be evolved, based on the general dimensions of a vessel, giving approximately the minimum height of the transverse metacenter and the corresponding draft, it should prove useful. This has led him to make the following investigation:

The general formula given in text books for the height of the transverse metacenter above the center of buoyancy is

$$B\,M = \frac{I}{V},$$

I being the moment of inertia of the plane of flotation about its middle line as axis, and V the volume of displacement in cubic feet.

For prismatic bodies the value of $B\,M$ is quickly arrived at, but in the case of those of ship shape, the finding of both I and V being somewhat laborious, this is not so. In the latter case the general expression for I is

$$I = \frac{2}{3} \int y^3 \, dx$$

and for V

$$V = 2 \int \int y \, dx \, dz$$

y being any half ordinate of the load water plane, in the first instance, and of any plane in the second. Ship curves being irregular, integration is effected by means of Simpson's or Tchebycheff's Rules, and results are obtained by which accurate diagrams of metacenters may be drawn.

Besides the foregoing, most text books give approximate formulæ for determining the position of the metacenter, which, for our present purpose, it is convenient to recapitulate. In such expressions for the moment of inertia of the water plane

$$I = L \times B^3 \times C_1,$$

and for the volume of displacement

$$V = L \times B \times h \times C_2,$$

L, B and h being the length, breadth and draft of a vessel, and C_1 and C_2 coefficients depending on the immersed form. Using these approximations the expression for the height of metacenter above the center of buoyancy becomes

$$B\,M = \frac{L \times B^3 \times C_1}{L \times B \times h \times C_2} = \frac{B^2}{h} C_3$$

If we call the height of metacenter above the base line y, and that of the center of buoyancy above the same line d,

$$y = B\,M + d.$$

Now, d may be expressed in terms of the draft h, say

$$d = k\,h,$$

k being constant for vessels of similar form. Thus we may write, substituting the value found for $B\,M$,

$$y = \frac{B^2}{h} C_3 + k\,h \ldots\ldots\ldots\ldots\ldots (1)$$

Now differentiate the expression for y twice with regard to h. We have

$$\frac{dy}{dh} = -\frac{B^2}{h^2} C_3 + k \ldots\ldots\ldots\ldots (2)$$

and

$$\frac{d^2y}{dh^2} = + \frac{B^2}{h^3} C_3 \ldots\ldots\ldots\ldots\ldots (3)$$

Since (3) is positive, the value of h, which makes $\frac{dy}{dh} = 0$, will, when substituted in (1), give a minimum value of y.

From (2) we get

$$h_m = B \sqrt{\frac{C_3}{k}} \ldots\ldots\ldots\ldots\ldots (4)$$

and from (1) by substitution,

$$y_m = \frac{B^2 C_3}{B\sqrt{\frac{C_3}{k}}} + k\,B\sqrt{\frac{C_3}{k}} = 2\,B\,\sqrt{k\,C_3} \ldots (5)$$

the suffix m being added to h and y to indicate that they refer to a minimum height of metacenter. Thus we have arrived at two simple formulæ giving the information desired.

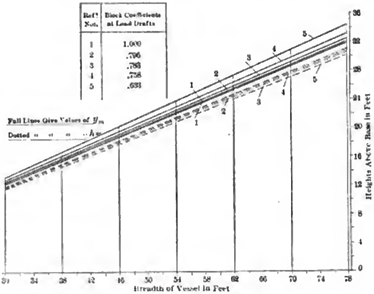

FIG. 1.

Let us apply the above to two typical cases, say, to a box-shaped vessel, which may be looked upon as the limit of the full-cargo vessel, and to a passenger steamer of fairly fine form. The case of most vessels will lie between these. Taking the box vessel, we have $k = \frac{1}{2}$ and $C_3 = 1/12$, as may be readily verified, so that

$$y_m = 2\,B\,\sqrt{\tfrac{1}{2} \times 1/12} = \frac{B}{\sqrt{6}} = .408\,B.$$

In this special case it will be found, by substituting in (4), that

$$h_m = .408\,B;$$

that is, the metacenter is in the line of flotation. The explanation of this is found in the fact, as shown by (5), that when the height of the metacenter above the base is a minimum, it is just double that of the corresponding center of buoyancy, and that in a box-shaped vessel the center of buoyancy is at half draft.

In applying the formulæ to our second example, care must be taken in fixing the values of the coefficients, which, of course, must correspond to the draft at which the height of metacenter is a minimum. In the present case the block coefficient at load draft is .633, and the coefficient required for the formulæ are as follows:

$$C_1 = .048$$
$$C_2 = .570$$
$$\therefore C_3 = \frac{.048}{.570} = .0844$$
$$k = .568$$

Substituting in equation (4) and (5) we get

$$h_m = B\sqrt{\frac{.0844}{.568}} = .386\,B,$$

and

$$y_m = 2\,B\,\sqrt{.0844 \times .568} = .44\,B.$$

Since h_m and y_m are linear functions of B, they may be readily plotted, and this has suggested the making of the diagram indicated by Fig. 1. In this diagram values of h_m and y_m, corresponding to vessels of varying degrees of fineness and of any breadth within the limits of the figure, may be read off.

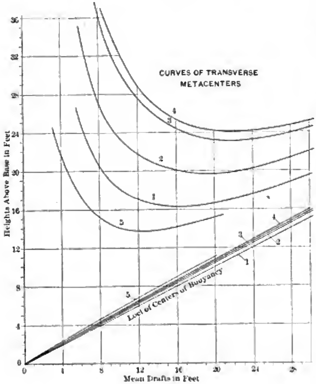

FIG. 2.

In the construction of Fig. 1 results of actual cases have been employed, and for vessels of exactly similar type the lines on the diagram are accurate. For vessels of similar type, but other degrees of fineness, a close approximation to the values of h_m and y_m may be found by interpolation.

Fig. 2 depicts the metacenter diagrams of the vessels employed in constructing Fig. 1, the particulars of these vessels being as follows:

No.	Description.	Length, Ft.	Breadth, Ft. Ins.		Load Draft, Ft. Ins.		Block Coefficient at Load Draft.
1.	Box vessel	...	40	0	.....		1.00
2.	Very full cargo steamer....	330	48	0	22	0	.796
3.	Ordinary cargo steamer....	469	56	0	27	3	.783
4.	Finer cargo steamer........	500	57	8	28	9	.758
5.	Passenger steamer	230	31	4	14	0	.633

The general line for box-shaped vessels is shown in Fig. 1, but only for comparison. The difference between a box-shape and even the fullest vessel of normal type is so great as to make it unsafe to use its curve as a guide in predicting values for ship forms.

The diagram (Fig. 1) is an interesting exercise in the geometry of the metacenter, but it has also a practical value. In designing, for instance, it should prove useful in arranging the permanent bunkers. By means of it, the center of gravity having been approximated to, and assuming the draft with coal out to approach h_m, the minimum value of metacentric height, or $G\,M$, might be obtained. If this should be too small or negative, it might be advisable to rearrange the bunkers. It may be pointed out, of course, that with coal out, water ballast could be run in; but it is inadvisable to do this with the ship in motion at sea; and if it could be obviated by another arrangement of bunkers, the design of the vessel would thereby be improved.

Fig. 1 should also be useful to shipmasters who know something of stability, and, in particular, how to make a heeling experiment. After loading and bunkering, the position of the center of gravity might first be found experimentally. Then the extent to which it would be modified with the coal out could be readily estimated, bunkers being as a rule of simple shape. If the position of the center of gravity thus found, taken in association with the minimum height of M obtained from the diagram, showed the vessel to be dangerously tender, it would be advisable to rearrange some of the cargo, unless it were possible to so plan the burning of the coal—*e. g*, by using upper bunkers first—as to prevent a dangerous rise in the position of G while the vessel was actually at sea. In port, of course, water ballast could be run in to take up the draft and bring down the center of gravity.

It is perhaps scarcely necessary to point out that such a diagram as Fig. 1 is only of importance in the case of vessels whose metacenter curves have generally the characteristics of those in Fig. 2. In some cases the *locus* of metacenters is a horizontal line, or nearly so; in others—in vessels having immersed sections of peg-top form, for instance—it is actually concave to the base. For such special vessels a diagram like Fig. 1 obviously could not be constructed. Most modern merchant steamers, however, have metacenter curves like the kind we have been dealing with, and it is to them the foregoing remarks are intended to apply.

FLOATING DRY DOCKS IN THE UNITED STATES. RELATIVE VALUE OF WOOD AND STEEL FOR THEIR CONSTRUCTION.

BY WILLIAM T. DONNELLY.*

While the floating dry dock is not by any means new in the United States, and while it is generally admitted to be an American invention, the application of technical knowledge or the skill of the engineer has so recently been called upon for its design and construction, that the writer feels almost bound to offer some historic references.

The oldest available record is a copy of a patent to J. Adamson for floating dry docks, December 13, 1816. For a description of this and of subsequent types of wooden floating dry docks, which have been developed in the United States, the author refers to a paper read before the Brooklyn Engineers' Club under date of January 25, 1905; and for an excellent detailed description of large floating dry docks built for the United States Government prior to 1850, parties interested are referred to "Naval Dry Docks of the United States," by Charles B. Stuart, chief engineer of the United States navy This is one of the most valuable works in existence, not only as regards floating dry docks but basin docks as well, giving such an excellent description of the construction and diffi-

* Read at the eighteenth meeting of the Society of Naval Architects and Marine Engineers.

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culties overcome in the building of the first basin dry dock at the Brooklyn Navy Yard as would be appreciated by those who have had the later construction under their care.

For the most modern description and record, bringing the history of floating dry docks in this country up to the date of the completion of the steel floating dry dock *Dewey*, reference can be had to the book entitled "Floating Dry Docks," edited by Sven Anderson, M. E., superintendent Floating Dry Dock Department, Maryland Steel Company. This work is a careful compilation of recent papers delivered before the various engineering societies in this country.

Special reference should be made to very important papers by Civil Engineer A. C. Cunningham, U. S. N., and Civil Engineer Leonard M. Cox, U. S. N., the latter paper dealing with naval dry docks and being a most complete presentation of mathematical and structural problems. This paper will also be found in the Transactions of the American Society of Civil Engineers for 1907.

In 1906 the author was retained by a large dry-docking and ship-repair company to prepare plans for a floating dry dock. The general requirements were that the dock should ultimately have a lifting capacity of 20,000 tons and that approximately 12,000 tons lifting power was to be built at the beginning and added to later on.

While the author's experience had previously dealt with wood as a structural material for floating dry docks, he was also familiar with steel for such structures, and owing to the fact that all docks of approximately this size had been built of steel attention was directed to that material, and a careful study made resulted in the selection and design of the Rennie type of dock, with steel pontoons and wings, the pontoons being 14 feet deep, 28 feet long and 127 feet wide. The steel wings were to be 40 feet high to give ample longitudinal rigidity. The details of this dock were very carefully worked out so that accurate weights were arrived at. They were 6,600 tons for the pontoons and 2,700 tons for the wings, or a total of 10,300 tons for the structure, which, on a basis of 20,000 tons lifting power, gives as a factor of structural weight relative to lifting power, of 5 : 10, which agrees fairly well with other large docks previously designed and built.

The fact that a working stress of 12,000 pounds per square inch was used throughout, and that the wings of the Rennie type of dock were made of exceptional depth to insure longitudinal rigidity, will account for a somewhat higher weight factor.

While this dock was not built, bids which were received indicated that the cost of the dock completed would be approximately $57 (£11.7) per ton of lifting power. For a more complete description of this dock and the novel method of pumping by compressed air which it was intended to use, those interested are referred to a paper entitled "A New Method of Pumping Floating Dry Docks," read before the Brooklyn Engineers' Club on May 9, 1907. The reason for introducing the matter here is to effect a comparison between this structure and similar docks with wooden pontoons.

In a pontoon dock of 7,000 tons lifting capacity, with steel wings and wooden pontoons, the pontoons are 100 feet long, 11 feet deep and 32 feet wide. Each pontoon has eleven frames or trusses on 3-foot centers. Top and bottom planking is 4 inches, the side planking 5 inches and the end planking 6 inches; 6-inch by 8-inch deck timbers are worked across the 10-inch by 10-inch truss members on top and bottom in such a way that it is possible to get in the 1¼-inch double tie-rods without boring, and so arranged that they can be replaced at any time.

The material is merchantable grade of yellow pine lumber throughout and the fastenings are all galvanized. There were required for each of these pontoons 135,000 board feet of lumber.

The steel wings of this dock are 368 feet long by 30 feet high, 12 feet wide at the bottom, and 8 feet wide at the top. The plating varies in thickness from one-quarter inch to one-half inch. The securing of the wings to the pontoons is accomplished by means of a cast steel shoe secured to the deck of the pontoon and connected by a link and taper wedge and similar shoe riveted to the side of the wing. On the outside of the dock, attachment to the pontoon is by a cast steel strap through-bolted to the side of the pontoon. This device is of exceedingly simple construction and has proved most effective.

A pontoon has been detached by knocking out the wedges in less than ten minutes. The remainder of the dock is then pumped up, when the detached pontoons can be floated out and dry-docked on the remaining pontoons. The total weight of steel work in the wings is 1,100 tons. Attention is called to the fact that all of this steel is normally above the water-line, where it is accessible at all times for examination and repair.

Contact between the wings and pontoons is made by a raised packing piece, 12 inches wide, surrounding the open top of the pontoons under the wings, it being understood that there is a hole in the bottom of the wing to allow free passage of water from the pontoon to the wing when the pontoon is full. The joint between the pontoon and wing is made with three-ply canvas packing, saturated with red lead, and the wing, at the point of contact, is reinforced with ⅜-inch by 12-inch steel plate to insure against possible corrosion, this being the only part of the wing, inside or out, which is not accessible when the dock is in commission.

The method of pumping is by a centrifugal pump in each end of each pontoon, all the pumps on one side being operated by a single electric motor through horizontal line shaft and vertical shaft to the pump. The delivery and entrance of water to the pontoon is through the pump, which has been found to be a very effective method of control. A more complete description of the construction and operation of this dock can be found in International Marine Engineering under date of August, 1909. While this dock is shown and referred to here as a 7,000-ton dock, with eleven pontoons and a length of 368 feet, it was actually built with ten pontoons and a length of 335 feet in the wings, this being the greatest length which would leave room for handling vessels in and out in its present location on the company's property. The additional pontoon is to be added and the wings extended when the plant is enlarged.

While wooden wings are not practical for the largest size of docks, they are applicable to docks up to 10,000 tons, and where used there is a bulkhead in the wings corresponding to each pontoon and that the construction of the wings may be interrupted at any point. In order to extend the dock, it is only necessary to build one or more pontoons, float them in position and extend the wings over them, which can be done without interrupting the use of the dock.

The machinery and pumping of this dock is similar to the one previously described.

COMPARISON OF WOOD AND STEEL FOR FLOATING DRY DOCKS AND METHODS FOR THEIR CARE AND PRESERVATION.

As previously stated, the building of timber floating dry docks in the United States is very old, and there are now in use in the Port of New York sixty-four floating dry docks, all of wood, ranging in tonnage from 400 to 12,000 tons, and in the United States there are ninety-one floating dry docks, three of steel and one with steel wings, ranging from 200 tons to 18,000 tons, having a total tonnage of 228,800 tons and an average tonnage of 2,500 tons.

The only steel commercial floating dry dock is at the works of the Great Lakes Shipbuilding Co., Detroit, Mich. The only

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other steel floating dry docks in use in the United States are the Algiers dock opposite New Orleans, La., and the steel dock taken by the United States Government from Havana during the Spanish War, now in Pensacola, Fla. The Detroit dock and the Algiers dock are in fresh water, which makes their preservation much easier.

The Tietjen & Lang Dry Dock Company, of Hoboken, has nine floating dry docks, all of timber construction, varying in lifting capacity from 800 tons to 10,000 tons. Their first dock was built in 1884, and is still in satisfactory operating condition. No deterioration whatever has taken place in the timber work below water, but extensive repairs from time to time have been made in the upper woodwork, which, of course, will deteriorate equal to, or somewhat more rapidly than, ordinary woodwork of buildings.

The John N. Robins Company, Erie Basin, Brooklyn, N. Y., has two large floating dry docks other than the pontoon dock with steel wings previously referred to. One of these docks, known as the balance dock, was built by William H. Webb and finished in October, 1854, and has been in continuous use ever since. The writer has recently had the opportunity of thoroughly examining and overhauling this dock and changing over the pumping plant from steam to electric operation. A most thorough examination of the interior and weight-supporting timbers showed practically no deterioration, not a particle of decayed wood being found below the deck. Certain corrections were made, due to faults in the original design, to obtain a more positive control of the dock in operation, and since the overhauling the dock has lifted fully as heavy ships at at any time in its history. Much of the upper woodwork of this dock has been replaced, and much more will have to be replaced from time to time.

Attention should be called to the fact that, owing to the size of this structure, 330 feet long by 100 feet wide, it has never been possible to entirely remove it from the water.

The other large floating dry dock of the John N. Robins Company is of the Dodge-Burgess type of sectional dock, having ten sections with pontoons 100 feet by 30 feet. The general construction of this dock can be seen by referring to the work by Stuart, entitled "Naval Dry Docks in the United States," previously referred to, where there will be found excellent descriptions with illustrations of similar docks built for the United States Government at Philadelphia and Portsmouth, N. H.

In protecting the wooden pontoons of floating dry docks and, in fact, all under-water parts of floating dry docks, it has been the universal custom to first thoroughly grave them with brown tar poisoned with arsenic, then apply two layers of best sheathing felt, thoroughly graving each layer in a similar way, and then over this to sheath the dock with 1-inch creosoted hemlock boards well secured with galvanized nails. This has been found entirely satisfactory to protect these docks from teredo and worms, and the custome in Eastern waters has been to leave them in the water for seven years before taking them out to replace any sheathing which may have become detached.

The largest floating dry dock on the Pacific Coast for many years was the Quartermaster's Dock in Puget Sound. This dock was built of timber in 1892, and while it has been exposed in what is considered to be very bad water for teredo since its construction, it was in excellent condition when examined by the writer last winter, although on account of its dimensions it has never been removed from the water.

At the time of the construction of the pontoon dock, with steel wings, a very thorough investigation was made as to the preservation of the steel wings by painting. This resulted in the use of a graphite paint of well-known manufacture. The cleaning and painting was done in the most thorough manner by day's labor under skilled direction, and when it was completed everyone expected the most satisfactory results. The outcome, however, was very disappointing. After two and a half years, the interior of the wings is now being coated with bitumastic composition and the outside will be painted with red lead and oil. None of the pontoons in the meantime have been removed from the water nor have they required attention in any manner.

All the writer's experience with floating dry docks and their construction and repair leads to the firm conclusion that for underwater work, such as pontoons for the Rennie type of dock, wood is a much superior material of construction to steel, that the original cost is much less, the cost of maintenance less, and the life of the structure greater than steel. For the wings and upper work, experience is equally conclusive for the use of steel. While it apparent that the cost of maintenance will be considerable, the structure will last much longer, and, with a sectional pontoon dock, where the wings are accessible at any time and any portion of the wings may be entirely replaced if necessary, it would seem that the structure as a whole will last indefinitely.

So far as the writer is able to judge by a somewhat limited experience, the only reliable protection for interior steel work of floating dry docks in salt water is the bitumastic compound above referred to, but the first cost of this protection is very great, being in the neighborhood of $6 (£1.2) per ton of steel for interior protection only. Any discussion which would bring to bear additional information upon this particular subject would be very much appreciated, and it is to be hoped that the experience of the United States Government with the floating dry dock *Dewey* at Manila will be of help.

A comparison of the materials used for wooden and steel pontoons shows that the weight of the steel per hundred tons of lifting power is 33 tons and the weight of wood per hundred tons of lifting power is 36 tons. It is evident that the difference in weight must be supplied by increased dimensions of the wooden pontoons. Other than in this particular, wood appears to have the advantage in every way.

While reference has been made to a pontoon dock of 7,000 tons lifting capacity, there does not seem to be any engineering limit to the size to which the Rennie type of dock can be built with wooden pontoons. A carefully worked-out pontoon for a 20,000-ton dock shows dimensions of 130 feet by 44 feet by 15 feet, and it will be readily understood that this structure is well within the practical limits for timber work.

Regarding the cost of the different types of floating dry docks, it is, of course, not possible to make any definite statements, as they are much influenced by the varying cost of material and the location where the dock is to be constructed. For the relative cost of the different types of docks on the eastern coast of the United States the following figures may be taken as being approximately correct:

COST PER TON OF LIFTING POWER.

	Per Ton.
Balance sectional timber dock with centrifugal pumps	$32 (£6.6)
All-wood pontoon dock with continuous wings	35 (£7.2)
Pontoon dock, steel wings and wooden pontoons	42 (£8.6)
All-steel pontoon dock	57 (£11.7)
Government steel dock, Dewey type	62 (£12.7)

The comparative cost for the western coast of the United States will be quite different on account of the increased cost of steel and the much lower cost of timber.

A Japanese Design of Surface Condenser.

At the last meeting of the Japanese Institution of Naval Architects, Captain-Constructor Y. Wadagaki gave a description of a surface condenser possessing some novel features, designed by himself, for an installation of two sets of 1,500 kilowatt generating units fitted at the Saseby Imperial Dockyard. The general design of the condenser is shown in Fig. 1. The exhaust inlet is at *A*, and the current of steam is directed

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tangentially to the inner surface of the condenser shell, which is of a spiral cross section. This has the effect of separating by centrifugal action any water in the exhaust steam as it enters the condenser. Near the center of the tubes, and parallel to the axis of the condenser, is a large split pipe *B* between the tube plates, containing a group of cooling tubes. An annular space is thus formed between the split tube and the condenser shell, of volute form, fitted with ordinary condenser tubes, and open at its narrow end; hence any steam at the end of one turn round the nest of the condensing tubes is caught up by the entering current of exhaust steam and again carried round. By suitable adjustment of partition plates, the flow of water through the tubes is made to follow the course that theory and practice assign to be the best. Through the bottom of the condenser, near the exhaust-steam inlet, a short length of pipe protrudes; this allows a certain quantity of water to accumulate and expose its surface to the incoming exhaust steam, the surplus water being drained off through the pipe by a water-pump suction. The air-pump suction is connected with the large split pipe, into which the air flowing round is finally entrained. Captain Wadagaki claims that by his design all the energy due to velocity of the exhaust steam is profitably employed in maintaining brisk circulation of steam among the condensing

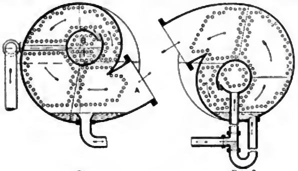

FIG. 1 FIG. 2.
A NEW TYPE OF CONDENSER.

tubes, and that this is effected without baffling plates or other obstructions, except such obstruction as the condensing tubes themselves must always furnish. Further, there is no short-circuit, dead-corner, or stagnant recess to detract from the efficiency of the cooling surface. Any water in the exhaust steam at the inlet is at once withdrawn, while water resulting from condensation of the steam within the condenser is separated from the surface of the tubes and promptly removed to the outside of the tube nest by virtue of its centrifugal force. This water ultimately flows to the bottom of the condenser along the inner surface of the shell, and comes again into direct contact with the entering exhaust, its final temperature being thus practically equal to it, whatever the quantity of circulating water supplied. The condenser, to a certain extent, therefore, becomes a feed-water heater. The work of the air-pump is further facilitated by the cooling of the air in the split pipe, where, by design of the water passages, the circulating water is the coldest.

In the arrangement above described there are two separate pumps—one for the air, the other to draw off the water of condensation. If a single pump is preferred, the design may be modified, as shown in Fig. 2, where the exhaust steam enters at the top, while a common suction is provided at the bottom for the water gathered there, and for the air collected in the split pipe, the necessary separation being provided by the U-bend shown in the diagram. Approximate figures are given by Captain Wadagaki in his paper of tests made at Sasebo, to show the high efficiency obtained with this condenser there installed.—*Vulcan.*

MARINE DIESEL MOTORS.

A paper on the above subject was read at the annual meeting of the German Naval Architects by Direktor Saiuberlich, of Osterholz-Scharmbeck, near Bremen. According to *The Engineer*, Direktor Saiuberlich said that since the times of the old low-pressure engine the shipping world had never stood on the threshold of such far-reaching developments as at the present time. In place of the steam engine, a further improvement of which appeared hardly possible, the Diesel motor was now being installed as a marine engine. For fluid fuel the Diesel motor was the most perfect internal combustion engine of the present day. In recent experiments the utilization of the fuel had reached 33 to 35 percent, as compared with 23 percent in the gas engine and 13 percent in the best steam-engine plant with superheater. This was a result of the direct use of the fuel in the cylinder without previous transformation, and of its consequent complete combustion. The construction of the Diesel motor was said to require material and workmanship of a very high class. These, however, were now-a-days obtainable, and the difficulties on this head formerly experienced were overcome. Like the larger type of gas engine the larger Diesel motor had very much the general appearance of the marine steam engine, on which it was more or less modeled. Now that several shipyards had shown that they could build the motors with the machinery already at their disposal, the prejudice against these engines would soon be overcome. Hitherto the motors had generally been of the single-acting description working on the four-cycle system. More recently the two-cycle engine had come to the front. The endeavors to apply the new system to the propulsion of large vessels had led to the application of double-acting motors of the two-cycle as well as of the four-cycle type. Such installations were now actually being made and would shortly be at work. The problem before the designer was to adapt the Diesel motor, that had worked satisfactorily on land, to the conditions on board a vessel, different in many respects and more difficult to meet, as these were. Moreover, the auxiliary machinery depended on the steam from the boilers, and a substitute for this had to be found. The advantages of the Diesel motor for the driving of vessels were the following: A gain in available space due to the removal of the boiler installation accompanying a reduction of that required for the new fuel; an increase in carrying capacity on account of the reduction in the weights of motive machinery and fuel; a possibility of using spaces formerly only partially available for the storing of the fuel; gains in time and wages due to easier and more rapid bunkering, coupled with the elimination of coal trimming; greater readiness for starting work; easier work for the engineers; abolition of stoking; greater cheapness of fuel; comparative coolness of he engine room; and greater radius of action for the vessel. Disadvantages were: The difficulty of obtaining fuel in many ports and the absence of steam for the deck machinery and for heating purposes. Herr Saiuberlich gave particulars of the first two Diesel motor vessels—the *Frerichs*, built for purposes of the shipyard, and the fishing vessel *Ewersand*, the engines for which, as well as the hulls, had been designed and built by Messrs. J. Frerichs & Company, of Osterholz-Scharmbeck and Einswarden. The *Frerichs* was a single-screw vessel, built to the rules of the Germanischer Lloyd for the small coasting trade. She had been at work since the spring of this year in the towing service and in keeping up communication between the banks of the river. She had a reversible four-cylinder Diesel motor of 200 horsepower maximum, making 360 revolutions per minute. The motive medium here used was gas-oil, one ton of which was stored in two tanks under the cabin. This amount, which might easily have been doubled, gave the vessel a radius of action of 240 nautical miles at a speed of 9.5

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knots. The vessel had a funnel for carrying off the gases. There was abundance of room owing to the small space required for the motive machinery. Reversing was effected by compressed air. A single movement of a lever in the desired direction of motion of the vessel moved the shaft so as to throw the machinery into gear in the manner required. This manipulation was very reliable and could be rapidly performed, if necessary, within a fraction of a second. A special arrangement of the compressor ensured the starting of the motor even if it stopped at a dead point. Cooling water and bilge pumps, which were driven from the crank shaft of the motor, were fixed on the common bed plate. The hot exhaust gases from the cylinder were cooled with water in a double-walled elbow pipe. After being collected into a single pipe they were led into a large condenser, which deadened the noise, and then passed on to the funnel. The bilge pump was used for cooling the exhaust. The compressed air required for some of the maneuvers was produced by the motor itself in a two-stage compressor which formed the fifth cylinder of the installation. It was stored in six large compression vessels in the engine room at the side of the vessel. The air in these was used for starting. In the design of the motor the requirement had been made that there should be as few cylinders and other working parts and as little complications as possible. The adoption of the compressor had enabled the six cylinders otherwise required to be reduced to four, the compressor cylinder being used on occasion for starting the motor when the four-cylinder arrangement did not suffice to avoid the dead-point position. Care had to be taken to keep down expense, which in the construction of the Diesel motor was still a very important consideration. The bed plate was of cast iron and in one piece. The cylinder cover was the most important of the larger castings in the motor, because all the mountings required were attached to it, and great care had to be taken to avoid unnecessary strains in it. The ordinary cast iron used for steam-engine work had been found to be the best material for the cylinder covers. The reversing gear was, in many respects, different from arrangements of the kind hitherto adopted. A horizontal shaft provided with two sets of cams and movable in its axial direction was fitted along the tops of the cylinders. The cams acted on valve levers and were thrown in or out of gear by the shifting of the shaft. The mechanical parts of the gearing were dealt with by the author in detail and illustrated by lettered sketches, from which it appeared that the cams effected the admission of fuel in either end position of the shaft, while there was a neutral position half-way between these. The actuating lever, arranged in the form of a hand wheel, admitted compressed air to the one or other side of the piston of a cylinder. The piston acted on a system of swinging levers, which moved the shaft above mentioned. A glycerine brake at the lower end of the compressed air cylinder provided against sudden jerks or uneasy motion in reversing. Arrangements were made by the admission of smaller amounts of fuel for driving the motor at "half-power" and "slowly," respectively. The air compressor, which, as already mentioned, took the form of a fifth cylinder with a crank on the main shaft arranged at an angle of 90 degrees with those of the motor, so as to have turning power when the latter were at the dead-point position, could, in the latter case, be used for starting by the admission of compressed air into it from the storage tanks. Each working cylinder was provided with a pump which supplied it with the exact quantity of fuel required. For driving these only two eccentrics were necessary, since each of them actuated a double piston, and the pumps were combined in such a way that the regulation of one-half of them was effected from the other half. The body of the pump was of wrought iron in each case. The regulation was effected by means of a simple governor; or it could be done by hand, in which latter case the governor was merely a safeguard against racing of the engine. In connection with diagrams which were shown the lecturer pointed out that in the case of quickly-running motors the combustion could not be so complete as in that of slowly-running ones, and that the combustion and expansion periods ran into one another. The *Frerichs* had been at work for a considerable time with good results, and after careful investigations made with her the insurance companies had agreed to a premium at the ordinary rate. The full speed of 10 knots could be reduced to 3.8 knots, the revolutions per minute thereby falling from 360 to 150. The reduction could be effected either by cutting out some of the cylinders or by supplying smaller quantities of fuel to all of them. Experiments with the reversing gear showed that the lever could be put over in less than a second. The time required for reversing the motor when running at full speed was 8 seconds; while the vessel herself began to go astern after about 27 seconds. The diameter of the turning circle of the vessel was about one and a-half times her length.

The lecturer then directed attention to the Diesel motor fishing boat *Eversand*, and said that the introduction of the crude oil motor into the fishing industry was an event of first-rate importance. He looked forward to the time when the German fish market would be entirely supplied by means of cheaply worked German motor fishing boats, instead of, as at present, having to draw its supplies largely from abroad. Towards the end of October this vessel had returned from a trial fishing cruise of five weeks, during which time she had not used more than three tons of crude oil, in place of the 20 tons of coal which a steam vessel of the same size would have required. It was anticipated that this amount could be still further reduced. The fishing winches, which might easily have been driven from the motor, were, as a matter of precaution for the first cruise, served by a small donkey boiler. The fuel was stored in a fixed tank in the engine-room, and the small space occupied by it would have been useless for other purposes. The stowing of part of the fuel in the herring-barrels now became unnecessary. The use of crude oil at sea was found to be in every respect reliable, and it was considered as certain that the motor would take the place of the steam engine in fishing vessels. The design was for the most part similar to that in the *Frerichs.* The high-speed two-cylinder motor developed 80 to 90 effective horsepower with 330 revolutions. Reversing was effected by means of a friction coupling and gear. This enabled the motor to be of extremely simple design, and to have relatively few cylinders, which, for the hard usage it would get in a fishing-boat, was of great importance.

Herr Saimberlich gave some further particulars that were not contained in the printed pamphlet distributed. In the course of a comparison of designs for a vessel for shipyard work with a Diesel motor and with a steam engine, it appeared that, with a given output of 100 horsepower, 11½ feet of length of hull and one stoker could be saved by the adoption of the new motor. A herring boat of 164 tons, with a steam engine, was found to be capable of doing only the same work as a vessel of the same kind of 140 tons with a Diesel motor. In a trawler, the substitution of a Diesel motor for a steam engine increased the length of the available hold by 13 feet. In a vessel of 5,400 tons for the Black Sea trade, 15,000 cubic feet were added to the hold space by the adoption of a Diesel motor. Assuming the vessel to make four voyages a year, this was equivalent to a profit of $4,380 (£900); the saving in fuel due to the Diesel motor for these voyages was $2,677 (£550), and about $1,168 (£240) in wages. In view of these facts, the author was of opinion that the applicability of the Diesel motor to ships was very great.

In reference to the paper, Professor Flamm observed that the opinion of Herr Saimberlich that the Diesel motor had a great future before is as a marine engine was shared by very many, but in answer to inquiries addressed to motor-making firms he had not yet succeeded in obtaining offers that showed to such advantage as the statements they had just heard. In the case of a fishing vessel it appeared that, as regards weight, the great advantage claimed was not obtainable. A motor of 100 horsepower had been offered for $12,897 (£2650). Only one firm was willing to take back the motor in case it should not have fulfilled the requirements after a year's trial. The prices asked for the motor, then, were considerably higher than those ruling for steam engines. The working expenses were less, it was true, but not to such a degree that it could be predicted therefrom that the Diesel motor would drive out the steam engine. He believed that the adherents of the motor would further their cause more if they gave figures that applied to results over a considerable length of time, instead of experimental data; unpleasant disappointments would then be avoided.

A FLYING MOTOR BOAT.

BY FRANK C. PERKINS.

It is maintained that the flying motor boat or combination aeroplane and high-speed water craft shown in the accompanying illustration will revolutionize to a marked degree transportation over the water both for pleasure and business.

It is stated that this craft has been thoroughly tried out, and has shown remarkable speed and stability, is called "The Flying Fish."

It is interesting to note that A. A. Schantz, president of the Detroit and Cleveland Aerial Navigation Company, has arranged for six of these equipments to be used in daily service between Detroit, Cleveland and Buffalo.

This combination air and water craft is built along the lines of a giant bird. The construction is a combination of the monoplane and hydroplane, designed to skim along the surface of the water, literally on its tail feathers, at a speed of from 65 to 70 miles per hour.

The first working model was taken out on the Detroit River, and skimmed over the ice, scarcely touching it, at an approximate speed of 60 miles per hour. This outfit was equipped with a less powerful engine than the present craft is equipped with, and it is expected that this new model will be of great interest throughout the world.

It may be stated that the hull of "The Flying Fish" is a water-tight, aluminum tank 5 feet 7 inches wide, 7 feet 2 inches long and 2 feet deep. The bow end is curved, but all other angles are 90 degrees. In front of the hull is set an eight-cylinder aeroplane motor, which operates the propelling power. This outfit has no water propeller, but is propelled by a large two-bladed air propeller measuring more than 6 feet from tip to tip. This wheel is turned at a terrific speed by the eight-cylinder motor installed.

In the photograph it will be seen that above the hull is arranged the single plane, measuring 26 feet and 6½ feet wide. The frame is covered with oil-soaked khaki. The shape is convex. Extending behind the hull is the tail, for all the world like the handles of a baby buggy, except that the arms are steel and the wooden cross-piece is a foot wide. On this flat board 5 feet 7 inches long, a foot wide and ½ inch thick about 10 feet behind the hull, the craft rests upon when under way, that is, when the boat attains sufficient speed forward, the plane lifts the hull out of the water entirely, leaving it resting only on its tail feathers touching the surface.

It is said that, as the speed of the boat increases, the "Flying Fish" rises from the water entirely and leaps over the top of the water in bounds, with the tail feathers on the rear touching the water at intervals and steadying the flight.

It is maintained that the boat is not expected to fly at any great distance or at any great height. The rush of air catches the plane and lifts it up 8 or 10 feet at times. The tail piece, however, is always in the water, controlling her equilibrium perfectly. Extending from the stern of the hull is the rudder. The rudder is a regular aeroplane rudder, but smaller, four-vaned, blades being covered with canvas. The cockpit is in the stern of the hull, into which the feet of the skipper extend as he sits in the small caned back chair balanced on the stern rail. The levers for controlling the rudder and plane are all under one man's control, and complete the craft weighs 750 pounds.

FLYING MOTOR BOAT "FLYING FISH."

It is believed that the possibilities of this invention are wonderful, both from a business and pleasure standpoint, as "The Frying Fish" will float perfectly on the water and there is less danger of tipping than in any other boat, for the plane will act as a preventer. In this boat the passengers will have all the sensations of flying, but there will be something more substantial than air to fall on should anything go wrong.

It is held that, while the first model was a small one, a larger craft has been designed, as noted in the picture, in which four or five passengers can be carried by the Detroit and Cleveland Aerial Navigation Company for daily service between Detroit, Cleveland and Buffalo. This company is very enthusiastic over the new device, and the idea is to have five or six aeroplanes or airships in operation in connection with lake boats.

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CARBON MANGANESE SILICON NICKEL CHROMIUM
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The recognition of Vanadium as an alloy for producing the most efficient types of steel known, has been fully granted by metallurgists and manufacturers all over the world. Many steel makers have found Vanadium such a valuable alloy that they have established totally new types of steel upon its qualities and given special trade-marked names to such steels. Whatever the name may be, it is important for you to insist that your steel contains Vanadium as you will then get the maximum efficiency as far as strength, toughness and durability are concerned.

Every reputable manufacturer now makes or uses Vanadium Steels. You can buy Vanadium Steels in which "Amervan" Ferro Vanadium, "The Master Alloy," is used from the following, and many others:

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Manufacturers Foundry Co.	Waterbury, Conn
Capitol Foundry Co.	Hartford, Conn
Rosedale Foundry and Machine Co.	Pittsburgh, Pa
Ross-Meehan Foundry Co	Chattanooga, Tenn.
Du Bois Foundry Co.	Cold Spring, N Y

Vanadium Cast Steel—Crucible.

Sivyer Steel Casting Co.	Milwaukee, Wis.
Riverside Steel Casting Co.	Newark, N. J.
Crucible Steel Casting Co.	Lansdowne, Pa
Damascus Crucible Steel Casting Co.	New Brighton, Pa
Lebanon Steel Casting Co.	Lebanon, Pa.
Michigan Crucible Steel Casting Co.	Detroit, Mich
West Steel Casting Co	Cleveland, O.

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Union Steel Casting Co.	Pittsburgh, Pa.
Mesta Machine Co.	Pittsburgh, Pa
Mackintosh-Hemphill Co	Pittsburgh, Pa.
Penn Steel Casting and Machine Co.	Chester, Pa.
American Steel Foundries Co	Chicago, Ill.
Pittsburgh Steel Foundries	Pittsburgh, Pa.
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Vanadium Malleable Iron.
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Bethlehem Steel Co.	South Bethlehem, Pa.
Crucible Steel Co. of America	Pittsburgh, Pa.
Colonial Steel Co	Pittsburgh, Pa.
Vanadium-Alloys Steel Co.	Latrobe, Pa.
Heller Bros. Co.	Newark, N. J.
Vulcan Crucible Steel Co	Aliquippa, Pa.
Cyclops Steel Co.	Titusville, Pa
Halcomb Steel Co.	Syracuse, N. Y.

Vanadium Forgings, Crank Shafts, Axles, Piston Rods, Etc.

Carnegie Steel Co.	Pittsburgh, Pa
American Locomotive Co.	New York, N. Y.
Mesta Machine Co.	Pittsburgh, Pa.
L. L. Driggs & Co.	New York, N. Y.
Erie Forge Co.	Erie, Pa.

Drop Forgings, Gears, Etc.

Driggs Seabury Ordnance Corporation	Sharon, Pa.
L. L. Driggs & Co.	New York, N. Y.
Transue-Williams Co.	Alliance, Ohio.
Wyman-Gordon Co.	Worcester, Mass.
Crescent Drop Forge Co	Hulton, Pa.
Baker Drop Forge Co.	Jackson, Mich.
Warner Gear Co.	Muncie, Ind
J. H. Williams & Co.	Brooklyn, N. Y.

Vanadium Automobile Cylinders.

Capitol Foundry Co.	Hartford, Conn.
W. P. Taylor Co	Buffalo, N. Y.
Manufacturers Foundry Co.	Waterbury, Conn.
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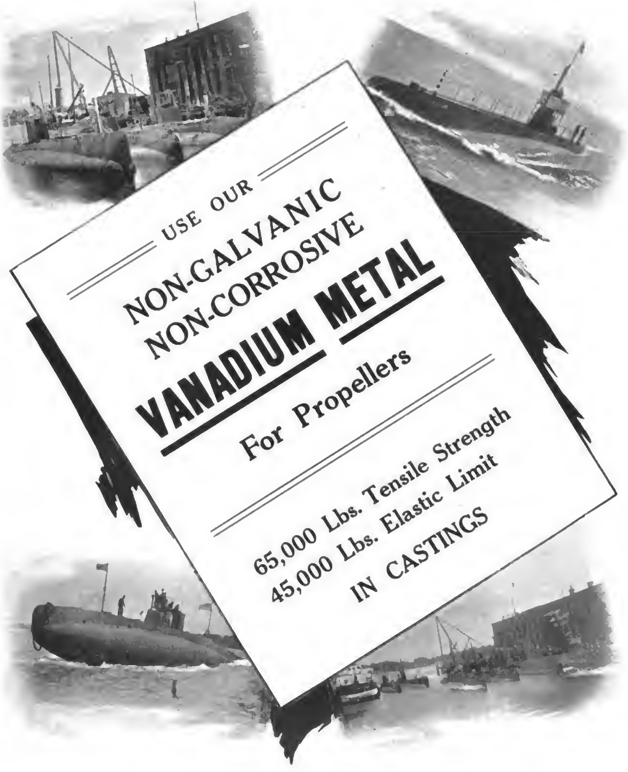

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REMARKABLE ECONOMY OF AN OIL FUEL INSTALLATION.

Every engineer knows or believes that oil fuel is in many instances much more economical than coal, and the following description will cover what is presumed to be a noteworthy example to aid this general belief. Furthermore, it is thought that the method of application to be described is the first instance of the use of one of its kind; at any event, the writer has no knowledge of a similar oil fuel burning plant.

The revenue cutter *Golden Gate*, on which this successful experiment has been tried, is a vessel of the ordinary harbor tug type, and is engaged in boarding duty in San Francisco harbor. This is an intermittent duty, involving daily a number of short trips around the harbor, a state of readiness to go at a moment's notice, and consequent lying at a wharf with steam up for the greater portion of the time. This tug is 110 feet long, and up to six months ago was provided with a watertube boiler of the Ward type, and a triple-expansion engine capable of producing 550 maximum indicated horsepower. The subject of oil fuel for the *Golden Gate* had been frequently

REVENUE CUTTER GOLDEN GATE.

transforming the coal bunkers into oil tanks was $15,000 (£3,000), an amount deemed prohibitive in view of the small sums available for repairs, and to the further fact that the vessel when new in 1896 cost only $50,000 (£10,000). As the old boiler had to be renewed last year, a new Babcock & Wilcox watertube boiler was installed, and during its installation the following scheme was thought out and put into application:

A small cylindrical tank, with a capacity of approximately twenty-three barrels of oil, was installed in the fireroom, well up under the deck beams (as shown in the accompanying plans), so as not to interfere with the withdrawal of the boiler tubes when necessary. Immediately under the tank was installed a No. 10, S. & P. oil pump, with the necessary heater, coil, governor, relief, gage, tank, strainers, etc.

The boiler is equipped with grate bars, etc., complete, the same as it would be for burning coal, with the exception that fire bricks are laid over the grate bars. The burners are spaced about 2 feet apart, project 12 inches beyond the door frame liners and are about 6 inches above the level of the grates, slanting slightly downward. The entire installation for burning oil, including the tank and its supports and all incidental expenses necessary to make the apparatus ready for use, was only $2,500 (£500). The advantage of this installation may be summarized as follows:

(1) Its non-interference with the coal-burning appliances; the regular coal bunkers not being disturbed, and, in fact, 10 tons of coal are carried in bags to trim the ship. In case the oil supply should run out, coal could be immediately burned, after removing the fire bricks off the grate bars and disconnecting the oil burners. If the vessel should go on a long voyage or be transferred to some port where fuel oil was not available there would be nothing to interfere with coal burning.

(2) The oil supply, small as it is, is sufficient for four or five days' steaming under ordinary circumstances. The oil is furnished from a pipe line on the wharf, where the *Golden Gate* is moored, and the tank can be filled in ten minutes.

(3) Owing to the small amount of oil carried the danger from fire is minimized.

(4) The great decrease in cost of installation; $2,500 (£500) for complete apparatus, as against $15,000 (£3,000) for the cost of tanks alone, if the coal bunkers had been transformed into oil tanks.

(5) The marked saving in fuel bills when compared with coal, as will now be shown.

RELATIVE FUEL CONSUMPTION FOR THREE MONTHS, ENDING DEC. 31, 1909, AND DEC. 31, 1910.

	1909 (With Coal.)	1910 (With Oil.)
Banked fires	1,945 hrs. 45 min.	1,705 hrs. 45 min.
Underway	238 hrs. 15 min.	190 hrs. 15 min.
Total miles steamed	2,030	1,604
Fuel expense	128.6 tons	253.7 bbls.
Cost of coal at $5.40 (£1 2s.) per ton		$694.44 (£138 9s.)
Cost of oil at $ .60 (2s. 6d.) per bbl		153.32 (£30 10s.)
Net saving for 3 months		$541.12 (£108 10s.)
Percentage saved by use of oil		77 8

It will be seen from the above tabulation that during the period in question the vessel did not steam as many miles under oil fuel as she did under coal, nor was she so long under banked fires. A much better comparison as to the relative cost of coal and oil as fuels can be deducted from the performances of November, 1909, and November, 1910, which were as follows:

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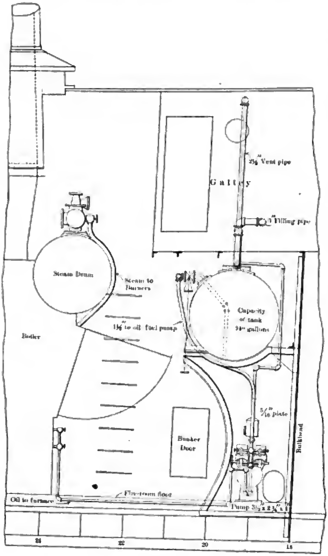
	November, 1909 (With Coal.)	November, 1910 (With Oil.)
Hours underway per day, average	4	3
Knots per hour	8 5	8 5
Total miles cruised per day	34	25 5
Banked fires, hours	620 5	464 2
Fuel used per day, average, lbs	4,726	1,205
Fuel used per day while underway	3,600	975
Fuel used per day under banked fires	1,126	230
Cost of fuel per day for steaming (coal at $5 40 per ton)	$8 40	
Cost of fuel per day for steaming (oil at $ 60 per bbl.)		$1 73
Cost per mile	24 cts	6 9 cts.
Cost of oil compared with coal, per mile, percent	28	
Saving per mile, per cent.	72	
Miles steamed per ton of coal at 8.5 knots	21 2	
Miles steamed per ton of oil at 8.5 knots	58 5	

From the foregoing tabulation it is clear that the cost of the oil fuel is only slightly in excess of one-fourth the cost



IN THE GOLDEN GATE'S BOILER ROOMS.

of coal under the former condition, which, to say the least, is a remarkable saving. A further reduction in the cost of operation of the machinery, due to the use of oil fuel, comes from the fact that the personnel has been reduced from four men to three, by dispensing with the services of one coal passer, whose annual wages, subsistence, etc., cost the government $674 (£141).

At the saving indicated by the returns from the first quarter of the operation of the oil plant there will undoubtedly be an annual saving in fuel of $2,160 (£432); this, with the reduction of $674 (£141) for labor, will make an annual saving of $2,834 (£567), due almost entirely to the installation of apparatus, the first cost of which was only $2,500 (£500).

The following notes and excerpts from the report of the engineer officer in charge of the steam machinery may prove of interest in connection with the operation of this plant, viz.:

The new boiler is well adapted for the use of oil as fuel, because of the flame-baffling system, combined with the large volume of the combustion chamber. This allows the sprayed oil ample opportunity to effect a complete combustion and passes the products of combustion to the stack at a low temperature. Under ordinary conditions there is no smoke. After the boilers had been in operation for two months the quantity of dirt and soot removed would not fill a two-quart can. The heating surfaces were almost as clean as when new, while, with coal, they would have been congested with soot.

With oil the steam pressure can be kept stationary, while the machinery can respond to unusual or varying demands.

A great economy is effected through the careful use of the damper. The fire bricks act as an accumulator of heat, and about 20 gallons of oil will maintain steam at about 100 pounds pressure for twenty-four hours, thus holding steam easily at night.

From water at 56 degrees F., steam is raised in one hour with the middle burner operated as slowly as possible and using an inappreciable amount of oil.

The proper adjustment of the fire bricks over the grate bars is important. They are laid flat and lengthwise across the grates. The five rows back are laid close together, and three extra rows are added for ordinary steaming. The remainder are laid in the same manner, with a space of 3 to 4 inches between each new row, depending on the amount of air required. If too much air is admitted, oil is wasted; and if too little, the burners give out a dark flame and sputter. The air supply must be balanced with the steam supply to get the best results.

The oil in the tank is about 80 degrees F. It is delivered to the burners at about 150 degrees F., under a pressure of 40 to 60 pounds, depending on the work required.

The efficiency of the entire system is dependent on the regularity of the oil supply. If through any cause the pump is not operated uniformly, no amount of attention will avail at the burners.

The oil used is the California product known as "Richmond Fuel," and the following are its physical properties and chemical analysis:

ULTIMATE ANALYSIS.	
Carbon	87 78%
Hydrogen	10 75%
Sulphur	.75%
Nitrogen	.34%
Oxygen	.38%
Moisture	.10%

PHYSICAL PROPERTIES.	
Specific gravity	0 952
Flash point	190 F.
Fire point	280 F.
Calorific value B. T. U	18,648

There are a lot of notes and tables which are of almost daily use. Handled by dirty hands these soon become so soiled that they cannot be read easily, if at all. It is but a slight improvement to varnish them. The best thing is not to handle them at all. This can easily be accomplished by placing them face up on the desk with a piece of plate or double thick glass on top. A small rim of wood should be nailed around the glass to keep it from sliding off. Where the lid of the desk is hinged the wooden border should have a small lip to hold the glass down upon it.

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THE MARINE STEAM ENGINE INDICATOR—XX.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

THE COUNTER PRESSURE LINE.

Under ideal conditions, and at the moment when the crank pin is crossing the dead center, the pressure in the cylinder should be almost, if not quite, as low as that in the chamber into which the exhaust passage leads. If this condition exists and the port opening is ample, the piston will meet with very little resistance due to steam friction. In fact, the difference in pressure necessary to produce a flow from the cylinder to the exhaust pipe or receiver will be so small that it will be hardly measureable, and the counter pressure or back pressure line** will be straight and parallel to the atmospheric line, as shown at *I*, Fig. 106.

If release is late and the valve opens slowly, but eventually

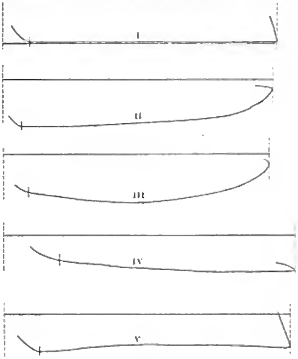

FIG. 106.

gives a good port opening, the counter pressure line will resemble *II*, while, if the line is like *III*, it indicates a restricted passage at each end of the stroke. If release is early and the steam speed high near the middle of the stroke, the counter pressure line will slope upward from the "toe," due to excessive steam friction near the middle, and to cramping of the exhaust near the end of the stroke, when the exhaust port narrows for compression while the piston speed is yet relatively high. (See *IV*.)

The designed velocity for exhaust steam through ports and passages is commonly as low as 4,000 feet per minute, and in land practice this rule is very generally observed. On shipboard, however, on account of lack of space and necessary weight limitation, it is practically impossible to provide passages sufficiently large for this low velocity. This is especially true in the design of intermediate and low-pressure cylinders of high-speed engines.

As an example taken from actual work, the following exhaust steam speeds should be carefully noted as representing good modern practice in two widely differing types of propelling machinery. The speeds given are in feet per minute, with the engines at maximum power:

MERCHANT MARINE TYPE, VERTICAL TRIPLE, ONE LOW-PRESSURE CYLINDER.

Exhaust from high-pressure cylinder	4120
Exhaust from medium-pressure cylinder	5375
Exhaust from low-pressure cylinder	6830
Exhaust pipe, low-pressure, valve chest to condenser	4975

NAVAL TYPE, VERTICAL TRIPLE, TWO LOW-PRESSURE CYLINDERS.

Exhaust from high-pressure cylinder	5700
Exhaust from medium-pressure cylinder	6900
Exhaust from low-pressure cylinder	8580
Exhaust pipe, low-pressure, valve chest to condenser	7200

The higher steam speeds in the naval engine are due to the fact that military necessity requires some sacrifice of efficiency in the machinery, in order that space may be saved, and all

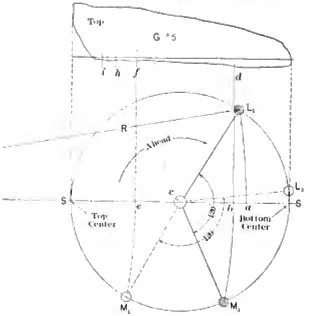

FIG. 107.

possible weight used in armor and armament without increasing the total weight of the vessel. These facts are mentioned in order that the reader may not be led to expect indicator diagrams from marine engines, which will compare favorably with those taken from land engines, which have been worked out without the same restrictions as to weight or space.

With regard to steam speeds in general, it should be noted that the velocities are average velocities, and account should be taken of the fact that steam and piston speeds increase from zero at the ends to a maximum near the middle of the stroke.

On diagrams taken from engines running at such speeds, that the steam velocities are excessive, we often see counter pressure lines like *V*. This line shows in a beautiful manner the banking up of the pressure near the middle of the stroke, due to the necessarily rapid flow of the exhaust through the ports at that part of the stroke when the piston speed is highest.

In the case of cylinders exhausting into receivers from which other engines take steam, the counter pressure is affected by the position of the engine cranks relative to each other, by the receiver capacity, and the order in which the various valve events occur. Refer to Fig. 107. When cut-off

* Copyright, 1911, by Charles S. Root.
** E. F. of Fig. 95, September, 1910.

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occurs in the low-pressure cylinder, the low-pressure piston is at *a* on the line of stroke *S S*, and approaching the bottom center. On this particular engine the length of the connecting rod *R* is five times the radius of the crank $c\ L_1$. With this length as a radius and a center located on *S S*, produced, sweep in the arc $a\ L_1$, cutting the circle, representing the path of the crank pin, at L_1, this locating the low-pressure crank pin at the moment of cut-off in the low-pressure cylinder. Draw $c\ L_1$, the center line of the low-pressure crank web. Lay off 120 degrees in the direction of rotation and mark M_1. This is the position of the medium-pressure crank pin at the instant of low-pressure cut-off. With the length of the connecting rod as before sweep in the arc $M_1\ b$. This locates the medium-pressure piston at *b* at the instant of cut-off in the low-pressure. Draw *b d* at right angles to *S S*, and produce it to cut the counter pressure line of the indicator diagram. It will be noticed that the counter pressure begins to increase at this point. This is because the escape of steam from receiver has been stopped by the closing of the low-pressure valve, while steam continues to flow into it from the medium-pressure cylinder. In other words, the medium-pressure piston is compressing the steam in the low-pressure receiver. The counter pressure reaches a maximum at *f*. When the low-pressure crank pin reaches L_2, the low-pressure engine commences to take steam for the up-stroke. The corresponding position for the medium-pressure crank pin is M_2, with the medium pres- piston on the line *e f*. The counter pressure line begins to fall after passing *f*, due to the steam flowing into the low-pressure cylinder, but as the capacity of the cylinder is comparatively small and the piston speed low up to this point, the drop in the receiver pressure is not abrupt. At *h* the medium-pressure exhaust begins to "wire draw," though the nearly-closed exhaust port and the influence of the receiver pressure on the cylinder pressure is at an end. Compression begins at *i* At the time the diagram of Fig. 107 was taken, the engine was running at only one-third power; steam speeds were low, and wire-drawing, due to high steam speeds, does not complicate the diagram.

The diagram of Fig. 100* shows the characteristic "hump" in the back pressure line in a very marked degree. In this instance the low-pressure valve was out of position owing to the wearing down of the gear. This caused a very late cut-off on the down stroke of the low-pressure, and the "hump" in the medium-presure counter pressure line is nearer the end of the medium-pressure up-stroke than in Fig. 107. The low-pressure bottom admission does not begin until about the time of compression in the medium-pressure, and, in consequence, the drop in the receiver pressure at this point does not appear on the card.

While the counter pressure in the low-pressure engine is not affected as that of the other engines by a varying receiver pressure, it is, of course, influenced by the condenser pressure, and it may not be out of place here to say a few words relative to the best vacuum to carry.

The flow of steam increases with difference in pressure until the lower pressure drops to about 58 percent of the higher pressure. With a greater difference the rate of flow does not increase, even though a nearly perfect vacuum be maintained in the condenser. In consequence, a better vacuum than is usually carried does not always result in lowering the counter pressure line in the low-pressure cylinder, although it does increase the load on the air pump. It is, therefore, desirable to carry that vacuum, which, if decreased at all, will produce a rise in the low-pressure counter pressure line and which, if increased, will result in no lowering of that line. This certain condenser pressure—which will be called the *economical* vacuum for want of a better term—is different for different engines and differs in the same engine when at different speeds. The economical vacuum should be determined for every installation when operating at the regular sea speed, and when once established should be maintained if it does not result in hot-well temperatures which are not permissible. The proper vacuum may be easily found by applying the indicator to the low-pressure cylinder and varying the vacuum until the correct point is found. In this way it will be possible to obtain minimum counter pressure in the main engines with the least possible load on the air and circulating pumps.

(To be continued.)

* December, 1910, issue.

Passenger and Freight Steamship Suwannee.

The Merchants & Miners Transportation Company, of Baltimore, has just added a handsome passenger and freight steamship to its fleet trading between Savannah and Baltimore. The vessel was built at the yards of the New York Shipbuilding Company, Camden, N. J., U. S. A., and is of the following dimensions:

LAUNCHING OF S. S. SUWANNEE.

Length over all	331 feet
Length B. P.	318 feet
Beam molded	46 feet
Depth molded to huricane deck	30 feet

The vessel is especially adapted for the coastwise trade and has been built to the rules of the American Bureau of Shipping, under special survey; the requirements of the Board of Supervising Inspectors of Steam Vessels for the equipment, etc., have also been fully complied with. The arrangement of accommodation is such as will give every comfort and convenience to the passengers, and provision is made for 150 first class passengers, 20 deck passengers, and crew and stewards' department, 56; a total complement of 226.

The cargo holds, ports and hatches are so arranged as to facilitate the handling of freight, and steam winches, cranes, etc., are fitted in connection with the same.

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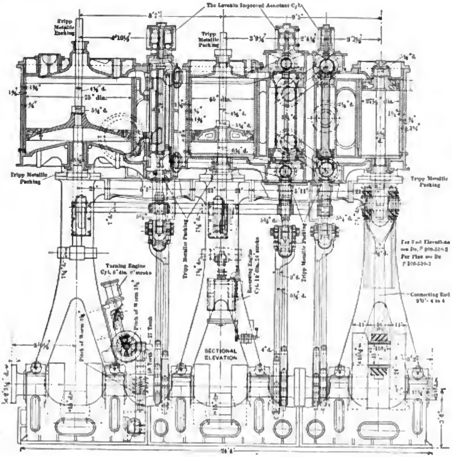
The propelling machinery is located amidships and consists of a three-cylinder reciprocating engine and four single-ended Scotch boilers. A double bottom is arranged in way of the machinery space for the carriage of reserve feed water, and all fore and aft for the purpose of trucking freight, and three large cargo ports are fitted on each side. A double bottom is fitted under the engine room, on the cellular principle with floors on every frame. The promenade and boat decks on top

S. S. SUWANNEE BEING FITTED OUT.

the peaks are also fitted as tanks. For the drinking water and for sanitary service separate tanks are provided.

Hull Construction.—The vessel has complete steel main of deck houses are carried out to the side of the vessel and are of light joiner construction.

Passenger Accommodations.—Accommodations for 150



ENGINE OF S. S. SUWANNEE.

deck all fore and aft, lower deck at ends forward and abaft of machinery spaces, and hurricane deck of steel stringers, ties and beams with wood decking all fore and aft. The vessel is subdivided by five steel watertight bulkheads, all carried to the main deck. The main 'tween decks are clear of obstruction first class passengers are all located in deck houses on the hurricane and promenade decks, there being 65 state rooms, four of these being arranged en suite, with special fittings and adjoining bathrooms, and four are extra large individual state rooms with toilet and shower bath to each. A spacious

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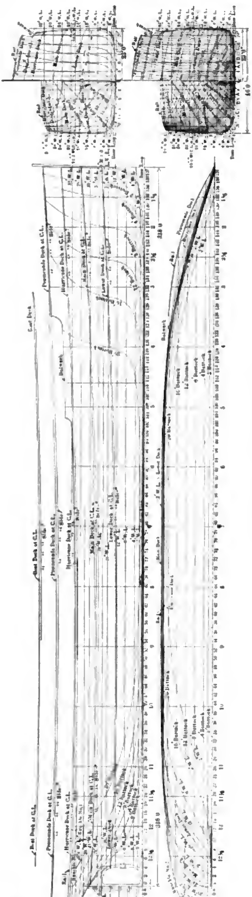

LINES OF MERCHANTS & MINERS S. S. SUWANNEE.

dining saloon is fitted on the hurricane deck capable of seating 82 persons, and a large social hall and smoking room are fitted up on the promenade deck, stairways and lobbies forming entrances to the same. Dome skylights add to the decoratice effect in these spaces. The 20 second class passengers are berthed in two rooms in the forecastle on the hurricane deck, the smaller of the two being reserved for ladies and provided with four berths, with toilet adjoining.

The captain and officers are located in a deckhouse on the forward part of the boat deck, with pilot house at the forward end.

The engineers are in deckhouses at the sides of the casings on the promenade deck, and the galley, pantry and stewards' staff are located on the hurricane deck alongside casings. The waiters, seamen and firemen are berthed in the forecastle on the hurricane deck. All modern conveniences are fitted in the state rooms, public rooms, stewards' department, galley and pantry. Built-in ice, fruit and vegetable lockers are also provided.

Cargo Arrangements.—The arrangements for rapid handling of the cargo are very complete. Large cargo hatches are provided to each hold, and radial cranes are fitted on the main deck and forward on hurricane deck to handle the cargo from the holds to the 'tween decks, whence it is trucked ashore through large cargo ports provided for that purpose. Hoisting engines are fitted at each radial crane. The holds have been kept clear of obstructions and the pillars supporting the decks are widely spaced, with overhead girders. A steam windlass is fitted forward with capstan head fited on the forecastle for handling the vessel; the engine and wildcats for handling the anchor cable are below on the hurricane deck. A steam capstan is also fitted aft for handling the vessel. Eight steam cargo winches are fitted, one to each radial crane to the cargo hatches. A steam steering gear is fitted, with auxiliary hand appliances. Life-saving apparatus is provided of ample capacity for the full complement of 226 persons and consists of seven metallic lifeboats and two metallic cylinder life-rafts, also one working boat for the use of the vessel; all boats being handled by Welin quadrant davits. The vessel is equipped with wireless telegraphy.

United States Naval Programme for 1911.

The naval appropriation bill recently passed by Congress contains the following provisions as regards the building of new vessels:

Two first-class battleships, to cost, exclusive of armor and armament, not to exceed the sum of $6,000,000 (£1,200,000) each. The general characteristics of these vessels embody as heavy armor and as powerful armament as any vessels of their class, combined with the greatest possible speed and radius of action.

Two fleet colliers of not less than 12,500 tons displacement, inclusive of bunker coal; the cost not to exceed $1,000,000 (£200,000); and the speed to be 14 knots.

Eight torpedo boat destroyers to cost not more than $825,000 (£165,000) each and to have the highest practicable speed.

Four submarine boats, to cost an aggregate of not exceeding $2,000,000 (£400,000).

One submarine tender, the cost of which must not exceed $500,000 (£100,000).

One gunboat, to cost not to exceed $500,000 (£100,000), which is exclusive of armor and armament.

One river gunboat, to cost not to exceed $225,000 (£45,000), exclusive of armor and armament.

Two sea-going tugs, to cost not to exceed $215,000 (£43,000.)

The total amount in the bill is $126,464,338 (£25,292,868), which constitutes the appropriation for the entire naval establishment for the year ending 1912.

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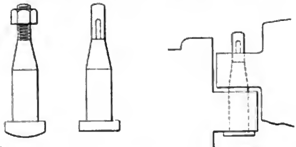
PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

The Repair of Broken Rudder Pintle Bolts.

It is a very inadvisable thing to have the chains of the steering gear of a vessel too slack, and as a precaution against trouble of this nature it is advisable that springs should be fitted to them. If this is not done there is a considerable amount of danger of the rudder lashing from side to side, more particularly if the ship is light, and if it should happen to be in a heavy following sea. The result of this will probably be that the pintle bolts will be broken, owing to the sudden strain put upon them. In a case of this sort in the



BROKEN RUDDER PINTLE BOLTS.

Atantic two pintle bolts of the shape shown in Fig. 1 were broken and fell out, and as soon as this was noticed the ship had to be stopped. In order to effect a repair which would stand until the vessel reached port, a gangway davit was secured and sawn into two lengths by chipping and filing these up; bolts were made of the shape shown in Fig. 2. As there were no screw-cutting lathes on board ship, it was necessary to cut cotter holes through the top of the bolt, as shown in the figure, and, after waiting until the sea went down a bit, these bolts were put in and secured by means of cotters, as shown in Fig. 3. The cotters had holes drilled in them, into which were placed split pins in order to keep the cotters from working out again, and the repair answered perfectly until the vessel was brought back into port.

Hull. RUDDER.

How a Spare Propeller and Shaft were Fitted at Sea.

We were on a voyage from Bombay to Dundee (Scotland) in ballast trim in the good ship *D*........... It was on this voyage that we lost our propeller, the loss of which was due to the tail end breaking off short just outside the stern tube.

The vessel being in the Indian Ocean and near some very inhospitable islands, noted for their man-eating propensities, and a strong current setting towards those islands, our captain and chief-engineer determined to attempt to fit the spare propeller and tail-end shaft which we had in the hold. This feat we managed to accomplish under very trying conditions, but in an entirely satisfactory manner. In order to prevent the vessel from drifting and rolling, a sea anchor, consisting of a long derrick, having sails, weighted with chains attached to it, was let out, and, as a further preventative, one of the anchors, with 30 fathoms of chain cable, was lowered away. This lessened the leeway considerably, but owing to the boisterous, squally weather the vessel continued to roll easily during the whole of the time the replacing of the propeller at tail-end shaft was carried out.

While the captain and his officers were making preparations for lifting and slinging the propeller, the chief-engineer and his staff were very busy down below disconnecting the shafting and chocking it up; they also rolled the intermediate length to one side and made it fast there. Our next job was to cut a plate off the tunnel top; and, as it turned out, it was a very difficult job owing to its being an inside plate, and now all was made ready for removing the broken shaft. The propeller was then unshipped in the hold and lowered away on to the floor of the hold, with, of course, the large end of the bore up. Having done this, we lifted the spare shaft on end and tried it in the bore of the propeller boss. We had previous to this taken every precaution to see that the taper and key were a good fit. All being now ready for fitting the propeller and shaft, orders were given to fill the fore peak, tanks, and fore hold; the water in the latter was only up to the outside level of the water. All this having been done, we now started to get the broken shaft in, and after about twelve hours' solid work we managed to land it in the hold. A wooden plug was fitted to the shaft hole on the outside; this kept nearly all the water out. Our next job was to get the new shaft into place; this job took us 24 hours' solid work. To finish, we had to make a Muntz metal cap to go over and protect the threads on the nut end of the shaft. This Muntz metal cap was run out flush, with the guard ring pushing the wooden plug out at the same time.

Everything being now ready for fitting the propeller, the difficult and dangerous operation of lifting a mass of metal of some eight tons over the side of the vessel, and passing it under the stern, had to be accomplished while the vessel was rolling in the trough of the sea, which was a very heavy one at the time, and which also prohibited the use of either boats or rafts. As all the hatches were fitted with two derricks, both derricks were utilized for the lift, the two being lashed together at the top and fitted with preventative spans on each, about 6 feet in, both being lifted together. The goose necks being 4 inches in diameter, and extra strong, it was not deemed necessary to add any further support to them. The masts did not go through the deck, but were secured to it by heavy gusset plates, and as the deck was supported by heavy through beams and longitudinals, no further support was added and did not prove necessary.

The purchases used were small mooring wire ropes, fastened to the derrick ends, and acting as top block, and so on, down to the winch barrel. We thought it better to try the gear when fitting the shaft, and this we did, and found it worked very satisfactorily. The propeller was now slung round the boss, the slings being well secured with small chain lashings, all terminating at the top, or key-way up side, so as to be easily undone when the propeller was fitted on to the shaft. In order to steady the derricks when making the lift, the four lifts, four tackles were used as guys, two on each side, these being shifted at one time, as required. At a favorable moment the lift was made, and, when clear of the hatch combings, the derricks were guyed over a little and then the propeller was safely landed and secured on the starboard main deck. The derricks were then guyed further over, a gin block was made fast to the center eyebolt under the counter and another to the propeller, from which a wire rope tackle was led from the capstan aft, through the starboard fair lead, gin of propeller, then to gin under counter, and the end made fast to the propeller. A large wire rope was then led from the forward capstan over the port bow, right along the whole length of the vessel's side, through the screw aperture and round the starboard quarter and made fast to the propeller boss. A similar wire rope was led from forward along the starboard side and also made fast to the propeller boss.

Every precaution having now been taken to prevent the propeller from swinging and staving in the ship's side, the propeller was lifted, and, at the first roll, it was allowed to slide over the ship's side into the water by lowering away the derrick tackles and starboard forward wire; at the same time the after capstan began to heave on its tackle and the forward capstan on the forward port wire. This immediately brought the propeller well under the counter into a comparatively quiet position. Blocks and tackle having being hung from the eyebolt under the port counter were made fast to the propeller and secured. The lashings were then taken off the derricks, and, after unhooking the port derrick tackle, it was passed over the port counter, through the screw aperture, and made fast to the propeller once more.

Another lift was then made and the propeller was brought into position, blocks being hung from the starboard eyebolt and made fast to the boss. The propeller was thus held up and forward by the derrick tackles, up and aft by the tackle to center eyebolt, up and against the body post by fore-and-aft wires, and sideways by the tackles to the propeller lifting eyebolts.

We encountered considerable trouble in entering the shaft and key into the propeller boss, owing to the inclination of the shaft, due to the tip of the vessel, and we only overcame this by taking off the weight now and again. We took the greatest care in handling the nut, it being securely lashed and made fast to the deck; the lashings were only removed when the nut had been screwed up three turns. To have lost the nut would to us have been just as great a disaster as losing the propeller. After "Monday" had been used vigorously for some time, and the propeller set hard up, the set pin was driven home and the most difficult work completed. The shafting we soon afterwards coupled up, replaced the bearings, warmed the engines through and started them very slowly. The voyage was once more resumed, after the repairs had taken eight days and twenty hours.

When we consider the difficult nature of the work so successfully accomplished and in so short a time, the lifting of a heavy mass of metal from the hold to the stern of a rolling ship, the fitting it on while at work on a plank 6 inches wide, one minute immersed 5 feet in the water alive with all sorts of terrible fish, and the next minute 15 feet in the air, hanging on to a heavy hammer or key or nut, the loss of which meant so much to us and to the success of the whole undertaking, or when we consider the great risk of a sudden storm coming on when the loose propeler was hanging from the stern, the pluck, energy and ingenuity of the captain, the chief-engineer and their respective staffs, will, I think, be appreciated by all in both professions. F. J. S. N.

Liverpool.

A LEAKY CONDENSER.

The tubes of a condenser require cleaning from time to time, and this is an operation that should be gone about with some care. If the steam passes through the tubes they can be sponged out with a solution of soda. If the steam passes around the tubes, the fresh-water side is filled with a solution of soda in fresh water, and this may be boiled. After using soda in the condenser, the interior must be thoroughly washed out to prevent the residual soapy matter entering the boiler. Periodical examinations should be made by taking off the manhole and hand-hole doors, for the purpose of cleaning out the grease deposited in the space provided for the condensed steam, and to examine the zincs and tubes; zincs are fitted in the condenser to arrest the corrosion of the tubes, or of the metal of the condenser set up by galvanic action, and those immersed in the salt water have the shortest life and must be frequently renewed. Where the condenser is separate from the engine frame, it is best to have the tubes and condenser shell of the same or similar metal, but for the sake of economy the shell is generally made of cast iron, but sea water destroys this material in time, rendering it soft and spongy, so that in some cases the metal can be cut with a knife. The zincs are secured as in boilers, in the form of plates, and they are also fitted in the form of rods. The method in the latter case is to provide screwed brass plugs, into which the zinc rods are soldered. The plugs are screwed into certain of the holes for the tube glands and are distributed over the surface of the tube plates. The plugs are provided with a square head for a spanner, and the rods project inwards along the length of tubes; these rods must be frequently renewed.

Before opening out the fresh-water side of a condenser it should be pumped out by whatever means is provided for that purpose, and this amount of fresh water is thus saved. It is also necessary to observe the precaution of airing the condenser after it is opened out, because the action of the water and zinc liberates hydrogen gas, and if a light is introduced for examination of the interior before the hydrogen gas has escaped an explosion may easily occur.

In testing for leaks it is well to remember that the tubes of a condenser are liable to split, and also that in spite of the zincs the material is frequently pitted by corrosion, and pin holes are formed. A very slight leak in the tubes of a condenser will, by accumulation, cause the water in the boilers to be rapidly salted and show a density, therefore the examination of the tubes must be carefully conducted. The method employed to examine the tubes depends on whether the salt water passes through or around them; if the salt water passes around the tubes, and the latter are vertical, the examination is easy. Take off the man-hole doors at the top and bottom, giving access to the steam and fresh-water spaces, and leave the salt-water space in communication with the sea. After a short interval introduce a light under the tubes, dry up the spaces, and look for drips from the tubes; taste the drops of water as they fall, and notice whether it is fresh or brackish; it is necessary to keep the top tube plate dry to find the leaky tube; otherwise, if the top glands leak, the salt water may run down a sound tube, because it is lower than the others. If salt water is running down a tube and the glands are tight it may be inferred that there is a leak in the tube. The practice in such a case is to drive a turned conical plug of soft white wood into both ends of the tube; the tube is identified at the top plate by passing a long wire through from the bottom. It generally happens that corrosion attacks a group of tubes, and, in some cases, 10 percent of the tubes may be so plugged before an opportunity occurs of replacing them by sound ones. Whenever a number of tubes have been corroded, it will be best to withdraw the whole for a thorough examination, and to test them under pressure singly.

If the salt water passes through the tubes, shut the main inlet and outlet valves tightly and rig the outside plugs on the ship's side (if possible) over the inlet and outlet orifices, then drain the condenser of fresh water and shut off all gage glasses and vacuum gages. Blank flange the pipes communicating with the low-pressure cylinder and air pump, and

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also, if necessary, any drain pipes from the cylinders and from steam and exhaust pipes, which are led to the fresh-water side. Fill up the space around the tubes with salt water by a hose, inserted before the blank flange is put on the inlet for exhaust steam. A cock must be introduced in this blank flange, leading by a copper pipe to a test pump, by means of which a pressure not exceeding 30 pounds per square inch is put on the condenser; the interior of the condenser being under pressure, the tube plates are carefully dried and the ends of the tubes examined for salt-water leaks. The first proceeding should be to screw up all the slack glands. There is sometimes difficulty in detecting a leaky tube, because the water pressure being applied outside the tube tends to close up openings; whereas under working conditions the salt water is drawn through from the inside by the outside vacuum, and any rents or cracks are opened out. In such a case all the tubes may have to be withdrawn and subjected individually to a water pressure applied internally. The writer has experienced such a necessity, the condenser being proved to leak under steam, though when cold and subjected to a water pressure no leaks could be detected. It may also happen that the leak occurs not through the tubes, but under the bolt heads securing the stays between the tube plates. It is always advisable to withdraw the packing from the glands of a number of tubes, to ascertain whether it is perished. If a jet of steam is discharged on to the tubes from a drain pipe or through the eduction pipe, it may cause them to chafe, and the jet of steam itself may wear holes in the tubes so that leaks are caused. To prevent such action, baffle-plates should be fitted to distribute the steam delivered and to take the momentum of the impact; the tubes should be a close fit in the intermediate diaphragm plates in order to prevent chafing. The internal surfaces of a condenser that are exposed to sea water should be coated with a good wash of Portland cement at each examination. If the usual waste of fresh water is noticeably diminished in quantity, there is good reason to suspect a salt-water leak to the boilers, and the density of the feed water should be immediately taken. It is a good plan in doing this, to boil away three-fourths of the water drawn off from the hot well before taking the density, in order to magnify the effect of a slight leak of salt water, which might otherwise escape detection by the salinometer or hydrometer. The latter is so graded that the density of sea water is 1o at 200 degrees Fahrenheit. It is also very useful to remember in this connection that nitrate of silver, if added to water containing even a trace of salt, produces a cloudy white precipitate. Should the water drawn off from the hot well show a density as low as one-half by the hydrometer, or should it even taste slightly brackish, it is necessary to take steps to ascertain the cause of the salt-water leak. Such a leak resulting in a rise in density of the water in the boilers is generally occasioned by leaky condenser tubes, and this can only be ascertained by opening up the condenser as previously indicated. There are, however, other causes, some of which may be found and remedied whilst under way.

(1) The sea suction of one of the feed pumps (if they have a sea connection) may not be properly closed.

(2) The air pump may be fitted with an automatic spring-loaded discharge valve, delivering into the circulating water discharge pipe overboard; if this valve is leaky, or is prevented from closing, salt water will leak back to the air pump during a temporary stoppage of the main engine. This automatic valve is fitted to relieve the air pump of a glut of water on starting; also for the discharge of the salt water admitted to the condenser, when the jet injection is in use. Jet injectors were formerly fitted to surface condensers for use in the event of the circulating pump being disabled.

(3) If the evaporator primes when the vapor formed is being passed into the main condenser, the density of the water in the hot well will rise, since the density in the evaporator is high.

(4) The supplementary or extra salt-water feed cock may be leaky.

One of the most important duties of the engineer of the watch is to pay close attention to the vacuum gage, recording the amount of vacuum in the main condenser. A reduced vacuum is a fruitful source of loss of economy, and the cause should be investigated. The temperature of the feed water delivered from the air pumps should be from 90 to 125 degrees F., depending on the temperature of the sea water, and the speed of the circulating pump should be adjusted to produce this temperature, or the main injection set to obtain this result, as the case may be. If the feed water is too hot it is probable that there is not enough circulating water and the vacuum will suffer; if, on the other hand, the feed water is cool and the vacuum is bad, the fault is probably with the air-pump valves, or may be caused by an air leak into the condenser; it is then advisable to go round all drain valves on the condenser, air pump and exhaust steam pipes, and see that they are not open to the atmosphere; also, if the main circulating engine exhausts both to the main and auxiliary condenser, see that both exhaust valves are not open and inspect the suction leading from the feed pumps to the condenser if so fitted.

Try the silent blow-off valve and the soda cock, and make sure they are shut. An imperfect vacuum may also be due to leaky glands on the low-pressure cylinder, which need repacking, or a split in the low-pressure receiver pipe, which latter the writer experienced in a certain case. Examine the vacuum gage, which may be defective or partially shut off; there are generally more gages than one on which the vacuum may be read. If they all show a low reading the vacuum is most probably defective.

It may be interesting to cite a case in which the writer had an experience with a leaky condenser a good many years ago. The steamer which he joined as second engineer had been laid up idle for some eighteen months, previous to her being chartered for mail and passenger service to the East Indies. It will naturally occur to every engineer that there was a considerable amount of overhauling to be done to get her ready for sea. Among other things, the chief decided to clean out the condenser, which was very dirty, and we proceeded in the usual way and in the manner herein before described, closing all outlets and inlets, and running the condenser nearly full of fresh water mixed with a strong solution of soda. A ¾-inch copper pipe was coupled up to the donkey boiler steam pipe and the condenser was thoroughly boiled out, then washed, and afterwards tested under a low-water pressure, to make sure all the tubes were tight, and, so far as could be seen, everything seemed in good order and condition. It ought to be here stated that the circulating water passed through the tubes, which had their ends packed with soft white wood ferrules. Accordingly the condenser was closed up, and, the other repairs and overhauling being completed, the vessel put to sea on her sailing date. We had not been many hours on the voyage before it was found that the boilers were gaining water. The feed water was immediately tested and found to be rather brackish, and some density was shown by the hydrometer. After consultation with the captain, the chief decided to stop the ship and take off the condenser doors, to ascertain the extent of the trouble; this was soon done without much trouble, as the weather was fine and the sea calm. The top man-hole door was also removed and the condenser run up full of salt water with a hose, and when this was accomplished quite a number of small leaks at the ends of the tubes were located and marked. After all the tubes had been carefully scrutinized the water was allowed to run from the condenser and all the leaky tubes were re-ferruled until all the spare ferrules had been used; the rest

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of the leaks were plugged. It was not, however, without some uneasiness that the doors were rejointed, as, judging from the condition of the old ferrules, there was trouble ahead; they were more or less perished, and the boiling they got, after the condenser being so long unused, pretty well finished them, although, as previously intimated, they appeared to be tight under test. The engines were put ahead again at a reduced speed, a close watch being kept on the feed water and the boiler water gage glasses, which, to our relief, did not show any increase in the water level. This state of things continued for about two days, when we ran into a heavy southwest gale in crossing the Bay of Biscay, accompanied by a mountainous sea, which caused heavy racing of the engines in spite of the efforts of the engineer standing at the throttle valve to ease her.

The outcome of this could be easily foreseen, as the circulating pump was worked from the levers on the low-pressure engine; the unequal revolutions of the engine sending the water through the tubes sometimes with a heavy thud, and then easing up, started the tubes which had not been referruled; and, again, we saw the water very rapidly gaining in the boilers until we were forced to blow down to prevent priming. Soon the steam began to fall, the vacuum was diminishing and the feed water was cold; there were no valves on the suction pipe of the feed pumps to enable us to adjust the amount of feed, and we soon found the air pump discharging water overboard that the feed pumps could not cope with, and add to this that the water in the bilges was steadily increasing until the wing flooring plates were up in the boiler room. It soon became necessary to blow about 12 inches out of four 13-foot diameter boilers every hour or so, and one of the engineers was detailed to do this particular work alone, and it kept him busy.

Of course, we could not attempt to effect any repair in such weather, even if we had had sufficient ferrules to do it with, as the steamer would have fallen off in the trough of the sea, and it was all that could be done to keep steam enough to maintain steerage way.

Fortunately for us, some thirty-six hours after the weather moderated the captain shaped his course for the nearest port, which proved to be Vigo. Eventually we limped into the harbor and dropped anchor. When the condenser was again opened up, it was seen that but few ferrules remained of the original ones, and a few of the tubes were completely out of the tube plate at one end. It is needless to say a thorough job was done this time: the whole of the tubes getting new ferrules and some new tubes replacing doubtful old ones. Again the test under pressure was applied and proved satisfactory. Steam was raised, and the vessel resumed and completed her voyage without further mishap. Perhaps of all the anxious and uncomfortable times the writer has put in at sea, not the least exciting was this episode of battling with a leaky condenser. C.

Seattle, Wash.

The Twelfth International Congress of Navigation.

This congress will meet for about one week during 1912, in Philadelphia, Pa. The programme is an interesting one, trips are to be made to various places not only near the city, but as far a-field as Canada. Visiting members are to be especially looked after in these excursions. Brigadier-General C. W. Raymond, retired, 315 Fifth avenue, New York City, is chairman of the American section.

Broken Reversing Block.

On one of the regular voyages of the S. S. *E——* from Philadelphia to New York, all went well until we were going into the dock in New York, when suddenly the reversing block on the low-pressure engine broke, the engine was standing, and on the order being rung up on the telegraph "full speed astern," away went the block. It was in all probability caused by water accumulating on the top of the piston of the balance cylinder, owing to the packing ring not being tight. There was also very little clearance on the top.

F. J. S. N.

The Vacuum Question.

Hartlepool Engine Works, Hartlepool.

Editor, International Marine Engineering:

I am much obliged for your letter of the 18th inst. and enclosed copy of International Marine Engineering, in which you give my paper, recently read before the Northeast Coast Institution of Engineers and Shipbuilders (page 55, issue of February, 1911).

I note that you have also a leader on the same subject (page 83). At the bottom of the second column you refer to the question of extra circulating water required in obtaining a high vacuum. Mr. Weir also took up this point in the discussion, and I have pleasure in enclosing a few pages of my reply, and from which you will see that the extra power required is very slight and practically negligible.

Yours faithfully,

Feb. 20, 1911. p. p. D. B. Morison.

EXTRACT FROM MR. D. B. MORISON'S REPLY TO THE DISCUSSION ON HIS PAPER.

Mr. W. Weir credits me with being aware that in order to maintain 28 inches vacuum in a condenser "you must pump almost twice the circulating water" than is required for 25 inches, and goes on to say that "he has taken the liberty of correcting the figures by adding to each the necessary expenditure for circulating water.

Let us analyse the 1,500 indicated horsepower cargo boat proposition (Table 2, p. 55, February issue), in which the circulating pump is driven by the main engines, and ascertain what the correction desired by Mr. Weir amounts to.

With an efficient condenser and sea water at 60 degrees F., a condenser vacuum of fully 28 inches can be obtained with an amount of circulating water equal to, say, forty times the feed, or about 1,400 gallons per minute.

Assuming an efficient condenser and a circulating pump of the reciprocating type working against 10 feet total head and driven by the main engines, the power required will be as follows:

$$\frac{1400 \times 10 \times 10}{33000} = 4.25 \text{ pump-horsepower}$$

and taking into account the mechanical efficiency, this corresponds to, say, 6 indicated horsepower.

If the quantity of circulating water is one-half or twenty times the steam condensed, then the power required for driving the pump will be even less than one-half. Therefore Mr. Weir's "twice as much" is at the most 4 horsepower out of 1,500 horsepower.

Dr. Weighton has proved that the gain in power in a triple engine by increasing the condenser vacuum from 25 inches to 28¼ inches, provided the engine is suitably designed, is as much as 5 percent, therefore the gain in power in the 1,500 horsepower engine for the 3¼ inches of vacuum is 75 horsepower, less 4 horsepower for the pump, or 71 horsepower net gain.

In referring to this question, Dr. Weighton says: "The amount of increased power absorbed in producing 28¼ inches of vacuum, as compared with 25 inches, is so small in the case of properly designed and proportioned engines in relation to the total power developed by the main engines that it will make scarcely any appreciable difference if it be neglected."

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CAR FERRY—"ANN ARBOR NO. 5"

What will probably be the most eventful trip on the Great Lakes for the year 1911 started on Sunday, Jan. 1, 1911, at 9:30 A. M., when the Car Ferry *Ann Arbor No.* 5 left the yards of the Toledo Shipbuilding Company at Toledo, Ohio, for Manistique, Michigan, arriving January 11, 1911, at 10 P .M. and loading cars January 12, and leaving at 10 A. M. for Frankfort, Mich.

To reach her destination, the steamer passed through part of Lake Erie, the Detroit River, Lake St. Clair, St. Clair River, Lake Huron, the Straights of Mackinac and part of Lake Michigan. In the Detroit River, the St. Clair River and the Straits of Mackinac, ice from 18 inches to 24 inches thick was encountered and passed through without any difficulty.

Opposite Marine City, on the St. Clair River, the steamer was for sixteen hours batling with ice 24 inches thick, very heavily windrowed; in most cases the windrows being grounded. Meeting the worst difficulties and conditions of the trip in the Straits of Mackinac, the steamer arrived at Manistique, a distance of 440 miles, in ten days and thirteen hours—under way during day-light hours only, thus establishing her reputation as an ice-crusher and a winter boat, arriving at Manistique without a mishap and everything in good working order and ready to take on a load of cars.

This car ferry is the largest of its type in the world, having a capacity of 30 42-foot cars, and is built for rigid winter service, running between the ports of Frankfort, Mich., and Manitowoc, Wis.

The contract was awarded by the Ann Arbor Railroad Company, from the design and specification of Frank E. Kirby, to the Toledo Shipbuilding Company on July 1, 1911, to be delivered at Toledo, Ohio, on January 1, 1911, furnished complete. The keel was laid on September 3, 1910; the vessel was launched on November 26, 1910, and completed and accepted December 31, 1910.

The general dimensions of the *Ann Arbor No.* 5 are as follows:

Length perpendiculars	363 feet
Length over all	378 feet
Breadth moulded	56 feet
Depth moulded	21 feet
Height between car deck and shade deck	17 feet 4 inches
Height of funnels above top of casing	31 feet 6 inches
Height from keel to top of funnels	78 feet
Number of watertight bulkheads	7
Gross tonnage	2884
Net tonnage	1961

RAPID CONSTRUCTION OF CAR FERRY "ANN ARBOR NO. 5."

The scantlings of the vessel are heavy for the service required, some of which are enumerated below.

The stem, sternpost and rudder frame are of forged wrought iron. Stem 4½ inches by 10 inches, rebitted from the 6-foot water line to the main deck; sternpost 6 inches by 10 inches, and rudder 10 inches diameter stock, 5½ inches diameter pintle and extra strong frame.

The construction is of the transverse system, with 9-inch by 21.8 pound bulb-angle frames, spaced, 2 feet, extending alternately from bilge to main deck and bilge to shade deck, frames lapped on plate floors at bilge. Floors 30 inches deep at center of 20-pound plate on every frame of 3½ by 3½-inch by 11.1-pound angle frames and reverse frames; reverse frames doubled in machinery space.

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Car deck beams of 12-inch by 30-pound channels, with 3½-inch by 3½-inch by 11.1-pound angles at top edge, spaced 4 feet, supported by three rows of heavy stanchions, brackets and ridge bars, car deck of 18-pound steel plate.

Keel plate 42 inches by 33.5 pounds, bottom plating 25.5 pounds, strakes shingled outside on the top edge and inside on the bottom, side plating 31 pounds, shingled. Main deck sheer strake, 31 pounds, doubled for two-thirds the length amidships. All shell plating forward from the keel to the sheer-strake doubled from the stem aft for 80 feet.

The steamer is built without double bottom, but each compartment is connected by a separate section and filling pipe through a manifold to a 12-inch by 20-inch by 16-inch ballast pump, so that any compartment may be partially filled or emptied for trimming purposes.

There are four tracks on the car deck, each rail set up on chairs of 8-inch by ¾-inch iron, located on each beam. Anchor rails outside of each rack, riveted to deck, to set up car jacks and holding chains. All the necessary car jacks, holding chains and gear were furnished as part of the equipment, together with a Westinghouse Air Compressor, piped to set up the air brakes on each string of cars.

The vessel is equipped with steam steering gear, electric light plant, steam windlass and capstan and steam gypsies.

A departure from the usual on this type of vessel is a hinged gate, enclosing the apron end of the ship for a height of 5 feet 6 inches above the car deck. This gate is for protection from the heavy following seas, and is operated by a winch, located under the car deck and is raised up out of the way when loading and unloading.

The cabins, consisting of smoking room, saloon, dining saloon, 15 state rooms and crew's quarters, are located on the shade deck. These are in pine and tastily finished in white enamel, all furnished complete.

The machinery and boilers are all below the car deck, with narrow casings extending up through to above the shade deck for stacks and light wells.

COAL BUNKERS.

Two coal bunkers of 500 tons capacity each, one forward and one aft of the boilers, extend across the ship with hatches between the rails of the tracks for fueling from hopper cars.

BOILERS.

Steam for the main propelling and auxiliary machinery is supplied by four single-ended cylindrical boilers, fitted with positive heated forced draft. The boilers are located in a single compartment, placed athwartships, with a fire room running fore and aft between them.

The boilers are 13 feet 6 inches diameter and 12 feet long, designed for a working pressure of 185 pounds. The total heating surface is 8,096 square feet, and the total grate surface is 184 square feet. The furnaces are 50 inches in diameter, with grate 5 feet 6 inches long, two to each boiler. Each furnace leads to a separate combustion chamber. The boiler tubes are 2½ inches in diameter and there are 334 in each boiler.

PROPELLING MACHINERY.

Propulsion is by means of two sectional propeller wheels, 12 feet 6 inches in diameter, with a cast iron hub and 4 cast steel blades to each. The propellers are each driven by a separate inverted, direct- acting, triple-expansion engine, having cylinders 21-inch, 33-inch and 52-inch by 40-inch stroke. Piston valves are fitted to the high and the intermediate-pressure cylinders and a double-ported slide valve to the low-pressure cylinder. The valves are actuated by the Stephenson double bar link motion, fitted with direct type of steam reversing gear. The pistons are cast steel. The piston rods, crossheads and connecting rods are forged steel. The crossheads have single slippers of brass. The engine framing consists of cast iron housings of box section, fitted on a cast iron bed plate made in one section. The crank shaft is of the builtup type. The thrust block is of the horse-shoe type. The air pump is of the ordinary bucket type, with jet condenser, driven together with a cooler and a bilge pump from the high-pressure crosshead.

CAR FERRY "ANN ARBOR NO. 5," IN SERVICE IN WINTER.

The Institute of Metals, of Great Britain, has appointed a committee to investigate the subject of corrosion, and the first subject which will be taken up is that of condenser tubes. Sir Gerard Muntz, the president of the Institute, is naturally much interested in the subject, and G. D. Bengough, of the metallurgical department of Liverpool University, is in charge of the scientific work.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

The bar before which all things mechanical must be tried and stand or fall by is commercialism. Opposition will avail but a short time if a money gain is shown. All history bears us out in this statement. Labor-saving machines or appliances can be translated as money-saving machines, and come they will, and to stay, for that very reason of saving, for they prove it. There is, however, much misrepresentation of facts. So often enthusiasm results in the fatal blunder of mistaking a success for victory that the world has learned to be very cautious in accepting statements from those directly interested. It is refreshing and rare to obtain such data as are given in this issue on oil fuel as applied to the revenue cutter *Golden Gate,* stationed on the Pacific Coast. The source of the information is such as to entirely preclude the possibility of error or sordid motives. That liquid fuel is being used in many places with great satisfaction is well known; but with the report referred to, in which it is so clearly shown how advantageous is its use, we look for a far more rapid advance in the future than in the past. There have been accidents reported with oil fuel, no doubt, but it does not need much brushing up of memory to recall accidents and dangers where coal has been responsible. It is unreasonable to anticipate that oil will become the universal fuel on shipboard, particularly in those parts of the world where coal is inexpensive and oil high in price; but the Pacific Coast of the United States is an ideal place for the use of oil, as evidenced by the figures quoted in the case of the *Golden Gate.* In very few places have engineers had the experience in using oil that those on the Coast have had, and this experience must, in a measure, account for this remarkable showing. Furthermore, there are few, if any, ports as conveniently suited for oil-burning vessels as San Francisco, as oil is piped to the wharves, and all that is necessary to do to fuel a vessel is to tie up to the wharf and connect up to the pipe line.

The fact that a number of eminent engineering establishments have taken up seriously building marine internal-combustion engines leads to the belief that there is faith back of works in this form of marine drive, if not wisdom. There are now several continental ships being fitted with this type of engine. Of three typical installations, one is a set of four-stroke cycle motor, single-acting cylinders of about 450 indicated horsepower; the second with a pair of two-stroke cycle motors, single-acting twin screws, each engine of about 900 indicated horsepower; and the third, a pair of two-stroke cycle motors, double-acting, of about the same power, and all of the Diesel type. It must also be remembered that in Germany there have already been built fishing boats equipped with these engines. On the larger vessels compressed air is used for reversing, while on the smaller boats a friction coupling and gear is employed. Of course, it is too soon to expect data as to the upkeep of large marine internal-combustion engines, but it will be the deciding point in their future use. It is probable that in the United States, where fuel is cheap and labor dear, repairs bear a larger relation to the fuel saving than in Europe, where these conditions are reversed. Or, in other words, what is saved in fuel may be offset by repairs. There are none, we think, to deny that the repairs of internal-combustion engines are far greater than those of steam engines, but just how much greater in large sizes of engines is unknown and is of grave importance. In discussing the subject of the upkeep of internal-combustion engines with those connected with their building and care it has been advanced that the cost of upkeep is not less than four times, or more than sixteen times, that of a steam engine—a wide margin indeed. There is no question whatever but that the upkeep is more. That improvements are on their way and will surely come is beyond question; but can the fact be overlooked or made light of that steam acts with a push while gas acts with a blow? And which of the two systems will result in the greatest repairs is hardly a question.

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Test of Twin Screw Tunnel Boat A. M. Scott.

The board of engineers, appointed under Act of Congress to investigate the best type, and to design and build the best type of towboat and barges for navigation and transportation on non-tidal rivers, convened at Charleston, W. Va., in March, to examine, test and report on the twin screw tunnel steamer *A. M. Scott*, described in International Marine Engineering for November, 1910, and designed and built by the Charles Ward Engineering Works. The board required the boat to take a tow of six loaded coal barges over a very tortuous course, where the channel is first on the left side, then abruptly across the river to the right side, making an "S" or reverse curve to enter the channel and avoid the bar, thence to a narrow artificial channel made by wing dams and side walls, about 1/3 of a mile long, producing very swift water, difficult to enter and usually only accomplished by flanking until properly in line. Below is a narrow channel sharply curved its entire length, and very long, only navigable heretofore by continued flanking; thence through a shoal, hard to enter, through a lock to shoals, where the currents are troublesome, making 16 miles of hazardous navigation.

We are informed that the *Scott* took this tow over the entire course without ringing a single backing bell, except while waiting to enter the lock. The *Scott* returned later to Charleston, where she was very satisfactorily put through various maneuvers, loose, turning around by rudder power head-on in this narrow river, backing straight up stream, steering to port backward and reversing to starboard without stopping her engines, then manipulating her in similar manner by the engines alone. This is believed to be the first time a boat has steered a tow of six loaded barges through such hazardous places. Six loaded barges is the standard tow for the largest towboats taking coal out of this river in 7.3 feet of water.

TECHNICAL PUBLICATIONS.

Motion Study. Frank B. Gilbreth. Size, 5½ by 7½ inches. Pages, 110. Figures, 41. New York, 1910: D. Van Nostrand Company. Price, $2.

We think most people will rather smile at the general idea of Mr. Galbreth, until they take time to read with care his book. Usually the excuse will be lack of time, the very thing that the book proposes to save, and we believe that its perusal will repay many-fold those who are wise enough to know that they have yet to learn how to save time.

Industrial Plants. Charles Day. Size, 5 by 7½ inches. Pages, 294. Illustrations, 48. New York: The Engineering Magazine. Price, $3.

If we were about to build, or owned, an industrial plant, we would certainly buy Mr. Day's book. In looking about us we find most admirable door checks that are a saving on our nerves, yet all over the country we also notice that a brick or the end of a string is doing duty on doors, and we fear that, figuratively speaking, this is the case far too often in industrial undertakings. The study of Mr. Day's book should do much to correct this state of things.

Heat. J. Gordon Ogden, Ph. D. Size, 5 by 7 inches. Pages, 113. Illustrations, 46. Chicago: Popular Mechanics Company. Price, 25 cents.

We do not believe that anybody can possibly invest twenty-five cents to better advantage, unless he is starving, than by buying this book. The scientific information is most interestingly imparted, making the subject as attractive as a story and, while engineers are conversant with much of the text, all will enjoy and profit by reading it.

Applied Thermodynamics for Engineers. William D. Ennis, M. E. Size, 9½ by 6½ inches. Pages, 429. Illustrations, 313. New York: D. Van Nostrand Company. Price, $4.

As we are every day bending our energies toward economy, this book of Mr. Ennis will repay those who are deciding on what prime mover is to be bought, or recommended. Mr. Ennis does not claim originality, but certainly sets before the student with far more than usual clearness the very broad subject of applied thermodynamics.

COMMUNICATIONS.

A Very Interesting Inquiry.

Editor International Marine Engineering:

Being a reader of your valuable journal, I take the liberty of asking you for a bit of information concerning a change which I propose to make in the ballast of a steel hull.

It is 110 feet long, 35 feet beam and 10 feet deep; owing to the loads that are put on it, a lot of ballast is required.

The hull is rapidly decaying, although very good as yet. I propose to remove the present ballast, concrete the interior entirely; in other words, to produce concrete hull inside the steel one. I propose to thicken up the concrete where I need ballast. Do you think this idea is a practical one?

Montgomerey, Ala. Stein.

Editor's Note.—It will be interesting to know if any of our readers have ever had any experience which will shed light on the above expressed idea.

Editor International Marine Engineering:

Will you please let me know whether the heating surface of boiler tubes is figured from the exterior or interior diameter, and will you also give solution of the following problem?

The volume in feet per second for a 48-inch pipe 3,000 feet long with a head of 3 feet. The total volume of water to come through this pipe in twenty-four hours is 16,000,000 gallons. Pipe.

The heating surfaces of boiler tubes are figured on their exterior when the heat passes around them, and on their interior when the heat passes through them as in return-flue boilers.

To find the quantity of water in gallons when the diameter of pipe is known for a velocity of 100 feet per minute. Square the diameter in inches and multiply by 4.08.

PERSONAL.

Mr. Walter A. Post, who has been general manager of the Newport News Shipbuilding & Dry-Dock Company for the past twelve years or more, has been elected president of the company, to succeed the late Mr. C. B. Orcutt. This is a very fitting recognition of the splendid work Mr. Post has done in building up this great shipyard.

Mr. Robert Wallace, of Cleveland, Ohio, one of the pioneer shipbuilders on the Great Lakes, died last month, aged 76. He was one of the purchasers of the Globe Iron Works in 1869; later he expanded his shipbuilding interests, which afterwards became a constituent part of the American Shipbuilding Company.

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Formal invitations have been issued in the name of Lord Brassey for the Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., announcing that the Jubilee meetings of the Institution have been provisionally fixed for Tuesday, July 4, 1911, and the following days, when it is proposed to hold an international congress in naval architecture and marine engineering. The invitation has been extended to distinguished naval architects, shipbuilders and marine engineers in all parts of the world.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loat & Trust Building, Washington, D. C.

974,516. LIFE-SAVING ATTACHMENT FOR SUBMARINES. SNIVELY S. PETERSON, OF SAN FRANCISCO, CAL.

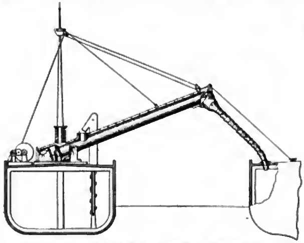
Claim 3.—The combination with a vessel adapted to be submerged, of a compartment in the vessel, and having ingress and egress door controlled openings, an edgewise swinging closure for the egress opening, means independent of said openings for admitting water into the compartment, and independent means controlled from within the compartment for draining the compartment. Eleven claims.

974,150. HYDRAULIC DREDGE. WILLIAM F. HUNTER, OF ARCATA, CAL., ASSIGNOR OF ONE-HALF TO THOMAS BAIR, OF ARCATA, CAL.

Claim 2.—The combination with a suction pipe having a cage on its inlet end, of a mouthpiece for said pipe having a portion partly covering the side of the cage to provide a side intake opening, and a gate carried by the mouthpiece for controlling said intake opening, the mouthpiece being rotatable and slidably mounted on the suction pipe. Eight claims.

975,212. COALING DEVICE. VAINO ANDERSON, OF KNAPPTON, WASH.

Claim 1.—In means for transferring coal from one vessel to another, the combination of an elevator comprising a tube pivotally mounted



upon the coaler and adapted to incline upwardly and outwardly therefrom, a flexible chute connected with the delivery end of the elevator and inclining outwardly and downwardly therefrom and connected with the vessel to be coaled, and a cable and pulley system between the two vessels and the said tube to automatically raise and lower the adjacent ends of the tube and chute to adapt them to the relative movements of the two vessels when riding the waves. Three claims.

975,584. METHOD AND APPARATUS FOR WRECKING BODIES SUNK IN WATER. ROBERT OWEN KING, OF BUFFALO, N. Y.

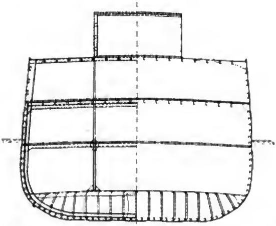
Claim 2.—An apparatus for wrecking bodies sunk in water, comprising a support, a drilling device mounted on said support, and electromagnets pivotally mounted on said support on opposite sides of the drilling device and adapted to attach themselves to said body. Four claims.

975,528. HATCH-FASTENER. ALEXANDER HYND, OF CLEVELAND, OHIO.

Claim 1.—In a hatch cover and tarpaulin clamping device, a bracket, a pair of independently movable clamping members, said bracket having a fulcrum support for one of said members and an inclined face or abutment for the other, and means one one of said clamping members and engaging the other for forcing one of the same downward onto the hatch cover and the other in engagement with said inclined face and hence latterly toward the coaming. Two claims.

975,699. SHIP OR VESSEL. CARL JOHAN FREDRIK MALCOLM LILLIEHOOK, OF STOCKHOLM, SWEDEN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO EMMA IDA BERTHOLDE CRAGGS, OF MIDDLESBROUGH, ENGLAND.

Claim 2.—A metal ship constructed with a plurality of continuous longitudinal beams directly attached to the deck plating, and a plurality



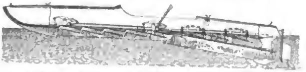
of cross beams disposed under the inner edges of the longitudinal deck beams; the upper longitudinal beams of the vessel being in preponderant number in relation to the cross beams. Three claims.

975,972. PROPELLER. GEORGE B. MARTIN, OF MARIETTA, OHIO.

Claim 1.—The combination with a boat having a suitable source of power, of triple propellers carried by the stern of said boat and adapted to be operated by said source of power, each propeller comprising a housing adapted to be carried by the bottom of the boat, cam ribs carried by said housing, a sleeve journaled in the bottom of said boat, a revolable shaft extending through said sleeve and adapted to be revolved by said source of power in an opposite direction from said sleeve, propeller arms carried by said shaft and said sleeve, and pins carried by said arms and adapted to engage said ribs and rotate said arms in a desired direction. Four claims.

976,588. HYDROPLANE MOTOR-BOAT. CHARLES MELDAU, OF NEW YORK, N. Y.

Claim 2.—A motor-boat provided with a bow keel increasing gradually in depth, a stern-keel also increasing gradually in depth, an intermediate



keel between the bow and stern keels, hydroplanes supported on said intermediate keel, and lever-mechanism for lowering or raising the intermediate keel and hydroplanes on the same. Eight claims.

977,438. AUTOMOBILE TORPEDO. GREGORY CALDWELL DAVISON, OF QUINCY, MASS.

Claim 1.—An automobile torpedo comprising a shell containing a chamber or flask for the storage of air or gas to develop the motive

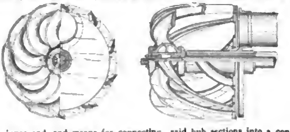
power, and machinery for driving the torpedo, and an explosive charge within the shell at the very stern thereof, whereby the gases resulting from the detonation are enabled to expand in the direction of the object attacked. Two claims.

977,816. PROPELLER. WILLIAM B. MAXWELL, GROVER C. MAXWELL AND EDWARD BUCKMAN, OF NEW YORK, N. Y.

Claim 1.—A propeller comprising a pair of blades having their circumferences disposed in the form of spirals from their leading edges to their following edges, the progressing face of one blade and the retreating face of the other merging into a continuous curve which extends from the eleading to the following edges, respectively, of said blades. Two claims.

977,901. CUTTER FOR HYDRAULIC DREDGES. ARTHUR W. ROBINSON, OF MONTREAL, QUEBEC, CANADA.

Claim 1.—In a cutter for hydraulic dredges, the combination of a plurality of continuous spiral blade arms, each having a hub section on



its inner end, and means for connecting said hub sections into a continuous hub. Eight claims.

978,090. SHIP MODEL TESTING. HERMANN WELLENKAMP, OF KIEL, GERMANY.

Claim 1.—In tank testing appliances of the character described, means adapted to engage the model tested for imparting an initial velocity

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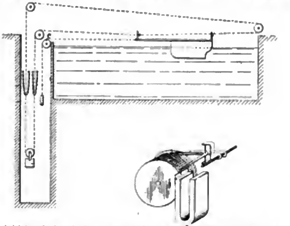
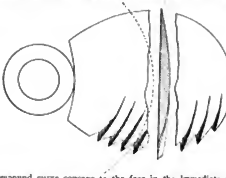
thereto, said means having limited duration of action a weight, and means in connection therewith for moving the model so as to maintain



its initial velocity during the period of measurement after the means for imparting initial velocity has ceased to act. Six claims.

978,677. SCREW-PROPELLER. DAVID WATSON TAYLOR, OF THE UNITED STATES NAVY.

Claim 9.—A propeller blade having in its developed section a substantially straight face extending to a sharp leading edge, and a back formed



by a compound curve concave to the face in the immediate vicinity of the leading edge and convex over the major portion of the bank, and ribs, concentric with the axis of rotation of the blade only on the leading portion of the back of the blade. Fifteen claims.

973,860. BARGE. RICHARD J. DONOVAN, OF AMBRIDGE, PA.

Claim 1.—A wooden barge having a steel rake end, consisting of side plating, bottom plating curved upwardly to form the rake, head or bumping block, a steel handling deck, and a steel water-tight bulkhead. Two claims.

972,809. LIFE-BOAT APPARATUS. AUGUST BRUN, OF CHICAGO, ILL.

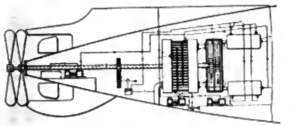
Claim 1.—In life-boat launching apparatus, the combination with a boat, of a supporting device which supports the keel and the sides of the boat and holds said boat in substantially horizontal position, an ejecting device which is movably mounted on said supporting device so as to engage one end of said body, and means for moving said ejecting device so as to force said boat lengthwise of said supporting device and eject the same therefrom. Twenty-one claims.

978,227. SUBMARINE BOAT EQUIPPED WITH SUBMERGING-PLANES. LAWRENCE Y. SPEAR, OF QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—A submarine or submersible boat having submerging planes, in combination with mechanism for supporting the planes against the blows of waves on their under surfaces when they are out of water, said mechanism comprising a transversely extending structure lying closely above the planes so that it will receive the thrust of blows directed against their under surfaces. Seven claims.

981,546. UNDER-WATER VEHICLE. SEBASTIAN ZIANI DE FERRANTI, OF GRINDLEFORD BRIDGE, ENGLAND.

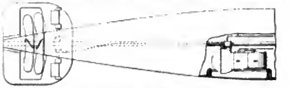
Claim 1.—In combination in a submersible, a combustion motor carried



by the same, a combustion chamber therefor, means for introducing into said chamber combustible and an excess of oxidizer, together with means for replacing said excess of oxidizer by a fluid other than said oxidizer under certain working conditions.

983,467. GYROSCOPIC STEERING APPARATUS. JOHN C. WALDRON, OF BROOKLYN, N. Y.

Claim 2.—The combination in a gyroscopic steering apparatus of a casing, an outer gimbal ring fulcrumed in said casing, an inner gimbal



ring fulcrumed in the said outer ring, a fly-wheel journaled in the inner ring, a steering engine connected to the casing, a valve chamber for the steering engine, an outer rotative cylindrical valve in the valve chamber of the engine, an inner tubular valve in the outer valve, connections between the said outer gimbal ring and the said inner tubular valve, and means to turn and locate the outer valve in operative position.

984,133. FLOATING DOCK. HANS GIESE, OF BERLIN, GERMANY.

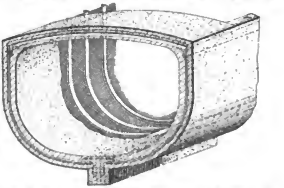
Claim 1.—A floating or off-shore dock, comprising a bottom pontoon having a chamber into which water passes while lowering the dock, and in which air is compressed by the entering water, a chamber to which water is admitted for sinking the dock, and means for forcing compressed air into said last-mentioned chamber to expel the water therefrom while water is being at the same time expelled from the first-mentioned chamber by the air compressed therein.

981,922. ELECTROLYTIC SHIP-CLEANER. GEORGE W. FRAZIER, OF PITTSBURG, PA.; MARY E. FRAZIER, ADMINISTRATRIX OF SAID GEORGE W. FRAZIER, DECEASED, ASSIGNOR TO PITTSBURGH ELECTROLYTIC MFG. CO., A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a ship-cleaner, the combination with a source of electricity, of a body movable independently of the ship to be cleaned, an electrode connected with and adapted to be supported in the water by the said body, and conductors leading from the source of electricity to the said body, one of the conductors being connected with the electrode, and another conductor arranged to be connected with the metal exterior of a ship.

984,285. HULL CONSTRUCTION. WILLIAM EDWARD McNEILLIE, JR., OF NEW ROCHELLE, N. Y.

Claim 2.—A hull construction, including a longitudinal beam, angle irons secured against the opposite sides of the beam and having their



out-turned flanges registering with the upper edge of the beam, a plurality of curved ribs secured in longitudinal spaced relation against the angle iron and extending upwardly therefrom, angle beams carried across the upper ends of the ribs and extending inwardly from the same, arched girders transversely disposed across the upper ends of the ribs and secured at their opposite ends upon the angle beams, a wire meshing secured against the outer faces of the ribs and the girders, and a body of concrete molded about the meshing to engage the ribs and the girders.

983,917. PROPULSION OF SHIPS. HENRY ALEXANDER MAVOR, OF GLASGOW, SCOTLAND.

Claim 1.—For the propulsion of a ship, the combination with a main thermo-mechanical plant of a supplementary alternating current electric plant capable of being used either alone or in conjunction with the main plant, at will, for driving the ship at different speeds and comprising an alternating current driving equipment capable of being run at different speeds.

984,152. WRECKING APPARATUS. FREDERICK OLIVER, OF CHARLOTTE, N. C.

Claim 1.—Apparatus for releasing grounded vessels, including manifolds, jet pipes suspended therefrom, means for supporting the manifolds in advance of the hull of a vessel, means for establishing communication between the manifolds, said manifolds and jet pipes being arranged to form a substantially triangular depression in the water-bed by the discharge of jets of fluid therefrom, flexible connections between the lower end of the jet pipes on each manifold, flexible connections between the jet pipes of the several manifolds, and forwardly and upwardly extending means for connecting the lower ends of the jet pipes to a supporting structure.

980,156. MARINE COMPASS. HARRY HERTZBERG, OF NEW YORK, N. Y., ASSIGNOR TO ABBOT A. LOW, OF HORSESHOE, N. Y.; MAURICE I. WOHL, OF NEW YORK, N. Y., AND HARRY HERTZBERG, OF BROOKLYN, N. Y., TRUSTEES.

Claim 1.—A compass comprising a box, a non-spillable liquid cup positioned therein, the side wall of said cup being curved inwardly upon itself and producing a mouth the diameter of which is less than that of said cup, a staff stepped in the cup and extending through the small diameter mouth portion thereof to a point above said cup, a magnetic needle mounted on the staff, and a float attached to the staff and adapted to be immersed in liquid to be contained in the cup.

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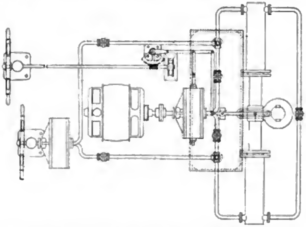
British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

21,932. MARINE STEERING GEAR. F. L. MARTINEAU, LONDON.
This invention relates to the combination of a pump whose pistons have a variable stroke, a continuously running electric motor and a pair of hydraulic rams directly connected to the rudder head. The wheel

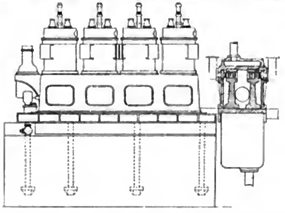


operates the stroke-varying rod through a worm and quadrant levers. The consequent travel of the rams operates through levers and links to return the rod and retain the rams in their new position until the wheel is again turned. An emergency pump worked by hand is provided, and stop valves as shown are provided for establishing the several water circuits.

22,320. AUTOMATIC APPARATUS FOR LIGHTHOUSES, ETC. F. G. ATTWOOD, LONDON.
By this invention gas at constant pressure (from a reservoir through a reducing valve) enters an impulse chamber fitted with a diaphragm whose movements open and close through a system of levers, the gas supply inlet and burner outlet, alternately, to give intermittent or flash lights. The diaphargm also operates a ratchet and pawl mechanism for winding a clock which times the working of the apparatus, by turning a shaft once every twenty-four hours, to throw the apparatus out of and into gear at sunrise and sunset, respectively. The variation in time is corrected for by a worm connected with the operating cam, and which is caused by a star-wheel carried by the shaft to make one-seventh of a rotation each day. Another clock may rotate a lantern.

25,232. PROPELLERS. W. H. DOBSON, GRAVESEND.
Relates to paddles which revolve completely within the water. By this invention only the blades project beyond the skin of the ship, the drum which carries them having its axis at right angles and its water side flush with the plates. The blades are rotated, for feathering each upon its axis, by toothed gearing. Water is allowed to form a layer between the drum and its casing and any passing through is pumped overboard. The flow is entirely stopped when the propeller is inoperative by means of a conical ring, which can be moved axially to close the clearance space. It can be shown geometrically that the average angle at which these blades meet the water is greater than that of screw blades, while their Absolute speed is less.

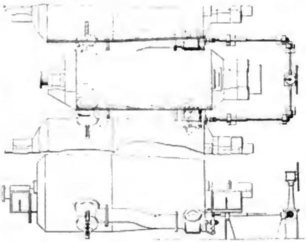
8,186. STARTING AND REVERSING MARINE INTERNAL COMBUSTION ENGINES. DR. P. PRAETORIUS, STETTIN, GERMANY.
Diesel engines are by this invention provided with "ahead" and "astern" turbines, the motors of which are secured to the crankshaft



and operated by steam or compressed air. This method allows of maneuvering ships having these engines with great safety and facility. The radius of action of the turbines is increased by leading the exhaust from the main engine into the jacket and, when compressed air is used, the compression pump may exhaust air through a separate pipe with advantage.

25,734. ELECTRICAL PROPULSION OF SHIPS. SIEMENS BROS. DYNAMO WORKS, LTD., AND DR. KLOSS, LONDON.
A ship having four propellers is driven by means of asychronous induction motors and generators, two of the motors being driven at normal speed by generators, the frequency of which is fifty-two times the frequency of the generators which drive the remaining motors at normal speed. The frequencies of one or more of each set of generators having normal frequencies can be halved at constant-speed by interchanging the connections between generators and motors.

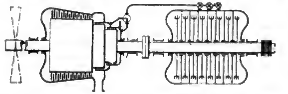
29,185. MANUFACTURING GEAR FOR TURBINES. J. N. BLENKINSOP, DOVER COURT.
According to this invention, gear is adapted to so control the supply of steam from the center turbine to the outer turbines that when steam



is cut off from either of the latter the other is receiving steam, thus enabling the center turbine and one outer turbine to go ahead while the other turbine may be either stopped or going astern. A hand wheel drives, through shaft and bevel wheels, a cross shaft geared to two side shafts, each having a female screw at its end nearest the valve and squared at its other end to engage and slide in the boss of the wheel that drives it. The female screws of the shafts screw into the two male adjusting screws of the valves. By rotation of the wheel in either direction one of the valves is closed by the end of the corresponding shaft bearing upon the valve actuating lever and the other valve is left free to work as usual.

16,160. SUBMARINES. G. PINO, GENOA.
The invention provides a device for saving the lives of persons who are imprisoned on a submarine which cannot be made to ascend in the water. In escaping, a person passes through the manhole f into the casing b, then he enters the buoyant chamber a through a door i, which he closes after him. He then opens cock k^1 and lets water through pipe k to fill the casing so that when screws f^2 are retracted the chamber a will rise from the vessel to the surface, where it will float with the cap h uppermost. l is a window.

28,943. MARINE TURBINE INSTALLATION. AKTIEN-GESELLSCHAFT. BROWN, BOVERI & CIE., BADEN.
This is a development of the invention No. 22,746, 1908, in which the propeller thrust of one turbine is counteracted by balancing devices in



another turbine. For maximum power chamber k is set in communication with chamber l, whilst for decreased power the valve o is turned and the pipes m and p are connected. Corresponding to the power, one of the stages of the turbine c is tapped and steam allowed to flow into the chamber k, and completely balances any axial thrust, even with the smallest loads. The valves are adjusted automatically when cruising.

29,895. SUBAQUEOUS AUDIBLE SIGNALLING APPARATUS. S. M. DAVISON, CAMBRIDGE, U. S. A.
This invention consists in securing to the skin of a vessel an enclosure in which is a shell free from the walls of the enclosure, and be-

tween the walls of the shell and the walls of the enclosure the air is withdrawn to form a vacuum which prevents sound passing to the inner chamber in which the receiving device is suspended. Another feature is the intensifying of the sounds passing, by insulating the receiver from the ship's noises, etc., so that only such vibrations as are received by the hull from without are transmitted, this insulation also largely absorbing vibrations caused by the engines, etc.

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International Marine Engineering

MAY, 1911.

A 20-INCH HYDRAULIC DREDGE.

The dredge illustrated herewith was specially designed to meet the particular conditions of the New York barge canal and is based on the design of the 30-inch hydraulic dredge, also built by the American Locomotive Company, New York, for the commissioners of Lincoln Park, Chicago. It was put in commission in September, and was in continuous service from that time until late in December, when winter necessitated the discontinuance of operations. In March, operations were again resumed. From Sept. 15 to Oct. 15, the total output, solid bank measurement, was 238,658 cubic yards. During the first half of the month a great many obstacles, such as tree stumps and large boulders, were encountered, but the cutter and its machinery were proof against accident on this account. Most of the material excavated was a hard, blue clay, which had to be sliced off by the cutter blades before it could be drawn into the suction pipe. The cutter used is of the open type, with spiral chrome steel blades. Though complete data covering the whole period of operation are not at present available, a careful record kept for the fifteen days ending September 30 showed that the coal consumed was 1.85 pounds per indicated horsepower per hour, and the material was delivered at a point 1,200 feet from the dredge. One of the noteworthy and interesting features in the design of this dredge is the arrangement for supporting the suction frame and cutter drive. The upper part of the suction frame is formed of a large steel casting or trunnion head, which rotates in bearings let into the sides of the well. The countershaft of the cutter engine is located on the axis of these side bearings. The engine drives the cutter through a set of gears on the trunnion head. These gears are encased in a water-tight compartment, and oil pockets are provided, which keep the teeth of the gears constantly lubricated. A ball joint connects the suction pipe on the frame with the one in the hull. This ball is so located that it is totally immersed in water, thus preventing any possible chance of air leaking into the pipe.

20-INCH DREDGE BUILT BY ATLANTIC EQUIPMENT COMPANY.

The hull of the dredge is of wooden construction, with a heavy steel girder running fore and aft. It has a length of 137 feet. The width is 36 feet, and the depth is 10 feet 2 inches. A main pump of centrifugal type, built entirely of steel, is employed. The shell was made of extra thickness to compensate for wear, and liners were omitted to simplify its construction, their continual removal being more expensive than a new shell replaced at long intervals. The main pumping engine is of the marine vertical, triple-expansion type, and indicates 700 horsepower at 225 revolutions. A heavy cast iron bed plate furnishes the foundation for the main engine and pump. On this bed plate are also located the thrust bearings, which consist of five adjustable cast steel horse shoes, babbitt-lined. They are so designed that any of them can be dismantled for inspection while the dredge is in operation, which materially facilitates the up-keep. The pump has a 20-inch discharge and a 20-inch suction. Its runner is 72 inches in diameter, which at 225 revolutions gives the required peripheral speed for discharging through 1,500 feet of pipe. The surface condenser, having 1,700 square feet, receives the exhaust from the main and auxiliary engines. Boilers of the water-tube type, carrying 175 pounds of pressure per square inch, are employed. They

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have a total heating surface of 6,040 square feet, with a total grate surface of 135 square feet. Water is furnished to the boilers by feed pumps of the Admiralty type. These are connected with the hot well, which receives the condensed steam from the main engine, winch and cutter engines. A heater installed between the feed pumps and the boilers receives the exhaust from the smaller auxiliary engines. Large, easy bends, instead of the customary elbows, are employed in all piping throughout the dredge of a size from 3 inches up. This gives the minimum amount of resistance to the flow of steam.

The winch engine is an 8 by 10 inch double vertical engine. It has five drums for the operations of swinging the dredge and hoisting the ladder and spuds. A self-contained engine located in the hold of the boat drives the cutter. This engine has double cylinders 10 x 14 inches. Reducing valves are placed in the pipe line of both the cutter and winch engines, and the steam pressure reduced to accommodate these engines, which only require 100 pounds pressure per square inch.

New York State Barge Canal.

While it will be some time before the Barge Canal will be completed, it will be convenient to have the data given below at hand to guide those who may in the future be interested in building vessels to navigate its waters. A general outline is given of the various routes, which are in the main now fixed, although some slight changes may be made on further consideration.

There seems to be an error in the State publication as to the depth of water, as both 11 and 12 feet are given, but the latter figure is correct.

BARGE CANAL.

The width at bottom to be 75 feet minimum.

The depth to be 12 feet minimum; over sills, 11 feet.

Water cross section to be 1,128 square feet.

Locks: Length, 328 feet; width, 45 feet; depth, 12 feet.

All bridges, either fixed or lift, shall have a clear passageway of not less than 15½ feet at its highest ordinary water level.

ROUTES.

Eastern Division: From Troy up the Hudson River to Waterford, through People's Island by new canal and back to the Mohawk River to Little Falls to just east of Jacksonburg, to Herkimer to Rome, through Wood Creek to Oneida Lake.

Middle Division: Through Lake Oneida to Oneida River to Three River Point to Seneca River to Onondaga Lake outlet, continuing up the Seneca River to Jack's Reefs.

Western Division: Thence westerly up the Seneca River to the mouth of the Clyde River to the present canal, or a line selected by the State Engineer, to Fairport; thence following the old canal route to about four miles west of Pittsford, across country south of Rochester to the Genesee River near South Park, across the river to near Johnson and Seymour, then west of Rochester, joining the present canal one mile east of South Greece, following thereafter the present Erie Canal to near Medina to a junction with the Niagara River at Tonawanda, thence by the Niagara River to Black Rock harbor to Buffalo, and on to Lake Erie.

Opening and Closing: While in construction the canal is to be opened not earlier than May 15, and be closed no later than Nov. 15.

A Useful Broom Handle.

The life of the marine engineer is sometimes lightened by engineering experiences which are not included in the textbooks, and incidentally a good deal of human nature is displayed in the course of such incidents. One of these may be worth mentioning as a horrible example. An engineer's apprentice who was willing, but inexperienced, was sent to fit a sea-cock handle onto the sea-cock under the engine-room floor. As this was in a rather awkward position, the youngster was seized with a brilliant idea which was entirely original, and which nearly resulted in sinking the vessel. He thought that it would be a good plan to slack back the nuts of the sea-cock gland, take out the plug and fit the handle onto it in the vise. Immediately, however, that he got the nuts off the pressure of water outside the vessel (which was loaded) forced the plug out of the cock and the inrush of water knocked the youngster down. He was so horrified at the result of his ingenuity that he did not advise the engineer until some time afterwards. When, however, the trouble could no longer be concealed the problem of plugging up the hole became an urgent matter. The actual plug was under water in the bilge, and could not be found, and, after a few moments of agitated thought, the only thing that the engineer could think of was to sit tightly on the sea-cock until the plug was located. It was found shortly afterwards after the bilge pumps had been set to work, and replaced in the hole.

Trouble, however, reasserted itself. It was difficult to see how to get the gland on over the plug, as immediately the pressure of the hand was taken off the plug it was forced out again in projectile fashion. By dint of further brain processes the engineer got the idea of using a broom shank. The end of the shank was placed on the head of the plug and pressed hard home, while the gland was placed over the other end. The length of shaft allowed the manipulation of the gland down onto the plug, and it was then easy to fit it in position.

The main lesson of this illustration is to show that, no matter how smart an apprentice or unskilled laborer may be, it is inadvisable to give him the simplest job to do without exercising an adequate amount of supervision over him, as quite unexpectedly he may be seized with an inspiration of his own. Broom.

Newcastle.

CUTTER OF THE 20-INCH HYDRAULIC DREDGE.

The Captain John Ericsson Memorial Society of Swedish Engineers has taken permanent quarters in the Engineering Societies Building, 29 West 39th street, New York City. The membership of this society comprises leading Swedish engineers in all parts of the United States.

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Clay-Cutting Suction Dredger for New Zealand.

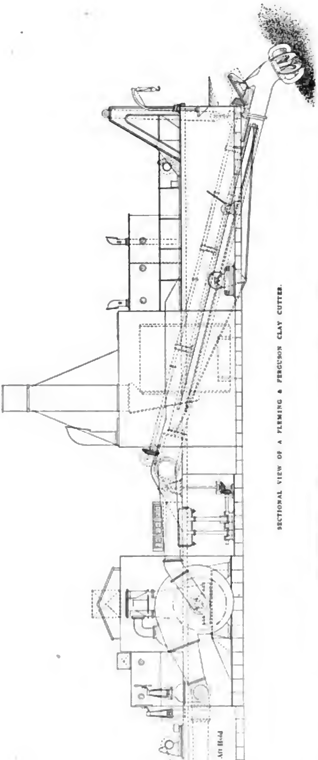
The pontoon suction dredger illustrated herewith has been constructed for the Auckland Harbor Board by Fleming & Ferguson, Ltd., Paisley, for work in deepening the harbor and reclamation of land at that port. The vessel has been designed to dredge 1,000 tons per hour from a depth of 33 feet, and discharge this quantity through 3,000 feet of floating pipes over a retaining wall 17 feet high. The connections for the floating pipes can be taken from either side or one end of the vessel as required, sluice valves being fitted to suit the different connections. The pump is built up of mild steel plates, and lined on the wearing surface with special steel renewable wearing plates. The impeller is made of cast steel, with renewable blades bolted on. The pump throughout is of strong construction to withstand the heavy shocks encountered in operations of this description, and it is of the single-suction type now generally adopted in this class of work.

The engines for driving it are of the triple-expansion, vertical marine condensing type of 1,200 indicated horsepower. The cutter is driven by independent compound-condensing engines through gearing and shafting led along the top of the suction pipes. The suction pipe works through a center well in the vessel, and is raised and lowered by wire rope tackle connected to an independent engine placed below deck. The gear for working the engine is led to a convenient position on the deck. A complete outfit of the auxiliaries usual in this class of vessel is fitted, and steam for all purposes is supplied by two large marine boilers, constructed to Board of Trade and Lloyd's requirements for a working pressure of 170 pounds per square inch. The hull is built of Siemens-Martin mild steel plates and angles, and is riveted up to Lloyd's requirements. Special strengthening girders and doubling plates are fitted alongside the suction pipe well, and at the sides of boiler casing, in order to compensate for the large deck hatches and to withstand the shocks and vibrations consequent on the dredging operations. The watertight bulkheads extend from the keel to the deck, and sub-divide the vessel into six watertight compartments. A sliding watertight door, operated from the main deck, is fitted to the bulkhead between the engine-room and the stokehold. The coal bunkers and feed-water tanks are placed about 'midships, evenly divided athwartships, and by their positions have little effect on the trim of the vessel, although both coal and feed-water are being consumed while the vessel is in operation. Both the engine space and the boiler space are covered with deck houses, large, airy and well lighted, easy of access, and arranged generally for stability and convenience. At the fore end of the ship there are two deck cabins for the use of the officers and crew. These cabins are roofed with thick pine to resist the heating action of the sun, and have tastefully furnished living and messing accommodation. Manœuvring operations are controlled by means of three steam winches, two forward and one aft; and these, with their equipment of anchors and chains, make the handling of the vessel easy. The outfit of the anchor davits, hand pumps, steam suction piping for bilges, etc., together with holds, stores and workshop, all tend to make the vessel a high-grade plant for cutter dredging. This is the second vessel of this class built by Fleming & Ferguson, Ltd., for the Auckland Harbor Board, and the Board, being so well satisfied with the first, decided to get a larger vessel of the same type.

THE CLAY CUTTER.

FLEMING & FERGUSON DREDGE FOR NEW ZEALAND.

New Zealand has recently been making great improvements in her harbors, and in carrying out the necessary deepening operations it has been essential to obtain a number of up-to-date dredging machines, and Messrs. Fleming & Ferguson, Ltd., have built and delivered the following: Twin-screw trailing suction hopper dredger *Eileen Ward*, built in 1910 for the Westport Harbor Board. This dredger was specially designed with heavy cast steel gravel pumps, capable of dealing with boulders up to 12 inches in diameter. She was also designed for stationary dredging. Her hopper capacity is 1,000 tons, and she is capable of loading herself in twenty minutes, rate of dredging being 3,000 tons per hour. Twin-screw stern-well bucket hopper dredger *Hapai*, capable of raising 1,000 tons material per hour from a depth of 45 feet. Hopper capacity 900 tons. This dredger is fitted with cast steel picks, to enable her to dredge rock and other hard material. Built in 1910 for the Auckland Harbor Board, New Zealand.



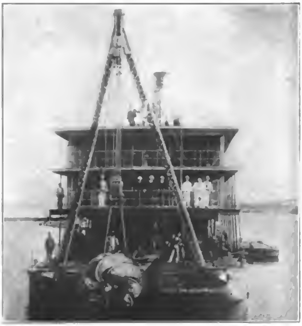
SECTIONAL VIEW OF A FLEMING & FERGUSON CLAY CUTTER.

The twin-screw combined bucket and suction dredger *Paritutu*, having the mouthpiece fitted with a rotary cutter for dealing with hard material, was built in 1910 for the New Plymouth Harbor Board, New Zealand.

Clay-Cutting, Hydraulic Dredger for the River Nile.

A vessel, or, more properly, a clay-cutting hydraulic dredge, was shipped to Khartoum from the works of Messrs. Lobnitz & Company, Ltd., of Renfrew, for the Egyptian government for service on the Upper Nile, not long since.

The dredge was designed by Mr. A. W. Robinson, M. Inst. C. E., Montreal, Can. The actual building was under the direction of the Egyptian Department of Public Works, whose adviser is Mr. C. E. Dupuis, and Mr. P. M. Tottenham, Inspector-General of Irrigation. The vessel was shipped out to Khartoum by sea and rail and there erected; being self-propelling it was able to make the voyage up the river several hundred miles to the place where work is in progress. The dredger is of the hydraulic type; it is designed to make wide cuts in the bed of the river, and to deposit the spoil on the



END VIEW OF LOBNITZ DREDGE.

banks through a floating pipe line having a suspended shore discharge. The hull is of steel, approximately rectangular in plan and section, 162 feet long by 38 feet beam. The machinery is mounted on the main deck and in the hold, the two upper decks being divided into accommodation for the officers and crew. A heavy steel suction frame is mounted in front, upon the end of which is fitted a powerful rotary cutter, adapted for dealing with stiff clays and heavy soils as well as softer material. The suction frame projects sufficiently in front to enable the vessel to cut its own flotation through solid ground when necessary.

Two steel spuds, or vertical anchors, are fixed in slides near the stern, each having a sharp point on the bottom, which holds in the ground and constitutes the anchorage for the vessel. The latter is caused to oscillate from one side to the other upon one or the other of these spuds as a pivot, by means of side lines carried out from the forward end and at-

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tached to the shore. The cutter makes a lateral cut upon an arc of a circle, and has a clear swing from side to side of 150 feet; it can make a channel of this width by 25 feet in depth at one time. The main machinery consists of a centrifugal

VIEW SHOWING DISCHARGE PIPE LINE.

dredging pump driven by a triple-expansion engine of 700 horsepower, together with boilers, winches, auxiliaries, cutter-

ANOTHER TYPE OF LOBNITZ DREDGE.

driving gear, etc., all of very complete and substantial description.

The boilers are of the Babcock & Wilcox watertube type, and the coal bunkers are arranged amidships, so as not to alter the trim of the vessel with varying load of coal. The dredge is propelled by a stern paddle-wheel, driven by horizontal compound engines of the usual type. The underbody of the hull is shaped or cut away forward and aft to facilitate propulsion, but it is designed more for stationary dredging work than for navigation. Suitable steering gear is arranged on the upper deck forward, where are also placed the levers and signals for operating the vessel when dredging. The accommodation for

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officers and crew is made especially roomy and comfortable. Separate decks are devoted to the native crew and the officers, each with accommodation for sleeping and dining in the open air, under double-shade decks and mosquito protection. The entire deck space of the three dredgers, and also the machinery space, are enclosed by mosquito netting of oxidized bronze, twelve meshes to the inch, in interchangeable steel frames, so arranged as to be readily removable.

The discharge pipe consists of a number of flexibly-connected floating sections and a terminal pontoon, from which the end of the pipe is suspended. The overhang of the suspended portion may be as much as 200 feet if required, so that the spoil may be put well back in marshy places. The flexible joints are of a new type, an all-metal, self-packing ball joint, avoiding the use of rubber or leather sleeves. The rotary cutter is of the Robinson improved type, and is of cast steel, with renewable cutting edges. The blades are made of special form, to cut heavy clay with as little resistance as possible, and are self-clearing. The strength of each blade is sufficient to safely withstand the strain due to encountering immovable resistances when running at full speed. This type of cutter apparatus represents the latest development of hydraulic dredging in heavy clay soils, and the success which has attended its use will have the effect of greatly extending the field of usefulness of this type of dredger, which had heretofore been thought useful only for sand or soft material. The strength and digging action of the cutter blades are fully equal to those of the buckets of the ladder type of dredger; the machine can therefore do work in any material that is adapted for hydraulic transportation through pipes equal to that carried out elsewhere by ladder dredgers.

LOBNITZ DREDGE ON THE LAUNCHING WAY.

Board of Trade Examiners.

We are informed that the Board of Trade has issued new instructions to examiners and candidates for certificates as engineers in the mercantile marine. According to these instructions, on and after Jan. 1, 1915, a candidate for a second-class engineers' certificate will be required, in addition to the present qualifications, to have served eighteen months at sea as engineer on regular watch on the main engines or boilers of a foreign-going steamers of not less than 66 nominal horsepower, or twenty-seven months in a home trade steamer of not less than 66 horsepower. A candidate for a first-class certificate must, in addition to this,

(a) have served at sea for eighteen months with a second-class certificate of competency or service on regular watch on the main engines or boilers of a foreign-going steamship of not less than 99 nominal horsepower as senior engineer in charge of the whole watch, or

(b) for 27 months with a second-class certificate of competency or service as first engineer of a home trade steamer of not less than 99 nominal horsepower, or three years with a second-class certificate of competency or service as second engineer of a similar vessel, or

(c) have served three years nine months with a second-class certificate of competency or service as third engineer of a home trade steamer of not less than 99 nominal horsepower, if during the entire period he has been the senior engineer in charge of the whole of a watch on the main engines and boilers, or

(d) possess, or be entitled to, a first-class certificate of service. There are also new instructions regarding the value, for certificate purposes, of time spent in technical and scientific training at schools recognized by the Board of Trade for the training of marine engineers.

The Boiler Accident on the Delaware.

So many wild statements have been made regarding the accident of some weeks ago to one of the boilers on board

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the battleship *Delaware* that we publish the following abstract of the finding of the Court of Inquiry held by the Navy Department:

Three rear headers, Nos. 8, 9 and 10, were blown bodily out of the boiler (a Babcock & Wilcox).

The headers were severely bowed, their tube faces bulged, and the metal showed signs of overheating. All the back headers of the outboard half of the boiler, 13 in number, were more or less bowed.

The 4-inch tubes next the fire were all more or less bowed near the back ends, and showed signs of having been burned; and the majority of the 2-inch tubes were more or less distorted, while a number showed signs of having been white hot.

The superheater tubes and manifolds showed a red color, and the 4-inch tubes through the first and second passes showed the blue color characteristic of overheating.

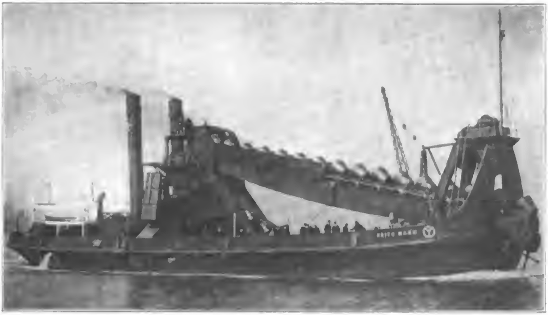
On two of the headers blown out were found scores and dents made by striking obstructions. The character of the scores and dents, and the blue color of the metal in the scores, indicated that the metal was in a softened condition, due to heat, when they struck.

From a consideration of all the facts presented, the court concluded that the explosion was due to the lack of a sufficient quantity of water in the boiler, and that the water-tender on watch at the time was responsible for this condition.

The so-called explosion could not have been very serious, as the captain, who was on deck at the time, did not even know that an accident had occurred until it was reported to him. In other words, the explosion did not make sufficient noise to attract attention on the upper deck.

Bucket Dredger "Heito Maru."

Heito Maru, built by Messrs. Ferguson Bros., of Port Glasgow, is of the bow-well center-bucket ladder type, and is capable of raising 1,000 tons per hour from a depth of 46 feet She is built to Lloyd's highest class. Side chutes are arranged for discharging the dredged material over either side into hopper barges, the lfting and lowering of each chute being worked by an independent steam engine. The main engines are employed for either propelling or driving the dredging gear. There are two speeds of gearing, to enable the buckets to be worked at different speeds according to the nature of material being dredged. Two large multi-tubular boilers supply steam to the various engines. The lifting and lowering of the bucket frame are controlled by an independent double-cylinder engine, working the builder's latest improved type of hoisting gear. The accommodation for the officers and crew is fitted forward, and is commodious and handsomely finished. Electric light is fitted throughout.



FERGUSON BROS. DREDGE HEITO MARU.

Suction Hopper Dredge St. Lawrence.

Messrs. William Simmons & Company, Ltd., Renfrew, have constructed a Simons patent cutter suction hopper dredger named the *St. Lawrence*, to the order of the Director of Works of the Admiralty. The *St. Lawrence* is of 2,000 tons hopper capacity.

Her arrangements are as follows: An independent set of triple-expansion engines for driving the dredging pump, with a complete installation of auxiliary machinery, is fitted in a separate engine-room immediately in front of the hopper compartment. Steam for the propelling and pumping engines, and all machinery throughout the dredger, is supplied by three marine type steel boilers. The dredging pump is of the most massive and powerful description to withstand the shocks which may be sustained when dredging in clay mixed with stones. The suction pipe is carried on a girder led through a well forward, and is of sufficient length to enable dredging to be done at a depth of 65 feet below waterline. The dredger is designed for cutting its own flotation. The cutter at the mouth of the suction pipe is driven through a line of shafting, fitted on upper side of suction frame, and machine-cut steel gearing actuated by a set of powerful, independent compound-condensing engines. In addition to the usual winches for mooring from the deck at bow and stern, a special winch is placed amidship, from which the moorings are led along the suction frame to fairleads at lower end.

The hopper is fitted with Simons patent arrangements,

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whereby the contents of the hopper can be discharged either through the doors in the ordinary way or over side by the pump for land reclamation. In addition to loading into its own hopper the vessel is arranged to discharge into barges moored alongside or through a pipe line. Two sets of triple-expansion surface condensing engines are fitted aft for propelling the vessel at a speed of 10 knots per hour. The auxiliary machinery in the propelling engine room is of the most up-to-date character. The results obtained with the *St. Lawrence* at Portsmouth have been in every way satisfactory. It is stated that the *St. Lawrence* results, in stiff clay, are quite double those obtained by bucket dredgers.

At the present moment Messrs. William Simons & Company, Ltd., are constructing another Simons patent cutter suction hopper dredger to the order of the High Commissioner for the Union of South Africa. This dredger, which is practically of the same size and capacity as the *St. Lawrence*, will be employed in the improvement of the depths of the bay at Durban.

DREDGER "M. O. P. 210 C."

The dredger *M. O. P.* 210 *C.*, constructed by William Simons & Company, Ltd., to the order of the Argentine government is of the trailing suction hopper type, and has accomplished some remarkable dredging at Buenos Aires. This vessel, which is the largest and most powerful of her type yet constructed, is fitted with extremely powerful suction and self-discharging pumps. Four sets of triple-expansion surface-condensing engines are fitted, so that all four sets are available for either propelling or pumping as may be required. Steam is supplied from four cylindrical multi-tubular boilers and one cylindrical multi-tubular donkey boiler, constructed for a working pressure of 160 pounds. The auxiliaries in the engine-room include an independent main condenser, independent steam-driven air and circulating pumps, feed, bilge and service pumps, feed heater, filter and evaporator and auxiliary condenser with independent air and circulating pumps.

The main centrifugal pumps are connected to the suction frame fitted in the central well at the stern. Water jets are arranged at the bottom of the suction pipe. The hopper doors are conrolled by powerful hydraulic gear, the power being supplied from two duplex sets of steam-pressure pumps. The hopper arrangements include Simons patent suction keelsons, which enable the load in the hopper to be discharged overboard for reclamation purposes. Steam hoist gear is provided for controlling the lower end of suction frame. The *M. O. P.* 210 *C.* is understood to have lifted and transported in 21½ days 600,000 cubic meters of clay in the Punta del Indio at Buenos Aires. This represents almost 40,000 tons dredged and discharged per day.

Among the dredging vessels now under construction by William Simons & Company, Ltd., is a very powerful twin-screw, 1,200-ton hopper dredger, to the order of the Isthmian Canal Commission. This dredger, which will be employed in doing some of the very hardest cutting in the Canal Zone, is fitted with two sets of dredging buckets—one set for clay and one for mud. This dredger will be capable of cutting its own flotation and dredging to a depth of 50 feet below the light waterline when the ladder makes an angle of 45 degrees with the vertical. The dredger is designed to discharge either direct into its own hoppers or into barges alongside. The dredging gear is arranged to give two different speeds of buckets per minute with a constant piston speed of engines, so that the full power of the engines is exerted whether the vessel is working on hard or soft ground.

Two steel cylindrical multi-tubular boilers will be fitted on board; either boiler is capable of supplying steam to the engines and all auxiliaries when at full work. The two sets of propelling engines, which are of the triple-expansion surface-condensing type, are of sufficient power to drive the vessel at a speed of 10 knots per hour. Powerful independent winches are fitted at bow and stern for manœuvring the dredger while dredging, and for raising and letting go anchors, etc. Hopper doors are controlled by hydraulic power. A complete installation of electric light is provided for efficient lighting above and below deck. Also all the most up-to-date appliances in vessels of this kind are fitted up on board.

SIMONS & COMPANY'S DREDGE ST. LAWRENCE.

The powerful dredger the *Pelican*, constructed by William Simons & Company, Ltd., for the Rangoon Port Commissioners, is one of the largest suction dredgers in the world. She is of the twin-screw type, 208 feet in length, 36 feet beam. The dredger is fitted with a suction pipe for dredging from a depth of 35 feet, and can deliver 80,000 cubic feet of sand and silt per hour through a pipe line 3,000 feet in length. Formerly either rubber or leather jointing was employed for pipe lines of this character, but owing to the heavy nature of the service, in the present instance use has been made of a ball and socket joint of cast steel, the design adopted being claimed to give maximum freedom of movement in every direction, while providing an absolutely watertight joint, special packing being employed for this purpose on the outer edge of the joint.

Gas Producer Experiments.—At the experiment station of the United States Bureau of Mines, Pittsburg, Pa., several trial runs have been made with an experimental gas producer, using coke as fuel, with which limestone has been mixed in varying proportions, the purpose being to flux the ash and form a liquid slag, thus avoiding clinker and ash troubles and consequent shutdowns. Liquid slag has been readily made, which runs freely from the producer. The high temperatures necessary are very efficient in the generation of gas.

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A Hydraulic Pipe Line Dredge.

The dredge illustrated and described herein was recently constructed by Ellicott Machine Company, of Baltimore, Md., for the Isthmian Canal Commission for work on the Isthmian Canal.

The dredge is of the cutter type with a single sand pumping outfit. The pumping machinery consists of a centrifugal pump directly connected to a triple expansion engine. The material to be dredged is loosened or agitated by a revolving cutter. The feeding into cut is by means of wire rope haulage on each side of bow with pivoted stern and the advance forward is accomplished by two spuds. The steam plant consists of four boilers of the Scotch type built to meet marine requirements for a pressure of 200 pounds per square inch.

General Dimensions.

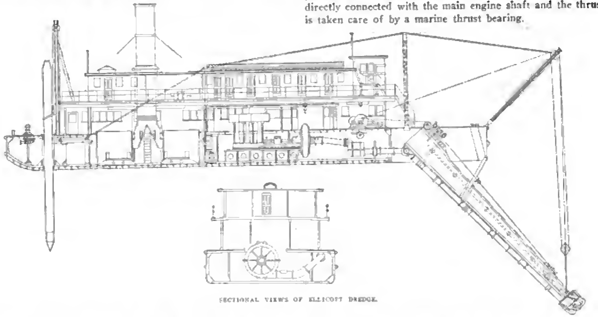
Length overall	150 feet.
Beam moulded	40 feet.
Extreme depth of hull	10 feet 6 inches.

In service the dredge has demonstrated a capacity, under ordinary service conditions, in excess of 750 cubic yards per hour, place measurement. At present, it is operating through a pipe line 7,000 feet in length dredging coral sand and coral rock. The aggregate indicated horsepower of this machine under ordinary conditions of service is approximately 1,000 horsepower.

Hull.—The hull is constructed throughout of steel and is divided into four water tight compartments by means of three transverse bulkheads and is strengthened by two fore and aft bulkheads running throughout the whole length of the dredge. The main engine and pump foundations and the foundations for certain parts of the auxiliary machinery are built of steel and so designed as to insure the greatest possible stability. Side lights are provided at frequent intervals on the sides of the hull to give light below the main deck in the day time. Marine coal scuttles and hatch openings are provided on the main deck.

Superstructure.—The superstructure is of wood throughout. It consists of a house over the main deck covering all parts of the machinery. The living quarters are above the main house. These consist of a pilot house at the forward end of which are located levers for operating all machinery except the main engine, throttle valves, etc., so that the operator has full control from this point. The living quarters are located aft of the pilot house and are commodious and comfortable. All door and window openings are provided with bronze screens and slatted sliding blinds. The staterooms of the captain and chief engineer are located immediately behind the pilot house, with bath room between. Aft of this is located the officers' mess room with staterooms for the various subordinate officers arranged on either side. Next follows the galley with refrigerator room and two pantries opening into the galley. The crew's mess room is next aft of the galley and the crew's quarters are at the extreme end of the upper house, arrangements being made for separate cabins for the firemen and deck hands, each cabin being equipped with showers and lavatories.

Pumping Machinery.—The pumping machinery consists of a centrifugal pump of the side suction disc lined type constructed throughout of steel and especially designed to withstand shocks and abrasion due to the passage of stones, gravel and sand and with very large openings to admit of the passage of solid bodies without obstruction. The pump is directly connected with the main engine shaft and the thrust is taken care of by a marine thrust bearing.



Sectional Views of Ellicott Dredge.

Main Pumping Engine.—The main pumping engine consists of a three-cylinder, triple-expansion vertical fore and aft condensing engine.

Agitating Machinery.—At the bow of the dredge is located a steel ladder or framework resting on heavy steel trunnions which are an integral part of the hull. The depth of cut is regulated by raising and lowering the outer end of this ladder, which is designed to dig to a depth somewhat in excess of 40 feet. The suction pipe is carried by the ladder and extends to the outer end, where it passes inside of a revolving cutter. The cutter is of the spiral type, constructed of steel, and is driven by a shaft through cut steel gearing.

Agitating Engine.—The agitating engine is mounted directly on the ladder at its inboard end. It is a double condensing engine especially designed to bear constant shocks and jars incident to the work which it has to perform. The crank pins, guides, bearings, and in fact every feature of this engine, are especially designed to meet unusual conditions of service.

Hauling Machinery.—The hauling machinery consists of a double reversible condensing engine operating through cut steel gearing a lay shaft which runs transversely across the deck. All drums are operated from this shaft by means of steel gearing with suitable clutches and brakes, one drum being used to raise and lower the ladder, two drums to operate the wire ropes by which the dredge is swung transversely back and forth across the cut and two drums are used in lifting the spuds which are located at the stern of the dredge. The transverse shaft carries gypsy heads on either end for breasting purposes and in addition a steam capstan at the stern.

the various connections are taken and with means to haul out the strainer and clean it without docking the boat. In addition to these auxiliaries, the following are located also in the engine-room: Salt water and fresh water pumps for plumbing and sanitary uses, jet pumps for circulating water to various bearings, filter box, heater, grease extractor and other marine fixtures such as gage-boards, wrench-racks, etc.

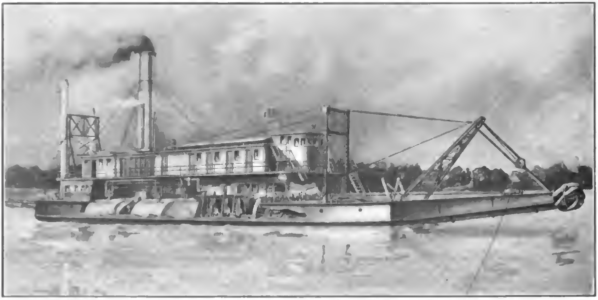
PUMP ROOM.—The pump room is located forward of the engine room and the main dredging pump is located therein,

THE BROWN SELF-PROPELLED HOPPER DREDGE.

BOILER PLANT.—The boiler plant consists of four wet back Scotch marine boilers built under marine rules for a working pressure of 200 lbs. per square inch and are so proportioned that the dredge may be operated under ordinary conditions of service with three boilers, leaving one as a spare. Provisions are made with oil tanks and coal bunkers so that the dredge may be operated either with fuel oil or coal, the fire-room being of ample size and convenient arrangement.

separated from the engine room by a water tight bulkhead. This room contains, in addition to the main pump, a stone box of ample size and quick closing valve on the main suction pipe. The fire pump is also located in this room and in addition to operating the fire service is used in connection with the operation of an improved ash ejector.

ICE PLANT.—The refrigerating machinery is located in the after end of the lower house. It is provided with ice cans



VIEW SHOWING MACHINERY IN THE ELLICOTT DREDGE.

ENGINE-ROOM.—The engine-room outfit is of the most modern type of marine construction. The condenser is of the surface condensing type with independent air and centrifugal circulating pump. Feed pumps are in duplicate, of outside plunger type. Special arrangements are made to prevent obstruction of sea connections by a central supply from which

for making ice, a scuttle-butt for drinking water and also cools the main refrigerator, which is located on the upper deck.

ELECTRIC PLANT.—An electric plant is provided by means of which the whole interior of the dredge is lighted and in addition a searchlight operated from the pilot-house and arc

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lights at the bow and stern, the wire being principally in conduits. A convenient traveling crane is located on the main deck and is of suitable capacity to handle all parts of the main pump and any part of the engine room and pumping machinery. Since the construction of this dredge, two machines of equal capacity have been constructed by this firm, one of which is working in the harbor of Havana, Cuba, having been purchased by the Huston-Trumbo Dredging Company, of Havana, and the other being purchased by the United States Government for the harbor of Mobile, Ala.

A Self-Propelled Grab-Crane Hopper Dredge.

The *Owenaminaue*, constructed by Messrs. George Brown & Company, of Greenock, is a very useful vessel for dredging rivers. She is of the grab-crane hopper type and is self-propelling. The crane grabs work at a depth of 50 feet, and lifts at 30 feet depth 160 tons per hour. The hopper has a capacity of 420 tons, and the vessel when loaded can proceed to sea at a speed of 7½ knots per hour. The propelling machinery is a compound surface-condensing engine, and the boiler is the marine type, having ample capacity to work both cranes or main engines. The cranes were supplied by Messrs. Clarke, Chapman & Company, Ltd., Gateshead, the grabs being Priestman single-chain type, arranged to work through a specially designed ball-bearing swivel attached to a wire rope on crane instead of the usual chain. The hopper doors are of two thicknesses of wood, hinged to a main fore and aft girder, and are slipped by a simple trigger arrangement on the side combings of the hopper, being closed independently by a rope led to the windlass or after capstan. The vessel is classed 100 A-1 by Lloyds, and was built under their special survey.

Sea-Going Bucket Dredger Adelaide.

The powerful seagoing bucket dredger *Adelaide* was built by "Werf Gusto," A. F. Smulders, of Schiedam, Holland, for the South Australian government. The apparatus is specially intended to dredge very stiff clay. Her main dimensions are the following:

Length	161 feet.
Breadth	34 feet 6 inches.
Depth	13 feet.

This dredger, which has been built in conformity with Lloyd's rules, Class 100 A, and under special survey, is provided with a compound main engine of 500 indicated horsepower, which works either the screw, while navigating, or the dredging apparatus. She is further fitted with the following machinery for auxiliary service: One compound engine of 150 indicated horsepower for working the fore and aft winches and the ladder-hoisting winch. A special steam engine for working the independent condenser which takes the exhaust steam of the main and auxiliary machinery. A steam engine working a centrifugal pump which supplies water to the chutes in order to facilitate the sliding of the dredging in the chutes, some kinds of clay being very sticky. A steam engine for driving the dynamo, by means of which the vessel is lighted electrically throughout. Steam for the above-named engines is supplied by two multi-tubular marine boilers, having each a heating surface of 980 square feet and working at a pressure of 120 pounds.

In view of the fact that this dredger will have to deal with soil of extraordinary toughness, the dredging apparatus has been very strongly designed. Instead of being formed by four legs only, as is usual, the main framing, carrying the upper tumbler with shaft and toothed wheels and the dredging ladder, consists of six heavy beams, of which three are at port and three at starboard side, the two aft beams of each side being, moreover, mutually connected by means of strong girders. In order to give an idea of the dimensions, it may be stated here that each of the large cast steel toothed wheels which drive

DREDGE ADELAIDE, BUILT BY SMULDERS.

the upper tumbler has a diameter of not less than 16 feet, whereas the weight of the upper tumbler, with its shaft and two beveled wheels, aggregates 21 tons. The power of the main engine is carried to the upper tumbler by means of a very substantial transmission of the fixed type, consisting of strong cast steel toothed wheels and a heavy, vertical shaft fitted inside the main framing. This transmission is provided with a friction brake, which disengages automatically the connection between the engine and the dredging apparatus as soon as the buckets, at any given moment, strike upon a submarine rock or any other object that offers too great a resistance to be safely dredged. This prevents the bucket chain or the transmission wheels from being broken by some violent shock that might suddenly stop the bucket chain. Instead of being provided with separate steam engines, directly fed by the boilers, the fore and aft winches as well as the ladder hoisting winch are worked by a single steam engine, placed in the engine-room, by means of cast steel gear wheels driven by shafting extending over the whole length of the vessel, including the raised fore-deck.

This dredger, which has been christened *Adelaide*, after the name of the port she is intended for, is capable of excavating to a depth of 43 feet below waterline. The buckets have a

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capacity of 21 cubic feet, the front being made out of a steel plate of heavy section, provided with cutting lip, whereas the bottom and back consist of a single piece of cast steel. The contract provided for a navigating speed of 7 knots per hour and an effective output of 500 cubic yards per hour when dredging stiff clay. During official trials she has steamed 8 knots, and has easily raised 630 cubic yards of hard clay in one hour, *i. e.*, 130 cubic yards per hour in excess of the output contracted for. The *Adelaide* made the voyage to Australia under own steam in seventy-eight days, a trip of 11,000 miles. Taking into account that she had to call at several ports for coaling purposes and that she had to struggle with a violent monsoon in the Indian Ocean, this may be considered a splendid performance for a bucket dredger.

Twin-Screw Bucket and Suction Dredger Hsin-Ho.

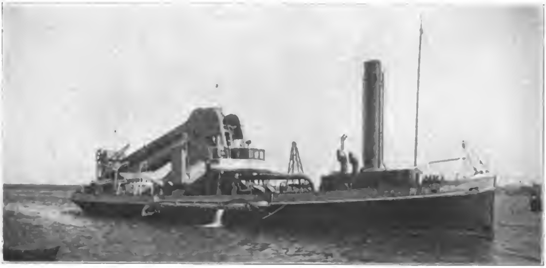
The "Werf Gusto" of Messrs. A. F. Smulders, Schiedam, Holland, have built a twin-screw combined suction and bucket dredger, the *Hsin-Ho*, for the Chinese government to use at Tientsin. This dredge is able to cut her own flotation and to discharge the spoil into barges alongside or through a floating pipe line of a diameter of 20 inches and a length of 1,000 feet, to a height of 9 feet above water level, when 21 cubic feet. An auxiliary engine works the dynamo which supplies electric light. The two main boilers are of the multitubular return-tube type, and have a heating surface of 1,380 square feet each and a working pressure of 120 pounds per square inch.

The *Hsin-Ho* is capable of performing the following dredging operations:

1. Dredging by means of the bucket chain and discharging directly into barges moored at either side. When working in this manner one of the main engines remains inactive.

2. Dredging heavy soil by means of the bucket chain and pressing it away through the floating pipe line, which is connected to the vessel's stem at water level. One of the main engines works the bucket chain and the water pump, while the second engine drives the force pump. Inside the main framing has been placed the spoil receiver, provided with a grating through which the spoil has to pass before reaching the force pump. Here the stones are removed by a set of rotating knives, whereas the big lumps of soil are cut up by a powerful jet of water supplied by a special high-pressure pump. The force of this water jet acts upon the spoil like a knife and forces it down through the bars of the grating.

3. Dredging as described above, but raising light instead of heavy soil. In this case the water pump and the sand pump may be coupled for working compound. The water pump,



THE SMULDERS DREDGE HSIN-HO.

dredging either by the suction apparatus or by the bucket chain. The main dimensions of the vessel are:

Length between perpendiculars...	157 feet 6 inches.
Breadth	36 feet 9 inches.
Depth	11 feet 6 inches.

The dredging depth of the *Hsin-Ho*, when dredging by suction or by means of the bucket chain with the ladder at 45 degrees, is 26 feet. Her theoretical output is 650 cubic yards per hour. With the bunkers filled with coal, water in tanks and boilers, the vessel being in full working order, her maximum draft is 6 feet 6 inches. The mean speed, when normally equipped, is 8 knots. The main engines are two in number. They are of the inverted type, compound, steam-jacketed, with surface condensers, and are designed to develop 320 indicated horsepower each. When the engine driving the bucket chain runs at 140 revolutions a minute, the bucket chain has to attain a speed of fourteen buckets per minute. During trials, however, sixteen buckets per minute were easily carried over the upper tumbler. The capacity of the buckets is acting as a sand pump, sucks up the spoil out of the receiver, and passes it on to the sand pump proper, which forces it away through the pipe line. One of the main engines then works the bucket chain and the suction pump, the second engine driving the force pump.

4. Sucking from the bottom, while navigating, by means of the starboard trailing suction pipe and discharging the spoil into barges moored at portside. A special high-pressure centrifugal pump is provided for working the nozzle-stirring arrangement fitted at the mouth of the suction pipe. When working in this way, one of the main engines drives the starboard screw and the suction pump, the other engine actuating the portside screw only.

5. Sucking from the bottom while at anchor and discharging into barges or through the pipe line. When pressing through the pipe line, the pumps may be coupled as described, each engine driving one pump.

The *Hsin-Ho* made the voyage to the Far East under her own steam.

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Gold Dredging by Electricity.*

BY H. W. ROGERS AND C. M. BLIVEN.

Dredging is the most recent of mining methods employed for recovering values in auriferous ground located below the water level or in streams where the flow of water is too great to admit of success by other means. That it has attained an important place in the industry is evidenced by the fact that, although the first successful dredge in California only began operations about ten years ago, to-day more than one-quarter of the gold mined in that State is secured by the dredging process, and the bulk of this is obtained from grounds previously mined. The development of the gold dredge affords one of the most interesting chapters in the history of mining. It is the latest of a series of successive steps in the recovery of placer deposits, following the pan, the rocker, the long Tom, the sluice box, the ground sluice, drift mining, the monitor and the hydraulic elevator. All of these methods had their time and place, and some are extensively employed to-day, but it remained for the dredge to solve the problem of mining in grounds below the water level and in rapidly flowing streams.

Rich deposits of auriferous earth lying below the water level in the valley of the Feather River in California led to the introduction of the machine and the establishing of this industry. The gravels had already been mined to the water level, and the wealth yielded is still a legend of the days when "hundred dollars (20 pounds) a day diggings" were not uncommon. For half a century men had striven to find a means of reaching the lower stratum, but without avail, for the water drove them back. When the dredge finally came it followed closely and was, in large part, due to an attempt to mine with the aid of powerful pumps, which, although inadequate, were suggestive of a more highly satisfactory method. The development, however, has had its failures as well as its successes, for, be the machine ever so perfect, it must fail unless it works in ground that contains gold in sufficient quantities to be profitable and where conditions are favorable for the successful recovery of the metal. Ideal dredging ground is of limited depth with a soft bed rock, free from large boulders, and with values evenly distributed. Where these conditions are combined, dredging for gold may be a profitable industry.

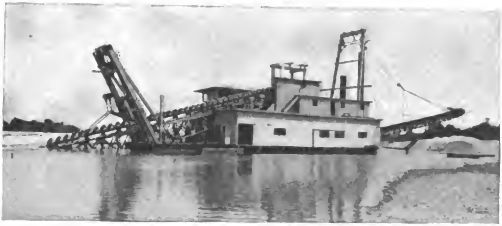
The early type of dredge, which was considered massive and powerful, is a striking contrast to the dredges of the present day. It was equipped with three and one-fourth cubic foot buckets, digging to a depth of 30 feet, and was driven by a 50-horsepower steam engine; and, although partially successful, was always very expensive, owing to the scarcity of fuel and the excessive cost of handling it.

With the rapid development of hydro-electric plants throughout the West, and the insurance of a continuous, economic power supply transmitted through great distances, the mining companies soon turned their attention to the electric motor for operating dredges.

The most successful and practical standard dredge of to-day is the continuous-chain, close-connected bucket type, varying in capacity from 3 to 13½ cubic feet. While the details may vary slightly, in general construction it is similar to the ordinary continuous chain-bucket dredge used for other work, except that it must be greatly strengthened in order to resist the excessive strains due to digging in rocky ground. The machinery consists of the digger or bucket line, revolving screens, sluice tables and boxes, stacker for carrying the tailings, high and low-pressure pumps, priming pumps, amalgamator, lines and spuds for guiding the dredge, and occasionally a sand pump.

Digger.—The digger consists of a steel ladder of massive construction, built to support the bucket line and resist the heavy strains while in operation, especially near bed rock. The bucket lips, bushings and rollers are made of manganese steel, which possesses the best wearing qualities and reduces the cost of maintenance to a minimum. The speed of the bucket line varies from 50 feet (with 18 to 25 buckets) to 75 feet (with 35 to 50 buckets) per minute, depending upon the condition of the ground. For the operation and control of the digger, a variable speed motor is used. This is located on the lower deck and belted to the driving pulley, which is generally situated in the rear of the pilot-house on the upper deck. The duty imposed upon this motor is severe, as it must operate under conditions calling for power varying from 75 percent overload down to 25 percent of its rated capacity. The motor recommended for this service is an alternating-current, induction-type machine, known as Form M, designed on liberal lines and equipped with a drum-type controller having fourteen running points, forward and reverse, with the necessary resistance for continuous operation on any notch of the controller from one-half to full speed. The maximum starting torque is required and obtained at about the fourth point of the controller, thus leaving three points on which to bring the motor up to half speed, at which time nearly full-rated torque is required. As a result of these conditions, the ordinary motor designed for intermittent service cannot be successfully applied.

Winch.—To keep the dredge in place and to move it about or hold it against the bank when digging, head lines are used,



GENERAL ELECTRIC GOLD DREDGE AT WORK.

* Abstract from *General Electric Review*, January, 1911.

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which are controlled from the forward end and operated by a six-drum winch driven by a variable speed motor. The winch motor, while of smaller capacity, is of the same staunch construction as the digger motor, and is equipped with a suitable controller and resistance to permit its continuous operation at from one-half to full speed. It has been found advisable to equip the motors for this service with solenoid brakes, by means of which the motor can be brought to a standstill almost instantly. It is then ready for the reverse operation without the usual reversing of the motor through the controller, which is not only bad practice but may result in a burnout, due to the heavy strain on the windings.

Pumps.—The high and low-pressure pumps for supplying water to the screens and sluices are generally connected to the same motor. A constant-speed Form K motor of compact construction and large overload capacity, with a speed of about 900 revolutions per minute, is usually installed for this work, and is supplied with extended shaft at both ends, these extensions being provided with flange couplings for direct connection to the pumps. The standard General Electric Form K constant-speed motor is recommended for use throughout the dredge, except on the digger and winch.

BUCKETS ON THE GENERAL ELECTRIC DREDGE.

Sand Pump.—To prevent the filling up of the basin in which the dredge floats, when digging in shallow water, it is sometimes found necessary to install a sand pump, which carries the fine tailings from the sluice boxes to the top of the rock pile by way of the stacker. This pump requires considerable power and is never used unless absolutely necessary.

Priming Pump.—This pump is used for priming the large pumps or for supplying water to the tables during the "clean up," and generally consists of a small, high-speed motor direct connected to a centrifugal pump.

Screens.—Either the shaking or revolving screen may be used to separate the gravel from the clay and permit the fine particles containing the gold to pass through onto the gold tables and sluices below. For this service a constant-speed motor is recommended, which can be placed on the upper deck and belted down to the driving pulley of the screen.

Stacker.—After screening, the large rocks are carried on a belt conveyor to the end of the stacker and deposited on the spoil in the rear of the dredge. For operating this conveyor, a constant-speed motor is installed at the extreme end of the stacker, where it can be readily housed.

The power for operating these dredges is usually transmitted by the various electric companies to a sub-station near the base of operations, at three-phase, sixty cycles, the voltage varying from 2,000 to 6,000 volts. Current is carried to the dredge through an armored cable floated on pontoons, where it passes through the main line oil switch to the switchboard, and is distributed to the various motors.

New York Barge Canal and the Hydraulic Dredge.

Until recently the use of the hydraulic dredge has been confined within rather narrow bounds. During the construction of the New York Barge Canal, however, a type of hydraulic dredge has been developed which has distinctly widened this field, and has made possible the utilization of this very desirable type of machine on work formerly belonging entirely to the dipper or elevator dredge. When the first of these dredges was built there were already a number of the older type in use on various parts of the canal. Some were successful, but others had proved expensive experiments, largely due to the attempt to dig material which cannot be successfully handled by the ordinary type of hydraulic dredge. The Bucyrus Company, of South Milwaukee, Wis., decided therefore to profit by this and build a more substantial machine. The result was three dredges carrying 20-inch suction and discharge pipes and equipped with heavier and more powerful machinery and greater boiler capacity than other dredges of the same type heretofore built. The material, it was found, that these boats could handle surpassed the most sanguine hopes of the engineers. One of the dredges was started in light material, consisting for the most part of gravel and clay. After working for some time in this material it struck unexpectedly a pocket of cemented gravel. In order to economize on time and also to experiment with this heavier type of machinery it was decided to try the dredge out on this material. This they proceeded to do, with no apparent ill effects except a small decrease in the output and a little more rapid wear of the cutter head. To overcome this a heavier cutter was substituted, made of a specially treated nickel chrome steel known as "YZ," developed by the Bucyrus Company in connection with placer dredges. This cutter is driven

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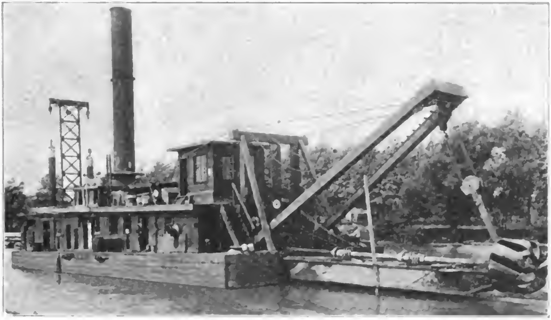
by a 10 by 14 independent engine. The pump casing and runner are particularly heavy, both being of "YZ" steel. The casing is unlined, with a shell of 2¼ inches maximum thickness in the zone of the greatest wear. To add to the available wear the shell is increased in thickness by radial ribs. The unlined pump casing has lately grown in great favor among dredgers for several reasons. In the first place, a lined pump has a high first cost and up-keep, and, secondly, experience has proved that it is exceedingly troublesome and expensive to keep in proper repair. The unlined casing, on the other hand, requires little attention, and when made of high-grade steel has a sufficiently long life to make it more desirable. Indeed, the saving in repair time alone more than makes up for the possible shorter life. The pump is driven by a vertical, triple-expansion, non-reversible engine of the marine type, with cylinders 15, 22 and 36 inches in diameter and an 18-inch stroke.

The boiler is 750 horsepower, designed for a steam pressure of 190 pounds. Practically every part except certain engine fittings is of steel, cast iron being eliminated wherever possible. A five-drum winch operates the spuds, the ladder and the swinging lines. This is driven by an independent 8½ by 8 engine. The discharge pipe in the stern is made with a special design of double swiveling joint, which takes care of the change in trim of the dredge and also allows for the wave motion. The pipe line consists of 32-foot sections of steel pipe riveted together. This pipe line may vary in length, of course, with the distance of the disposal areas. It is floated on pontoons consisting of heavy watertight casks. The sections are joined by means of strong rubber sleeves. The shore line consists of 16-foot sections joined by telescoping. The full capacity of these dredges under the most favorable conditions has never been tested. The *Clyde*, however, has done 1,230 cubic yards an hour in extra heavy material, and under more favorable conditions had made, with ease, 400,000 yards a month in two shifts of eight hours each. In five months last summer the dredge made 1,300,000 cubic yards, despite the fact that during one month a very heavy streak of slate was encountered amounting to some 75,000 cubic yards, which required a whole month to clean up. This output was made working three eight-hour shifts.



BUCYRUS COMPANY'S HYDRAULIC DREDGE.

Suction Dredger for the Argentine Government.

The Argentine government has received an addition to her fleet of dredgers, employed in the harbor works and the approaches thereto, in the new vessel *M. O. P. 209 C*. It is a powerful suction-hopper dredger, designed and built by the "Werf Conrad" Company, of Haarlem, Holland. The dredger has some interesting new features.

The dredger has a length of 84.5 meters, with a beam of 14 meters and a depth of 6.66 (270 feet by 44 feet 6 inches by 22 feet), and her loaded draft is 4.80 meters, or 16 feet. On this draft she carries besides 500 tons of bunker coal, 2,100 tons of dredged material, as found on the bar known as "Punta de Indio," for which exposed position the dredger is specially constructed and appointed. There are four sets of triple compound-surface condensing engines of 500 indicated horsepower each, two engines driving the screws and the two other engines driving each a centrifugal dredging pump. As the four engines are so grouped as to be two by two in one line, they may be readily connected so as to drive each pump or each screw with the aggregate power of both engines. When dredging, however, each engine runs separately, the connecting only being used either when pumping ashore over a long distance or when steaming on a long voyage. The vessel's speed when loaded is 10 knots when working at 1,700 horsepower. All four engines have one condenser in common, separate air and circulating pumps being provided, the air being left out at every transverse keelson between the doors, being a centrifugal pump made by the builders. The dredging pumps are built up from steel plates and angles, and have a complete internal lining of special steel, which is to be renewed when worn. They have suction pipes of 28 inches diameter, carried through the vessel's sides, one on the starboard, one on the port side and then pointing forward so as to be driven against the material to be dredged by the forward motion of the vessel. The lower end of each pipe, which is nearly on the half length of the ship when lowered down, is towed by a strong steel hawser, set tight by special steam winches placed above the cargo hold, which is covered over the greater part of its length, the water being only allowed

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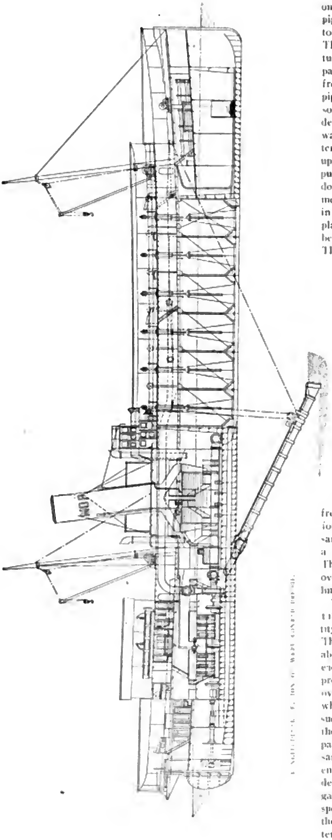
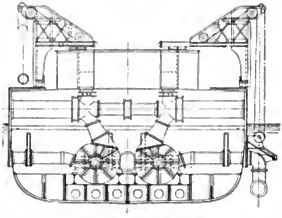


to escape from the hold over a short length at the extreme fore-end. The hawsers pass over sheaves fixed as near the bow as practicable at each side. There are two steam winches on the manœuvring deck for raising and lowering the suction pipes, and two hydraulic cranes take the after ends of the pipes to lift them above the deck level and to run them in-board. The catheads, from which the forward ends are suspended, turn up when the pipe is raised so far as to touch, so that this part of the pipes is also carried in-board. When pumping from the bottom the material is delivered into the hold by two pipes, which are of a square section, and without a bottom for so far as they run over the hold. Thus all material is first deposited at the extreme after-end of the hold, where, as the water can only escape at the extreme fore-end, and the material only comes farther forward when the after part is filled up, by which arrangement a great saving in the practical output is achieved. The hold may be emptied by the usual bottom doors or by the pumps, there being a special suction arrangement on the builder's own patent to achieve this. It consists in having the bottom doors of a hollow section formed by two plates, the lower plates being continuous, the upper plates being left out at every transverse keelson between the doors. These transverse keelsons also consist of two plates; in the



'Thwartship Section of Dredge.

front plate a door is cut, which opens into the suction channel formed by the bottom doors. Water is admitted if necessary by valves on the front bulkhead of the hold, thus insuring a strong current to force the stuff into the suction channel. The delivery in the case of drawing from the hold is directed overboard or into a connection pipe to which the floating pipe line can be attached.

The official trials gave an average output of 6,000 meters (18,000 square feet) of dredged material per hour, this quantity filling the hold completely in only fifteen minutes' working. The emptying by the pumps takes still less time, or about twelve minutes on an average. The bottom doors are each separately worked by a vertical hydraulic press, these presses being operated from the bridge deck, which extends over the full length of the hold. There are also the hand wheels for working the smaller doors, giving access to the suction channels in the bottom, and the winches for working the suction pipes as well as the hydraulic cranes for the after part of these pipes, so that all the work is carried out on the same deck level. A flying bridge, with wheel-house and engine telegraphs, is supported on pillars above the working deck, and affords a free view all round necessary for the navigation of the ship. In the engine-room there are also fitted special high and low-pressure pumps for forcing water into the interior of the suction pipes to facilitate the clayish material in gliding without too great a resistance. The suc-

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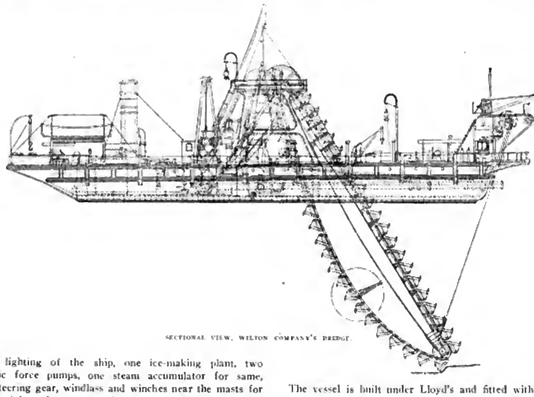
tion pipes are fitted outside with hollow rings, to which the delivery pipes of these pressure pumps are attached, small nozzle-shaped plugs being screwed into the thick plates of the suction pipes into such positions as to create a spiral film of water inside the pipes. This arrangement, invented by Mr. Carlesimo, has proved to be effective in dealing with the material found at Punta de Indio. The suspension of the after part of the suction pipes is arranged so as to give a little when the resistance against the pipes in the bottom becomes too great. Thus the bend at the ship's side is curved downwards, and a flexible connection of curved form used in lieu of the ordinary straight length of flexible joint. The arms carrying the weight of the pipe are hung from the bend, and these links allow of sufficient play to lift the mouth of the pipe free from the bottom, by means of a cable pulling the forward suspension in a broken line instead of the straight line corresponding to the usual position.

As auxiliary machinery there is a complete installation for electric lighting of the ship, one ice-making plant, two hydraulic force pumps, one steam accumulator for same, steam steering gear, windlass and winches near the masts for lifting weights of 15 tons and 10 tons, respectively, at fore and main mast. A complete repair shop is installed on a level with the upper platform in the engine-room, containing an electrically-driven lathe, shaping machine, punch and shear, drilling machine and smith's hearth. Electric fans are installed in the engine-room and crew spaces, as well as in cabins, and the sanitary arrangements of the vessel are very complete, there being four bath rooms with hot and cold showers and sitting baths completely fitted. The crew's quarters are in the bow under the main deck, the ship's officers aft under the same deck, while there are a suite of engineers' cabins on the main deck at each side of engine-room trunk casing, comprising cabins for chief engineer of the surveying department, seven assistant engineers' mess room, bath room and closet. The equipment is completed by a fast steam launch, set overboard by the after derrick; further, there are two life-boats and one dinghy. The life-boats are hung on stout arms of channel section, connected by a pipe running over the full length of the boat. To this pipe the boat's falls are attached and the whole arrangement is suspended from the funnel. When the boat is lifted from its chocks the arms are lowered down so far as to carry the boat clear from the suction pipes, after which the boat is lowered by its own gear.

A Combined Suction and Bucket Dredge.

The Wilton's Engineering & Slipway Company, of Rotterdam, Holland, has built for Mr. C. H. Campbell, dredging contractor, of New Broad street, London, England, a dredge which has been named *Subworker*. It is of the following dimensions:

Length	141 feet.
Length over horn ends	161 feet.
Breadth	27 feet 11 inches.
Depth at fore end	12 feet.
Depth aft	10 feet 4 inches.



SECTIONAL VIEW, WILTON COMPANY'S DREDGE.

The vessel is built under Lloyd's and fitted with a triple-expansion steam engine of 300 indicated horsepower. The transmission to the top tumbler is by means of heavy belts and cast steel spur wheels with double helical teeth. The sand-pump is coupled directly to the crankshaft, and has suction and discharge tubes of 21½ inches diameter. The maximum dredging depth by buckets or suction tube is 50 feet. The chutes are inclined to the stern in order to work with long barges. The center chute is automatically worked by the ladder to get the right position for the different dredging depths. The barge-loading arrangement of the pump is made by steel pipes, as shown on the print. The buckets contain 24 cubic feet, and are constructed of special steel, the weight of each bucket being 24 cwt., and each bucket being fitted with three manganese steel digger teeth. The picture herewith shows the trials at Rotterdam, in which the dredger lifted 400 tons of material per hour.

This dredger is fitted out with a main and an auxiliary ladder, permitting her to dredge at great depths with total guidance of the buckets and under a good angle of excavation.

U. S. Suction Dredge New Orleans.

In presenting particulars of the *New Orleans*, now under construction by the Fore River Shipbuilding Company of Quincy, Mass., it is of interest to review briefly the comparative conditions under which dredges are operated in America and in other countries.

In the United States and Europe the development of dredging appliances has progressed along somewhat divergent lines. In the former the tendency has been to employ the outside contractor in the development of harbors and channels, while in Europe it is common to find such work in control of local authorities created for the particular purpose. The private contractor naturally wishes to restrict the size and expense involved in his plant, while a powerful public corporation will build the largest possible appliances, regardless of first cost, with a view to the greatest economy in operation—therefore, we may expect to find in the United States a great development of the smaller type of dredge, such as the dipper, clamshell, and small suction-pipe line types, while in Europe we find the greatest advance in the building of the enormous bucket-ladder, hopper, suction and other costly but powerful and economical dredging appliances. But in the United States there is one exception. The War Department, which, through the Corps of Engineers, controls all river and harbor developments, is the largest owner and operator of dredging plant in the world, and is necessarily involved in dredging projects of the greatest size and importance, from that of the Panama Canal downwards. One of the problems of great complexity is the keeping of the entrances of the Mississippi River clear of the mud which comes down in endless volume. Jetties have been built at great expense with a view to creating a scouring action in the channel, but an enormous accretion of mud in shoals results at the end of the jetties and forms a bar obstructing the passage of large vessels. To cut this bar and continue the course of the channel between the jetties, continual dredging is essential. The conditions compel the use of the largest and most powerful type of hopper dredge available and it became necessary, therefore, for the Corps of Engineers to adopt some novel type of dredge in order to handle the enormous masses of mud economically and efficiently. Hence the order for the *New Orleans*.

This dredge is of the following dimensions:

Length over all (not including dredge head)	315 feet
Length between perpendiculars	300 feet
Breadth moulded	50 feet
Depth moulded	26 feet
Length of hopper	93 feet 9 inches
Capacity of hopper	3,000 cubic yards
Draft loaded	20 feet
Coal bunker capacity	300 tons
Speed loaded	10 knots

The vessel has a straight stem and twin semi-elliptical sterns, between which the dredge arm is placed, and is rigged with the two pole masts. The ten hopper wells are located amidships with the boiler-room immediately forward and the engine-room abaft of them. From the after engine-room bulkhead aft, the vessel has a channel or well, dividing the hull and forming twin sterns. In this well is arranged the dredge suction arm, forming a huge girder about 67 feet long, incorporating the two 9-inch diameter pressure water and two 26-inch diameter suction pipes. At the forward end of this well a massive cast steel pillar block on each side supports a pair of heavy cast steel trunnions, which in turn carry the girder arm. At the lower end of the girder is a huge pair of hinges by which the bucket head is attached so that it has a movement of rotation about a horizontal axis at right angles to the direction of the girder to enable the cutting angle to be varied at will. This dredge head is manipulated by durable steel wire rope falls running over

THE DREDGE NEW ORLEANS.

ANOTHER VIEW OF THE WILTON COMPANY'S DREDGE.

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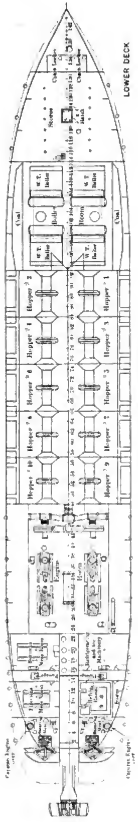
large sheaves carried on a massive stern bridge built astride the well, the falls in turn being operated by a powerful deck winch, which enables the dredge head to be lowered to a dredging depth of 50 feet or to intermediate depths, or raised clear of the water. The head, as already explained, is practically a huge enclosed rake, which in the case of the *New Orleans* is some 18 feet wide by 5 feet fore and aft, serrated along the edge with sharp cutting teeth through the incisors of which is ejected high pressure water to aid in disintegrating the spoil and make it of suitable consistency to be sucked through duplicate suction pipes into the pumps from which it is deposited in either of the several hoppers.

Installed in the engine room are two specially designed 26-inch centrifugal dredging pumps, having chambers lined with manganese steel and with removable wearing pieces on the impellers of high grade cast steel. The main engines comprise four sets, arranged in pairs tandem and built on common bedplates, of triple expansion inverted marine type, having cylinders 12 inches, 19 inches and 32 inches, with a common stroke of 24 inches and capable of exerting a combined horsepower of 2,500. The two after sets of these main engines are coupled direct to the propeller shafting and the two forward sets to the 26-inch centrifugal dredge pumps. By an ingenious arrangement of clutches the propelling and pumping engines can be coupled together so that the full power of all four engines can be exerted on the twin propellers when desired, while, when dredging, the after sets will be free to drive the propellers and the forward sets will drive the dredging pumps. The pressure water or jet pumps for disintegrating the material being dredged are three in number, of the vertical duplex pattern, capable of a combined capacity of 300 cubic feet of water per minute. Steam is supplied by four Babcock & Wilcox watertube boilers, having a total heating surface of 12,664 square feet and grate surface of 317 square feet. The installation is capable of filling the ten hopper holds in less than 120 minutes, the combined capacity of which is 3,027 cubic yards, or approximately 3,000 tons. The dredged material may then be transported by the vessel to any convenient dumping ground at a speed of 10 knots per hour, when, by the manipulation of four hydraulic ram mechanisms, the hopper doors, 20 in number and opening outwardly through the ship's bottom, may be operated either individually or simultaneously for discharging material, an operation, therefore, occupying only a few minutes when all doors are open.

The hoppers have a mixing water pipe system by which sea connections can be opened to furnish mixing pressure water to thoroughly loosen the precipitated material. Another important feature is the arrangement of settling troughs, baffle plates and overflow sluices provided to allow any surplus water which has been sucked in to escape overboard without carrying dredged material. Should it be desired to utilize the dredged material for reclamation work, a swivel deck discharging pipe has been installed, to which the necessary lengths of shore piping may be coupled, and through this pipe the dredge can discharge her own cargo by sucking it from the hoppers and ejecting it to any location desired or, as a third alternative, into scows or other hoppers alongside.

The *New Orleans* furnishes comfortable and commodious quarters for its crew. The captain, inspector and first mate are berthed in a large deck house, while the chief engineer and his assistants have been accommodated in the after deck house and adjoining the engine room. This after deck house is also arranged for stewards, cooks, etc., and provided with suitably furnished mess rooms for officers and petty officers, together with toilets, wash places, etc. On the lower deck aft on each side of the well are mess rooms for seamen and firemen, cold storage rooms and refrigerating machinery.



DECK PLAN OF DREDGE NEW ORLEANS

The monkey forecastle is divided off into quarters for seamen, firemen, oilers, storerooms, wash places, carpenters' workshop, etc., while nearby are located the quartermaster and boatswain. As the *New Orleans* will operate mostly in semi-tropical waters, the greatest attention has been paid to the sanitary and ventilation arrangements, and all living quarters and machinery places are well supplied with both artificial and mechanical ventilation.

The auxiliary machinery comprises a No. 9 Hyde Windlass Company's steam and hand windlass, three No. 3 Hyde Windlass Company's steam capstans, and twin sets of Williamson Bros.' spring quadrant type steam steering gear, operating the two rudders in unison and controlled by an improved telemotor system operating from pilot house forward. Considerable attention has been paid to the special hoisting winch, furnished by the Lidgerwood Manufacturing Company, which has been designed so that when there is a pull of ten tons on each dredge arm fall, the winding speed will not be less than 50 feet per minute. This winch is placed on top of the after house, on a steel foundation built up from the main deck, and arranged so that the winch man will have a clear look-out aft and operate the engine, to lift or lower the dredge arm, by turning a vertical wheel either to port or starboard as in a steering-wheel. The electric light plant consists of two 110-volt generators, each of 25 kilowatt capacity, driven by Curtis steam turbines. The vessel is lighted throughout by electricity and in addtion there is supplied a searchlight, of 35 amperes capacity. A steam heating system is installed, with individually operated radiators.

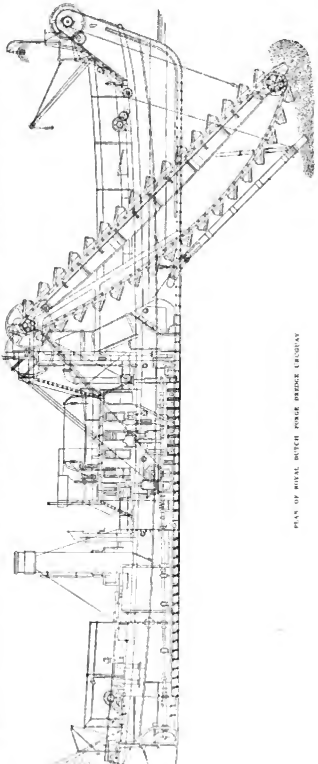
Self-Propelling Bucket-Suction Dredger Uruguay.

Dredger *Uruguay* was ordered by the Uruguayan government from the Koninklijke Nederlandsche Grofsmederij (Royal Dutch Forge Company), at Leiden, Holland, and represents a type of dredger which can be called an universal dredger. The material to be dredged can be raised either by a bucket chain or a suction pump, and delivered in barges alongside or through a floating pipe line direct on shore at a distance of 1,000 feet against a height of 20 feet. The principal dimensions of the dredger are as follows:

	Feet.
Length over all	145
Breadth	26
Depth molded	9
Draft, maximum	5
Dredging depth	27

The draft was kept as light as possible to enable the dredger to pass over the various sandbanks in the river mouth, where she is intended to work. The vessel is provided with two compound surface-condensing engines; one engine, placed lengthwise, for driving the suction pump and the propeller, the second engine, placed athwartships, for working the bucket chain. The vessel is further provided with four double-cylinder steam winches for working the hoisting ropes for the bucket ladder and suction pipe, the bow, side and aft chains. The dredger is lighted by electricity throughout. Steam for the above-mentioned engines is supplied by two marine boilers, having each a heating surface of 753 square feet and a working pressure of 120 pounds per square inch.

The bucket chain has a capacity of raising 300 tons of material per hour. The buckets are constructed of steel plates and provided with hard steel cutting bands. The engine power is transmitted to the upper tumbler shaft by two belts, two pulleys and two sets of cast steel gearings. The sand pump is of equal capacity to the bucket chain, and is constructed of steel plates and angles, and fitted inside with removable hard steel weaving plates. The flyer is of S. M. steel.



PLAN OF ROYAL DUTCH FORGE DREDGE URUGUAY

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forged in one piece—the flyer shaft fitted with hard steel weaving bushes. The suction pipe is constructed of ⅜-inch steel plate, and is mounted on a strong ladder placed in well. The delivery pipes are mounted on floaters of cylindrical form, and constructed of steel plates and coupled by means of specially designed couplings of armored leather. The dredger has been tested thoroughly, and the output of the bucket-chain as well as of the suction pump showed an excess of the requirements stipulated by the government. The vessel made her voyage to Montevideo under her own steam.

SUCTION DREDGE URUGUAY IN OPERATION.

Chesapeake Bay Steamer Three Rivers.

The Maryland Steel Company, of Sparrows Point, Md., has completed, for the Maryland, Delaware & Virginia Railroad, the side wheel steamer *Three Rivers*, for night service on the Chesapeake Bay, to accommodate 350 passengers. The dimensions of this vessel are:

Length on water line	180 feet
Length over all	188 feet
Beam, molded	36 feet
Beam, over guards	57 feet 6 inches
Depth, molded	10 feet 5 inches

The hull is steel fitted with four watertight bulkheads. The boilers are two in number, of the return tubular type, 8 feet 9 inches diameter by 13 feet 9 inches long, each, and are fitted with superheaters. Sixty pounds of steam is carried. Her engine is a vertical condensing beam with a 40-inch cylinder and a 9-foot stroke. Feathering paddle wheels are provided, 20 feet in diameter, with 8-foot buckets, which are of oak. She is fitted with a Hyde windlass, capstan and steam steering engine. The electric plant is a 20-kilowatt General Electric outfit direct connected. Sixty tons of coal can be carried in the bunkers. The finish of the boat is very acceptable, the joiner work being painted white with gilt relief. The main stairs, however, are hard wood. Interlocking ribber tiles are fitted throughout, except in the kitchen and pantry, where asbestolith is used. In all the rooms steam heat is supplied, as is also running water. Every comfort has been provided for passengers.

NEW BAY LINER THREE RIVERS.

The British navy estimates, as made in a preliminary announcement, call for an expenditure of £44,392,500 ($221,962,500) for 1911. The programme includes five *Dreadnoughts*, three protected cruisers, one unarmored cruiser, twenty destroyers, six submarines and an increase in the personnel.

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TYPE 1. For general run of castings, such as propellers, propeller struts, couplings, relief valves, shaft sleeves, thrust rings, gear pumps, hooks, gun mountings, stern bearings, etc., etc.

TYPE 2. For marine fittings, condensers, gate valves, rocker arms, bilge pumps, binnacle stands, mast fittings, cleats, chocks, belaying pins, governors, search light stands, towing hooks, brackets, eccentrics, throttle valves, torpedo tubes, torpedo breeches, conning towers, periscopes, deck plates, etc., etc.

TYPE 3. For engine housings, engine bedplates, air compressor bedplates, air compressor framings, hand wheels, gears, rudder bearings, stuffing boxes, windlass gears, windlass drums, bearing brasses, bushings, spiral gears, port lights, air pumps, reducing valves, etc., etc.

TYPE 4. For whistles, radiator valves, also for forging purposes.

TYPE 5. For plug cocks, steam traps, thermostats, etc.

TYPE 6. For forged pump rods, bolts, valve stems, hose couplings and all kinds of fittings to be riveted. This type is also produced for rolling and drawing.

TYPE 7. For general hardware, quadrants, railings, name plates, indicators, hatches, grease cups, oil cups, gauges, stanchions, engine telegraphs, controller fittings, etc.

TYPE 8. For air compressor cylinders, oil pumps, injectors, exhaust headers, exhaust valve bodies, elbows, tees, water jacketed bearings, gas mufflers, hydraulic valves, hydraulic valve fittings, steam valves, etc. It is a high pressure Steam Metal.

TYPE 9. A special metal used in ship bells, electric bells, electric gongs, fire bells and gongs, submarine signal bells, etc.

TYPE 10. For turbine buckets, superheated steam valves, steam nozzles, pump linings, trolley wheels, circulating pumps, safety valves, journals, glands, etc.

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1	71,000	28,500	32.0	27.8	1 Inch
2	65,400	28,400	38.5	31.1	1 Inch
3	65,100	34,400	18.5	17.2	1 Inch
4	56,900	22,800	57.5	43.7	1 Inch
5	59,500	22,000	52.0	37.6	1 Inch
6	51,100	18,100	65.0	45.3	1 Inch
7	59,200	23,000	50.0	39.1	1 Inch
8	32,000	17,500	21.0	18.8	1 Inch
9	62,940	32,960	8.0	17.0	1 Inch
10	70,000	40,000	21.8	....	1 Inch

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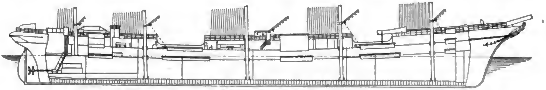
FRENCH AUXILIARY MOTOR SHIPS.

BY J. PELTIER.

The total amount authorized in France as bonuses to the shipbuilders and ship owners, according to the law of 1893, amounted to 151,000,000 francs (£6,040,000) ($30,200,000). The big "wind-jammers" built under this law profited most by it.

In 1912 sailing ships will receive their last subsidy. Many ship owners, not being able to carry on their business without a subsidy, are now trying to obtain a "special compensating law," while well-managed and old firms are attempting to hold their business through up-to-date methods of appliances. Messrs. Prentout-Leblond and T. Leroux, of Rouen, who are known all over the world for their enterprising spirit, among other shipowners decided last year to alter their four-masted petroleum bark into an auxiliary ship. In order to do this, the *Quevilly* underwent alterations for nearly one year in the Havre docks, changing her stern and putting in twin screws, expending about £6,000 ($30,000), which included installing oil motors. This four-masted bark was built in 1897 by Messrs. Laporte & Company of Grand Quevilly, near Rouen, and she proved herself in every way a seaworthy boat, making several remarkable passages between New York and Havre. She is steel-built, divided into ten watertight compartments, with two steel decks extending fore and aft, giving her great longitudinal strength. She is propelled by twin screws actuated by four-cylinder Diesel engines, built by the Maschinen Fabrik Augsburg-Nurnberg Akt.-Gesellschaft. Her trial trip was carried out on the 15th and 16th of January, last. Her displacement is about 3,000 tons and the best run she made on the measured mile was somewhat over 7 knots, her average speed being 6.1 knots. It is expected, however, that with 100 tons of fuel in her tank her radius of action will be 4,000 to 4,500 nautical miles. The owners of the *Quevilly* were so confident of results that before any trial was made they ordered a five-masted auxiliary cargo boat from the Gironde Works & Shipbuilding Company, Bordeaux. She is named *France* and will be the largest of her class, and will be put in the New Caledonian ore trade. Her dimensions are as follows:



LONGITUDINAL SECTION OF MOTOR EQUIPPED SHIP.

Length over all, 131 meters (430 feet).

Length between perpindiculars, 119 meters (390 feet).

Mean breadth outside plate, 17.50 meters (57 feet 5 inches).

Mean draft astern, fully loaded, 7.20 meters (23 feet 6 inches).

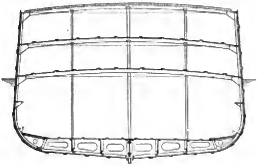
Cubic capacity, 9,960 cubic meters (352,000 cubic feet).

Displacement, fully loaded, 10,730 tons.

Gross tonnage, 6,100 tons.

Net tonnage, 5,500 tons.

This vessel will be propelled by twin screws, the motive power being two Diesel engines, two cycle, of the Schneider-Crels improved patent of 900 horsepower each. The main engines, auxiliaries and fuel tanks are located aft in a watertight compartment. As the stern of the ship, on account of the contracting lines, is of little use for cargo, the engine room will be situated aft, thus making more room for cargo. The motors are to be built by Messrs. Schneider & Company at their works at Le Creusot. Windlass, winches and capstans, respectively five and nine in number, will be used for handling the anchors, hawsers and cargo, and will be actuated by steam, a donkey boiler being fitted on board for generating steam. It is to be noted that all mainsails and the general working of the ship and its sail are to be handled by the use of the steam winches. She will be lighted throughout by electrcity, the generator being run by a small motor. She will also be heated throughout by steam. The accompanying



THWARTSHIP SECTION OF FRANCE.

drawings give details as to the engines, arrangements and accommodations, etc.

If the hoped-for results are obtained, the *Quevilly* and the *France* will become new types of long-distance, or over-sea vessels, and such ships ought to be the best and cheapest for such work. On shorter voyages it may be found that motor boats will prove more efficient than auxiliary-fitted vessels, but on long voyages the auxiliary ship will undoubtedly prove more satisfactory. In 1902, owing to the large number of big sailing ships built in France, close attention and study were given to the type which promised best returns, and the auxiliary ships will undoubtedly prove themselves the more efficient, being able to make regular trips, independent of calms or contrary winds. The many sailing ships built under the subsidy law of 1893 cost on an average 650,000 francs (£26,000) ($130,000) and it is figured that the cost of an auxiliary motor would amount to £2,000 ($10,000) extra, and the ship owner could well afford to pay this additional sum, as it practically doubled his income.

In an article published in the French press about twelve years ago it was said that a 50 horsepower motor, or two 75 horsepower motors, weighed 70 tons approximately, and that these operated by liquid fuel would give satisfactory results, such fuel being easily obtained all over the world, and at a price even lower than in France. The revolutions considered best for the propeller were about 200 per minute, and they should be so located as to be completely submerged when the ship was in ballast, and it was suggested that the handling of the motors should be so arranged that it could be done from the deck. On a consumption of ⅛ gallon per indicated horsepower hour, this ship would have a radius of action of about 1,000 miles, or 265 steaming hours. She would be able to navigate anywhere, and certainly such an equipped

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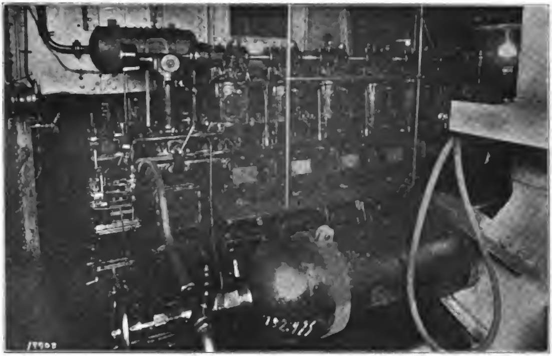
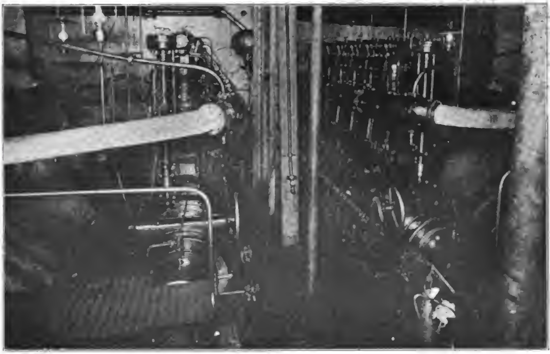
boat would have every advantage possible in getting charters, as she would have to pay less insurance, no towing bills, less local pilotage, canal, lighthouse or harbor dues.



SIDE VIEW OF ENGINE ON THE QUEVILLY.

We find in the Lloyds and the French Veritas only twenty-three auxiliary ships of 300 tons net register, and of vessels of



OIL MOTORS ON THE AUXILIARY SHIP QUEVILLY.

1,000 tons register there are only four. The following information should be looked at with attention, noting especially the *Herzogin Sophie, Charlotte* and *R. C. Rickmers,* the first-named being the training ship of the North German Lloyd. The *Rickmers* is a splendid vessel belonging to the well-known firm of Rickmers, Reismuhlen, Rhederei & Schiffau Akt. Gesellschaft, and was built in their Bremerhaven yard. As the owners' rice mills turn out something like 200,000 tons of rice a year, it was profitable, of course, to

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transport this product in their own vessels. The *Rickmers* made long voyages under steam and canvas, her average mean speed being equal to that of any cargo boat of similar size, and, being fitted with engines, she was able to handle herself in all weather to advantage, and her running expenses were small. One of her first voyages from New York to Saigon lasted eighty-five days, and another from Hamburg to San Pedro ninety-seven days, and, in spite of the fact that she encountered very unfavorable weather in rounding Cape Horn, she made most satisfactory time, as the following log will show:

10,357 miles under sail in 60d. 13h.	= 172	miles per day.
	= 7.18	knots per hour.
5,504 " " steam in 37d. 4h.	= 148.6	miles per day.
	= 6.20	knots per hour.

15,861 miles in 97 days 17 hours = 156.61 miles per day or 6.8 knots per hour. The calm zones of the equator she passed through under her own steam and rounded Cape Horn partly under canvas and partly under steam.

THE QUEVILLY IN DRY DOCK

During the season about sixty large "wind jammers" sailed from Europe to the Pacific ports, averaging 155 days for the passage, while the *Rickmers* gained 58 days over the sailing vessels. If we compare the voyage from Hamburg to San Pedro with the best trip made by the five-masted bark *Preusen*, the finest sailing ship under the German flag, from Cuxhaven to Valparaiso, some 5,000 miles shorter and which was covered in eighty-four days, it is fair to conclude that the *Rickmers'* passage, owing to her auxiliary engines, was most satisfactory, as she made an average of 141 miles per day, or 6 knots per hour, and carried 32,000 tons of cargo. It is somewhat surprising that the *Rickmers'* company, after obtaining such excellent results, did not build an improved ship, and that they did not must be accounted for by the extremely low freight rates during the last few years, and also to the extraordinary tonnage under way in English yards, and the general depression in trade. The triple expansion engines fitted to the *Rickmers* will not be duplicated, as the auxiliary motor evidently will answer the purpose far more economically. If we take into account the weight and space required for coal per mile or knot run, we can easily see that the net cost is greater than with liquid fuel, and a motor does not require from twelve to twenty-four hours to get up steam, and has many other advantages. This class of auxiliary boat will be a vast assistance between countries and their colonies for secondary lines of commerce, enabling them to have more frequent communication and at less cost. With the present prices quoted by shipbuilding yards, an auxiliary ship can be built cheaply; the motor can be installed economically, and these points must be alluring to enterprising ship owners. The firm of Messrs. Prentout-Leblond & E. Leroux of Rouen are to be complimented for their enterprise in equipping the *Quevilly* and the *France*, and these vessels will certainly be watched with the keenest interest by the shipping houses everywhere.

STERN OF MOTOR-EQUIPPED SHIP.

I may say that a company has been formed at Paris under the name of the "Société des Navires Mixtes," with a capital of 750,000 francs ($150,000) (£30,000) to develop this interesting type of auxiliary vessel.

The *Herzogin Sophie Charlotte* was built by the Rickmers Company in 1895. Her dimensions are as follows: Length, 276 feet 3 inches; breadth, 43 feet 2 inches; depth, 25 feet 5 inches. Her gross tonnage is 2,581, and net tonnage, 2,310. She carries water ballast to the amount of 1,150 tons, and is built of steel, with two decks.

The *R. C. Rickmers* was built by the Rickmers firm in 1906. Her dimensions are: Length, 410 feet 5 inches; breadth, 53 feet 6 inches; depth, 30 feet 4 inches. The gross tonnage is 5,548, and net tonnage, 4,696, and she carries water ballast of 2,700 tons. She is built of steel. Her engines (steam) are three-cylinder, 18⅞ by 30 11/16 by 47¼ inches, with a stroke of 31½ inches. This engine is to develop 1,000 horsepower and the bunker capacity is 630 tons.

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The *Taisu Maru* was built by the Kawasaki Dock Yards in 1904 and was the training ship for the Japanese Navy. Her length is, 274 feet 4 inches; breadth, 42 feet 9 inches; depth, 24 feet 1 inch. She is built of steel, with four decks, and fitted with two triple-expansion steam engines, 13 by 21 by 34 inches by 27 inches stroke. She has, of course, two propellers.

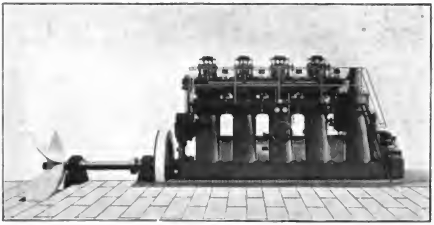
The *Quevilly:* This vessel was built by Leporte & Company in 1897. Her length is 308 feet 5 inches; breadth, 45 feet 8 inches; depth, 26 feet 8 inches. The gross tonnage is 3,271; net tonnage, 2,578. She is built of steel, with two decks and ten watertight compartments. Two motors are Diesel, of four cylinders each, and develop 300 horsepower each.

A 1,000 Horsepower Marine Oil Engine.

BY J. RENDELL WILSON.

There is far more activity on the Continent than is generally realized in connection with the construction of marine oil engines of the Diesel type for large ships, and already engines of 1,500 horsepower have passed the test bed stage. Prominent among the firms making strenuous efforts in this direction are Carel Frères, of Ghent; Schneider et Cie., of Paris, and the Maschinenfabrik Augsburg, Nurnburg, the latter company having, by the way, a three-cylinder engine of 6,000 horsepower nearly completed; while Fried Knapp is said to have a marine oil engine building of well over 2,000 horsepower per cylinder. In view of these facts the illustration and following brief description of a four-cylinder engine of 1,000 horsepower, recently built by Messrs. Schneider & Company, in conjunction with Carel's, for a French cargo vessel that will trade on the Seine, should be of great interest. The illustration is from the Belgian paper *Neptune*.

The engine stands about 12 feet high, and is of the two-stroke reversible type, starting and reversing, etc., being, of course, by compressed air. The compressor, of the three-stage variety, is situated at the forward end, in appearance greatly resembling a fifth cylinder, and is driven off the crankshaft. This cylinder is shown next the fly-wheel. As in the case of other Diesel type engines, ignition is entirely by compression; that is to say, the fuel is sprayed in by air at a pressure of nearly 1,000 pounds per square inch, causing instant combustion. As the piston on the down stroke uncovers the exhaust port in the usual manner, it also uncovers a separate inlet port, which admits air from a special compressor at about 6 pounds per square inch. This air is also controlled by a valve in the cylinder head, which opens at the end of each stroke, allowing the cylinder to be well cleansed of all residual exhaust gases. When the piston covers the exhaust port at the commencement of the up stroke, this valve is closed. Pure air is then admitted and compressed to about 600 pounds per square inch, and the fuel is injected by the greater pressure at the top of the stroke. The same cycle of operations, of course, is then repeated continuously. It is of interest to note that it has been found necessary to water-cool the compressors as well as the cylinders and exhaust arrangements. To each cylinder there is a separate fuel pump, which can be dismounted and cleaned without stopping the engine, only the cylinder affected being put out of action. By having a separate fuel arrangement to each cylinder the fuel supply can be regulated independently if necessary. At any time the horsepower being given by any cylinder can be ascertained by the indicator diagrams with which each cylinder is equipped. Regarding lubrication, the crank case is of the enclosed type, and so forms a reservoir for the oil. It is supplied to the bearings by force from a pump, and en route it is filtered. The filter is equipped with a by-pass system, in order that it can be opened up and cleaned while the engine is running. While on test the engine gave every satisfaction.



FOUR-CYLINDER, 1,000 HORSEPOWER OIL ENGINE.

S. S. Honolulan's Voyage Around the Horn.

Steaming 14,000 miles on her maiden passage without being compelled to stop for repairs or overhauling is the enviable record made by the new American-Hawaiian liner *Honolulan*, Captain T. P. Colcord, which recently arrived in Seattle direct from Baltimore. During the run of 54 days, the only stop made was at Punta Arenas, where the vessel dropped anchor for ten hours to cable and also to await a favorable tide to run through the Strait of Magellan. The *Honolulan* was built by the Maryland Steel Company, Sparrow Point, Md., and the vessel's deck engineer officers speak in the highest terms of the steamer's performance.

When leaving Baltimore, the *Honolulan* carried 14,000 barrels of fuel oil, more than sufficient to steam over the long route. She arived on Puget Sound with 2,000 barrels remaining, establishing a name for herself as an economical vessel. The steamer *Missourian*, of the same fleet, two years ago sailed from the Atlantic to Puget Sound with enough fuel oil to last her the long distance, but, aside from these two instances, there is no record of other vessels having done the same to Puget Sound. The fast steamers *Yale* and *Harvard*, which recently arrived on the Coast, from New York, burned

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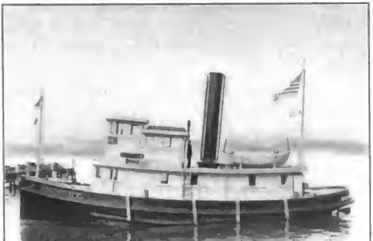
both oil and coal, but it was necessary for them to make frequent stops to replenish their bunkers.

During the *Honolulan's* passage, the only difficulty encountered was at infrequent intervals when water in the oil caused a little trouble. The engines were stopped but once, and that was at Punta Arenas. Had it not been necessary

STERN RUN OF ARGENTINE DESTROYER.

to cable, the *Honolulan* could have steamed the entire distance without stopping. The vessel's quadruple expansion engines, 25-inch, 36-inch, 52-inch and 76-inch by 54-inch, worked as if they had been in service for months. As a matter of fuel economy and for the purpose of not overworking the machinery, the *Honolulan* was run at reduced speed during the greater portion of her passage. Only two of the three boilers were used during this time and, with two boilers at 62 revolutions, she averaged 11 knots. Under three boilers at an average of 70 revolutions the steamer ran between 12.5 and 13 knots. Three boilers were in service while she steamed through the Strait of Magellan, where the maximum power was desired, and also north of the equator in the Pacific.

She is equipped with a wireless, 2-kilowatt, 60-cycle plant. On the Pacific the longest distance at which direct communication was maintained was with the shore station at Los Angeles, 1,400 miles away. On the Atlantic, considerable static disturbance was encountered, but none in the Pacific. Probably the most remarkable feats in wireless achieved was that done by the *Honolulan* when she was a long distance off the Mexican coast in longitude 110 West. The Ward liner *Merida*, when in the Gulf of Mexico, was picked up at a distance of about 1,000 miles. The *Merida* took the *Honolulan's* message, transferred it to Cape Hatteras station, and, in turn, it was relayed to New York; the *Honolulan* thus reporting herself to her owners when thousands of miles away. The



TUGBOAT SOUTHWARK, BUILT BY THE WATERS-COLVER COMPANY.

remarkable feature of this feat was that between the two steamers, on the Isthmus of Mexico, was a mountain 17,000 feet in height, which did not seem to interfere with the aerial waves.

Approaching Puget Sound, the *Honolulan* got splendid results with the submarine signal. She picked up the bell submarines on the Columbia River and Umatilla Reef lightships

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at a distance of from nine to fourteen miles. This system is now installed on all of the American-Hawaiian liners on the Pacific Coast, and it is found of great value in waters where foggy weather frequently prevails.

Argentine Destroyer Mendoza.

The Argentine destroyer *Mendoza* was launched a few weeks ago in a French shipyard in France. Considerable spec-

ANOTHER VIEW OF ARGENTINE DESTROYER.

ulation seems to have been awakened concerning the shape of the stern of this destroyer, and this feature is clearly shown by the two illustrations which we give.

The builders expect to obtain a speed of 34 knots, although the contract speed is but 32 knots.

The dimensions are as follows:

Length over all	289 feet 8 inches
Breadth	28 feet 3 inches
Draft, aft	17 feet 1 inches
Displacement on trial	950 tons

The boilers can be fired with either coal or liquid fuel. The air pressure in the boiler room is 5 inches water gage. The lines of the hull are most perfect and account in a large degree for the satisfactory speed. The armament consists of four 4-inch quick-firing guns and four 20.86-inch torpedo tubes.

Two Tugs for Philadelphia.

The two new tugs built for the Department of Wharves, Docks and Ferries of the City of Philadelphia have been delivered by the builder, the Waters-Colver Company, West New Brighton, Staten Island.

These tugs were built complete, including the engines and machinery. They were delivered to Philadelphia the opening day of the inside route between Philadelphia and New York. The *Kensington* is the larger of the two tugs, being 65 tons, built of wood, 81 feet long, 20 feet breadth and 9 feet depth. She is equipped with a compound fore and aft engine 12 x 26 18 inches, has one Scotch boiler 10 feet 6 inches by 10 feet. The *Southwark* is a 42-ton tug constructed of wood, 66 feet long, 16 feet breadth and 7 feet depth of hold. She is equipped with a single engine 14 x 14 inches, with one marine leg type boiler 5 feet 6 inches by 10 feet. On the day of the trial trip, the *Kensington* developed a speed of 13.9 miles per hour, much exceeding the contract requirement of 10.5 miles.

High-Speed Ferryboat Kennedy.

This high-speed vessel was built and engined by the Willemette Iron and Steel Works, Portland, Ore., and the exacting demands of her contract were most cleverly met by the works. She is a vessel 190 feet long, 28 feet beam and 12 feet depth of hold, designed for a daylight passenger boat, operating on a run 16 miles long, from Seattle to Bremerton. It was desired to have the maximum passenger accommodation on a limited displacement. The contract called for a speed of 20 miles per hour to be maintained for four consecutive hours. The vessel has a displacement of about 450 tons and has pas-

HIGH-SPEED FERRYBOAT KENNEDY.

High tensile steel is used in the hull, and she is galvanized up to and a little above the waterline. Four White-Foster boilers and two Rateau turbines, delivering 18,000 horsepower at 650 revolutions per minute, make up the motive power.

senger accommodation for 900 passengers. The nature of the service required of the *Kennedy* is such that the United States inspectors consider her in the class of a ferryboat and give her passenger license accordingly. In the calculations for

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powering the *Kennedy* it was estimated that 2,000 horsepower would be required to maintain 20 miles per hour with a safe margin.

The space available for boilers was about 13 feet by 30 feet, and the problem of installing satisfactory boilers in this space was a serious one, particularly as forced draft was not possible. The Ballin watertube boiler seemed to fit the space conditions. It was decided to install two of these boilers of 4,000 square feet of heating surface each.

The engines for the *Kennedy* were designed for 2,000 indicated horsepower, the cylinders being as follows: High-pressure, 18; intermediate-pressure, 27; low-pressure, two, 34; stroke, 24 inches; working pressure, 250 pounds.

On official trial trip, the *Kennedy* developed 2,300 horsepower at 205 revolutions per minute.

Electrically Controlled Railway Drydock.

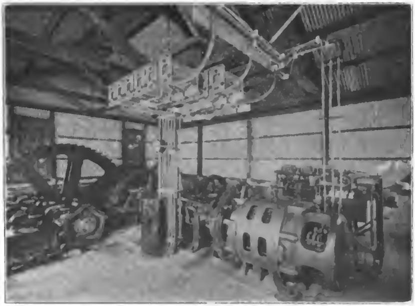
The Kensington Shipyard Company of Philadelphia, which is the repair department of the Wm. Cramp & Sons & Engine Building Company, has just added to its equipment a new Crandall railway drydock.

The project of getting an additional drydock at the Kensington yard involved the question of which type would be most suitable for the class of work to be done, and for the limited space available for its installation. After considering the three prevailing types of drydocks, the railway drydock was decided upon, since it could be installed within the limited space in such a way that vessels, while being docked, would be inside of the adjacent piers, and also without encroaching too far upon yard room.

The new drydock is 270 feet long, on keel-blocks; 290 feet long over the floor; 58 feet wide in the clear, and has a capacity of 2,500 tons displacement. The cradle travels on four tracks on the flat rail and roller method. The foundation is of piling, driven to bed rock, or to a hard-pan overlying the rock. The dock is constructed mainly of yellow pine timber, braced and trussed in a very substantial manner. The cradle is equipped with a full set of patent releasing bilge blocks. The lifting of the dock is accomplished by four heavy chains of the Crandall special type, equipped with a patent compensating device, which assures equal strains on all the chains. The chains are arranged on the endless system, working over sprocket wheels, driven by a powerful geared hoist. The power is furnished by a 225 horsepower electric motor, using

THE KENSINGTON RAILWAY DRYDOCK.

2,200 volts, capable of hauling largest loads in twenty-five minutes. With one exception, this is, so far as we can learn, the largest electrically driven railway drydock in existence—that one exception being a 4,000-ton similar drydock at Piraeus, Greece, designed by the same firm, and having a 300 horsepower motor. The official test of the new drydock was made when the steamship *Antares*, 279 feet long, was hauled up in twenty-one minutes. The entire work was designed and built by H. I. Crandall & Son Company, East Boston, Mass. The chains were made by Messrs. Bradlee & Company, of Philadelphia, and the electric equipment by the Westinghouse Electric and Manufacturing Company.



ELECTRIC POWER PLANT OF KENSINGTON RAILWAY DRYDOCK

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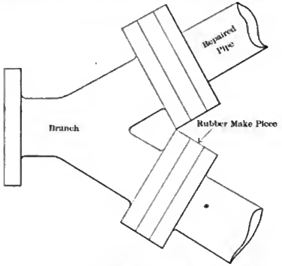
PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Broken Sanitary Suction Pipe.

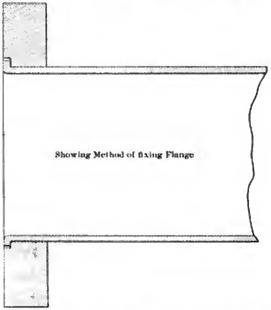
On the ship I was on we had direct acting sanitary, as well as bilge, pumps, worked off the arm of the air pump levers. The pumps, two on each side, kept the sanitary tank, wash deck, and fire connection pipes full at sea, whilst we had an independent duplex pump for the work in port. Each pump was supplied with the regular pet cocks to admit a little



THE SUCTION VALVE

air, as is usual with all pumps, but as plunger pumps worked off the air pump levers are naturally dependent upon the speed of the engine for their number of strokes per minute, an unequal supply of water is the result. Especially so is this the case when the engines are racing at all. The pet cocks set for normal speed, therefore, may hardly be enough for such times and a slight "knock" is occasioned.

Three days out from New York one trip we ran into very heavy weather in the Atlantic, and the engines were racing just as much as two Aspinal governors would allow them, when the propeller was bared. There was a little knock in the pot pump, but as the plunger was making uneven strokes, due to the racing, and then drawing up, of the engines, the engineer at first took little notice of it, but a few minutes afterwards a louder knock and a rapidly filling port bilge made the same man investigate a little more fully. The donkey pump was started on the bilge, as the water was gaining on the direct acting bilge pumps rapidly, and it was then found that water was pouring out of the suction pipes for the sanitary pump. The suction valve on the ship's side was shut, stopping the rush of water, and it was found that the two pipes, one leading to each pump and joined to a branch at the ship's side valve, had broken off close to the flanges. In each case the flange of the broken pipe was left bolted on to the pump chamber. It was surmised that the pet cocks had become choked and caused the damage; anyway, there was heavy vibration in the suction pipes, tending to draw them apart. Ours was a passenger ship, and the independent sanitary pump was inadequate to keep the sanitary tank full at sea, maintaining a proper salt water supply throughout the ship, so the repair had to be accomplished at once. When completed, it remained as it was for two months, and until we arrived at the home port and had two new pipes fitted, the rubber makepiece we put in, as explained below, taking up what vibration there was. The pipes were 4-inch copper pipes with ⅞-inch flanges. The edge of the



broken pipes was filed straight, and the two flanges were filed out in the hole large enough to allow the pipe to go through. The pipes were then fitted in the flanges, and beaded over, the flanges being beveled on the face side in the hole, and recessed the thickness of the pipe, as in the sketch, to allow for this. The pipes were too thin to think of cutting a thread on them, so we resorted to the preceding method of fixing the flange, which we squared up in the process of riveting and beading over. The pipes had broken off at the flange, and allowing for filing-up straight, and about ⅛ for beading over, the distance to make up when connecting was about 1¾ inches. The distance piece was made of rubber, and this we accomplished by utilizing two of the spare rubber valves, used for the large independent donkey bilge-pump, cut to size and punched for bolts. The valves were just over 1 inch in thickness, so we had to use a piece of ¼-inch rubber jointing also, and when bolted up we put another stay on each pipe. As the pipes were for different pumps, two engineers were able to work on each, allowing the job to be done much quicker than otherwise. It made a good solid job when completed, and, considering all things, did not take long to fix up. H. W. H. K.

Welding and Calking at Sea.

A good many engineers at sea are sometimes at a loss to distinguish between iron and steel when they see it, and are therfore not sure whether it is possible to weld a broken article with the means at their disposal. It is therefore just as well in passing to mention for the guidance of young

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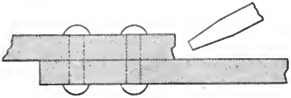
engineers that cast iron is simply iron ore smelted and contains a very large amount of carbon; it cannot, therefore, be welded. It is possible, however, to burn two pieces together, but this cannot be done on an ordinary tramp steamer. Wrought iron is cast iron which has been puddled; by means of this process the bulk of the carbon in the cast iron is extracted, rendering the wrought iron capable of being forged or welded. Steel is pure iron with the addition of a smaller amount of carbon than is present in either of the two classes mentioned and it can be cast, forged or welded with facility. Cast iron is distinguished by its brittle fracture and



CALKING A SEAM.

gray color; wrought iron, by its fibrous fracture, and steel, by its close grain. It is also lighter in color than cast iron.

Welding is very seldom done in the engine-room at sea, and it usually turns out to be a failure, owing to some detail having been neglected. It is not, of course, to be expected that a heavy job such as a connecting rod or similar part can be welded at sea, but if care is taken it is quite possible to weld small parts of wrought iron or steel, such as firing tools used in the stoke hold. If this is done, considerable trouble may be avoided by repairing the rake and slices instead of using the spare ones and waiting until the ship arrives at home in order to send repairs ashore.

In order to weld or join together two pieces of iron or steel on board a vessel, they are heated to white heat, and sand is used as a flux before they are hammered together. For example, in order to weld, say, a rake shaft, the two ends which have to be joined together are heated (Fig. 1),

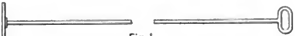


Fig. 1

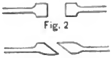


Fig. 2

Fig. 3

WELDING FIRE ROOM TOOLS.

and then they must be jumped up or thickened in diameter as shown in Fig. 2 in order to make sure of getting the rod down to its original size again after welding. The ends must then be scarfed, as shown in Fig. 3, and then heated to white heat; any scale that may be on the heat should then be knocked off, and sand should be sprinkled over the surface. As quickly as possible the two scarves must be hammered together and everything must be done very quickly, otherwise a bad weld will be formed. This is worse than useless, as after using the rake for a little while it will give way again and half of it will be left in the fire.

Attention may be drawn to another point: many engineers at sea have a very poor idea of calking the seams of a boiler, or what tools may be required. By calking is meant the closing up of the seam, either by riveting or upon the appearance of a leak. Such a leak is probably caused by excessive expansion, owing to the fact the water was not properly circulated in the boiler when steam was being raised. In the calking the edges of the plate are first chipped or planed in order to present a good, clean working surface, and then the calking tool is used. The ordinary tool aboard ship is just a blunt chisel about ¼-inch thick at the mouth and it is used to burr up the inner edge of the plate. A good engineer will, however, make for himself tools of different sizes and shapes in order to suit all kinds of work, such as calking round awkward corners and bends. If he attempts to use the ordinary tool for all classes of calking he is only damaging the plates to no purpose.

Stockholm. A Weld Calker.

Setting Propeller Blades on the Great Lakes.

On the freighters of the Great Lakes it is a common occurrence to break a propeller blade, and it is very handy to have a simple means to set the new blade to the required pitch. The simplest and handiest method I have used is a pitch board and straight edge. A common-sized wheel on the largest boats is 14 feet 6 inches diameter with 14 feet pitch. About 6 inches from the end of the blade is probably the best place to measure. One-twelfth of the circle makes a handy length pitch board. The base length of the pitch board should equal the chord of one-twelfth the circumference. To get it I use this method:

In the figure R = radius and r = chord.

Then c =

$$\sqrt{\frac{R^2}{2} + \left(R - \sqrt{R^2 - \frac{R^2}{2}}\right)^2} : \text{if} = 81'',\ c = 41.9''.$$

Then our pitch board would be proportioned like Fig. 2. $c\ c$ are clamped to hold the pitch board to the blade, and B

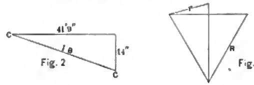


Fig. 2 Fig. 1

TOOLS FOR SETTING PROPELLER BLADES.

is an angle bracket to keep it square with the blade. The straight edge should be made like the sketch, of ⅝-inch by 3-inch white pine, Fig. 3; f is a ¼-inch rod put through a hole drilled edgeways through the straight edge; c is a center, to fit the center in the end of the shaft; B is a bracket, to assist in holding the straight edge against the hub. Put the pitch board on the blade, and set the ends at 6 feet 9 inches radius with the straight edge, using the center in the shaft and the feeler rod. Then reverse the straight edge and hold the opposite edge against the hub, so that the feeler is at the edge of the pitch board. If the feeler touches the edge of the pitch board at each end the same, then the blade is correctly set. If not, move the blade around on the hub.

This method of using the straight edge seems to give better results than by sighting over the edge of a board to the straight edge laid across the hub. E. S. S.

Cleveland.

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RECENT LEGAL DECISIONS

Injury from Slipping on Newly Painted Steel Deck of Vessel.

A laborer in the employment of an engineering company, while engaged in carrying two iron grate bars from a dock to the deck of a steel freighter, sustained injuries for which he sued his employers. The grate bars were carried to the deck for convenience of loading upon another vessel alongside. Two ladders were provided by the company, which were placed against the hull of the boat and about 25 feet apart, which the plaintiff was required to use. The top deck of the boat was constructed of steel plates, which had been painted prior to the day of the accident. The plaintiff had made about sixteen trips up the first ladder with iron grate bars, two at a time. The bars were 5 feet in length and weighed about 60 pounds apiece. He was then induced by the foreman to carry the grate bars up the second ladder. On reaching the top of that ladder it was necessary for him to step over a railing from 9 to 12 inches high. He was the first man to go on the second ladder, and as he stepped over the railing his foot slipped on the paint, and he was thrown to the deck, the two iron grate bars crushing his hand. He testified that the cause of his foot slipping on the deck was the fact of the paint not being set or dried, of which he was unaware and had not been warned.

The circuit judge directed a verdict for the defendant, but this was reversed on appeal. It was held that it was a fair question for the jury whether the deck was slippery because of the fresh paint, and thereby rendered unsafe and dangerous. The plaintiff was entitled to a safe place to work. If the place had been rendered unsafe by reason of its having been recently painted, and if the deck was covered with fresh paint so as to make it likely that plaintiff would fall or slip with his load, it was the duty of the defendant to warn him of the danger, especially where the appearances were deceiving.

Orso v. Great Lakes Engineering Company, Michigan Supreme Court.

Compensation for Designing and Superintending Construction of Yacht—Erroneous Admission of Evidence.

An action alleged as one cause of action that the plaintiff was employed to design and superintend the construction of a steel steam yacht for defendant (except the interior joiner work and fittings), for which he was to be paid 5 percent of the cost of the vessel. Defendant admitted the employment, and the jury fixed the cost at $87,685. Plaintiff contended that he was entitled to 5 percent on the cost of the small boats, forming part of the yacht's outfit, irrespective of whether or not he actually superintended the purchase of these. Upon conflicting evidence, the jury found in his favor, and that the cost was $5,900.

For a second cause of action plaintiff alleged that the firm employed in connection with the construction of the interior joiner work and owner's quarters, owing to their inexperience in naval architecture, encountered so many difficulties that they were forced to call upon him for assistance, and that defendant, the owner of the yacht, employed him to assist them, and that he did so. On conflicting evidence the jury also found in plaintiff's favor as to this employment, allowing him 3 percent on the cost of the work, which they found to be $27,970.99.

In reversing the judgment for a new trial the court said that it would have affirmed the judgment had it not been that a letter from defendant to plaintiff was received in evidence which related to the deckhouse, and not in any way to the second cause of action; and the judge of the trial court by error in his instructions to the jury referred to this letter as relating to this disputed matter.

Wells v. Baker, New York Appellate Division.

Performance of Contract of Sale of Anchors.

In an action for the price of twenty-five kedge anchors, amounting to $54. The delivery of the goods was admitted, the defense being that the sale was not a completed transaction, but simply part of a contract under which the plaintiff undertook to deliver five lots of varying sizes, but had only delivered one lot. The defendant claimed that the contract was entire and indivisible. The plaintiff proved that he had delivered all the goods contracted for, although he sued only for a part. It appeared that some of the anchors were returned to him by the defendant on the claim that its customer, the United States Naval Department, would not accept them. There was no proof, however, that the articles so returned were not in accordance with the specifications, nor was there any proof that there was any agreement that the articles were to be delivered subject to the approval of the Naval Department. Whether the contract was entire or divisible, there was proof of its apparent performance by the plaintiff. It was, therefore, held to be an error to dismiss the plaintiff's complaint.

Friedman v. Marine Manufacturing and Supply Company, New York Appellate Division.

Steamship Held Liable for Injuries to Contractors' Workmen.

A tank steamer contracted for repairs to be made on certain of its tanks. Before the work was begun it attempted to clean the tanks with live steam. After this was done, the contractors' servants appeared and were informed that the pump in one of the tanks was ready to be disconnected. While they were engaged in this work, with the aid of an open light, oil ran out from some portions of the pump, resulting in an explosion of gas, by which one of the workmen was injured. He libeled the ship for damages and obtained a verdict.

It was held that, the ship having undertaken preparation for the work, the contractors were only responsible for the method of doing it in the light furnished to them, and that the ship was negligent in permitting the contractor's servants to perform the work with open lights without warning.

The J. M. Guffey, District Court, E. D., New York.

Marine Engineer's Right to Have Fireman.

After part performance of an engineer's contract to operate a yacht, the engineer refused to continue unless he was furnished a fireman. This the owners refused to do. At this time there was no meeting of minds with reference to a rescission of the engineer's contract for the season. The owner procured a new engineer. The engineer left the boat without expressing any desire to continue the contract, merely intimating that he would stand on his rights. It was held, in a libel by him for wages, that, the original contract not having included the services of a fireman, unless subsequently agreed to, he was only entitled to recover for services up to the time of his quitting work.

The Imogene, District Court, E. D., New York.

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The great spur which urges man on to wonderful engineering achievements is the time element. We look upon the face of the earth as given us by Nature, and find barriers which, while small compared to the rest of the world's surface, effectually stop economical traffic between localities. To illustrate, the Isthmuses of Suez and Panama are typical. Through one of these strips of land a waterway has been cut, and the second is progressing rapidly. In looking over the past there seems to be little new under the sun; yet records are not found of the ancients undertaking much submarine work,nor do we find records of dredging to any extent. It does not seem hard to find the reason for this, as, with shallow draft and small vessels, deep channels were not required, and the Mediterranean Sea was practically the great navigable water of the known world.

In this month's issue we give accounts of dredges of modern construction and design, which we feel will interest our readers. In considering the condition of dredges and dredge work, we find that in Europe almost invariably dredges belong to and are operated by governments, in order to deepen harbors, keep them clean or open canals; while in the United States private enterprise owns most of the dredges, save in the Canal zone, and these two conditions have a very marked effect on design. In the governmental ownership the question is to get the very best possible article, as it is not to be used for making money directly, but indirectly, by giving the citizens of the country better means of communication with each other and their neighbors, thus inducing business. The result of this is that foreign dredges are of the highest efficiency and lasting qualities, and their first cost is not so closely considered as in the United States, where, on the other hand, the dredges, being private property, every consideration must be given to first cost, so that a fair monied return on the investment can be hoped for. Looking over the illustrations of dredges given in this issue, the solidity of the European makes becomes apparent, and yet we find that what might be termed the lighter-looking dredges of America are doing most satisfactory work. The part played by dredges in modern civilization is not appreciated by most of us. Just now the Panama Canal holds central place in dredge work; but the Cape Cod Canal and others, especially the New York Barge Canal, are by no means small undertakings, and they are only made possible by the modern dredge. Again, a considerable amount of the gold which is taken from the earth is obtained through the means of dredges. As the first cost of a dredge is large, it is of the utmost importance that the various parts be made substantial and lasting, for when a dredge shuts down it is like any other machine—a money consumer instead of a money maker. Recent advance in the manufacture of steel has enabled dredge work to be carried on with less interruption than a few years ago. If we can offer a criticism in dredge design, it is that the tendency to simply increase the cross-section or weight of a part that is broken or has given out could be advantageously changed by the study of a better form to resist strains and shocks rather than merely the brute-force ways of adding material.

We remarked on the internal-combustion engine in our April issue. Since then we have information that a battleship is being equipped with a prime mover of this type. The remarkable strides made in the use of this prime mover in marine work are quite enough to make us pause and ponder. If a thousand horsepower is to be developed in one single cylinder—and we are credibly informed that this is so—then 1,500 horsepower will soon be a fact. Without data, it is somewhat of a guess as to what diameter of cylinder these engines would have; but probably it would be in the neighborhood of 70 inches, and certainly it is a bold engineering undertaking to produce this. We feel that one thing in connection with internal-combustion engines as fitted to vessels should be borne in mind, and that is, their great economic value would seem to lie in their being able to propel a ship at a set speed from port to port, and not in their maneuvering powers.

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Novel Salvage Operations.

For the first time in the history of salvage operations on the Pacific Coast, a floating, pontoon drydock, of handy size, has been successfully utilized to raise from an extreme depth a passenger and freight steamer. The method of using scows to raise a submerged object, taking advantage of the tides to raise the wreck, is no novelty, but in the present instance the practicability of a drydock operating independently of the tides has been thoroughly demonstrated. As the result of the success of this experiment, the steamer *Kitsap*, 195 gross tons, which sank in 240 feet of water in Seattle Harbor, following a collision, was raised.

Valued at $45,000 (£9,000), the *Kitsap* was insured for 80 percent of her value and after the accident was considered a total loss, owing to the great depth of water. However, the officers of the Elliott Bay Dry Dock Company, Seattle, believed that their dock could bring the *Kitsap* up, and when they offered to make the attempt the insurance companies were willing. The salvors were to be paid 60 percent of the vessel's appraised value after she was safely hauled out in drydock.

Two tugs were chartered to attend the dock, which was towed from its site to the scene of the wreck, where the dock was made fast with two anchors at one end, allowing it to swing with the tide. A one-inch steel cable was buoyed at one end and the other was swept under the wreck by the tug. This was no easy task, and it was not until the third day that the line caught. It held fast under the bow and the dock gave a lift, raising the wreck by the stem. Then a second cable of the same size was swept under the keel until it held fast some distance from the stern. A lift was taken by the dock with both cables, and the tugs towed dock and wreck inshore for about 150 feet. When the submerged hull fetched up against the sloping bank, one of the cables parted. In its place a 1⅜-inch steel cable was swept under the wreck and made fast. On the next lift, the second cable carried away and it was replaced by a second 1⅜-inch steel line. No further breaks occurred with the heavier cables, each of which was about 1,600 feet in length.

With the wreck held securely by the two strong cables, the dock was successively filled and pumped out. Each lift brought the wreck up about 19 feet, and while thus suspended from the dock, both dock and hull were towed into shoaler water, until the wreck brought up against the sloping bottom. When the weather was favorable, operations were continued night and day, from 6 to 12 men being employed. The longest tow accomplished at one time was 300 yards, and the entire distance the wreck was moved until it lay in 60 feet of water, where a diver could examine it, was 600 yards. Under favorable conditions, it was possible to make five lifts in 12 hours.

When in 60 feet of water, the wreck was first examined by a diver, who found the vessel lying on her bilge with a list to port. One cable was fast 30 feet from the bow, and the other 15 feet forward of the stern post. While the diver was making fast two other cables, the wreck was brought up to within 28 feet of the surface. Over the ends of each cable was slipped a heavy iron ring which dropped to the wreck and held it fast. When the four cables were fast and everything secured, the hull suspended from the dock was successfully towed across the bay, a distance of three miles, to be beached for temporary repairs.

With each lift the cables, which were brought up over the wings and made fast on top of the dock, were drawn taut, the necessary tackle being on the dock. The bottom of the bay is covered with three or four feet of mud and at a depth of 40 fathoms, with a square inch pressure of at least 90 pounds, it required immense power to move the steamer, especially from her original position. However, the dock showed no indication of strain and was not leaking after performing this notable salvage feat. The *Kitsap* is a single-screw, wooden vessel, built at Portland, Ore., with the following dimensions: Length, 127.5 feet; beam, 22 feet; depth, 7.5 feet; gross tonnage, 195, net, 123. The dock is 140 feet in length, with a beam of 34 feet 6 inches, a capacity of 600 tons and a lift of 19 feet. The pumps are operated by two 16-horsepower Union gasoline engines. R. C. H.

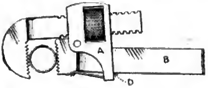
Seattle.

Laws Concerning Wireless Telegraphy.

After July 1, 1911, all ships leaving American ports must be supplied with wireless telegraphy, provided they carry 50 passengers or more, unless the voyage is under two hundred miles. The requirements are that the apparatus will have to have a radius of at least one hundred miles, and the operator be able to send and receive at least twenty words per minute, five letters being counted as a word; and he must be conversant with the international regulations applying to wireless traffic and be able to write legibly. He must hold a certificate issued by the United States Government, certifying to his ability to adjust wireless apparatus, and be "skilled" in its use in the true meaning of the word. At the present time, the awkward condition exists that, while the Act of Congress appropriated money to carry out the examinations of operators, it is not available until the first of July. This will probably result in vessels not being able to comply exactly with the law, as it would be hardly possible to obtain certificates under the circumstances by that date, but, at least, all the apparatus can be installed.

How to Use a Pipe Wrench.

Every engineer knows that a pipe can be easily jammed by a pipe wrench, but if my instructions are carried out, one can be used on even thin pipes without jamming them, says a correspondent in *Power*.



Place the wrench on the pipe and get it to bite; then slack off on the nut until the frame *A* comes in contact with the handle *B*, at *D* (see illustration), thus preventing the jaws from closing; the wrench then has power to turn, but not to jam the pipe.

In Determining Owner's Liability for Injuries Chief Engineer of Yacht Held Fellow Servant of Oiler.

An oiler on a steam yacht was injured by slipping on an alleged defectively guarded platform. He admitted, in an action by him against the owner for damages, that he voluntarily continued to work on the platform after he became aware that it was dangerous. He stated, however, that the chief engineer had promised to fix it. It was held that the chief engineer on a vessel, like all the rest in the service of the owner, except perhaps the master, was a fellow servant of the oiler, in the absence of direct authority to represent the owner, and that therefore the oiler could not recover.

Hollis v. Widener, Pennsylvania Supreme Court.

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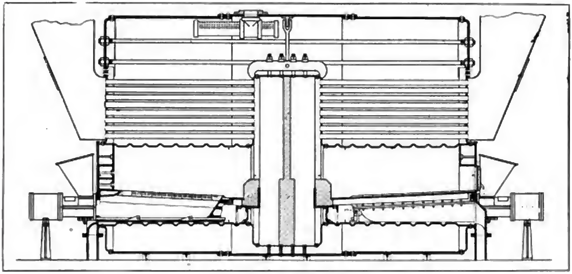
The Nicholson File Company, Providence, R. I., has just issued a catalogue regarding its product which deserves the most favorable commendation. We believe it to be the finest catalogue, not only in design and layout, but in printing, that we have ever seen. The many files and other product of this company are illustrated in the most perfect manner, making it, we believe, a most valuable work of reference on the subject of files, rasps, etc. The Nicholson File Company is to be congratulated upon its business foresight in issuing such a splendid catalogue.

Mr. Axel Holm, who has been connected with American shipyards for some years, has accepted an offer to become assistant naval architect at the Copenhagen-Denmark Floating Dock & Shipyard.


DREDGE BOILERS EQUIPPED WITH JONES STOKERS.

The Jones Stoker as Applied to Dredges.

When the city of Chicago decided to increase the area of Lincoln Park by dredging and filling, the question of a proper dredge was a very serious one, and, after the dredge was installed and working, the smoke from it became embarrassing and the commission suffered from all the ills of excessive smoke, which was complained of loudly until the Jones Stoker was installed. We give a line drawing of this


PLAN OF STOKER EQUIPPED BOILERS.

Naval Constructor William J. Baxter, who has been transferred from the New York to the Boston navy yard, will leave a host of friends who will miss him greatly.

stoker as fitted to the boilers in the dredge; also a half-tone showing the fire room. The Jones stoker is made by the Under-feed Stoker Company of America, Marquette Building, Chicago. Besides getting rid of the smoke, which was such an important matter, the economy in the use of the stoker was a surprise, and satisfactory to the commissioners. Before it was installed, coal was being paid for at the rate of $3.75 a ton (15s.), and after the stoker was fitted, coal at $2.35 (8s. 5d.) was found to be equally good for steaming. The repairs for an entire season on this stoker were reported by the commission as considerably less than $5 (£1). This certainly may be considered excellent, and the small amount for up-keep is the best evidence of the construction, lasting qualities and practical working of this stoker.

Improved Kerosene Torch.

Oil as fuel for many purposes gains daily, and of all oil products kerosene is probably the most widely known and distributed. Taking advantage of this, as well as other points, the Hauck Manufacturing Company, 140 Livingston street, Brooklyn, N. Y., has placed on the market a kerosene torch.

NEW HAUCK KEROSENE TORCH.

Certainly the use of kerosene appeals to many on account of no insurance restrictions, its safety and ease with which it can be obtained, cheapness and safety. The uses to which this torch can be applied are almost endless, in general shop work. The torch is so constructed as to keep the tank cool, and only small pressure is required to operate it.

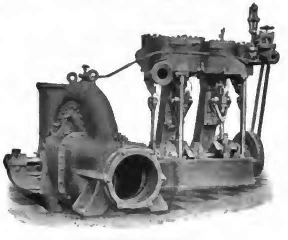
Stub Yoke and Rod Ends.

The Billings & Spencer Company, Hartford, Conn., is putting on the market the new design in yoke and rod ends here shown. It is expected that this new pattern will prove popular with the motor boat builders. This design permits of the greatest possible radius of action, maximum strength and minimum weight. The short stub end is rounded to facilitate electric welding. All are furnished either in blank, milled or assembled, and in various sizes, as listed in the pocket-size booklet issued by this company.

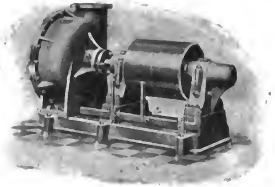
BILLINGS & SPENCER YOKE AND ROD ENDS.

Allen Centrifugal Pumps.

To those who go down to the sea in ships, the great prerequisite for all appliances is reliability. Sailor men are accused of being slow in taking up new things, but it is not fair that this should be so. A false move, a poor selection, may mean the death of many, and great loss of money. It is this feeling of reliability which makes the appliances of W. H. Allen, Son & Co., Ltd., Bedford, so popular. In this mechanical production, the design gives the idea of solidity and lasting qualities. Their Conqueror centrifugal sand pumps, which we illustrate, are used for handling crushed quartz, etc., where such products are mixed with water. Such work is, of course, very destructive and wearing. It is only by the use of special materials, care in design, that lasting qualities of such pumps as these can be accomplished. Owing to the difficulty of working manganese steel, Messrs. Allen use instead a high grade of cast iron, which has all the necessary value of homogeneity. The section system of liners reduces the cost of up-keep on these pumps. What is best in material and design takes time to determine, and by a number of experiments and proper records the above company has carefully



ALLEN ENGINE AND PUMP.



ALLEN CENTRIFUGAL PUMP.

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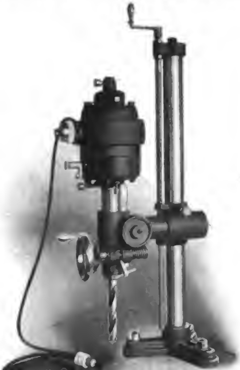
worked out the difficult problems which are presented in the case of sand pumps. Their engines are sold singly or



LAMB ELECTRICALLY DRIVEN DRILL.

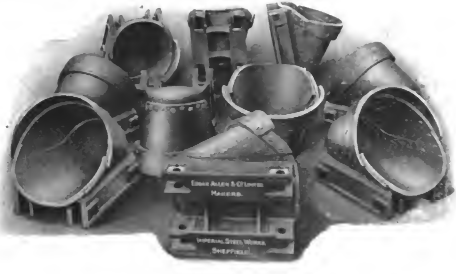
coupled with their pumps for the above uses or for ship use. They make these pumps from 4-inch suction up to 18-inch suction, and they can be adapted for belt drive or electric drive as the necessities of the case demand.

Lamb Portable Electrically Driven Radial Drill.

The Lamb Electric Company, of 20 Huron street, Grand Rapids, Mich., has perfected a convenient electric-driven radial drill, which we illustrate. The application of electric drive in this drill simplifies the construction, so that while there is ample power to drive a 1-inch drill and feed it to its work properly the weight is only 125 pounds to 150 pounds, depending on the current available. The feed is through a worm and wheel, pinion and rack, and a quick return is provided when wanted; the thrust is received on ball bearings, the column is made of steel tubing, and is 2½ inches diameter. As usually made the following is the range of work: Twenty-eight inches from spindle to base, 8¼ inches from center of spindle to column, travel of spindle is 5 inches, and the hole in same is No. 3 Morse taper. The extreme height of the drill is 40 inches. One convenient feature of this drill is that it can be fitted for two speeds, and to make the change only a button has to be pushed. The radial feature makes it most convenient. The range, as above given, can be altered to meet requirements.

Steel in Dredger Work.

Dredger makers and dredger users have cause to thank the steel maker for the increased efficiency of modern dredgers. It is a matter of no small difficulty to find the most suitable steels for all the various parts of a complete machine. For instance, take the use of manganese steel. This ateel is exceptionally tough and resists abrasion to a high degree. Although so hard that it cannot be machined, it is, at the same time, so tough that it can be bent double while cold without showing signs of fracture. It has been found invaluable for dredger work, for pins and bushes, links, tumblers and bucket lips. We reproduce an illustration of some buckets made by Edgar Allen & Company, Ltd., of Sheffield, which shows very clearly the method of attaching these lips—the steel for the lips being their Imperial manganese steel. Dredger parts made of manganese steel wear longer than when made of the best quality of ordinary hard steel, thus reducing the up-keep cost enormously.



EDGAR ALLEN STEEL DREDGE FITTINGS.

The Reno Freight Carrier.

We illustrate the Reno freight carrier, a device which can be fitted in warehouses, on steamship piers and at railroad terminals, for the rapid handling of freight. It is manufactured by the Reno Inclined Elevator Company, of 555 West Thirty-third street, New York, U. S. A. The machine consists of an endless chain of special construction provided with pivoted

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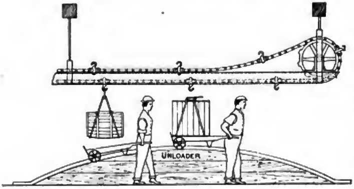
hooks, which are carried by small iron wheels, which roll upon the flanges of a pair of channel beams bolted together and spaced about 1 inch apart, thus forming a strong truss frame or carrying track capable of spans of considerable length. At each end the chain passes over a sprocket wheel, and these wheels can be driven by motors in either direction. The



RENO FREIGHT CARRIER.

method of loading is illustrated very clearly. Probably no machine on the market will perform more operations than this one.

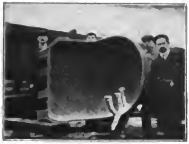
Howden Draft for Dredges.

While the question of turbines or cylinder engines is being considered with a view to economy, we are constantly seeing more and more efforts directed towards heating the feed-water of boilers or the steam itself by superheating, and we strive to perfect our boilers in every possible direction by more perfect design and superior material, yet, when we come right down to what is the initial point, it is the consumption of fuel. A good boiler can show very poor results if the coal is not properly consumed, and in order to do this we must have air, and this must not cost us so much that we waste a "pound to save a penny." To handle air is a study and not one which can be taken up in a few hours and thoroughly understood. Experience is an expensive teacher, but it is, as a rule, thorough. We go to a doctor when ill because he has made a study of our bodies, but in business we are not apt to be so wise, especially in engineering. To know how to use air under our boilers we should go to those who have made a study of it, and Messrs. James Howden & Company, Ltd., of Glasgow, probably have had a more extended experience in this line than any other firm in the world. The constantly increasing demand for their product is good evidence that what they undertake is well done. Many of the dredges referred to in this issue are fitted with the system of the above company.

Repairing of Dredger Buckets with "Thermit."

The "Thermit" welding process is of value in dredge work. A welding outfit consists of a supply of welding compound, a suitable sized crucible, a mould built around the part to be welded, and suitable arrangements for drying the mould and preheating the job. The "Thermit" process consists in fusing the broken parts by means of extremely hot molten mild steel, produced in the crucible from the welding compound. The compound is ignited by means of a special ignition powder which produces the necessary temperature to start the combustion of the compound, and in about 30 to 45 seconds the reaction is complete, with the result that half of the weight of the compound is produced in the form of highly superheated liquid mild steel, the remainder being slag.

A brief description of a repair to a large dredger bucket will be interesting. The fracture—which extended for about 18 inches—was opened an inch, so as to allow the molten metal to more easily fuse the parts, and to form a connection between the metal band on each side. All scale, rust, etc., was removed; a wax pattern was formed each side of the fracture and coated with plumbago, the bucket was placed in a bed of moulding sand, and the facing sand rammed hard against the wax pattern. The holes for preheating and for the runner and risers were made off wooden patterns. A preheating torch was applied to the heating hole, and this melted out the wax, thus leaving a space for the liquid metals to flow into. The preheating was continued until the parts were red-hot. In the meantime the crucible was rigged up over the runner, charged with the welding compound. On removing the preheating torch the hole was securely filled with a dry sand plug, the compound ignited, and in about 45 seconds the crucible was tapped, allowing the molten metal to flow into the mould. After cooling, the mould was removed, and the runner and risers cut off. The repair proved very satisfactory, and after twelve months' service the bucket, upon inspection, was found to be in exceedingly good condition. It is asserted that when repairs are made by the "Thermit" process the welded part is stronger than before the breakage occurred. The process is equally suitable for repairs to stern frames, rudder posts, etc. Broken iron castings can be welded when due allowance can be made for contraction stresses. The



A THERMIT REPAIR JOB.

"Thermit" metal combines equally well with either cast, wrought iron or steel. It is manufactured by Thermit, Ltd., London, E. C., and Goldschmidt Thermit Co., 90 West street, New York.

Mr. Louis L. Bernier, the well-known marine engineer, has been engaged by the Sanitary Water Still Company of Jamaica, L. I., and Washington, D. C., to take full charge of its marine department for the sale of evaporating plants and feed water heaters.

TECHNICAL PUBLICATIONS.

Ship Turbines. Dr. Bauer and O. Lasche. Size, 8 by 5 inches. Pages, 200. Illustrations, 104. Munich: R. Oldenbourg. Price, 8 marks in Munich.

No work on the subject of turbines which we can recall goes more minutely into this very interesting subject, and gives clearer information. It might be said that with this work at hand the engineer could feel he was equipped to undertake turbine work in any of its details. The illustrations are so many that they almost explain the test to those who do not read German. The authors are to be congratulated.

Die Schiffsschraube und ihre Wirkung auf das Wasser. Oswald Flamm. Size, 11 by 7½ inches. Pages, 23. Illustrations, 116. Munich: R. Oldenbourg. Price, 10 marks in Munich.

This work by Dr. Flamm is very remarkable. By means of photography the effects of various forms of propellers are most clearly shown under many varying conditions while actually propelling a boat. The subject is admirably treated, and the information given added greatly to our knowledge of what goes on under water.

Record of American and Foreign Shipping. Size, 8 by 9½ inches. Pages, 1,018. Illustrations. Tables. New York, 1910. American Bureau of Shipping.

The volume for 1911 of the "Record of American and Foreign Shipping," American Lloyds, published by the American Bureau of Shipping, 70 Beaver street, New York, is its 43d volume.

The record contains full reports and particulars of vessels of all classes and nationalities training with the United States, Canada and southern countries. It also contains rules for the construction and classification of steel, iron and wooden vessels; rules for survey of machinery and boilers for vessels; provision for the installation of electric lighting and power apparatus on shipboard, and much other valuable information of special importance to underwriters and all firms or persons interested in shipping. These rules are recognized and accepted by the United States Government.

Besides the usual full information for the benefit of subscribers in the way of rules for construction, with their accompanying illustrations and tables, all of the utmost practical and technical value, the work contains such features as list of addresses of prominent shipbuilders, dry docks, marine railways, marine machinery and boiler constructors of the United States; list of vessels whose names have been changed; also compound names indexed as per last name, names and addresses of owners of vessels classed in the record.

This record of shipping is the only book now published containing reports and particulars of all American vessels, and the reports in detail of repairs to wooden vessels still in existence should be of special value to underwriters.

The work has the approval and is endorsed by the important boards of underwriters in the United States, and is accepted throughout the world by those interested in shipping as a standard register and classification of vessels.

Machine Shop Mechanics. By Fred. H. Colvin, A. S. M. E. Size, 5 by 7 inches. Pages, 172. Illustrations, 116. McGraw-Hill Book Company, New York-London. Price, $1.10 (4/6).

Some people have a gift in imparting knowledge and putting things in a light which is clear, yet not dazzling, and Mr. Colvin in his "Machine Shop Mechanics" shows this enviable quality. He selects for illustrating his text every-day articles that the machine shop man sees and often wonders why such and such dimensions were used, and how the designers got at the sizes of various parts. And further, thinking machinists want to know what is "inside of things"; as, for instance, the hydraulic jack on page 116. If we could only get people to read and remember something they read and apply the knowledge, our work in the world would be more satisfactory. Most men, who are real men, do not mind hard work, but chafe under hard work without results. Mr. Colvin's little book will enable a certain class, and a large one, to accomplish more and not waste their energy and other people's time, and we hope, therefore, the "Machine Shop Mechanics" will have a wide sale. If the mechanic who has not had the advantages of a fair education will read Mr. Colvin's little book, there will be fewer perpetual-motion machines made in the world.

The Engineering Index Annual for 1910. Size, 6½ by 9¼ inches. Pages, 496. New York, 140 Nassau street, *The Engineering Magazine*. Price, $2.00 (8/-).

The amount of time that can be saved by buying this book and keeping it at hand cannot even be guessed at. Every engineer should have it. The brief descriptions of books on all engineering subjects are admirable. A clear idea is given of the contents of each, and the compilers have evidently used every effort to make the work complete, and seem to have been most successful. Very few can appreciate the enormous amount of labor and care which must be given to get out a work of this kind. A new feature is introduced in this issue, adding to its convenience. It is the assembling of all catch words under their classified arrangement in the front of the book. This will be greatly appreciated. It would seem to us that the Index should be in the hands of every trade school, or, in fact, any educational institution.

Elements of Machine Work. By Robert H. Smith. Size, 5 by 8 inches. Pages, 192. Illustrations, 204, with tables. Price, $2.00 (8/-).

This work goes into the details of many operations which are seldom described in text-books, and is up-to-date in modern appliances. Whether it is the author's idea to thoroughly instruct or only suggest by this book, we are not sure, but we should think the former; as, for instance, there is a clear explanation of a power hack saw for cutting off stock, but it neglects entirely the fact that very often the hack saw does not cut straight, but "runs," as it is termed. Certainly, this fact is well known to every user of this convenient tool, and not to call attention to it, and show how to correct it, is an oversight. Taking the book as a whole, there is a great deal of information imparted, and it is well worth reading from the first to the last page.

Temperature Entropy Diagram. By Chas. W. Berry. Size, 5 by 7½ inches. Pages, 387. Illustrations, 125. Numerous tables. John Wiley & Son, New York-London. Price, $2.50 (10/).

This book of Professor Berry's seems very timely, as just now the matter of efficiency in steam and its generating and use is being most closely considered not only by those who are thoroughly familiar with the subject but by many who are badly handicapped by the lack of knowledge which is so clearly supplied in this book. While Professor Berry asserts that the work is by no means exhaustive, and is for the student of thermodynamics, we must say that less could not be said on the subject and that more is hardly necessary. In other words, it is difficult to conceive that the consideration of energy turned into mechanical work and its relation to heat and change of volume could be treated more clearly, and the study of this book will undoubtedly redound to the advantage of those who are groping in the dark for a light which is so admirably supplied.

Principles of Machine Work. By Robert H. Smith. Size, 5 by 8 inches. Pages, 388. Illustrations, 425. Tables, numerous. Boston: Industrial Text-Book Company. Price, $3.00 (12/-).

The amount of work entailed in bringing out this book is difficult to estimate. It is original, not being a "hodge-podge" of catalogues, but most carefully prepared, and the illustrations are admirable, being clear and well-chosen to lay before the reader "eye-explanations." Examples of work in the machine shop and how it is generally handled can be found for many cases, but, of course, it is not to be expected that in any such work every possible case can be shown and explained. Besides the ordinary run of work, many most convenient "dodges" are shown, such as how to tap large with a tap, how to get out a broken tap, etc. In some cases, the explanations, we think, are a little lacking, as, for instance, on page 336, how to locate the holes A and A' is by no means clearly explained; it represents a double thread which finishes what is called "square"; that is, it does not run out, but finishes in the holes above referred to. The usual way to locate these is to gear the lathe, dog the work, and, with a threading tool, run a line for each thread and by this line

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locate the finishing holes. We think that it is rather an oversight to practically neglect the milling machines in this book. It certainly deserves a place in machine work. In considering the book in general, we are not sure whether the good machinist who knows the trade thoroughly well, or the inquiring youth, will be most interested, but we do feel that the machinist will be most edified, as from its pages it would be impossible to learn the machinist trade without the adjunct of the actual tools, and with personal instruction, but it is certain that no clearer explanations, in most cases, could be made than found in this work of general machine shop work.

The Principles of Scientific Management. By F. W. Taylor, M. E., D. Sc. Size, 6 by 9 inches. Pages, 77. Harper & Bros., New York-London. Price, $1.50 (6/).

The natural inclination of man is to take it easy, or, to take the idea of Mr. Taylor, he is lazy. To set out to correct this is certainly a vast undertaking. Mr. Taylor's method to overcome this inherent quality of mankind is to pay more for more work done. The "Principles of Scientific Management" is based on the idea of noting with the utmost care and minuteness the time of operation or movement and to study the record so made, and by that study eliminate much, or rearrange the entire scheme. Mr. Taylor does not shut his eyes to the difficulties which are to be encountered in trying to improve mankind, but he takes a most hopeful view, believing that the spur which will force men forward in the race to their satisfaction and those who employ them is money gained. We can hardly agree with Mr. Taylor in many of his views. In fact, we think that he often makes comparisons between extremely poor showing of existing conditions and the very best rearranged conditions. This obviously is unfair in considering the general subject. For instance, he notes lifting 7½ tons of pig iron was a day's work. This he augmented to 47½ tons in the same time. Now, if men were unloading or loading pig iron at the rate of only 7½ tons in ten hours, somebody was woefully ignorant, or else negligent, in allowing such condition to continue. Twenty tons a day of loading pig iron we have often seen. Mr. Taylor makes the point that one of the great troubles in the world is lack of knowledge on the part of those who direct or, more properly speaking, who are at the head of large enterprises. This is an unfortunate fact, but it is hardly to be expected that anybody short of the Almighty should have the infinite knowledge of thousands of men.

We do not see that Mr. Taylor has any right to the word "scientific management" as something new. To our own knowledge in this and other countries, the close scrutiny of work with a view to produce greater economy has been the constant study of many. That we, today, even if we adopted in toto with every condition ideal, Mr. Taylor's methods would not produce perfection, as perfection "Dwelleth Not Beneath the Stars." We think that it is rather a slur that is cast on many by Mr. Taylor's appropriating the word "scientific"; certainly, record has been kept and deductions made, and this is scientific, long before Mr. Taylor's exposition came before the public. One thing Mr. Taylor absolutely neglects in furnishing information is the statement of how much of the savings, as laid down by him, costs on his side? How long did it take, and how many dollars were expended in finding out the savings? And this information would certainly be interesting. We admit at once that if a permanent saving of one cent per day can be made, that it has to be multiplied by infinity to get at its final gross footing. But supposing Mr. Taylor took hold of a works for a year, will the saving which he will effect, if the management is already good, offset the cost of the investigation and rearrangement of the business? We feel again like resenting the general expression of Mr. Taylor's book, that the past has been practically all rule-of-thumb.

Scientific Management of Railways. By Louis D. Brandeis. Size, 6½ by 9½ inches. Pages, 92. New York-London: *Engineering Magazine*. Price, $1.00.

Mr. Brandeis is a man who has made the statement that we can save a million dollars a day in railway operation. We are not railroad men and, therefore, on that point we are unable to say nay to Mr. Brandeis, but we have a right to judge this statement by other statements which he makes in this book, or, at least, gives it as coming from him. If the statements about which we know are not correct, we are fair in assuming that the statement of the million dollar saving is a pure guess, excusable perhaps under the excitement of an after-dinner speech, but hardly permissible when written down in cold black and white. On page 15, the following idea is expressed: Thirty-five steel castings are received. The work on them had been set at three hours each. The machinist took twenty-three hours to machine the first one and then protested loudly. The foreman called the matter to the attention of the superintendent, who said, "Anneal the castings." This was done, but no good resulted. The superintendent went to the general manager, we presume, who tells the "super" to make a special study of the castings. This was done, and a twenty-hour time was set on each. The manager tells the "super" that it was his fault, as he should not have allowed hard castings to come into the shop. The "super" protests and is told that he had better kill the purchasing agent, which he agrees to do. In the meantime, the manager writes to the vice-president, who made a complaint to the steel foundry, telling it not to send any more hard steel castings, and so, according to the book, and we quote from it, "this system resulted in making the vice-president remedy a difficulty that otherwise might have lasted indefinitely." We venture to remark that should the name of this vice-president become known he would have to take to the woods. He would be the most popular human being in the world, he could command any salary, as the users of steel castings will readily admit the supreme ability of a vice-president, or even a president, who can, by writing to steel foundries, obtain always satisfactory castings. There is an old, old saying that a "shoemaker does well to stick to his last." We understand that Mr. Brandeis is a lawyer. Just why the world is suddenly flooded with a mania for using the word "scientific" is hard to understand. Good common-sense in law, in mechanics and elsewhere may not sound quite as well, but, under the guise of science, an immense amount is being perpetrated in the engineering world which is, as one of the New York journals most admirably terms it, "scientific poppycock."

A Valuable Account of Fire Room Methods.

We are constantly invited to consider economy in all our transactions. We must study to turn around once and make it count twice, and, if we work things right, we will "save a million dollars a day" somehow; but every once in a while somebody comes to light who is not saying much, but just doing something. We have an example of this in Mr. F. R. Low's account of his trip to Lawrence, Mass., to meet Mr. George H. Duncan, who is the American Woolen Company's chief engineer, and inspect a battery of boilers planned by him, and stoked by his patent "Hibernian Automatic Stokers," consisting of well-trained Irishmen, who fire at regular intervals and produce most satisfactory economical results, results which save money. It is well worth while to send to the B. F. Sturtevant Company, of Hyde Park, Mass., and get Mr. Low's account of his visit.

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Capt. Will J. Ward, editor of the "Maritime Review," Cardiff, has favored us with a copy of his latest novel, "S. S. Cruack, or the Scheme that Failed," which has just been published at 5/-. It is a good yarn, written in Capt. Ward's usual humorous vein.

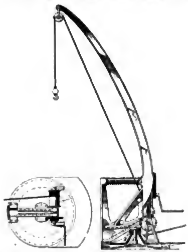
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

986,399. CRANE OR DERRICK. ANDREAS P. LUNDIN, OF NEW YORK, N. Y., ASSIGNOR TO WELIN DAVIT AND LANE & DE GROOT COMPANY, CONSOLIDATED, A CORPORATION OF NEW YORK.

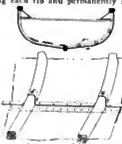
Claim 6.—In a crane or derrick, a frame adapted to rotate about a vertical pivot, a crane arm having a curved surface at its lower end supported to swing vertically in said frame; a base supported by said frame



on which said curved surface rolls, means for preventing said curved surface from slipping on said base, means for swinging the frame horizontally and means for swinging the crane arm vertically.

986,411. BOAT CONSTRUCTION. EINAR L. M. SIVARD, OF BROOKLYN, N. Y., ASSIGNOR TO WELIN DAVIT AND LANE & DE GROOT COMPANY, CONSOLIDATED, A CORPORATION OF NEW YORK.

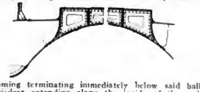
Claim 2.—In boat construction, the combination with an outer metallic plating and transverse wooden ribs, of metallic stay-pieces located at a plurality of places along each rib and permanently securing the rib and



plating together, each stay-piece comprising a metallic strip connected to the metal plating at each side of the rib, spanning the same and also having an independent connection with the rib alone.

986,861. SHIP CONSTRUCTION. JOHN REID, OF NEW YORK, N. Y.

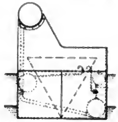
Claim 1.—In ship construction, a hull or outer shell plating, a deck plating, an inner plating extending from said deck plating to said outer shell plating and forming at each side thereof topside ballast tanks



transverse framing terminating immediately below said ballast tanks, longitudinal girders extending along the inside of the walls of said ballast tanks and means for stiffening and supporting said longitudinal girders at intervals throughout the length of said ballast tanks.

986,829. SELF-UNLOADING BARGE. ANDERS FREDRIK WIKING, OF STOCKHOLM, SWEDEN.

Claim 1.—A self-unloading barge, comprising a floating body, a liquid containing receptacle positioned below the deck thereof and at one side



of the floating body, a receptacle located above the deck and at the other side of the floating body, and means for transferring liquid from said first receptacle to said second receptacle.

986,108. SELF-LEVELING COT, BUNK, COUCH. A. L. WERTHEIM, LONDON, ENGLAND.

Claim 1.—A bunk comprising a set of timber frames, a gimbal frame, a cot suspended from said gimbal frame, said cot comprising a body portion, a bracket secured to each corner of said body portion, a plurality of supporting bars, one of said supporting bars passing through each of said brackets, a spring mounted upon said bar, and an adjusting collar mounted upon said bar to adjust said spring.

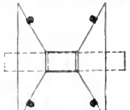
986,373. METHOD OF GENERATING STEAM FOR SUBMARINE BOATS. RAYMOND D'EQUEVILLEY-MONTJUSTIN, OF KIEL, GERMANY.

Claim 1.—In the method herein described for propelling vessels of the submarine type, which consists in using a fired steam boiler to propel the vessel during surface travel, using a hot water boiler to generate steam during submerged travel, and using a soda boiler in connection with the fired steam boiler to supply the necessary steam generating power upon the exhaustion of the hot water boiler, and in conducting the heated water remaining in the hot water boiler to the soda boiler as feed water, whereby to prolong the submerged travel.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

27,957. RAT GUARDS. R. J. CONOLEY, LONDON.

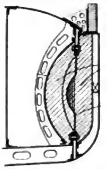
In a prior patent, No. 5,008 (1901), the inventor described a cone to be fitted upon the hawser and form a trumpet-mouth device intended to prevent the passage of rats along the rope beyond the trumpet mouth.



That device is suitable for use in one direction only, but this invention refers to a duplicated device of this type. The trumpet-mouths face in opposite directions and are connected by a central neck portion adapted to be clamped about the hawser.

11,378. SHIPS OR VESSELS. G. E. ELIA, PARIS.

Relates to means for neutralizing the effects of a submarine explosion. The outer plating is backed by a filling of cork or other elastic material of about the density of water, and within which is a framework of steel cables. The packing is backed by heavy plating stayed by framing. If an explosion ruptures the plating it compresses the material and deflects the cables, but does no further damage; then the material expands



to its former space. If any is torn away it is of the same density as the water, and the balance of the ship is unaffected. In a modification two containers in an elastic bag are broken by the shock of an explosion so that their contents generate a gas, which expands the bag to press the cables outward to nearly the line of the plating, and thus balance the ship.

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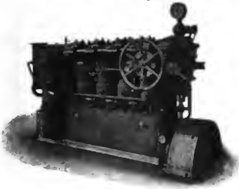

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Riveters are described in Catalogue No. 3, issued by the Hanna Engineering Works, 2095 Elston avenue, Chicago. A fully-illustrated description is given of the Hanna type of riveter, in which is combined in a simple form toggles, levers and guide links to give the large opening of the toggle joint movement with its gradually increasing pressure until the desired pressure is reached, then a simple lever movement throughout a considerable space under approximately maximum pressure. This space is said to be sufficient, so that there need be no uncertainty about the pressure applied to rivets, and the machine once adjusted for a certain length of rivet and thickness of plate, it is claimed that no further adjustment is required for ordinary variation in lengths of rivets, size of holes or thicknesses of plates, thus producing hydraulic results with a pneumatic riveter.

A Stocklist of Marine Engines and Boilers.—The Marine Iron Works, Station A, Chicago, Ill., designers and builders of triple-expansion, fore-and-aft compound, high-pressure and stern paddle-wheel machinery, have issued a stock list, from which the following selection is made, to show the large number of engines and other marine machinery this company has on hand for immediate delivery: New work—"One pair 14 by 60 stern paddle-wheel marine engines; one double cylinder, size 18 by 17 inches, open front column back marine engine; one 14-28 by 17 fore-and-aft compound marine engine, can be fitted with either steam or hand reverse; one 4-8 by 5 fore-and-aft compound marine engine for 500 pounds steam pressure; two triple cylinder 3½ by 4 engines for 500 pounds steam pressure; two double 4 by 5 non-reverse engines with governor (single acting); one rotine engine with 4-ampere dynamo, combined base; one 4-cylinder 5 by 6 gas engine, 24 horsepower; two 2-cylinder 5 by 5 gas engines, with reverse clutch. Refitted—One 4½-7¼-10¾ by 8 op. col. frm. triple-expansion engine; one 4½-7¼-10¾ by 8 op. frt. sol. bk. triple-expansion engine; one 8 by 8 piston valve heavy service tug engine; one horizontal Westriver type boiler, 42 inches diameter by 18 feet long, 150 pounds steam pressure, United States test; one watertube boiler, 6 x 8 feet, 200 pounds steam pressure; one single drum steam capstan, 4½ by 7 engine; one generating set, belt-driven, 50-light dynamo engine, 4½ by 5; one 12 by 12 steam engine; one 5-10 by 5 fore-and-aft compound marine engine; one 45 by 8½-foot steam launch, complete. All refitted machinery has been put through the factory and we can guarantee it in every way. We will be pleased to quote lowest prices on any or all of this work, also to send blue prints or photographs of same. Write us when needing either new or refitted machinery."

"American Vanadium Facts" is published by the American Vanadium Company, 318 Frick building, Pittsburg, Pa. A recent issue tells just what vanadium is. "Vanadium is a chemical element, a true metal, refined from vanadiferous ores found widely distributed throughout the earth. Its atomic weight is 51.27; specific gravity, 5.5; melting point, above 2,000 degrees C. It was vaguely known as early as 1801, but its actual discovery dates from 1830, when Sefstrom found it in samples of remarkably fine and ductile Swedish iron. Doubtless the excellent qualities of Swedish irons and steels have always been due in a large measure to their vanadium content, as vanadium is present in nearly all the Swedish iron ores. Its influence in the improvement of metals was not fully shown until late in the nineties, when by the deliberate addition of vanadium to various grades of iron and steel, remarkable results were obtained in the increment of tensile strengths without the usual accompaniment of increased fragility. This was a new fact in metallurgy; for all other elements used to strengthen steel, carbon, manganese, nickel, chromium, etc., carry with their benefits the inevitable defects of hardness, brittleness and lack of elasticity. At the time of this discovery, vanadium was a very rare metal, and was priced at fabulous values. It was used only for such purposes as tinting glass and porcelain, making aniline dyes and in certain purely academic applications. With the new century, however, came the discovery of large deposits of vanadium ores by the engineers of the American Vanadium Company, and, as a result, in less than ten years vanadium has been commercialized; it is now manufactured by the ton and has created a veritable revolution in the old ideas of the maximum physical properties of steel. On account of its very high melting point pure vanadium cannot be added to steel; but Ferro-vanadium, an alloy of one-third vanadium and two-thirds iron, fuses at a much lower point than either iron or steel, and may thus be dissolved and completely distributed through the molten bath."

When writing to advertisers, please mention International Marine Engineering.

The "Atlantic" steam shovel is described in an illustrated Bulletin No. 105, published by the American Locomotive Company, 50 Church street, New York. Since the introduction of the "Atlantic" shovel many improvements have been made in the details of the design, but the basic principles upon which it was constructed have been unchanged. One of the notable features of the "Atlantic" steam shovel is a liberal use of cast steel, but the most important departure from previous practice, and a distinctive feature of this make of shovel, is stated to be the use of a direct-wire rope hoist in place of the indirect chain hoist used by other manufacturers.

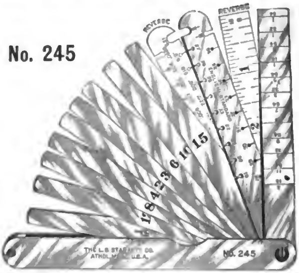
"Imperial" duplex compressors are described in circulars published by the Ingersoll-Rand Company, 11 Broadway, New York. "There are three different elements going to make up the net economy of a compressor—the mechanical efficiency, the volumetric efficiency and the compression efficiency. 'Imperial' mechanical efficiency is as high as it can be made by means of large bearings carefully finished, ample lubrication, rigid construction to maintain true alignment, and simplicity resulting from the minimum number of parts. 'Imperial' volumetric efficiency is the result of the splendid 'Imperial-Corliss' inlet valves and the 'Imperial Direct Lift' discharge valves, all requiring the minimum of clearance space and providing large admission and discharge areas. 'Imperial' compression efficiency is all that could be expected from fully jacketed air cylinders and (in compound types) an intercooler of large proportions and great cooling capacity. More important than all of these, however, is the fact that the 'Imperial' compressor maintains its high economy indefinitely. It doesn't merely promise well at the outset. It continues its high-duty performance indefinitely. Whether in the 'Imperial X' Meyer steam, or in the 'Imperial XB' power-driven type, you will get splendid returns per horsepower of energy applied and expended."

Marine packings, fibrous, semi-metallic and metallic, adapted for every service, including steam, water, air, acids, gas and ammonia, are described in a handsomely illustrated and printed catalogue of 144 pages, published by the Crandall Packing Company, Palmyra, N. Y. "Crandall packings are made from special materials under our own specifications and lubricated by our patented cold oil process. It has been shown by analysis that packing manufactured by this process passes through no chemical change whatever, and samples from which all particles of oil and plumbago had been removed by a chemical test were found to be in the same condition as goods which had never been subjected to lubrication. Thus the necessary elasticity and expansion are retained without the ensuing deterioration of materials, which cannot be prevented when any other process is used. Thoroughly tested to successfully withstand the highest pressures and temperatures. Positively will not melt, harden, blow out, score or gum the rods. Designed for hard work and guaranteed to give full value in efficiency and length of service. All styles made in ring form, cut accurately to size, always ready for immediate use, saving time and waste and insuring a perfect fit and ease of application. We carry at all our branches a complete line of stock styles for immediate shipment, and orders can be filled on day of receipt at factory if necessary."

The Jordan commutator truing device is described by the manufacturer, Jordan Bros., Inc., 74 Beekman street, New York, in a catalogue just issued. "It was in 1898—thirteen years ago—that the Jordan commutator truing device was invented. Practical electricians and machinists then, as we are now, and had been for many years prior to the time mentioned, we had experienced in our work the manifold disadvantages of truing commutators in a lathe or with portable slide rest. A substitute there was none. As is perhaps usual in such cases, our dissatisfaction aroused, it continued to grow and grow, and we felt more keenly every day the really abolute need for some other methods of truing. We thought of, built and tried many makeshifts, but it was not until 1898 that we felt we had gotten something worth while, something worth patenting. We tried out this device thoroughly. Three long years we used it in our own work, and finding that it worked perfectly, or, at any rate, that it was very much better than the old style methods of truing commutators, we decided to place it on the market. To-day the Jordan commutator truing device is used the world over by electric lighting companies, in isolated stations, in electric railway plants, by electrical manufacturers—in fact, wherever electric motors and generators are used. And it is giving satisfactory results to every user. Elsewhere in this booklet we prove this statement by letters and extracts from purchasers. That's the real test—not what we say about our device but what its users say."

Engineers' Taper, Wire & Thickness Gage

No. 245



This gage is especially designed for the use of marine engineers, machinists and others desiring a set of gages in compact form.

The taper gage shows the thickness in 64ths to 8-16ths of an inch on one side, and on the reverse side is graduated as a rule three inches of its length, reading in 8ths and 16ths of an inch.

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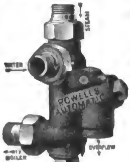

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The Kroeschell-Schwartz gyrating flame crucible furnaces are the subject of a catalogue published by Kroeschell Bros. Company, 444 West Erie street, Chicago, Ill. "We call special attention to the fact that our furnace melts from the bottom up. Impossible to burn metal; consequently less oxidation than by any other method. Our burner prevents noise; it mixes the fuel and air thoroughly and atomizes perfectly with low pressure. All spilled metal drops automatically through the slag hole. No ash mixture. We claim great fuel economy; minimum amount of labor in operating; more heats per day than from any furnace on the market; increased life of crucibles."

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Latest improved air tools are described in bulletins published by the Independent Pneumatic Tool Company, 1307 Michigan avenue, Chicago. Among the tools illustrated in this bulletin are riveting and chipping hammers of various sizes, air drills, stay-bolt drivers, hose couplers, etc. Regarding the "Thor" No. 90 hammer, the statement is made that it is guaranteed to drive rivets faster, leave a better finished job and to cost at least 50 percent less for repairs than any other make. This hammer will be sent on trial at the company's expense.

Air compressors are described in Publication L-87, issued by the National Brake & Electric Company, Milwaukee, Wis. The compressor described therein comprises an electric motor and compressor both mounted on the same base, thus forming a single, compact and powerful unit of installation. All working parts are well protected from possible injury and yet are readily accessible for inspection. The compressor is thoroughly lubricated by the splash system, which requires no attention further than to occasionally replenish the oil. An automatic controlling device serves to maintain the air pressure within predetermined low and high limits. This type of compressor is built in capacities ranging from 50 to 300 cubic feet of free air per minute, and can be furnished with either direct or alternating-current motor.

L. W. Ferdinand & Company, 201 South street, Boston, have issued the following directions for melting their marine glue and paying the seams of decks: "Cut the glue into small pieces, melt in a pot or cauldron over any moderate fire, keeping it stirred now and then. When the glue is all melted the heat is about 212 F., but rather too thick to run freely, and if used in this state air bubbles may arise, therefore it requires boiling and stirring a few minutes longer, and should be used at a heat of from 250 to 300 F.; it then becomes perfectly liquid, and should be used as quickly as possible. Continued boiling hardens and injures the glue, hence thinnings are sometimes necessary. Common observation will soon enable the workman to see the proper heat at which the glue should be used for the work in hand. The marine glue never boils over into the fire like pitch, although it will occasionally ignite while being melted if the flame be allowed to touch it, and it will continue to burn until the glue would be destroyed; when this takes place cover the pot or cauldron over with a piece of sacking, or any air-tight substance; this will immediately extinguish the flame; but this igniting will never take place if proper care be taken. Application of marine glue to decks: The flexibility of the glue is one of its most valuable qualities, as it allows the timbers to contract and expand, still retaining its great adhesive power to the edges of the plank. When the planks become contracted by the heat of the sun, a draft takes place on the glue, and the seam becomes expanded. When the planks are swollen by rains, and there is a pressure on the glue, the seam becomes contracted. As the temperature varies, these forms continue to assume each other's shapes year after year (if the deck has been properly calked and payed) until the deck becomes worn down to the oakum. It does not stick to the feet in hot weather. Fourteen pounds Jeffery's extra quality marine yacht glue will run from 200 to 250 feet of seam 3/4 inch deep by 1/4 inch wide. If properly used and not overheated it will last four to six years in a seam, and has been known to last ten to twelve years. When carefully applied to a dry deck it will never leave the sides of the seam."

TRADE PUBLICATIONS

GREAT BRITAIN

Centrifugal pumps are described in an illustrated bulletin published by W. H. Allen, Son & Company, Ltd., Queens Engineering Works, Bedford. "The development of a centrifugal pump for dealing satisfactorily with sand and slime pulp and cyanide solution, and also for sand dredging purposes, has had our attention for a number of years, and we have now supplied many pumps for these duties to gold, diamond and other mines, where the duty required of a pump is very onerous. After careful investigation on our part as well as our various representatives in the different mining centers, and basing our design on this extended experience which we have gained, we have arrived at a type of pump which gives great satisfaction, both as regards length of life and efficiency in operation. For this class of pump the life of the liners is quite as important as the efficiency of the pump itself, so that these liners call for very careful attention. At the present moment we are shipping numbers of these pumps to mines in various parts of the world, and are in a position to guarantee their results."

When writing to advertisers, please mention International Marine Engineering.

Engaging and disengaging gears for boats, launches, etc., are described in circulars published by William Mills, Ltd., Atlas Works, Sunderland. The advantages of the Mills gear over all others are said to be simplicity, manageability, reliability and safety. "Every sailor can understand, impossible to make a mistake, does not require a trained crew, it requires no preparation for hooking or unhooking, only one way to hook and only one way to unhook, causes no obstruction in any part of the boat, it is always ready for use, there are no loose parts to be lost or misplaced, no safety pins to be forgotten, no lanyard across the center of the boat to be tampered with by passengers, thus removing all liability of pulling anyone out of the boat after disengagement, or of preventing the disengagement; no rods along the bottom to be fouled by ice, etc.; gear may be fitted to stem or stern post, or any other convenient position; boat can be hoisted close to davit head; when gear is disengaged there is nothing to foul or catch the gunwale; no fear of accident to fingers when hooking on in rough seas; the block is hooked on, very little effort is required, and engagement will be instantaneous; it is perfectly under the control of the person in charge of the boat; certain simultaneous disengagement; impossible to cause an accident through dropping the boat too far from the water, as often happens to slip gears; boat cannot be disengaged until nearly water borne; boat can be disengaged with good towing strain on the falls; boat can be disengaged when ship is steaming through the water in all kinds of weather, and has been tested with perfect success up to 16 knots speed."

A four-spindle drilling, tapping and boring machine is described in a circular issued by Webster & Bennet, Ltd., Atlas Works, Coventry. "This machine is designed for boring two separate pieces of work at once, and for this reason the right-hand pair of heads are independent of the left pair. It is equally suitable for operating on four separate pieces. The frame is designed to obtain the rigidity necessary for heavy boring, trepanning or tapping. To secure this the members, columns, cross slide, etc., are of box or tube section. The heads are adjusted horizontally on the cross slide and quickly bound to it when in the desired position. The cross slide is elevated by power and secured to the columns at whatever height the work in hand demands. The spindles are driven by internal spur gears and run in long steel sleeve bearings bushed with gunmetal. The down thrust is taken on adjustable friction collars. The spindle ends are threaded on the outside and bored taper inside. The speed changes are in geometrical progression. The drive of one pair of spindles is independent of the other, the cones, pulleys and gearing being duplicated. The double gearing is put in or out of action by levers. The feeds are automatic and driven by wide belts. The feed of one pair of spindles is independent of the other. Any or all of the spindles may be fed at once. Hand feeds are provided for facing and recessing. The feed trips operate at any desired point, and are adjusted independently on each head. The spindles, being balanced, are returned quickly by hand. The tapping motion on each head is controlled by hand lever. The table has planed tee grooves in its top and front faces. It slides between the columns by means of worm and twin rack gearing. The base plate is recessed at the front to accommodate long work which may be lowered into a pit and secured to the vertical face of the table; the table crank being then operated at the back. All gears are cut from solid blanks and enclosed where necessary. The equipment comprises two countershafts with self-oiling bearings, chart and necessary spanners."

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International Marine Engineering

JUNE, 1911.

THE WHITE STAR STEAMSHIP OLYMPIC.*

NOTES ON HER MACHINERY.—The White Star liner *Olympic* was drydocked on Saturday, the 1st of April, at Belfast. She was the first vessel to be berthed in the large new dock constructed by the Belfast harbor commissioners.

The *Olympic* had been moored at the adjoining deep-water wharf, and two powerful tugs took her towards the entrance; material assistance in the operation was given by two 30-ton capstans. The difficult task of warping her in was accomplished by the 11-ton capstans placed near the head of the dock. At 10.50 the bow of the vessel crossed the entrance line and 11.39 (eight minutes before high water) the stern passed the same place. She is 92 feet 6 inches wide and the dock entrance 96 feet, so that the margin in width was very slight. At 12.25 the caisson gate was placed and half an hour later the dock was partly emptied, so as to allow the liner to rest on the keel blocks and permit the shores to be placed in position. At 2.30 the whole vessel could be seen.

She is expected to go on trials about May 28 and be handed over to the White Star on the 31st of that month. The same day is fixed for the launching of her sister ship, the *Titanic*. Meanwhile, we are now able, by the courtesy of the builders, to present fuller details of the machinery of the *Olympic* than were available at the time of the launch.

The reciprocating engines in the *Olympic*—two sets, one driving each wing-shaft, as described in our December number—are of the four-cylinder, triple-compound type. They are arranged to work at 215 pounds per square inch and to exhaust at a pressure of about 9 pounds absolute. These engines are of the four-crank type, balanced on the Yarrow, Schlick and Tweedy system. The high-pressure cylinder is 54 inches in diameter, intermediate cylinder 84 inches, and each of the two low-pressure cylinders 97 inches in diameter, the stroke being 75 inches. Two slide valves, each with two ports in a common chest, are worked by two rods, through crosshead to single links, low-pressure cylinder, high-pressure cylinder, a single piston valve, two piston valves similarly arranged to the twin slide valves, intermediate-pressure cylinder, low-pressure cylinder, and, finally, at the aft end, two slide valves. The valves, as already noted, are operated by the Stephenson link motion. There is a loose coupling on the tail shaft, so that it can be withdrawn from the stern to facili-

CASING OF THE OLYMPIC'S CHANGE VALVE.

* See issue of December, 1910, for further description of the *Olympic*.

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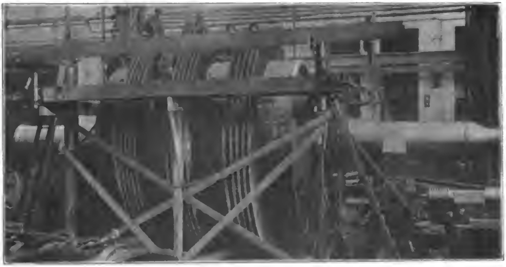
tate repair. The propellers driven by the reciprocating engines have each a cast steel boss and three bronze blades, the diameter being 23 feet 6 inches, and when developing 15,000 indicated horsepower for each engine the revolutions will be 75 per minute.

The exhaust-steam turbine, by which the central screw is driven, is of the Parsons type, taking exhaust steam at about 9 pounds absolute, and expanding down to 1 pound absolute. The condensing plant is designed to attain a vacuum of 28½ inches (with barometer at 30 inches), the temperature of circulating water being 55 degrees to 60 degrees F. The rotor is built up of steel forgings. It is 12 feet in diameter, and the blades range in length from 18 inches to 25½ inches, on the segmental principle, laced on wire through the blades and distance pieces, at the roots, and with binding soldered on the edge, as usual. The length of the rotor between the extreme edges of the first and last ring of blades is 13 feet 8 inches.



TURBINE ROTOR AND SHAFT.

The rotor has a weight of 130 tons, and the turbine complete weighs 410 tons.

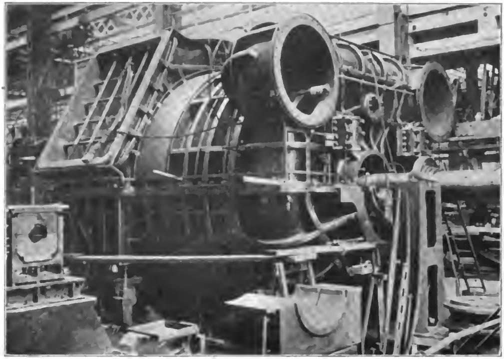
There are twenty-nine boilers in the ship with 159 furnaces. All boilers are 15 feet 9 inches in diameter. Twenty-four are double ended, 20 feet long; five are single ended, 11 feet 9 inches long. At each end there are three furnaces, all of the Morison type, with an inside diameter of 3 feet 9 inches. The working pressure is 215 pounds. The boilers are in six watertight compartments, five boilers athwartship. The boiler compartment nearest the machinery space accommodates the single-edded boilers, so arranged as to be available for running the auxiliary machinery. Two boilers in each of two other compartments have separate steam leads to the auxiliary machinery, which includes the electric lighting installation. The electric output is 1,600 kilowatts. The other five rooms are fitted with the double-ended boilers. The uptake connections are widely spread. The uptakes for two centre boiler-rooms exhaust into the second funnel from the forward end; and the two after boiler rooms exhaust into the third funnel. The fourth funnel is intended for ventilating purposes, and it also has the galleys chimney. All the funnels are elliptical in plan, the dimensions being 24 feet 6 inches by 19 feet, and the average height above the level of the furnace bars is 160 feet.

There is a main bunker 'tween decks, immediately within the skin of the ship, and into this the coal is first shipped and then distributed into bunkers athwart the ship and at stokehold level. These bunkers are arranged on each side of the main bulkheads, and immediately in front of the furnaces. Each stoker takes his coal from the bunker door. In each of the five boiler rooms there are two See's ash ejectors and four Railton and Campbell's ash hoists. A large duplex pump is in a separate compartment in each boiler room. This pump works the ash ejectors, circulates or feeds the boilers, and can be used for pumping the bilges, but in three of the boiler rooms there are independent ballast pumps. The pumps are directly connected to the bilge, as well as to the general bilge system. The air is supplied to the stokeholds by "Sirocco" fans—two for each boiler room. The exhaust turbine, instead of being in the same engine room with two sets of piston engines is in a separate compartment abaft the main reciprocating engine room, and divided from it by a watertight bulkhead.

In the reciprocating engine room there are two sets—one driving the port and the other the starboard shaft; in the wings there are the main feed and hot well, bilge, sanitary, ballast, and fresh-water pumps, and a contact and surface heater; while on the port side is the extensive refrigerating plant. In the exhaust-turbine room there is, immediately forward of the turbine, the manœuvring or change valves, which control the flow of steam either to the turbine or to the condenser—the latter for manœuvring. This control is exercised from the main starting platform through a Brown's hydraulic engine, placed between the two change valves on the bulkhead. There is a steam strainer, through which the steam passes on its way from the piston engines to the turbine in each wing. There are two oil coolers and a pump for circulating the oil in them. Abaft the exhaust-turbine room, and on each side of the shaft driven by the turbine, and within the wing shafts, there are four sets of electric light engines, each of 400 kilowatts capacity. There are also on a gallery above the lead water line in the exhaust-turbine room two electric generating sets of 35 kilowatts capacity. Steam pipes are led from three of the boiler rooms to these emergency electric generators independently and above the watertight bulkheads, and from this steam supply also it is possible to work any of the pumps connected to the bilge throughout the ship. Between the boilers and the main steam stop-valve there is a steam separator. There are two main steam leads from the boiler room, each terminating at the stop-valve and separator, which are situated against the forward engine room bulkhead.

The exhaust pipes from the low-pressure cylinders connecting with the change valve are fitted with bellows joints, which consist of two flattened conical discs with special steel rings and with flanges to take the pipes. All the pipes in proximity to the condenser are fitted with these bellows joints.

The change valves for shutting off steam to the turbine and opening it to the condenser direct, for manœuvring purposes, are of the piston type with a ring of special form. When the pistons of these valves are in their highest position, steam has a clear flow to the strainer and thence to the turbine; when the piston is lowered the connection to the strainer is closed and that to the condenser is opened. The reduction pipe from the turbine to the condenser is fitted with a large sluice valve (the closing slides in two pieces, worked together through worm-and-rack gear) actuated by an electric motor. Four sets of gun-metal circulating pumps, two for the port and two for the starboard condensers, with 29-inch inlet pipes, are driven by compound engines. For each condenser there trolled from the navigating bridge by telemotors and from the docking bridge, aft, by mechanical means. The electric lighting engines, which indicate each about 580 horsepower, are of the Allan vertical three-crank compound, enclosed forced-lubrication type, running at 325 revolutions per minute. Each set has one high-pressure cylinder, 17 inches in diameter, and two low-pressure cylinders, each 20 inches in diameter, with a 13-inch stroke. They take steam at 185-pound pressure per square inch. Each engine is direct-coupled to a compound-wound dynamo, with an output of 100 volts and 4,000 amperes, continuous current, so that their collective current capacity is 16,000 amperes. The dynamos are of the ten-pole type and are fitted with inter-poles. In addition to the four main generating sets there are two 30-kilowatt engines and dynamos, placed in a recess off the turbine room at the saloon deck level, well above the water line. Three sets will be supplied with steam from either of several boiler rooms and will be available for emergency purposes.



ONE OF THE TURBINE CASINGS.

are two sets of Weir's air pumps, of the "Dual" type, both air and water barrels being 36 inches in diameter by 21-inch stroke. The water from each condenser passes into a feed tank; thence it drains into a control tank, from which the hot-well pumps draw it, discharging it through the Weir's surface heater to a Weir's contact heater, on the engine room bulkhead. The surface heater takes the exhaust from the electric engines for heating the feed, while the contact heater utilizes the exhaust from the other auxiliaries for the same purpose. The water from the contact heater gravitates to the main feed pumps.

The steering gear is fitted on the shelter deck. The diameter of the rudder stock is 23½ inches. The gear is of Harland & Wolff's wheel-and-pinion type, working through a spring quadrant on the rudder head, with two independent engines having triple cylinders, one on each side. The quadrant is designed to minimize the shocks receievd in a sea-way. The spur-and-bevel gear is of cast steel. The gear is con-

Australian Liner "Aeneas."

To carry on the new service which the Ocean Steamship Company is inaugurating between Great Britain and Australia a number of large and splendidly equipped passenger and freight steamships are being built in Belfast and elsewhere. The first of these, the *Aeneas*, of 19,500 tons displacement, was launched August 23, 1910. She is a twin-screw vessel, 509 feet long over all, 60 feet molded breadth and 40 feet molded depth. She has five decks: the promenade, center castle, upper, main and lower decks, providing accommodation for about three hundred passengers in commodious and airy, two, three and four-berth cabins. The cabins on the center castle deck are lighted and ventilated from the ship's side, being arranged on what is known as the "tandem system." All of the public rooms throughout the vessel are large and airy, and have been specially fitted up with a view to providing the greatest comfort for the passengers. The dining saloon is

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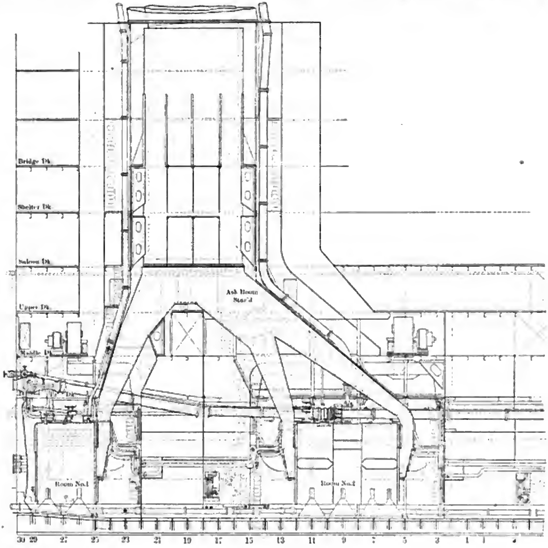
on the second deck. It is tastefully decorated with oak dado and panels in French grey. There is a central lighting well in the room, which rises through two decks and is surmounted by a handsome stained glass skylight. The panels of the well being decorated with the coats-of-arms of the various provinces of the Australian Commonwealth. A series of handsome oak staircases lead from the dining room to the main entrance hall on the center castle deck, which is decorated in oak dado with upper panels in white enamel. Abaft the entrance hall is the music room, exquisitely decorated in oak with French grey panels tastefully relieved by ornaments in the Adams style. On the same deck, but further aft, is the smoking room, the decorations of which are in the Early English style, carried out in oak embellished with a series of artistically carved frieze panels illustrating scenes in the hunting field. The vessel is lighted throughout by electricity, and efficient ventilation is provided throughout the living quarters by means of electrically driven fans installed in all the public rooms. An adequate steam heating system, for use in Northern latitudes, is installed, as well as the most modern appliances for insuring the safety of the ship, such as wireless telegraph, submarine signaling apparatus, modern lifeboats and launching apparatus.

As much of the cargo which is carried in the Australian trade is frozen meat, dairy produce and fruit, one entire hold and the after between deck have been thoroughly insulated and fitted up for the carriage of this class of cargo. The refrigerating plant is on the CO_2 system, the cooling effect being transmitted to the holds by means of brine circulating pipes arranged in coils. Another innovation, which has only recently come into general use on large steamships operating on long voyages, is an up-to-date steam laundry. The cargo space of the vessel is divided by watertight bulkheads into six main holds, which, on account of the girder system of construction, are practically free from obstruction, and thus capable of receiving large and bulky freight, such as motor cars, boilers, locomotives and machinery of all kinds. The hatches to these holds have been constructed of large size to meet the requirements of such cargo, and each hatch is served by two or three steam winches, the largest of which are capable of dealing with weights up to 40 tons.



UPTAKE AND BREACHING ON THE OLYMPIC.

The propelling machinery consists of two sets of triple expansion engines, constructed by Messrs. Workman, Clark & Company, Ltd. Steam is supplied by three double-ended Scotch boilers, working under an improved system of forced draft. The stokeholds are provided with both ash ejectors and steam ash hoists. The engine room is large and is well lighted and ventilated to insure as efficient service as possible in tropical waters. There is the usual equipment of auxiliary machinery.

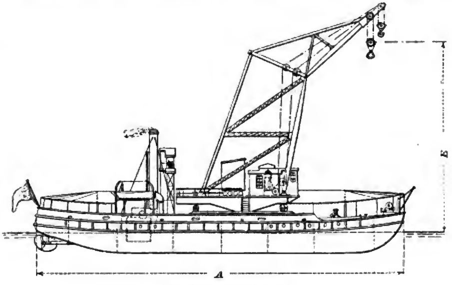
Twin-Screw Floating Crane.

The crane which we illustrate was built by the firm of A. F. Smulders, Schiedam, Holland, for the Argentine Government. The crane is for the harbor of Buenos Aires. There were two of these cranes, the main dimensions of which are as follows:

	100-Ton, Ft.	Ins.	60-Ton, Ft.	Ins.
Length between perpendiculars	154	2⅝	131	2⅜
Breadth between perpendiculars	55	9 5/16	55	9 5/16
Depth amidships measured at the side	13	1¼	11	9⅜
Clear lift	78	9	78	9
Clear overhang	27	2¼	27	2⅜
Swinging radius	27	2⅜	27	2⅜

The 60-ton crane is of the same construction as the 100-ton crane, with the sole difference that instead of a five-sheave block it has one with three sheaves, and that the jib is of a somewhat lighter construction. The steam anchor-winch, two steam-winches, with the necessary sheaves, are on deck for the purpose of working the vessels. Besides the space for boilers, engines and coal, the vessels are fitted with cabins for the chief engineer, captain, first and second engineers, with messroom, crew space for thirty men, galley, etc. Each ship has two boilers, each of 1,076 square feet surface, and working at a pressure of 120 pounds, which provide the steam for two compound engines with surface condensation, each working on a propeller. The diameter of the high-pressure cylinder is 15 inches and that of the low-pressure cylinder 30 inches, the piston stroke being 20 inches. During the official trial the engines of the 100-ton crane developed together about 550 indicated horsepower, and gave the vessel a speed of nearly 15 kilometers (9.3 statute miles) per hour.

The crane-winch is driven by a vertical compound engine, having cylinders 12 inches in diameter and 23⅝ inches, and a stroke of 14 inches. The exhaust steam is delivered to a surface condenser in the engine room. Both the live steam and the exhaust steam are conducted through the center of the crane platform by means of a cast copper conduit, provided with the necessary glands to allow of the turning of the platform. The winch drives two sets of drums, one set for the lifting of 100 tons, which is done by means of a five-sheave block, and one set for the lifting of 20 tons by means of a two-sheave block, both with two hoisting cables. The lowering of the weights is done by automatically-worked brakes and noiseless ratchets. The crane can be turned at will to the right or left by a set of conical friction wheels. The engines of the 60-ton crane developed together 601 indicated horsepower, giving the vessel a speed of 16 kilometres (9.9 statute miles) an hour, whereas the contract prescribed 12 kilometres (7.4 statute miles) only in the case of both cranes.



TWIN-SCREW FLOATING CRANE.

Jubilee Meetings of the Institution of Naval Architects.

A preliminary programme of the International Congress in Naval Architecture and Marine Engineering, to be held in connection with the jubilee meetings of the Institution of Naval Architects, London, to celebrate the fiftieth anniversary of its foundation, has been announced. It is as follows:

Monday, July 3.—Evening: Reception at the Royal United Service Institution.

Tuesday, July 4.—Morning, 11.30 A. M.: Opening of the International Congress by His Royal Highness the Duke of Connaught, K. G., in the Connaught Rooms, Great Queen street, near Kingsway. Afternoon: Official visit to the Coronation Exhibition, Shepherd's Bush. Evening: Reception given by the Right Hon. Lord Brassey, G. C. B., past president of the Institution.

Wednesday, Thursday and Friday, July 5, 6 and 7.—Mornings, 11 A. M. to 1 P. M.: Reading and discussion of papers in the halls of the Institution of Civil Engineers and the Institution of Mechanical Engineers. The programme will include papers contributed by leading English, American, Italian, Japanese, German, French and Swedish engineers.

Wednesday, July 5.—Afternoon: Visit to the Empire Festival, to witness the Pageant of London, in the grounds of the Crystal Palace. Evening: Grand festival concert in the Queen's Hall.

Thursday, July 6.—Afternoon: Visit to the National Physical Laboratory to inspect the national experimental tank. Evening: Banquet to the delegates and representatives, at the Connaught Rooms, Great Queen street, near Kingsway.

Friday, July 7.—Afternoon: River trip down the Thames, to visit the docks and shipping of the port of London.

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THE COMING BIG CUNARDER.

We live in the age of big ships, and no one can say that the limit is even yet within sight. The competition among the Atlantic shipping lines to possess the largest and the fastest vessel afloat continues. It is barely six months since Messrs. Harland & Wolff launched for the White Star Line the *Olympic* as "the largest vessel in the world." And so she was, but there was no assurance that even a vessel of 882 feet 6 inches length over all would spell finality in the arts of the shipbuilder.

Ere she was three months in the water preparations were made to lay down in a British yard a vessel exceeding the dimensions of the *Olympic*. Since the launch of the *Lusitania* and *Mauretania* persistent reports have been in circulation associating the Cunard Company with a design of larger size than either of these vessels. That design is now taking form in the yards of Messrs. John Brown & Co., Clydebank, Glasgow. It is, of course, not possible to obtain positive details of a vessel of which the keel plates are hardly laid, for the specifications are still subject to revisal, but there is no doubt that the new Cunarder will exceed by about 120 feet the length of the *Mauretania* and *Lusitania*. The Cunard Company, as a matter of fact, has planned a vessel 850 feet in length between perpendiculars and 885 feet over all. The Government in this case, as it did in the *Lusitania* and *Mauretania*, has no part. Messrs. John Brown & Co., Clydebank, the builders of the *Lusitania*, and of a fleet of Cunarders before her, are the experts entrusted with the new work, which will approximately cost £2,000,000 ($10,000,000).

The interim specifications are for a vessel of 885 feet over all, comparing with 882 feet 6 inches in the *Olympic*. The *Olympic* is 92 feet broad, but the Cunard Liner will have a breadth of at least 95 feet 6 inches. The length of the *Mauretania* is 762 feet and the breadth 88 feet. The new liner is not to emulate either the *Mauretania* or the *Lusitania* in speed, but will surpass the *Olympic*, which, of course, makes no claims to being a fast ship. The speed of the *Olympic* is 21 knots, but the new Cunard vessel will be constructed for an average speed of 23 knots on a draught of 34 feet. The contract speed of 25 knots by the *Mauretania* and the *Lusitania* has been frequently exceeded by both these vessels. The new Cunard Liner will have turbines operating quadruple screws. She will have four funnels and two pole masts. Her coal capacity will be 6,500 tons, and her total displacement 50,000 tons. That is to say, she will displace 5,000 tons more than the *Olympic*. Her double bottom will be arranged to carry oil fuel if found advisable. There will, of course, be an installation of wireless telegraphy. There will be Turkish and electric baths at the disposal of the passengers, a printing establishment for the issue of a daily paper, and a swimming pond will vary from 50 inches to 15 inches. There will also be a theatre stage in the first-class lounge. The accommodation to be provided is: For first class passengers, 650; second class, 740; third class, 2,400, a total of 3,790, which compares with 2,500 in the *Olympic* and 2,200 in the *Mauretania* and the *Lusitania*.

The possibility of a breakdown of machinery on such a large steamer has been well considered, and means are devised to ensure that in the event of such an accident taking place no disablement will result. A general rule with the Admiralty is for a double skin round the hull at the part enclosing the machinery. If a collision occurs and plates are fractured or should the vessel ground and damage plates the inrush of water finds its way between the skins and does not come in contact with the machinery at all. An alternative plan is to construct the main bulkhead in the engine room in two distinct watertight compartments. The new Cunarder will, we understand, have a double skin to the load line. Shipowners usually content themselves with indicating the dimensions and special features they desire and leave the details to the shipbuilder. The Cunard Company knew what it wanted before issuing the specifications as to the general arrangements. The desire in detail for the comfort of the passengers was that while the new liner will not outstrip the *Mauretania* and *Lusitania* in speed, she will surpass them in luxurious equipment, in fittings, and in the general arrangements for the comfort of passengers. The passenger accommodation may possibly be increased to bring it up to 4,000, so that with her crew and a full complement the number on board will be about 5,000. She will then have accommodation for 1,800 passengers more than the *Mauretania* or *Lusitania* and for 1,500 more than the *Olympic*. There will be suites of rooms, many single berths, and family suites, a passenger lift, complete telephone system throughout the ship, a system of electric bells, etc., as well as what has been named above.

The figures named above were in the specification, but before placing the contract with Messrs. John Brown & Co. the ultimate dimensions of the vessel were left open. The company desires not a record-breaking vessel nor cares whether she exceeds in size the new Hamburg-Amerikan liner *Europa*, so long as she meets its wishes and suits its business. Something has been added to the length originally specified, but the ultimate figures closely approximate what we have stated.

The Cunard Company has decided that the new steamer shall be named *Aquitania*, the practice of the company being to name after provinces of the Roman Empire on or near the Mediterranean. This name is derived from Aquitaine, a Roman province in France.

Preparations are now being made at Clydebank for laying the keel of the new vessel. She will occupy the berth upon which the Lusitania was constructed. The Lusitania was built at an angle of 40 degrees to the river, which angle will be exceeded, in view of the increase of 140 feet in length. Although many powerful vessels have been built at the Clydebank yard, it was decided before laying the keel of the *Lusitania* to specially prepare the berth on account of the intense forward pressure at the bow at the launch when the stern became water-borne. Piles were driven into the area subjected to this pressure, and bound on top with crossties in order to distribute the strain. Among present plans is one to lay a special berth of concrete. Messrs. Brown give £10,000 to the Clyde Trust to be used for river improvements for launching facilities at their yards. The river opposite is about 610 feet in width, but the launching area includes the confluence of the Clyde and Cart, into which the *Lusitania* was launched. It is capable of extension, and the scheme of the Clyde Trust provides for the widening and deepening of the river opposite Brown's establishment. About two years will elapse before the new Cunarder is completed for service, but she will be ready for launching next year.

35-Mile Steam Yacht Sovereign.

What is guaranteed to be the fastest steam yacht in the world was launched last month at the Morris Heights, New York City, yard of the Gas Engine & Power Company and Charles L. Seabury & Co. This new speed wonder was built for M. C. D. Borden, of New York and Fall River, and is to make 35 miles an hour. She was christened by Mrs. B. H. Borden.

Mr. Borden, who is one of the oldest members of the New York Yacht Club, has owned many handsome steam yachts

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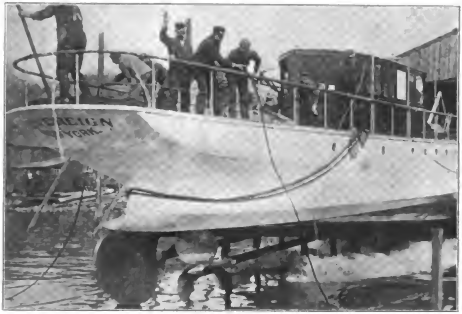
whose records for speed have made them conspicuous, but nothing to compare with the *Sovereign*. This yacht was built from the design of Charles L. Seabury, and is 165 feet over all, 158 feet at the waterline, 4 feet 6 inches draft, and has a beam of 16 feet. She has twin screw. Thirty-five miles an hour is guaranteed by the builders, and, so far as we recall, has never been attempted in a vessel of this type. The new yacht will have four smokestacks, giving her the distinctiveness in this respect that no other pleasure craft in the United States possesses. In this and other ways her appearance will attract much attention.

35-MILE STEAM YACHT SOVEREIGN.

The *Sovereign* has a bronze keel. The stern is of steel, with bronze bushing, and the stern post is a steel plate, flanged and fitted to the counter. The frame is of galvanized steel, the floor of steel plates, the garboard strake and bilge plating of Tobin bronze. The sheer strake and side plating are of steel, as are the keelson, deck beam, bulkhead and engine foundation.

The machinery will consist of two triple-expansion engines, and steam will be generated by two water-tube boilers. The *Sovereign* will be fitted with steam steering gear and will be handled from the bridge at the after end of the forward deck-house. The yacht will be lighted throughout with electricity. She has excellent accommodations for her owner.



LAUNCHING STEAM YACHT SOVEREIGN.

The Steamer Sankaty.

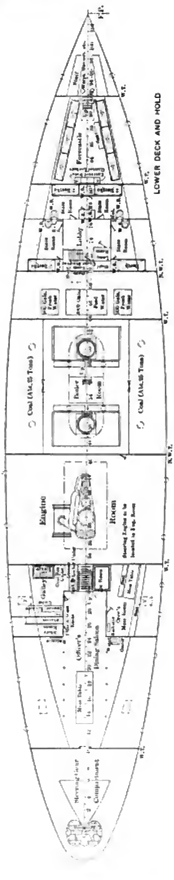
A new steamer has been added to the fleet of the New Bedford, Martha's Vineyard & Nantucket Steamboat Company in the *Sankaty*, built by the Fore River Shipbuilding Company. This vessel differs from the four others owned by this company, in being of the screw-propeller instead of the side-wheel type. Previous to the time of contracting for the *Sankaty* the shallow water at the Nantucket bar had made it impossible to design a propeller boat with sufficient carrying capacity at the permissible draft. With the deepening of the channel, however, this condition was removed. The *Sankaty* is designed under the classification of the American Bureau of Shipping both for freight and passengers, and it is expected that the winter work in carrying the Nantucket mails will fall largely to her, the other steamers not being of sufficient power and suitable design to combat the worst storms.

The *Sankaty* is of the sponson-deck type, the overhang forming an integral part of the structural hull. The main deck and joiner deck are complete all fore and aft, and the hurricane deck extends from the stern to the pilot house, providing stowage for the boats and an ample walking space for passengers. Below the main deck a lower deck extends forward and aft of the machinery spaces to the ends of the vessel. The vessel is divided fore and aft by transverse bulkheads into six watertight compartments, insuring an unusual amount of safety in event of damage to the hull. The general dimensions follow:

Length over all	195 feet.
Length on waterline	188 feet.
Breadth extreme, outside of guard.	38 feet 2 inches.
Breadth molded at waterline	31 feet 6 inches.
Depth molded	12 feet 6 inches.
Draft loaded extreme not to exceed.	9 feet 6 inches.

The interior arrangement provides commodious quarters for passengers and an ample freight space, as well as berthing for the crew. The fore part of the main deck is a clear freight space. At the bow are the windlass, etc. The house starts about 53 feet from the stem and has two sliding doors in the forward bulkhead of ample width for the passage of automobiles and large freight. Back of the bulkhead in the center a stairway leads up to the joiner deck. The boiler and engine house is amidships, with main stairway up to joiner deck aft of the engine enclosure and the stairway down to the dining-room. At the foot of main stairway is the entrance lobby and social hall, with purser's office on the starboard and chief engineer's stateroom on the port side. The joiner deck is given over entirely to the accommodation of passengers. Forward and aft of the house the deck is an open promenade with slatted wood seat arranged wherever possible. On the inside the house comprises a large and tastefully-decorated main saloon with a special parlor aft for ladies. For the convenience of people desiring privacy there are located on either side of the main saloon three well-appointed day rooms and a commodious stateroom.

The structure of the hull was especially designed for the rough winter service in which the vessel will be engaged, the parts being especially strengthened where necessary. The usual type of frame and reverse frame is used, the floors being carried straight across the top and fitted intercostally at the center line. In way of the sponsons the frames are carried continuously around the curve of the side to the fender channel. The reverse frames are carried straight up from the sides and are connected by a bracket to the frames and deck beams and by suitable riveting to a longitudinal strength girder running under the beams. Five channel web frames on each side with doubled deck beams furnish additional stiffness in way of the machinery spaces. The side keelsons and



LOWER DECK PLAN OF STEAMER SANKATY.

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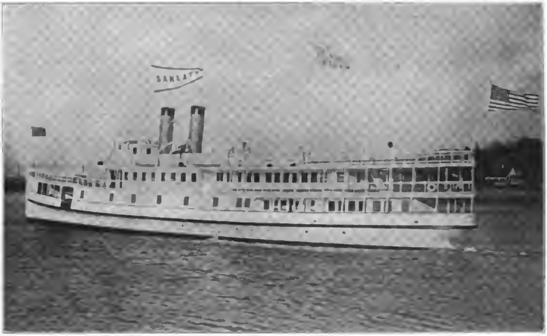
stringer are of double angle, the first keelson having also an intercostal plate with angle clips to shell and floors. The foundations for the engine, boilers and auxiliaries are specially constructed on high floors and longitudinals or on built-up foundations. The flat plate keel is provided with an extra heavy steel rubbing piece to prevent injury in case of grounding on a bar, and an 18-inch I-beam with plate floor stringer and channel rider make up the vertical keel. The shell plating is arranged with "in-and-out" strakes carried continuously on the curve of the sponson and attached to the deck through a vertical channel, which also holds the fender. Above the main deck a steel bulwark runs all fore and aft.

The lower deck beams are of angle section or alternate frames with steel stringer and tie plates. Main deck beams are channels on alternate frames, except under forward deck, where there are angles on every frame. The deck is plated complete over machinery spaces, seven complete bulkheads are fitted below main deck, five being watertight. Longitudinal coal bunker bulkheads extend the length of the boiler space on either side. The decks are supported throughout by pipe stanchions and I-beam girders.

The steering gear is of the Hyde combined steam and hand type, 6 inches by 6 inches, and interchangeable only at the engine. It is located in the engine room, being connected to the quadrant by a ¾-inch wire rope, and is driven by wire rope and bevel gears from the pilot house. Aft on the main deck is located a Providence-type crank capstan. Four 36-inch cleats with mooring parts are arranged on each side, two forward and two aft. The windlass forward on the main deck is of the Providence hand pump brake type, and is fitted with wildcats to take both 1-inch and ¾-inch close link chain cable. The drainage system consists of galvanized iron bilge suction pipes drawing from each watertight compartment and leading through a manifold to the bilge pump in the engine room. The fire-main comprises a brass pipe running fore and aft under the main deck with risers terminating in hose gate valves on the main, joiner and hurricane decks. Two deck fire pumps are supplied.

The electric plant consists of a General Electric Curtis turbine set of 15 kilowatt capacity, with switchboard complete. One hundred and fifty outlets are provided for, and independent circuits are run to the running lights and to the projector, a 13-inch General Electric commercial type with pilot house control. The lighting arrangement in the principal passenger spaces gives a pleasing effect, being on a special system in use on other boats of this company. The lamps are attached to the cornice itself by a special fitting of neat design, the wiring being entirely concealed in the molding, which is grooved at the back for the purpose. The electric fittings throughout are in bronze finish.

The life-saving appliances are four 24-foot metallic lifeboats, one 12-foot and one 8-foot metallic cylinder life-raft and 1,000 cork life preservers. In addition a wooden "pick-up" boat 16 feet long is installed. The boats are handled by the ordinary swivel-type davits. One 1,000-pound and one 900-pound Baldt stockless anchor are supplied, with a steel davit and tackle for handling. Also 30 fathoms of 1-inch and 30 fathoms of ¾-inch close link chain. The *Sankaty* is amply steam heated throughout the living spaces, and the exposed steel surfaces have been covered with cork paint, ensuring the maximum amount of comfort to passengers during the winter months.

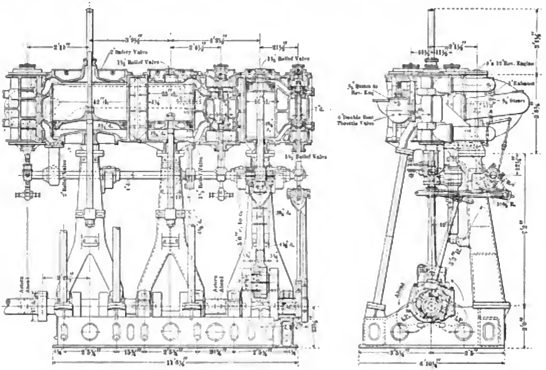


STEAMER SANKATY GOING INTO COMMISSION.

THE PROPELLING MACHINERY.

The propelling machinery, located amidships, consists of a vertical inverted, three-cylinder, triple-expansion engine, with cylinders 16, 25, 42 inches diameter, having a stroke of 27 inches. The bed-plate of the main engine is of the usual box section form in one piece, having six cross girders. The six main bearings, 8½ inches diameter and 9 inches long, with their caps, are cast iron lined with white metal. The cylinders are supported by seven columns, three cast iron at the back and four forged steel at the front. The box guides, bolted to the back columns, are hollow and fitted for water circulation. The crankshaft is forged steel throughout with webs shrunk to pins and journals. All webs are 5¼ inches by 16 inches. Crankpins are 8½ inches diameter, 10 inches long. The cylinders are arranged, beginning at the forward end of the engine, high-pressure, intermediate-pressure and low-pressure. All cylinders are fitted with piston valves. The high and intermediate-pressure cylinders each have one and the low pressure two valves of this type. The valve diameters are 7 inches for the high and 13 inches for the inermediate and low-pressure. All valves are fitted with balance cylinders for taking the weight of valves and gear. The high and intermediate-pressure pistons are flat cast iron, the low-pressure is cast steel of conical form. All pistons are fitted with cast iron followers and Christie packing rings. The piston rods are 3¼ inches diameter, the low-pressure being fitted with a tail rod 2⅜ inches diameter. Piston rods and valve stems are packed with metallic packing. The crosshead shoes are cast iron fitted with composition gibs, faced with white metal. The crosshead pins are 4½ inches diameter and 5 inches long. The connecting rods are forged steel, 60 inches between centers, fitted with composition top end brasses and cast steel bottom brasses, lined with white metal. The valve gear is of the thrust bearing is of the usual horseshoe type, having seven adjustable cast iron horseshoes faced with white metal. The stern tube bearings are of composition lined with strips of lignum vitæ. The propeller is of the solid type, cast iron, 8 feet diameter, 10 feet 6 inches pitch, 29 square feet developed area.

The main air pump is of the Blake vertical single-acting beam type, with steam cylinders 7½ inches diameter, air cylinders 16½ inches diameter, all with a common stroke of 10 inches. The main condenser has a cylindrical steel plate shell, with cast iron water chests and cover. There are 1,344 ⅝-inch brass tubes 7 feet ¼ inch between tube sheets, giving a cooling surface of 1,544 square feet. The tube ends are packed in the usual manner with cotton wicking, secured by brass glands screwed into rolled composition tube sheets. Cooling water for the condenser is taken from a centrifugal pump furnished by the Morris Machine Company, having an 8-inch suction and 8-inch discharge. The pump, direct connected to



ENGINE OF STEAMER SANKATY.

usual Stephenson double bar link type. A 6-inch double poppet throttle valve, worked by a hand lever, controls the supply of steam to the high-pressure chest. All receivers are copper pipes, installed with ample bends for expansion.

The reversing gear consists of a direct-acting steam cylinder, 8 inches diameter, 12 inches stroke, secured to the back of the intermediate-pressure cylinder. A forged steel reverse shaft, 4 inches diameter, carried in bearings at the back of the engine, transmits motion from the reversing engine to the links. The cut-off of each valve may be adjusted separately by means of a sliding block, working in slotted reverse shaft arms. A hand-turning gear is fitted at the after end of the bed-plate. The thrust shaft is 8½ inches diameter with seven collars 15 inches diameter, 1¾ inches thick, forged solid with the shaft. The line shafting is 8¼ inches diameter, and the propeller shaft is 9 inches diameter. The propeller is secured to the tapered end of the shaft by a composition nut and steel feather. All shaft couplings are 17 inches diameter, 2½ inches thick, connected by six forged steel taper bolts. The a 6 by 6 vertical engine, has the following connections: 8-inch suction from sea and 6-inch bilge suction, with 8-inch discharge through main condenser. The following additional pumps are fitted: One main feed, 6 inches by 4 inches by 6 inches vertical duplex, with suction from the feed and filter tank and fresh-water tanks and discharge to the boilers, through a grease extractor and a Reilly feed-water heater. There is one auxiliary feed, a duplicate of the main feed. One fire and bilge, 7½ inches—4½ inches by 10 inches horizontal duplex, with suctions from the sea, engine-room bilge, bilge manifold and fresh-water tanks, and discharge to the fire main, ash ejector, condenser, salt-water sanitary system and overboard. One salt-water sanitary with suction from sea, and discharge to salt-water system and crosshead guides. One fresh-water sanitary with suction from the fresh-water tanks. There is also fitted one 1½-inch injector. Many of the valves are of Starr Brass Company's make.

The vessel is fitted with two double stacks having a total height of about 44 feet above the grates.

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The steam pressure is 225 pounds, furnished by four Almy boilers. Each of these boilers has a grate area of 40.49 square feet, with 1,553 square feet of heating surface, and measures 93 3/32 inches wide, 89⅛ inches long, 112½ inches from bottom of ash-pan to top of hood, 24 inches from bottom of ash-pan to top of grate, 30 inches from top of grate to crown of fire-box. Weight, without water, 23,000 pounds; weight, with water, 25,400 pounds. These boilers are what is known as Class E.

The ashes are handled by means of a 4-inch ash ejector of the Fore River pattern. She has 1,000 Armstrong life preservers. At the time the design was made a series of model tank tests were conducted, and from these results it could be predicted that the contract speed could be maintained. She was first standardized by making twenty runs over a measured course, the speed varying from 8 to 16½ statute miles per hour. The steam pressure at the highest speed was easily maintained by the boilers. Following the standardization a four-hour run at sea was made and the contract speed of 15 statute miles per hour was readily exceeded. The owners of the *Sankaty* have put into effect their belief that true economy, especially in boiler practice, lies in ample reserve power. This had the advantage not only of economy in fuel consumption and long life to the boilers, but gives a margin of power for use in adverse conditions of ice and weather.

TORPEDO BOAT DESTROYERS WARRINGTON AND MAYRANT.

Among the ten destroyers authorized by Congress in May, 1908, are included the *Warrington* and *Mayrant*, of which the former has recently completed its contract trials.

The contract for the above-mentioned vessels was awarded to the Wm. Cramp & Sons' Ship and Engine Building Company, of Philadelphia, in October, 1908. The contract time was, respectively, twenty-three and twenty-four months, and the price for each was $664,000 (£132,800), which is exclusive of equipment and certain other articles furnished by the Government.

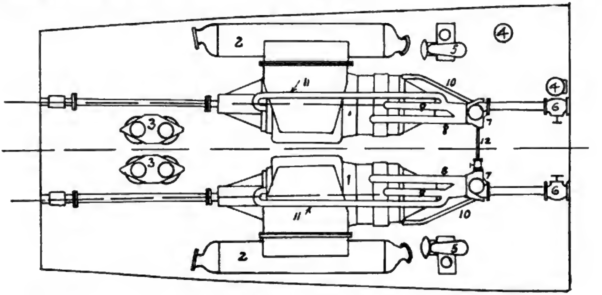
Some data and dimensions of the hull, machinery and armament are given below:

Material	Mild steel
Length between perpendiculars	289 ft. 0 ins.
Length over all	293 ft. 10½ ins.
Beam on L. W. L.	26 ft. 0½ ins.
Mean draft	8 ft. 4 ins.
Displacement	742 tons
Block coefficient of fineness	.414
Capacity of oil fuel tanks	234.2 tons
Capacity of reserve feed tanks	14.8 tons
Total horsepower, designed	13,000
Speed, designed	30 knots

Armament.—Five 3-inch, 50-caliber, semi-automatic guns; three 5-meter by 45 centimeter deck torpedo tubes; three 3-inch guns, all of which are furnished by the Government.

Propelling Machinery.—An interesting feature about the two destroyers in question is marked by the use of the Zoelly marine turbine for the propelling machinery, and the White-Forster water-tube boiler for the steam generating plant. The *Mayrant* and *Warrington* are the first and only ships in the United States Navy having this type of machinery.

As will be noticed from the plan appended, the two turbines are placed side by side in about the middle of the engine room, with sufficient room left outboard for each condenser. This arrangement of the machinery allows for a comparatively large and unobstructed floor space, together with ready accessibility of the auxiliaries.



MACHINERY PLAN OF DESTROYERS.

1. Main Turbines.
2. Main Condensers.
3. Main Air Pumps.
4. Main Feed Pumps.
5. Main Circulating Pumps.
6. Main Steam Stop Valves.
7. Maneuvering Valve.
8. Steam to Ahead Turbine, max. full speed.
9. Steam to Ahead Turbine, reduced speed.
10. Steam to Ahead Turbine, cruising speed.
11. Steam to Astern Turbine.
12. Main Steam Cross Connection.

The Zoelly turbine is essentially of the impulse type, but, when used for marine purposes, where steam speeds of necessity must be low, the pure impulse action is changed in the low-pressure zone to the combined impulse-reaction system as used in Parsons turbines. The turbines installed in the *Mayrant* and *Warrington* consist, in the high-pressure zone, of twelve pressure stages, in each of which there are two velocity stages, or, in other words, two movable vane rows and one stationary row. All of these stages consist of turned steel discs fastened to the shaft, the separation of the stages being accomplished by circular diaphragms fitted tight in the casing and having a labyrinth stiffening box, each surrounding the shaft. In the low-pressure zone, where the vanes are mounted on a drum, there are four stages, the first one of which is an impulse stage with eleven rows of buckets, while the three succeeding stages are impulse-reaction with varying number of rows of buckets or vanes.

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The backing part of the turbine is similar to the ahead-going part, but with a considerably smaller number of stages.

Both ahead and backing turbines are assembled within the same casing, the exhaust from both being taken out in one common exhaust nozzle connecting to the condenser. There are three direct steam connections to each ahead-going turbine and one to the backing turbine. At each steam connection the casing forms a steam belt extending the length of the arc occupied by the nozzles. The number of these nozzles vary from eighteen in the first stage, gradually increasing both in number and size until the last stage has been reached. The movable vanes extend all around the discs, while the stationary row of each stage only contains a sufficient number of vanes to properly distribute the steam coming from the nozzles to the moving vanes. The nozzles at each separate steam inlet are proportioned as to size and number in such a way as to admit a steam quantity needed to give the power corresponding to full speed, reduced speed and cruising speed of the ships.

There are no nozzle valves, all regulation of steam admission being performed by a throttle valve to each steam connection. When going ahead the turbines turn outboard, the starboard propeller being right-hand and the port propeller left-hand. As in all of the other destroyers of this class, the turbines, together with all the engine-room auxiliaries, are placed in one compartment aft of the boilers. The main steam line operating valves are connected with a steam manifold fastened to the front of columns with brackets between the forward engine-room bulkhead and the turbines. The operator thus faces the turbine while manipulating the valves. Each steam manifold conneets by pipe through a main stop valve on the bulkhead to a line of main steam pipes running on each side of the ship.

Auxiliaries.—There are two main twin, single-acting air pumps placed aft, one on each side of the center line of the ship, between the two shafts. Engine-driven circulating pumps are placed immediately forward of the condensers. The two main feed pumps are placed forward in the engine room.

The condensers are box shaped with semi-cylindrical top and bottom. The tubes are ⅝-inch diameter by 15 feet 2 inches long between tube sheets, the total tube surface in each condenser being 5,002 square feet. The cooling water enters at the bottom and leaves at the top, while the exhaust steam circulates around the tubes in an opposite direction. A direct air pump suction pipe from the bottom of each condenser connects to each air pump, the two pump channelways being inter-connected by a cross-pipe fitted with a sluice valve.

There are also placed in the engine room evaporators and distiller, feed heater, two 5-kilowat Curtis turbine-driven dynamo sets, lubrication oil pumps, oil cooler with circulating pump, fire and bilge pump, feed tank and an auxiliary condenser. In each fire room are located two Terry turbine-driven, forced-draft blowers.

Boilers.—Four White-Forster water-tube boilers are placed in two separate compartments with one fire room between each pair of boilers. They are made for burning oil only, and are designed for a working pressure of 250-pound gage. They are not arranged with superheaters. The tube-heating surface in each boiler is 4,500 square feet. The circulation of the gases of combustion in the White-Forster boiler is similar to that of the Yarrow. The constructional feature which distinguishes this boiler from others is to be found in the curved tubes, which are set at such angle in the tube sheet that any one tube may be removed without disturbance to other tubes, through the manhole placed on the front head of the boiler drum. All boiler tubes are made of seamless, cold-drawn steel of 1-inch outside diameter.

Arrangements of oil fuel tanks and oil-burning arrangement is, in general features, as well as in individual details, identical to arrangements described in various articles recently published in these columns.

There are three smokestacks, the top of which is about 33 feet over the oil burners.

The auxiliary boiler feed pumps are placed in each fire room.

Propellers and Shafting.—The propellers are cast solid and are made of manganese bronze. They have each three blades machined to give a true pitch of 6 feet 2 inches. The diameter is 6 feet 8 inches, with a projected blade area of 20.41 square feet.

The shafting is made of Class A steel forgings, 7 inches diameter and solid.

Trial Data.—The standardization trial of the *Warrington* was made on a course off Delaware Breakwater on Jan. 11 last. The official speed trials were performed Jan. 12, 15 and 16, when a four-hour full-speed trial, a 25-knot trial of seven hours, and a 16-knot trial of ten hours were run.

Four-Houa Full-Speed Trial.—

Average pressure at boilers, gage	246 lbs.
Average pressure at engine room, gage	238.7 lbs.
Average pressure at turbine, first steam belt, slow speed, gage	142.9 lbs.
Second, medium speed, gage	144.6 lbs.
Third, full speed, gage	191.7 lbs.
Average vacuum, inches	28.95
Average pressure in fire room, ins. water	4.65
Average revolutions per minute of forced-draft blowers in fire room	1,212
Average pressure in lubricating oil system	21.1 lbs.
Average double strokes, main air pumps	46
Average revolutions per minute, main circulating pumps	355
Average temperature, injection	45.5° F.
Average temperature, discharge	75.0° F.
Average revolutions per minute, turbines	641
Slip of propellers, mean	22.8
Total shaft horsepower	12646
Mean displacement on trial	720.2 tons
Pounds of water per hour per horsepower, all purposes	14.54
Pounds of fuel oil per hour per shaft horsepower	1.392
Pounds of water evaporated per hour per pound of fuel oil	10.44
Nautical miles run per ton of fuel oil	3.774
Speed per hour, knots	30.123

Seven-Hours 25-Knot Speed Taial.—

Average pressure at boilers, gage	246 lbs.
Average pressure at engine room, gage	241 lbs.
Average pressure at turbine, first steam belt, slow speed, gage	165.8
Second, medium speed, gage	195.1
Third, full speed, gage	85.0
Average vacuum, inches	29
Average pressure in fire room, in inches of water	3.2
Total shaft horsepower	7808
Average revolutions per minute of turbines	502
Speed per hour, knots	25.026
Pounds of water per hour per horsepower, all purposes	15.86
Pounds of fuel oil per shaft horsepower per hour	1.381
Pounds of water evaporated per hour per pound of fuel oil	11.48
Nautical miles run per ton of fuel oil	5.358
Average displacement on trial	735 tons

Ten-Hour 16-Knot Speed Trial.—

Average pressure at boilers, gage	248.5 lbs.
Average pressure at engine room, gage	245.5 lbs.
Average pressure at turbine, first steam belt, slow speed, gage	171.7 lbs.
Second, medium speed, gage	5.3 lbs.
Third, full speed, gage	13.95 lbs.
Average vacuum, inches	29.23
Average pressure in fire room, in inches of water	1.38
Total shaft horsepower	1607
Average revolutions per minute of turbines	291.7
Speed per hour, knots	16.26
Pounds of water per hour per horsepower, all purposes	21.996
Pounds of fuel oil per hour per shaft horsepower	2.189
Pounds of water evaporated per hour per pound of fuel oil	10.04
Nautical miles run per ton of fuel oil	10.355
Average displacement on trial	726.6 tons

The foregcing article, together with two others, having appeared at different times in these columns, finishes a series of articles in which have been described the general features of the propelling machinery and boilers, and in which have also been given the principal trial data of three destroyers of the same class and dimensions as regards hull, but all having machinery of different type. The destroyers thus described are the *Preston*, with Parsons turbines and Thornycroft boilers; the *Perkins* and *Sterret*, with Curtis turbines and Yarrow boilers, and the *Margrant* and *Warrington*, with Zoelly turbines and White-Forster boilers.

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Interesting Propeller Experiments.

Prof. Oswald Flamm, of the Technical High School of Charlottenburg, has made some most interesting experiments with screw propellers with a view of finding out the effect on the water through which they passed. The series of illustrations we give from his book are novel and highly interesting and instructive. It is to be regretted that more means were not placed at the disposal of the professor so that he could carry out his work to his liking, but this condition is a most unfortunate one, that far too often exists under similar circumstances.

Professor Flamm calls attention to the lack of accurate knowledge concerning just what can be obtained from a propeller. He wishes to obtain the effect on the water in front of the propeller, at the propeller and in its wake. In order to do this he could not trust to human vision, or can human vision record what it sees. He, therefore, had recourse to photography, which can not only only see, but makes a thorough record of what is seen. He also called into use that most convenient form of power, electricity. Owing to limited apparatus and means he could not make all the records that he desired and he experienced considerable difficulty in recording the exact powers exerted. His experimental tank was 10 meters long (393 feet), 8 meters wide (26 feet 2 inches), and 6 meters deep (19 feet 8 inches). The tank was of plate-glass and he used filtered water. In order to obtain a view of the propellers glass sides and bottoms were necessary and, of course, clear water could only be employed. Into this water he threw the rays of a searchlight of some 24,000 candle-power. Above the tank he erected a track and mounted on it a truck, and from this apparatus extended down into the water an arm or strut which carried the propeller and its motor. These propellers were in various forms, but not freaks. They were such as were used in torpedo boats, tow-boats, express boats, packets and yachts, and altogether were thirteen in number. Some of the special wheels were designed by Professor Flamm. The revolutions of the propellers were from 2,000 to 3,000 per minute. In taking the photographs the exposures were approximately one-thousandth of a second each. In the trials the carriage was loaded with various weights, but Professor Flamm does not express himself as very well satisfied with the records he obtained as to the power required to move a given load at a given speed under the conditions.

FIG. 1.

FIG. 2.

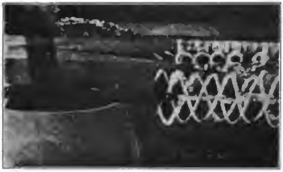

FIG. 3.

FIG. 4.

Examination of the photographs shows some interesting features. The illustration marked Fig. 1 clearly brings out the drawing down or suction of the water just above the screw. In the experiment when this photograph was taken the carriage was weighted with 20 kilograms (24 pounds) and the propeller was three-bladed, making 3,600 revolutions, and the advance of the carriage is noted as slow.

The illustration, Fig. 2, with a weight of 4 kilograms (8.8 pounds) and 2,500 revolutions of speed of 2.45 meters per second (9.6 feet) the suction loses the peak effect and shows a more elongated depression, keeping practically parallel with the surface of the water after leaving the point immediately above the blade of the propeller. There are no detailed descriptions or drawings of the carriage or transmission mechanism, but it is not at all difficult to conceive of many satisfactory plans which could be carried out under the circumstances. The carriage was fitted with a strut carrying a torpedo-shaped body at the stern, on which was fitted the screw. Of course, the strut was a thin fore-and-aft cross-section and faired with great care.

Illustration Fig. 3 has no data given as to the revolutions,

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etc., but the spiraling effect in the water is splendidly shown, and here again the sucking down above the screw is brought out. With a four-bladed propeller the effect, as shown in Fig. 4, is interesting. Here 1 kilogram (2.204 pounds) was the weight on the carriage. The screw turned 1,250 revolutions and a speed of 1.2 meters (4.72 feet) was obtained, and the curious "ropy" effect of the water is interesting to note.

The professor calls attention to the fact which we all have suffered from more or less, and that is, with the utmost care the propeller is almost always a trial and error problem. Certain conditions being given, a propeller wheel can be designed to do certain things, but there always seems to be a pleasant smile on the face of those who "chase the x's" and produce the drawing of the wheel, when results approximately coincide with what was sought, and it is somewhat strange that so often the hoped-for result is exceeded. The smile broadens, but good engineering can only be obtained by exact data, and, while we are often assured by experts that wheels can be, without question, properly designed, there seems to be a great amount of docking done to replace propellers. In other words, we really consider that with the present knowledge we cannot call the design of a propeller an exact art, and it is to be hoped that further investigations of Professor Flamm can be made to put us in possession of facts to correct this conditions.

DOCKING FACILITIES OF THE PORT OF NEW YORK.*

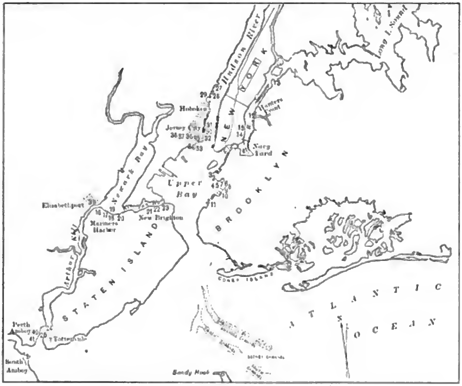
For docking vessels at the Port of New York, there are provided, in all, 92 appliances. Of this total, 6 are graving or fixed location basins, 72 are floating hulls or pontoons, and 14 are marine railways.

Of the 6 graving docks, 4 belong to the United States and are located at its New York Navy Yard. The remaining 2 are the property of a private shipbuilding company, and are at its yards in Erie Basin.

Of the 72 floating docks, 50 are "balance" or single pontoon docks; 20 are sectional, or of the multiple pontoon type, and 2 are "mud" or open end box docks, and all are private property.

Of the floating docks, the largest is that of the Morse Dry Dock & Repair Company, having a claimed lifting capacity of 15,000 tons. It is of the sectional type, having five pontoons, each of which is provided with a duplicate pumping outfit operated electrically. It has a hull length of 408 feet and a deck length of 478 feet, the difference being made up with an overhanging deck or outrigger at each end. Between wings, it has a top width of 120 feet, and a deck width of 103 feet. The dock is entirely of wood and lies between two piers, which serve to hold it in position.

The second in size is a sectional dock at the yards of Tietjen & Lang, Hoboken, N. J., which has a lifting capacity of 9,000 tons. It is built entirely of wood, has five sections or pontoons, which make up a hull length of 408 feet and a deck length of 468 feet, including the outriggers. Between wings it has a top width of 98 feet and a deck width of 98 feet. The dock is entirely of wood and lies between guide piers.



LOCATION OF DOCKS IN NEW YORK HARBOR.

In the following order are the twelve firms having the largest floating dock tonnage facilities:

Name	Largest Single Dock Tons	Total Number Docks.	Total Tonnage.
Tietjen & Lang	9,000	9	24,200
J. N. Robbins Co *	6,000	3	16,000
Morse Dry Dock and Repair Co *	15,000	1	15,000
J. Shewan & Sons	5,500	6	12,500
Staten Island Ship Building Co	4,000	5	10,800
Theo. Crane's Sons	5,000	3	8,000
Raritan Dry Dock Co	4,500	3	6,140
J. Tregarthus Son	3,000	3	6,000
W. J. Cakey & Co.	3,000	3	5,200
F. McWilliams	2,000	4	4,000
Perth Amboy Dry Dock Co	2,500	3	3,700
McAllister Dry Dock & Ship Yard Co.	1,500	3	2,700

* Has also two graving docks. † The lifting capacity given for this dock is that claimed by the owner and has not been checked by the writer.

*Compiled by Frederick O. Harris, Civil Engineer, U. S. Navy, assisted by C. P. Bonner.

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The two privately owned graving docks are at the ship yard of the J. N. Robbins Company, Beard street and Erie Basin, Brooklyn. One of these has a top length of 515 feet, sill depth of 25 feet. Both docks are of the Simpson type, originally of wood throughout, though the smaller has been largely renewed with concrete. Both docks have the floor

DOCKING FACILITIES, PORT OF NEW YORK.

Key No.	Location.	Owner.	Kind of Dock.	Capacity		Length	
				Tons.	Draft.	Deck.	Bot.
	Brooklyn, N. Y.						
1	Foot Sands Street	United States Government	Graving Dock	.....	25	347	320
				.....	26	471	440
				.....	29	648	605
				.....	35	703	700
2	Erie Basin	J. N. Robbins & Co.	Graving Dock	.....	21	515	483
				.....	25	612	578
			Floating Sectional	6,000	17	375	375
				6,000	21	400	400
			Floating Balanced	4,000	17	330	330
3	Conover Street	Schuyler & Caddell	Floating Sectional	500	12	130	105
			Marine Railway	1,500	15	287	...
				600	9	187	...
4	Erie Basin	Theo. A. Crane's Sons Co.	Floating Sectional	2,000	18	235	205
				5,000	20	358	300
			Floating Balanced	1,000	18	265	191
5		Wm. J. Gokey & Co.		1,000	16	180	130
			Floating Sectional	1,200	12	188	160
			Floating Balanced	3,000	18	265	191
6	Foot Smith Street	Furman & Birkland	Floating Sectional	500	10	120	120
7	Foot Court Street	Downing & Lawrence	Marine Railway	800	10	230	...
				800	10	230	...
8	Foot 20th Street	Ira S. Bushey	Floating Balanced	1,000	14	170	110
	Foot 23d Street	Tebo Yacht Basin Co	Floating Balanced	800	13	90	90
9				1,000	17	190	150
10	Foot 26th Street	Jas. Shewan & Sons, Inc	Floating Sectional	5,500	23	396	357
			Floating Balanced	500	16	160	120
11	Foot 50th Street	Morse Dry Dock and Repairing Co.	Floating Sectional	15,000	28	478	400
	Long Island City, N. Y.						
12	Hunters Point	McWilliams Bros	Floating Balanced	375	13	150	100
			Floating Sectional	250	13	120	100
13	Astoria	Ward & Co.	Marine Railway	1,000	8	175	...
				1,000	8	175	...
	New York City, N. Y.						
14	Houston Street, E. R	Jas. Shewan & Sons	Floating Balanced	3,500	25	276	206
				2,500	22	240	190
				800	16	180	140
				700	16	160	120
15	Foot 7th Street, E. R.	Jas. Tregarthen, Son & Co.	Floating Balanced	1,000	16	191	135
				3,000	20	280	185
				2,000	19	231	162
	Staten Island, N. Y.						
16	Mariners Harbor	Rankin Dry Dock Co	Floating Balanced	1,500	15	185	130
17		The Staten Island Shipbuilding Co.		2,500	18	220	165
				1,500	15	185	130
18		Brewer Dry Dock Co.	Floating Sectional	800	12	140	118
19		Shooter's Island Shipbuilding Co	Marine Railway	4,500	19	385	...
20		Caddell Bros		500	10	150	...
21	West Brighton	Staten Island Shipbuilding Co	Floating Balanced	4,000	22	304	212
				1,800	18	200	151
				1,000	16	190	141
22		McAllister Dry Dock & Shipbuilding Co.	Floating Sectional	1,500	15	225	200
				700	13	125	126
			Floating Balanced	500	12	125	100
23		Frank McWilliams		2,000	18	209	152
				1,000	18	190	120
				500	13	130	100
				500	13	123	101
24	Tottenville	J. S. Ellis & Sons	Marine Railway	250	6	120	...
25		A. C. Brown		1,000	14	200	...
26	City Island, N. Y.	Robt. Jacob		1,000	20	166	...
				600	12	120	...
				650	12	85	...
	Hoboken, N. J.						
27	Weehawken	Union Dry Dock and Repair Co	Floating Sectional	1,900	17	216	190
			Floating Balanced	1,000	12	130	120
				600	13	158	100
28		The Weehawken Dry Dock Co	Floating Sectional	1,000	12	135	135
29	17th Street, N. R	The Tietgen & Lang Dry Dock Co	Floating Balanced	800	13	140	100
				2,000	18	236	176
			Floating Sectional	1,000	15	172	121
			Floating Balanced	1,200	14	189	149
				1,800	18	229	169
			Floating Sectional	9,000	22	468	408
			Floating Balanced	1,400	18	190	130
				1,000	16	184	134
				6,000	22	330	250
30	Jersey City, N. J	Alex Miller & Bro.	Floating Balanced	2,000	18	185	143
			Floating Sectional	1,000	14	138	126
31		Burt & Mitchell	Floating Balanced	750	15	171	131
32		Theo. Smith & Son		1,100	15	181	131
33		W. T. Hanley	Floating Sectional	600	10	130	120
34		O'Donnell Anderson Dry Dock Co	Floating Balanced	600	12	137	122
35		Jno. Swenson		1,000	14	175	126
				500	12	130	90
36		B. Long & Son		1,100	11	145	110
37		Morton & Rankin	Floating Mud	800	10	120	120
				900	10	120	120
38		Patrick O'Rourke	Floating Sectional	400	9	90	90
39	Elizabeth Port, N. J.	The New Jersey Dry Dock Co	Marine Railway	1,500	10	225	...
			Floating Balance	400	14	163	121
40	Perth Amboy, N. J.	Perth Amboy Dry Dock Co	Floating Balance	700	14	160	160
				2,500	18	250	250
				500	12	125	125
41		The Raritan Dry Dock Co		500	10	130	100
				1,500	14	207	187
				4,500	20	312	250

a bottom length of 483 feet, a top and bottom entrance width of 98 feet and 46 feet, respectively, and a N. H. W. sill depth of 21 feet; the other has a top and bottom length, respectively, of 612 feet and 578 feet, a top entrance width of 85 feet, a bottom entrance width of of 45 feet, and a N. H. W. level with the sill, and they conform generally to the usual types of graving docks.

All of these establishments have machine, forging and wood-working shops, and are equipped for repair business. Of the firms having small docks, several do largely a yacht and

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pleasure craft business; others confine their operations to barge and scow building and repairs, while in other cases the docks are an adjunct to the larger operations of machine, forge and boiler shop business.

Of the marine railways, the largest, which is now shut down, is that of the Shooters Island Shipbuilding Company at Mariners Harbor, S. I., with a cradle length of 385 feet, and a tonnage capacity of 4,500. This firm has a well-equipped plant for general shipbuilding and repair work, but is not now actually engaged in business.

The other railways are much smaller and do building and repair work within the capacity of their plants.

Among those firms having facilities for handling large vessels, there is a generally accepted schedule of dockage charges for vessels whose tonnage rates amount to fifty dollars or more per day. For vessels of smaller size, the charges are contingent upon circumstances, and there seems no generally applied rate.

The following tariff applies generally to all large vessels, the rates being per gross ton; cargo and removabe ballast being charged for in some cases, while in others the basis is the gross ton register as given in Lloyds. The first day, 8 cents per ton; the second, third, fourth and fifth days, 7 cents per ton; all subsequent days, 6 cents per ton, but no charge shall be less than $50. Five or more continuous hours constitute one day. One hour and less than five hours constitute one-half a day. Lay days on which no work can be done on account of bad weather are at half price. Sundays and holidays are free, unless work is performed, in which event full rates obtain. Docking time begins when the vessel enters the mouth of the dock, and continues until it has cleared the same. Vessels lying in dock for the account of the dock company do so without charge.

The following regulations govern the use of the docks of the United States Government by other than its own ships (See Art. 926, 4, 5, 6, 7, of the regulations):

"No work shall be done by the Government force at a Navy Yard or Station for private individuals or corporations, except by authority of the Secretary of the Navy, upon application specifying the nature of the work to be done, and accompanied by a certificate from the Commandant, that *the necessary labor and appliances cannot be procured in the vicinity from private contractors.* Where work is authorized at a Navy Yard or Station for private parties, they shall deposit with the Paymaster of the Yard, a sum sufficient to cover the estimated expenses to be incurred. The total cost shall be defrayed from such deposit. The special deposit for payment shall be made by check payable to the order of the Commandant of the Yard or Station, and by him endorsed to the Paymaster of the Yard........Any balance of the special deposit remaining in the hands of the Paymaster shall be returned by check to the party making the deposit. The "charging" rates current in the vicinity shall be used in fixing the cost of private work, which shall not be less than the actual expense to the Government. Tools, power, light, etc., shall be included in the cost, and the rates for such appliances, etc., shall be those charged per hour in the vicinity, but in no case less than the cost to the Government therefor. In docking private vessels at Navy Yards or Stations, the usual rates per gross ton register for docking and maintaining in dock current in the vicinity shall be charged, provided, however, that no such charge shall be less than the actual cost."

The following is the schedule of charges for private individuals or corporations using the Government dry docks at the New York Navy Yard:

For docking vessels in Dry Docks Nos. 1 and 2, the charges will be:

(a) For steamers, 5 cents per gross ton for docking (included undocking).
For sailing vessels, 5 cents per net ton for docking (included undocking).

(b) For steamers, 5 cents per gross ton per lay day.
For sailing vessels, 5 cents per net ton per lay day.

For docking vessels in Dry Dock No. 3, the charges will be:

(a) For steamers, 8 cents per gross ton for docking (including undocking).
For sailing vessels, 8 cents per net ton for docking (including undocking).

(b) For steamers, 8 cents per gross ton per lay day.
For sailing vessels, 8 cents per net ton per lay day.

Lloyd's Register of Shipping for the quarter ending March 30, 1911, states the world's tonnage building, not including the United Kingdom, is 649,132 in 287 vessels. The gross tonnage built in the United Kingdom amounts to 1,374,664 in 480 vessels, 317,000 tons greater than reported in the previous twelve months. The war tonnage of the United Kingdom was 384,740 in 65 vessels, which is the highest on record for the past ten years. The commercial tonnage of the United States is 98,863 tons in 54 vessels. Germany leads all but England, with 67 vessels of 215,557 tons, France following with 29 vessels of 123,690 tons.

The Chilean government has, either under construction or contract, extensive navy yards and harbor improvements at Talcahuano, consisting of machine shops, a large new drydock and extensive breakwater and harbor works. When these improvements are completed the government will have a well-equipped naval station and one of the best harbors on the Pacific Ocean south of San Francisco. These improvements will cost very close to $10,000,000 gold, and it will require about three and one-half years to complete them. Nearly everything about the naval machine shops is English.

The article on page 148 of our April issue, entitled "Stability of Merchant Vessels," through an oversight, did not have the author's name attached to it. This article was written by Mr. George Nicol. In the article the symbol "Z" is used in one or two instances in place of "Y."

The new Hamburg-American steamship, whose name has been changed from *Europa to Imperator*, is to have forty-six watertube boilers of the modified Thornycroft type. The propelling power will be four Parsons turbines modified in several ways, such as including the go-ahead and the astern turbines in the same casing. The ship will have three funnels, two for boiler draft and one solely for ventilation. It is expected that this one funnel will make it possible to do away with all ventilating cowls. By the use of watertube boilers it is expected to save at least 3,000 tons in the weight of the ship.

GRAPHICAL SHIP CALCULATIONS

Ship calculations in nearly all cases are made by the aid of integrating rules, such as Simpson's, Tchebycheff's or Borda's, which can give only an approximate result. For all these rules are gained by substituting a curve of mathematically expressible character for the original curve, as it is laid down in the drawing of the ship's forms. Much more correct results can be ascertained by graphical calculations, which, moreover, will very often effect a saving of time, especially

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with ships whose ends are cut away to a considerable extent, such as motor boats and yachts.

To show how to arrange such a graphical calculation, the displacement, centers of buoyancy and waterline, metacenter and moment to change trim of the boat below shall be calculated. The dimensions are as follows:

	Feet.
Length over all:	44.6
Length of waterline	39.4
Extreme breadth	9.85
Draft	3.28

On the horizontal base line *B B* (Fig. 3) the distances of the sections shown in the body plan are marked and vertical lines drawn through these points. The areas of the sections are found by planimeter from the body plan, and set off on their respective lines in a convenient scale. Thus we get curve 3, Fig. 3, the area of which represents the displacement of the boat. This is only calculated up to waterline 4, and the area of the curve is 2.868 square inches. As the scales are, horizontally, 1 inch = 8.33 feet; vertically, 1 inch = 13.67 square feet, we must multiply the area of the curve by 8.33×13.67 to have the displacement in cubic feet, $2.868 \times 8.33 \times 13.67 = 326.67$ cubic feet.

To obtain the longitudinal position of the center of buoyancy with respect to a suggested cross plane, the moment of the curve of displacement with respect to this plane is determined graphically in the following manner:

Take two of the vertical lines (*U U* in Fig. 3) at equal distances from the fixed cross plane 6. From any point of the displacement curve draw a horizontal line (such as *P F* and *Q F*) to meet *U U;* further draw the straight lines *O-F-P M*, *O-F-Q M*. Thus every point, such as *P* and *Q*, of the displacement curve produces a point as *P M* and *Q M* on its vertical line, and the curves 4 are found. The area under the part of curve 4 to the left of cross plane 6, multiplied by the distance between *U U* and *Y Y*, represents the moment of the part of the displacement curve aft of cross plane 6, and the area of that part of curve 4 to the right of 6, multiplied by the same distance, represents the moment of its fore part.

This method of drawing moment curves was devised by Nehls, and can be proved by referring to Fig. 2. The moment of the curved area *A O B*, with respect to the *Y* axis, shall be found. Take a strip, *F G H I*, of this area so narrow that the curved piece *H I* may be taken as straight. The moment of that strip is the product of its area *F G H I* multiplied by the lever *l*, or (*K L* being the mean height of the strip) $F G \times K L \times l$. Draw the line *U U* parallel to the *Y* axis and at a distance *d* from it, and close the figure by drawing *K P* and *O P M*. Now the following relation exists between *L M*, *P U*, *l* and *d*, *O M L* and *O P U* being similar triangles:

$$L M : P U = l : d.$$

$$L M \times d = P U \times l = K L \times l.$$

Therefore, the moment of the strip may be written $F G \times L M \times d$, instead of $F G \times K L \times l$. $F G \times L M$ is the element strip of a new area, the boundary of which is found by constructing a new point *M* to every point of the original curve, as it is done with *K* in Fig. 2. As the moment of every element strip of the original curve is given by the product of the corresponding element strip of the moment curve, multiplied by the common distance *d*, the sum of the moments of all original element strips, being the moment of the whole original area, is represented by the area of the moment curve multiplied by the distance *d*.

In our ship calculation the moments abaft and before plane 6 are counteracting, and therefore the difference between them is the moment of the total displacement curve. Of course, the center of buoyancy lies on the side of the wider moment area.

It is not necessary to work out the moment in fourth powers of a foot, for the moment itself is scarcely required. The planimeter readings of the moment areas are simply subtracted from each other, and the remainder is divided by the planimeter reading of the displacement curve; the result, multiplied by the standard distance *O U*, is the distance of the center of buoyancy of the fixed cross section.

The position of the center of buoyancy below the load-waterline is found by using the curve of waterline areas 1 in the diagram, Fig. 3. The horizontal lines *W L* 1, *W L* 2, etc., are spaced in a convenient scale, *e. g.*, 1 : 25, and on them the respective areas of waterlines are set off. A curve is passed through the end points, called the curve of waterline areas. By integrating this curve up to the different waterlines, the displacement below the respective waterlines is obtained. As the scales are, horizontally, 1 inch = 136.7 square feet; vertically, 1 inch = 2.083 feet, the planimeter readings in square inches must be multiplied by $136.7 \times 2.083 = 284.8$, to get the displacement in cubic feet. The figures from the diagram are tabulated below:

	Planimeter.	Displacement.
Up to W. L. 1	0.0465 square inches	13 cubic feet.
" W. L. 2	0.186 "	53 "
" W. L. 3	0.588 "	168 "
" W. L. 4	1.145 "	326 "
" W. L. 5	1.83 "	521 "

The respective displacements are set off on their corresponding waterlines, thus leading to the scale of displacement (curve 2 in diagram, Fig. 3). The area of this curve below any waterline, divided by the displacement up to that waterline, gives the distance of the respective center of buoyancy below the waterline.

To prove that, suppose *A. W. L.* in Fig. 4 to be the curve of waterline areas and *Sc. D.* the scale of displacement obtained from A. W. L. An increase in draft $D_1 D_2$ causes an increase in displacement represented by the area $D_1 A_1 A_2 D_2$. In the scale of displacement this increase is the difference between the displacements at drafts D_1 and D_2, *i. e.*, $D_2 B_2 - D_1 B_1 = B_2 F$. Now, supposing $D_1 D_2$ being small, the curves pieces $A_1 A_2$ and $B_1 B_2$ may be taken as straight, and therefore the area $B_1 B_2 C_2 C_1 = B_2 F \times E G$. *E G* is the distance of the displacement portion $D_1 A_1 A_2 D_2$ or $B_2 F$ from the waterline, or, in other words, its lever, with respect to the waterline. The area $B_1 B_2 C_2 C_1$ therefore represents the moment of the displacement portion $D_1 A_1 A_2 D_2$, and as every portion of displacement is represented by a corresponding part of the area between the scale of displacement and the waterline, this whole area means the moment of displacement with respect to the waterline. It may be expressed in fourth powers of a foot, using the scales as above stated, horizontally, 1 inch = 224.28 cubic feet; vertically, 1 inch = 2.083 feet. As the planimeter gives 0.651 square inches, the moment of the displacement below *L. W. L.* works out at

$$0.651 \times 224.28 \times 2.083 = 304.18 \text{ feet}^4.$$

$$C.\ B.\ \text{below}\ L.\ W.\ L. = \frac{304.18}{326} = 0.934 \text{ feet.}$$

The result must be drawn in according to scale. The way shown in getting it has been chosen only to have a clear connection, and may be much abbreviated. It suffices to divide the area by the length of its upper limit line, without regard to scales, the displacement being represented by this length, which is found to be 1.455 inches.

$$\frac{0.651 \text{ square inches}}{1.455 \text{ inches}} = 0.4475 \text{ inches.}$$

For, using the vertical scale in the diagram, 0.4475 inches corresponds to 0.934 feet.

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It remains to fix the longitudinal position of the *C. B.* by the numbers obtained from the diagram. The difference between the areas of the moment curves is 0.1084 square inches aft of section 6, and the area of the curve of displacement being 2.868 square inches, the distance of the *C. B.* abaft section 6

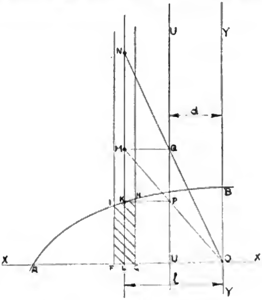

FIG. 2.

works out at $\frac{0.1084 \times 78.74}{2.868} = 3$ inches. For the unity distance *O U*, by which the quotient of the areas is to be multiplied, is 78.74 inches.

The height of the transverse metacenter above *C. B.* is got by dividing the transverse moment of inertia of the load-waterline by the displacement. Let the curve *A K B* in Fig. 2 represent the load-waterline, and regard a small part *F G H I* of it, which may be taken as a rectangular area of the width *F G* and the height *K L*. The moment of inertia of such an area, with respect to the *X* axis, is given by $\frac{F G \times K L^3}{3}$.

Therefore, if we set off the third powers of the waterline's half breadths, and pass a curve through, one-third of the area between this curve and the *X* axis will give the moment of inertia of the half waterline, and two-thirds of it the moment of inertia of the whole waterline.

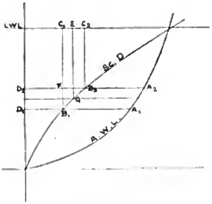

FIG. 4.

In the diagram, Fig. 3, the waterline is drawn below the base line *B B* to avoid confusion. The third powers of its ordinates are taken from tables and lead to the curve 8, the area of

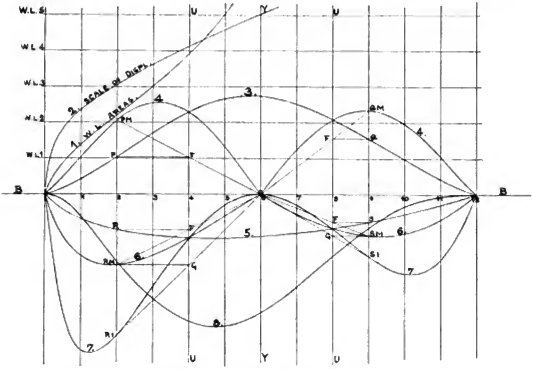

FIG. 3.

which is 3.325 square inches. As the scales are, horizontally, 1 inch = 8.33 feet; vertically, 1 inch = 44.85 feet; the transverse moment of inertia of the load-water plane amounts to $3.325 \times 8.33 \times 44.85 \times \frac{2}{3} = 828$ feet. The height of the transverse metacenter above *C. B.* then is

$$\frac{828}{327} = 2.63 \text{ feet.}$$

It remains to determine the moment to change trim 1 inch. For that the longitudinal moment of inertia of the load-water plane, with respect to the cross axis through its center, is required. From the waterline 5 moment curves are derived in the same way as the moment curves of the displacement curve were found, and the center of flotation determined by them. Then, taking the moment curves as new original curves, and applying on them the same construction, we find new curves (7 in the diagram), the areas of which, multiplied by the square of the distance *O U*, will give the longitudinal moment of inertia of the load-water plane with respect to the suggested axis (section 6). To get the moment of inertia, referring to the axis through the center of flotation, we must subtract $A \times a^2$, where A means the area of the load-water plane and a the distance of its center from the suggested axis.

After having obtained the center of flotation, we could have determined the moment of inertia with respect to the center axis direct; but that would make more trouble than the way indicated above, which is also taken from Nehl's method.

Area of half load-water plane (No. 5) 1.6 square inches = 111 square feet.

Difference between planimeter readings of moment curves, 0.45 square inches.

Center of flotation aft of section 6,

$$\frac{0.45}{1.6} \times 78.74 = 22.15 \text{ inches.}$$

Sum of areas of curves 7, 3.15 square inches.

Longitudinal moment of inertia referring to section 6,

$$3.15 \times 2 \times 6.562^2 \times 69.3^* = 18{,}580 \text{ feet.}$$

$$A \times a^2 = 690 \text{ feet.}$$

Longitudinal moment of inertia, referring to axis through center of flotation, 17,890 feet.

Moment to change trim in fresh water,

$$1 \text{ inch} : \frac{17{,}890}{12 \times 35 \times 39.4} = 1.08 \text{ foot tons.}$$

To calculate the displacement, centers, etc., for any other draft would simply be a repetition of the way shown for waterline 4, and therefore may be dispensed with. Some practical rules might yet be of value:

STEAM TRAWLER FOAM.

To prove its exactness, Fig. 2 must be referred to once more. In developing the proof for the moment curves we found the equation

$$L\ M \times d = K\ L \times l.$$

Regarding the similar triangles *O L N* and *O U Q*, we have

$$L\ N : U\ Q = l : d$$

$$L\ N \times d = U\ Q \times l = L\ M \times l = \frac{K\ L \times l^2}{d}$$

$$L\ N \times d^2 = K\ L \times l^2.$$

Now the moment of inertia of the element strip *F G H I*, with respect to the *Y* axis, is given by $F\ G\ H\ I \times l^2 = F\ G \times K\ L \times F$, or, substituting $L\ N \times d^2$ for $K\ L \times l^2$.

$$F\ G\ H\ I \times l^2 = F\ G \times L\ N \times d^2.$$

The moment of inertia of every element strip is represented by the product of the element strip of a new curve multiplied by the square of the standard distance d, and therefore the moment of inertia of the whole original curve is given by multiplying whole the area of the derived curve by d^2.

From the diagram the following results are obtained:

1. Take the drawing paper sufficiently wide to avoid the planimeter running over the edge.
2. To simplify multiplications, take the distance d a simple number, but not too small, to avoid too wide areas for the moment and moment of inertia curves.
3. Add and subtract adjoining areas with the aid of the planimeter. As the base line is sometimes rather long, it is best to use planimeters of long range.

American-Built Steam Trawlers.

No vessel requires to be more staunchly built or more carefully designed and fitted out than the fishing boat, for at the best the fisherman's life is a hard and dangerous one. Of late years, however, the introduction of power in these boats has bettered conditions greatly. Among the most successful boats recently built, not only as regards efficiency and economy, but also as regards safety and comfort, are the steam trawlers

* From scales.

Spray, Ripple and *Crest*, built by the Fore River Shipbuilding Company, Quincy, Mass. These boats are extremely staunch and seaworthy, being fitted with triple expansion engines and Scotch boilers. They can carry sufficient coal to steam from fifteen to sixteen days. The crew consists of eighteen men and they are most comfortably housed and the officers' quarters are luxurious. Every appliance for the fishermen's art, or trade, is supplied. An otter trawl is provided in each boat. The fish wells are able to carry about 100,000 pounds. The illustration which we give shows the design of these boats.

The French Steam Trawler Catherine.

The hull is of mild steel, meeting the demands for the highest class of the French *Veritas*. She is divided into five water-tight compartments, with cellular double bottom. Her entire accommodations have been studied with great care in order to give the maximum amount of comfort in the warm climate, where she is used. There is a large forecastle, in which are the firemen's, boatswains' and fishing masters' rooms. Above these is fitted a powerful steam windlass and all mooring appliances. The anchors are the latest stockless type. Below the decks are the native crew's quarters with accommodations for sixteen men; also quarters for eight white sailors. These two rooms are completely separated in order to avoid trouble between races. Below this deck is the general storeroom and chain room, also the net room. The ventilation of this part of the ship has been given special attention in order to insure fresh air as far as is possible, on account of climatic conditions. The fish well is 32 feet long, to which can be added, if needed, 11 feet. The hatch is 9 feet 6 inches.

A powerful steam winch of 10 tons capacity, with all the necessary gear for handling the nets, is fitted, and is most complete. Aft of the third water-tight bulkhead is the cross bunker in the boiler room; also longitudinal bunkers with a normal capacity of 135 tons of coal. The fourth water-tight bulkhead is between the boiler and the engine rooms. Aft of the fifth water-tight bulkhead is the shaft tunnel and provision rooms; also the second engineer and mates' rooms.

A large deck house has been provided, in which are the captain's rooms, the officers' dining room, the galley, which is able to provide for thirty men, and the boiler rooms and larder. Aft of the large engine room skylight is the chief engineer's room and the entrance to the cabins below. Above the captain's room is the chart room, in which is the steering gear, and aft of which is the owner's cabin. Above these is the navigator's bridge. The cabins are all pleasingly decorated and fitted with electric lights and ventilated.

The engine is a three-cylinder triple, making 170 revolutions per minute and giving a speed on the trial trip of 14 knots. All the auxiliaries are of the very highest grade. Steam is supplied by a single-ended, cylindrical boiler of the marine type, fitted with two furnaces. The dimensions are as follows: Diameter, 13 feet 2 inches; length, 10 feet 6 inches; grate surface, 49 square feet; heating surface, 1,613 square feet. The working pressure of the boiler is 180 pounds.

The boat is yawl rigged, and has a good sail area, in case the engine is dismantled. Three life boats are fitted, which are installed by special davits of the French Navy type.

It is interesting to know that the bay of Levrier is so full of fish that it is only necessary to use the trawlers' nets for half an hour at a time and the catch is better than four hours' fishing on any part of the French coast. It is not unusual to have the net leave the bottom and come to the surface on account of the huge number of fish that are caught. The catch is usually salted for the European market. Some of it, however, is sent to Senegal, Morocco and Sahara.

FRENCH TRAWLER CATHERINE.

Fuel Oil Statistics.

Oil-burning figures are remarkable, according to the daily press. On the Pacific Coast the Pacific Mail is equipping the *Para, Pennsylvania* and *Aztec* with oil burners, and Mr. R. P. Schwerin, manager of the line, is quoted as stating that his engineers estimated a saving of $160,000 (£32,000) per annum. The use of oil saves time. Before its use forty-five days was an average voyage between New York and San Francisco. This was cut down to twenty-four days, which is about railroad freight time, but it is only fair to say that competition had something to do with this reduction in time. To make a comparison, the American-Hawaiian steamer *Nebraskan* made the voyage from New York to San Diego, Cal., with coal in fifty-seven days five hours and forty-three minutes, burning 2,267 tons of poor coal and with a fire-room crew of fifteen men. Returning, she burned oil to the amount of 8,826 barrels, or about 1,260 tons of California oil, with but six men in the fire-room. On the outward passage, however, the *Nebraskan* made 13,280, while on the return trip she only made 12,760, the outgoing voyage being made longer by the calling at St. Lucia and Coronel for coal. By the use of oil 57 tons of cargo space was saved. The financial gain is reported by the press as $500 (£100) per day. One chief engineer, three assistants, three furnace men, three wipers, one deck engineer and six oilers were all that were required to handle the oil. The regular watch, when under way, was one engineer, two oilers, one furnace man and one wiper. When coal was used five men were on watch in the fire-room, as against two when oil was used.

It is also stated that an efficiency of from 70 to 80 percent of oil fuel in California is obtained, as against 60 to 65 for the coal. A pound of California crude petroleum contains 19,000 British thermal units, while the average Pennsylvania coal contains 14,000 to 14,500 British thermal units. A pound of this oil will evaporate twice as much water as a pound of coal. The actual evaporation efficiency of a pound of oil will be in the ratio of 17 to 10.

In INTERNATIONAL MARINE ENGINEERING for April is a verification of the economy in using oil, in the description of the test of the Revenue cutter *Golden Gate*.

DESIGN AND CONSTRUCTION OF FREIGHT STEAMSHIPS FROM THE ARCGO TRANSFERRING STANDPOINT.

H. McL. HARDING.*

The importance of being able to increase the efficiency of transportation at steamship terminals is now being recognized by the highest executives.

FREIGHT HANDLING MACHINERY.

There are two ways in which improvements are now being made: First, in the installation of machinery in the place of manual labor, and second, in the arrangement and construction of the pier sheds. There still remains a third—namely, the design of freight steamships, so as to remove the present obstructions to quick and economical freight transference. There have recently been constructed in the United States several new steamships, exclusively for transporting freight. Although these vessels are designed for freight carrying only, little or no improvement has been made in the location, number or size of hatches, and side ports, so as to facilitate the loading and discharging the freight. Some of the newest freight steamships are no easier to load and discharge than the passenger vessels.

The following are some of the special features which hinder the rapid and economical freight transference:

The side ports are too narrow and not of sufficient height. There is a limited number of over-all hatchways, and these are generally too small. In some of the forward and aft hatchways it is necessary to hoist from the deck level over the rail. The building of officers' quarters, kitchens, mess rooms and even store rooms, over the whole central portion of the vessel, greatly increases the difficulties of reaching the cargo between decks and renders necessary the blind hatches.

In the handling of freight it should be remembered that machinery is now supplanting manual labor, and will be exclusively employed as soon as the personal equation is supplanted. The most modern methods and the type of such mechanism should be taken into consideration when the design of new freighters is being prepared. The modern machines now being installed at many ports are overhead traveling gantry cranes which, in discharging, lift directly or vertically from the hatches. With coastwise steamers the movement of freight is not only from the hatches, but also through side ports, by manual labor. Considering the mere loading or discharging of the vessel, there would be far greater economy in hoisting the cargo through the hatches and placing it upon the side of the pier than in hand trucking it through the side ports, provided, that freight handling was considered in the designing of the ship. By the latest methods the freight can be taken from the holds to cars, to warehouses, or to any portion of remote sheds without rehandling.

Where the vessel is to carry passengers as well as freight it is necessary to more or less sacrifice freight un-

ANOTHER FREIGHT HANDLER.

loading facilities to the accommodation of the passengers, but there may be a possibility of improvement even here. Where, however, only freight is to be transported, one of the most important things to consider is not only the economical tranference of freight between the vessel and the shore, but also rapid transference. In fact, by some steamship superintendents rapidity is considered of more importance than economy. In some of the coastwise lines the charter value of a vessel is given as $400 (£80) per day, and if such a vessel can be loaded or unloaded in one day instead of two there is a saving of $400 (£80), and if there be a daily succession of such steamers during the course of the year the saving would be very great.

The recently-built coastwise steamship is constructed with small side ports and comparatively small hatches. On account of the design of this type of freighter there must be a great number of lost labor hours in conveying the freight to and fro between decks, the hold, and the hatchways, or the side ports. Generally at each hatchway there are twelve to fourteen men employed in placing the freight so that it

* Terminal Engineer, 20 Broad street, New York.

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will come within reach of the ship's fall, or the hook of the overhead gantry crane, or for removing it from the hatchway. There is no doubt but that with a steamship properly designed for the quick and economical transference of freight there could be effected a saving in manual labor of 5 cents (2½ pence) per ton. On 2,000 tons this would be a saving, even when mechanical methods are employed, of $100 (£20) for loading and $100 (£20) for unloading, or $200 (£40), and, in addition, less time required for the transference, which may represent a far more important economy. This saving in charter value should be 10 cents (5 pence) per ton additional. At present one of the most difficult places in which to handle freight is the lower hold. The freight is lowered into the hatchway and then it is dragged by main force from the hatchway often 40 or 50 feet. In discharging, a chain is placed around the case, the hook of the ship's fall is attached to the chain and the package is drawn over the other freight until it reaches the hatchway, where it is elevated in the usual manner. It is necessary to drag this case or package over an uneven surface, catching here and there a corner of a box and often breaking the casings and causing other damage.

Among other obstacles to freedom in freight movements in the present type of steamships are the stanchions which support the decks. In some of the newer vessels steel knees or elbows in the arch construction are used and stanchions are largely dispensed with, but even in some of the latest vessels these stanchions are still retained. Provision should be made for the stresses on decks and keelsons, as the top and bottom

FREIGHT TRANSPORTER.

members of the fore-and-aft girder. The steamships of the Brunswick Line were built on these lines and have been in operation for five or six years and no structural weaknesses have been reported. The views herewith of an ore freighter used upon the Great Lakes show the absence of deck obstructions. The upper deck is flush from forecastle, aft. The question is whether freight steamships cannot be constructed somewhat like these vessels or be a combination of the two. There is no question but that with modern freight transferring machinery a boat like the lake steamships, from which has been taken a load of 12,000 tons in about five hours, if filled with a miscellaneous cargo, could be far more quickly unloaded than any of the types seen along the Atlantic coast. The lake vessel is filled with ore, but it would be a long and difficult matter to unload even 12,000 tons of ore if the ocean type of boat were used. There were carried 13,000,000 tons of package freight in the lake boats last year.

If a freighter could be so constructed that boxes, barrels and packages of all kinds could be hoisted vertically and swung over the side without the lateral or horizontal moving between decks it would be a great improvement over the present laborious methods between decks and in the hold. In freight vessels as much of the deck as possible should be composed of hatches. The quarters and accommodations of the ship's crew should be forward and aft. The large lake freighter has a length of about 600 feet, with thirty-six or so hatches, while the length of the coastwise steamer is seldom more than 400 or 500 feet. It should be possible to design a vessel of sufficient strength and stability and to arrange that the freight could be lifted vertically from the hold. While there seems to be a great diversity of opinion in regard to the possibility of building such a vessel, and making it of sufficient strength, yet from the experience obtained from the Brunswick steamships and the lake carriers it seems as though some engineer, by properly proportioning and arranging the steel structure, can produce a boat which shall, in the near future, be the accepted type for freight transportation.

TRAVELING DOCK CRANE.

The following data in reference to miscellaneous cargo freight and to the expense incurred for labor within the hold of the vessel will show that economy is possible in freight handling, provided the design of the vessel is changed so as to give ready access to the cargo:

Outbound Freight (Manual Labor.)

Average cargo per ship.............................2,000 tons
Average cost per ton handled, manual labor only, including tiering $0.37 (1/6)
Average number of men employed.........................170
Average number of men in ship (holdmen)..................60
Average time of loading...............................17 hours

Inbound Freight (Manual Labor.)

Average cargo per ship.............................2,000 tons
Average cost, including tiering......................$0.39 (1/7)
Average time discharging.............................17 hours
Holdmen 60

Outbound Freight (Machinery.)

Loading 2,000 tons in nine hours:
Total manual labor costs..................$218.00 (£43 12/-)
Cost holdmen $162.00 (£32 8/-)
Cost per ton loading, including tiering............$0.13 (6½d.)

Inbound Freight (Machinery.)

Discharging 2,000 tons in nine hours:
Total manual labor costs.......................$245.00 (£49)
Holdmen $189.00 (£37 16/-)
Cost per ton discharging, including tiering........$0.14 (7d.)

It will be seen what a large proportion of the labor costs

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is consumed within the ship, even when mechanical methods are employed.

In loading, it is....$162.00 (£32 8/-) of the $218.00 (£43 12/-)
In dicharging, it is....$189.00 (£37 16/-) of the $245.00 (£49)

Not long since, I went over a new freight steamer with the stevedore and he was praising the new vessel, its solid construction, its lines, and many other points of excellence, but I asked him if he thought it was convenient for loading and discharging. He did not want to express an opinion, for, to use his own words, "I would be considered a knocker, and my opinion would not be considered of value by the engineers." It developed in the short conversation that he regarded the boat as most inconvenient to load and discharge on account of the small and narrow hatches, the low headroom of the side ports, and the fact that the side deck ports could not be opened down to the deck, so that the load had to be hoisted up over the rail. These and many other facts were drawn from him, and further, that he considered this new boat far inferior to the older boats in regard to the ease with which freight could be taken to or from the vessel, and he deplored the fact that more time would be consumed in loading and discharging.

From numerous conversations with men who have charge of important terminal work, and from a careful study of the operating condition of handling freight, it seems to me that if the naval architect or builder would spend a week by the side of the stevedore and see the exact process of handling the freight, not merely for an hour each day, but from the time the gang starts in the morning until it leaves off at night, noting carefully the difficulty in handling the different kinds of freight, such as lumber and structural steel, with a full knowledge of the unnecessarily lengthened labor hours, there is no doubt but that more attention would be paid to this important subject of miscellaneous freight transference. Comparison between some of the steamers built in the United States and those in Great Britain, especially those from Glasgow, shows that vessels can be built with very much larger hatchways, even for ocean duty, by American designers. It now remains for some naval architect to design a vessel which shall be the type for many years to come, and this vessel should be designed with reference to its use from the freight handling standpoint, due provision being made for strength, stability and all other necessary conditions. It is not intended that any of these and other important features shall be sacrificed, but that they shall be retained, and, in addition, provision made for the loading and discharging of the vessel in not over half the time and at a greatly reduced expense. I fully realize that it is easier to take down from the shelf the dust-laden plans and designs of the past and copy these rather than to start afresh with new calculations, but now the impelling force is the necessity for more improvement in freight transference. If the above is true in regard to the naval architect how much more is it true in regard to the shipbuilder, who must not only evolve new plans, but consign to the waste heap forms, patterns, and possibly even machine tools?

The manager of a large steamship company who was asked why he perpetuated these obstructions to freight movements, said, "We employ and leave these matters to the shipbuilders and naval architects, and suppose there are good reasons for not making any changes." It is hoped that a discussion will be aroused and that the more progressive builders and architects will indicate how vessels can be constructed so as to help the transportation companies in this important matter of facilitating the terminal work. Herewith are some views of freight-handling machinery adapted for taking the freight directly from the hold of the vessel and placing it upon the pier floor.

HANDLING ORE ON THE GREAT LAKES.

A new type of steamship has lately been constructed by Messrs. Osbourne, Graham & Company, Sunderland, which is classed at Lloyd's 100-A, and is of the arch construction, with enormous hatchways. It is stated that by the redistribution of material that the longitudinal strength has been greatly increased and that the form and structure do away entirely with the usual hold-pillaring. Clear arches are given without any obstructions. Longitudinally the form is also that of an arch, and with the transverse girder, there is greatly increased handling room. This seems a move in the right direction, as not only is freedom from obstructions thus obtained, but also a clear, unrestricted vertical movement of freight, which is so essential where machinery takes the place of manual labor.

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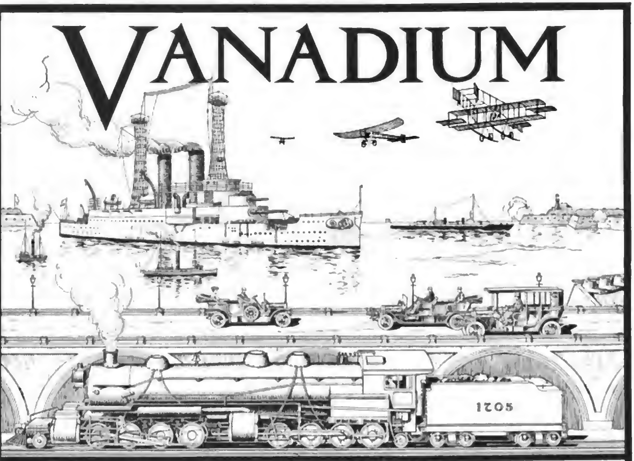

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VANADIUM BRONZE

TO FIT ALL CONDITIONS OF MARINE SERVICE, IS HEREWITH SHOWN. THE PHYSICAL PROPERTIES OF EACH TYPE SHOULD BE NOTED IN THE APPENDED TABLE.

TYPE 1. For general run of castings, such as propellers, propeller struts, couplings, relief valves, shaft sleeves, thrust rings, gear pumps, hooks, gun mountings, stern bearings, etc., etc.

TYPE 2. For marine fittings, condensers, gate valves, rocker arms, bilge pumps, binnacle stands, mast fittings, cleats, chocks, belaying pins, governors, search light stands, towing hooks, brackets, eccentrics, throttle valves, torpedo tubes, torpedo breeches, conning towers, periscopes, deck plates, etc., etc.

TYPE 3. For engine housings, engine bedplates, air compressor bedplates, air compressor framings, hand wheels, gears, rudder bearings, stuffing boxes, windlass gears, windlass drums, bearing brasses, bushings, spiral gears, port lights, air pumps, reducing valves, etc., etc.

TYPE 4. For whistles, radiator valves, also for forging purposes.

TYPE 5. For plug cocks, steam traps, thermostats, etc.

TYPE 6. For forged pump rods, bolts, valve stems, hose couplings and all kinds of fittings to be riveted. This type is also produced for rolling and drawing.

TYPE 7. For general hardware, quadrants, railings, name plates, indicators, hatches, grease cups, oil cups, gauges, stanchions, engine telegraphs, controller fittings, etc.

TYPE 8. For air compressor cylinders, oil pumps, injectors, exhaust headers, exhaust valve bodies, elbows, tees, water jacketed bearings, gas mufflers, hydraulic valves, hydraulic valve fittings, steam valves, etc. It is a high pressure Steam Metal.

TYPE 9. A special metal used in ship bells, electric bells, electric gongs, fire bells and gongs, submarine signal bells, etc.

TYPE 10. For turbine buckets, superheated steam valves, steam nozzles, pump linings, trolley wheels, circulating pumps, safety valves, journals, glands, etc.

TESTS BY TENSION OF THE DIFFERENT TYPES OF VANADIUM BRONZE CASTINGS.

TYPE.	TENSILE STRENGTH, SQUARE INCH, LBS.	ELASTIC LIMIT, SQUARE INCH, LBS.	ELONGATION IN TWO INCHES PERCENT.	REDUCTION OF AREA, PERCENT.	DIAMETER OF TEST PIECE.
1	71,000	28,500	32.0	27.8	1 Inch
2	65,400	28,400	38.5	31.1	1 Inch
3	65,100	34,400	18.5	17.2	1 Inch
4	56,900	22,800	57.5	43.7	1 Inch
5	59,500	22,000	52.0	37.6	1 Inch
6	51,100	18,100	65.0	45.3	1 Inch
7	59,200	23,000	50.0	39.1	1 Inch
8	32,000	17,500	21.0	18.8	1 Inch
9	62,940	32,960	8.0	17.0	1 Inch
10	70,000	40,000	21.8	....	1 Inch

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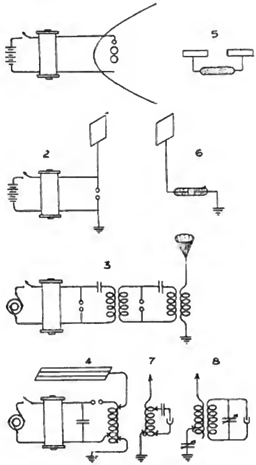
DEVELOPMENTS IN WIRELESS TELEGRAPHY.*

BY COMMANDER S. S. ROBISON.

The purpose of this article is to show briefly to what extent wireless telegraphy has developed in nineteen years. Marconi transmitted a distance of two miles in 1895; in 1896 he transmitted a distance of four miles. In 1897, using vertical wires 150 feet high, signals were successfully exchanged at a distance of about nine miles. A distance of thirty-four miles was reached, and in 1899 on land and between two British men-of-war about sixty miles apart at sea, also eighty-five miles, partly over sea and partly over land.

The apparatus was a 25 horsepower, the frequency of alternating current being 50 cycles per second. From it signals



ARRANGEMENT OF WIRELESS APPARATUS.

were sent across the Atlantic and received on an aerial about 400 feet long, suspended from a kite.

So that in less than eight years after wireless telegraphy was shown to be practical a range of wave lenghts from 1.3 up to 1,500 meters had been used.

The method of construction shown in Fig. 3 was modified so as to omit one of the oscillation transformers, and with this omission this method of generating electric waves is still in use and is commonly called that of inductive coupling.

Professor Slaby subsequently produced, with Count Arco, what was known as the Slaby-Arco system, which used the method of direct connection or direct coupling shown in Fig. 4. This became the general method of coupling transmitters. Stone, however, used the method of inductive coupling both for sending and receiving.

The first portable and convenient means of measuring wave lengths produced by oscillating circuits were made by the Slaby-Arco Company in Germany about 1902.

The use of wave meters showed that, in general, circuits tuned to resonance and connected to each other, as shown in Figs. 3 and 4, generated and radiated waves of two lengths, one longer and one shorter than that which would have been produced by either circuit if oscillating free from the influence of the other.

A difficulty confronted the designers; if they used the plain aerial and generated waves of but one length they were limited to small powers and short distances.

If they used direct or inductively-connected tuned circuits they produced waves of two lengths, only one of which could be received, and part of the energy was consequently wasted.

So that, although the means were discovered of generating waves of any desired length and radiating any desired amount of power, difficulties arose in the use of the large powers which were found to be necessary to send long distance—two waves were generated where only one was desired. This difficulty was partially overcome by weakening the mutual induction between circuits, so as to bring the two waves nearly into coincidence in length; but, in general, the existence of two wave lengths interfered with the sharp tuning which is necessary to prevent interference in receiving.

In 1906 M. Wien observed that while using a spark gap made of metal surfaces placed very close together his measuring instruments only indicated one wave in the radiating circuit—the aerial.

Investigation of this phenomenon appeared to indicate that the gap, possibly on account of the cooling effect of the large surface and mass of material used, regained its di-electric strength to such an extent after two or three sparks had passed that the remaining energy was not sufficient to break the gap down again, so that the closed circuit made but two or three oscillations.

The manner in which the closed circuit transfers energy to the open circuit it appears that this form of spark gap, made up of a number of very short gaps between metal plates, prevents the retransfer of energy from the open to the closed circuit after the closed circuit has completed the first transfer and is momentarily stopped.

With the spark gap open, whatever vibrations are set up are not in tune with those in the open circuit and they absorb little energy from it.

We have two ways of generating electric waves of any desired length, namely, weakening the mutual induction between coupled circuits and by means of the quenched spark.

Aerials generating short wave lengths are more efficient radiators than those generating long ones; but short wave lengths suffer more absorption over land and sea than long ones.

For over-land communication the greater radiation efficiency of the oscillations producing short wave lengths is counteracted at much shorter distances by the greater absorption of short waves. This absorption varies greatly with the character of the land surface—whether wet or dry, level or hilly or mountainous.

It was demonstrated that for short distances the attenuation due to distance varies directly as the distance and does not fall off according to the law of inverse squares.

The distance which signals can be received from an aerial varies directly as its vertical height and directly as the amount of oscillating current in it; also directly as the height of the receiving aerial, so that the efficiency of two similar aerials

* Abstract, *Journal, American Society of Naval Engineers.*

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for wireless telegraph purposes varies as the square of their height.

Taking the lower limit of received current which will produce audible signals as 1/100,000 of an ampere, experiments indicate that in order to communicate 400 miles, with masts 200 feet high, using a 300-meter wave, we must have an oscillation current in the aerial of 1 ampere; to ensure good communication we should have 4 amperes.

To ensure good average communication at 2,500 miles, with masts 450 feet high, we would require, with a 6,000-meter wave, a current of 50 amperes in the aerial to secure readable signals, and about 200 amperes to ensure good communication.

With parity of other conditions vertical wires 20 feet long are sufficient for communicating one mile; 40 feet, four miles; 80 feet, sixteen miles.

This law is not complete, as it failed to take into account the effects of absorption.

The recent Brant Rock experiments are the most extensive series of observations on absorption, the results of which have been published.

It appears we have certain means of generating electric waves of any desired length. We cannot say that they are simple.

Sir William Crookes included in the term receivers, which he knew only as short resonators with which waves were detected by observing the sparks passing between their terminals, apparatus which we now divide into three classes: Receiving circuits, detectors and means for making the action of the detectors audible or visible, such as telephones, ampliphones, Morse writers or recorders.

Marconi in his experiments used as a receiver the apparatus shown in Fig. 5—two metal or tinfoil-covered glass plates connected by a tube containing metal filings.

In 1897 Marconi fixed the proper length of the plates of his receiving apparatus to make them resonate by using plates of tin foil pasted on glass and making a cut across the foil with a very sharp penknife, and bringing it close to the sending apparatus shown in Fig. 1 in such a position that the strips of tin foil are parallel to the line joining the centers of the oscillating spheres, when sparks would jump across the cut.

When the length of the strips were adjusted to approximate resonance the sparking occurred at the greatest distance from the oscillation producer; he brought it to the sending apparatus and made his adjustments there and then set it up elsewhere.

When he used long, vertical wires as senders the method of tuning the receiving set by means of the sending set in its immediate vicinity was not practicable. In May, 1897, with the sending apparatus connected to a vertical wire 150 feet high, the receiving apparatus was at first connected to a wire 90 feet high, about 60 feet above sea level, and for two days attempts to communicate over a distance of three and a half miles were unsuccessful. On the third day the receiving apparatus was carried down to the beach, at sea level, and connected to the 90 feet of wire by the additional 60 feet necessary to reach sea level, making 150 feet in all, and communication was immediately established.

The direct-connected sending apparatus shown in Fig. 4 came into use, direct-connected receiving apparatus was introduced, the connections being as shown in Fig. 7, except that the arrangements for variable connections in both inductance and condenser, and which are used for tuning both the closed and the open circuits, were not introduced at this time, but were a later development.

Stone developed a method of sharp tuning by the introduction of an intermediate-tuned receiving circuit, introduced between the open circuit and the closed detector circuit.

Both the weeding-out circuit, as proposed by Stone, and the Fessenden interference preventer are useful under certain conditions, but usually the inductively-connected tuned receiving circuit (Fig. 8), without any intermediate circuit, is that in general use.

Receiving circuits are not in general more delicate except in the sense of being more selective.

For ordinary ship communication the reliable operating distance of coherers, with expenditure of 2 to 3 kilowatts in the sending apparatus, was from fifty to seventy-five miles.

Many other kinds of detectors were discovered, which could be used with a telephone, but none of them proved to be sufficiently reliable to be placed in general use until the electrolytic detector was developed by Fessenden in 1902.

The introduction of detectors, such as the electrolytic, tripled the working range of telegraph sets.

In 1905, General Dunwoody, U. S. A., introduced carborundum crystal detectors. Crystal detectors are now in general use.

Considering the requirement of darting the sheaf of rays in any required direction. This has not been satisfactorily accomplished except for very short distances.

Marconi generated free electric waves in the focus of parabolic mirror and directed them towards his receiver, which was placed in the focal line of the mirror, but the distances that he was able to cover by this method were so short that he soon discarded this for the vertical earthed-wire transmitter, which generated earthed waves.

Surrounding this vertical wire with a reflector by which the waves could be directed was manifestly impracticable, and no serious efforts in this direction were made for a number of years.

Artom attempted to generate elliptically shaped waves by the introduction of multiple aerials.

Guarini attempted actual direction by means of refracting the waves. Marconi discovered that a transmitter, having a large portion of the aerial horizontal, received more strongly in the direction away from which the horizontal wire pointed and sent more strongly in the direction from which it received the best.

Horizontal aerials radiating from a common center, like spokes of a wheel, were set up on shore in such a way that each one could be connected at will to a common vertical aerial. It was found possible to determine the direction of the sending vessel from the station on shore by connecting the horizontal parts in succession to the vertical parts. The strongest signals were received when the vertical part was connected to that spoke of the wheel pointing away from the direction of the sending vessel.

The trans-Atlantic wireless stations have the horizontal portions of their aerials pointed directly away from each other. This method of directive sending and receiving is only applicable to shore stations. No satisfactory explanation of the cause of the directive effect has yet been offered.

Stone, in the United States, based his attempts at directive receiving on the fact that two vertical wires in a plane at right angles to the direction of the waves would have oscillating currents of the same phase and strength induced in them, which could be made to neutralize each other and produce zero signals.

An unsuccessful attempt was made to determine the relative bearing of two ships from each other by this method.

The importance of having a reliable means of determining the direction from which wireless telegraph signals are coming cannot be overestimated. Being able to direct them is of equal importance.

One operator can be ready to receive two wave lengths at the same time, making use of two receiving sets, one connected to each ear; but this does not cover the case. The custom is to have the receiving circuits broadly tuned for listen-

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ing in, and then adjust them as sharply as to be non-interfering.

Wireless telegraphy is indispensable to the efficient operation of navies, both in peace and war.

Electric Steering Gear.

In general, electric steering gear involves the principle of operating the auxiliary steering gear mechanism by an electric motor in place of the steam engine, which motor may obtain its power directly from dynamo room feeders, and will operate in synchronism with the rudder; that is, the motor is started and stopped by means of a powerful automatic controller each time the rudder itself is started and stopped. The electric gear consists of a disc-brake, a main automatic controller with a resistance, a limit switch and follow-up drum master controller. The master controller consists of a small follow-up controller installed in the steering engine room, and operated by connections to the tiller ropes or telemotor in a similar manner to that employed in operating the valves of the steam engine. This follow-up drum control is also connected to the main driving shaft, and in this manner a follow-up motion is produced, which is in all respects similar to the control obtained by the steam engine equipment. The change from steam to electric, or electric to steam drive, can be accomplished by throw-over clutches or equivalent means.

The control equipment acts to automatically accelerate the motor and to provide a slow speed and bring the motor quickly to rest. In case of overload, the control equipment operates to limit the motor current and torque to a predetermined safe value. A movement of the steering wheel on the bridge produces a corresponding movement of the control mechanism in the steering engine room, whieh through the control equipment starts the motor, and then by mechanical eonnections from the rudder to the control mechanism in the steering engine room, before mentioned, a follow-up is effected and the motor automatically stops at the desired angle. A reverse motion of the steering wheel will revolve the control equipment in an opposite direction, and starts the motor and rudder in the opposite direction.

In order to prevent the rudder from jamming a limit switch is provided, which will automatically shut down the motor at extreme angles of travel. It is possible, however, to operate the equipment in the reverse direction after the limit device has operated at one of the extreme positions.

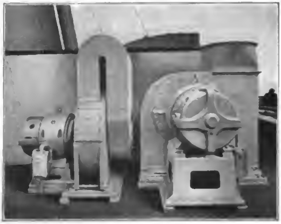
The steering engine and electric motor are provided with mechanical clutches on the main engine driving shaft, so that either the engine or the motor may be thrown into gear with the shaft as desired.

The connection between the tiller rope and telemotor and the follow-up drum in the steering engine room and the connection between this drum and the engine shaft are so proportioned that the results when steering with the electric gear will be similar to those obtained with the steam engine; that is, a given throw of the steering wheel will produce the same angular travel of the rudder with the electric gear as with the steam. Any movement of the steering wheel on the bridge corresponds to a certain number of degrees of the rudder in one direction, and turns the master controller a proportionate number of degrees, and is followed immediately by the starting of the motor and turning of the rudder in that direction; the motor-driving shaft operating while driving the rudder to return the master controller toward the initial or center position. When the motor has reached the angular position, as indicated by the steering wheel, the motor-driving shaft will have made the proper number of revolutions to bring the master controller back to the initial position, at which point the control circuits in the master controller are broken and the motor is stopped.

The reversal of the movement of the steering wheel reverses the rotation of the motor, and the rudder is turned in the opposite direction, which will revolve the master controller back towards its off position, and the motor will continue to revolve until the rudder is in a position corresponding to the steering wheel, at which point the master controller is in its off or stop position. The manufacturers of the steering gear described in this article are the Williamson Bros. Company, Philadelphia, Pa.

Ship Ventilation.

The art of ventilation, which is now generally recognized as a most important branch of sanitary science, has probably received even more attention at the hands of the builders of large passenger vessels than has been the case with architects of modern buildings. Certain is it that shipbuilders have far greater difficulties to contend with. For instance, there is a larger number of persons on board in comparison to the space available than on land, involving consequently a larger volume of air than is usually required in buildings, excepting, of course, theatres, etc., where, however, the occupation is only temporary. Further, this volume of air has to be distributed



VENTILATING FANS ON BOARD THE OLYMPIC.

among innumerable cabins at such a low velocity as not to cause a draught—so easily noticeable in confined spaces. Provision must also be made for warming the air, as well for its removal when vitiated. And all this must be accomplished with the utmost regard to economy of space. Artificial ventilation is now rapidly superseding natural ventilation at sea, as it has been doing for some time past on shore. The difficulty of obtaining with cowls alone an adequate and regular supply of fresh air below deck, and of controlling and distributing the air current produced by them, has led the modern shipbuilder to adopt mechanical ventilation, with its small and compact units of comparatively high volumetric capacity. No better example of up-to-date practice could be found than on the White Star liner *Olympic*, the largest vessel afloat. Messrs. Harland & Wolff have equipped it with no fewer than seventy-five electrically-driven Sirocco fans, measuring from 20 inches to 50 inches in diameter. Some of these fans, which are connected to heaters, distribute the fresh warmed air throughout the ship, others are used for extraction purposes, while twelve large fans are employed for the ventilation of the stokeholds.

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LAUNCH OF THE TITANTIC.*

The general arrangements for launching the 45,000-ton White Star steamship *Titanic*, which occurred on May 21 at the Harland & Wolff shipyard at Belfast, were similar to those in the case of the sister ship *Olympic*, which were described in the December, 1910, issue of INTERNATIONAL MARINE ENGINEERING. The vessel was held on the ways by hydraulic triggers, only requiring to be released by the opening of a valve in order to let her glide into the water. Her launching time was sixty-two seconds, her speed 12 knots and her weight about 25,000 tons.

The *Titanic* is of the same design as the *Olympic*. The following are the leading dimensions:

Length over all	882 ft. 9 ins.
Length between perpendiculars	850 ft.
Breadth, extreme	92 ft. 6 ins.
Depth, molded, keel to top of beam, bridge deck	73 ft. 6 ins.
Total height from keel to navigating bridge	104 ft.
Gross tonnage (about)	45,000 tons.
Load draft	34 ft. 6 ins.
Displacement (about)	60,000 tons.
Indicated horsepower of reciprocating engines	30,000
Shaft horsepower of turbine engines	16,000
Speed	21 knots.

The *Titanic* is a triple-screw steamer having a combination of reciprocating engines with a low-pressure turbine. The reciprocating engines exhaust into the low-pressure turbine, which drives the central propeller. The reciprocating engines which drive the wing propellers are sufficient for manœuvring in and out of port and going astern. There is no necessity for an astern turbine, which is required in steamers fitted with turbines only. There are twenty-nine boilers for the ship, having in all 159 furnaces. All of the boilers are 15 feet 9 inches in diameter; but twenty-four are double-ended, being 20 feet long, while five are single-ended, being 11 feet 9 inches long. The shells of the latter are formed by one plate; the others have, as usual, three strakes. At each end there are three furnaces, all of the Morison type, with an inside diameter of 3 feet 9 inches. The working pressure is 215 pounds, and this under natural draft. The boilers are arranged in six watertight compartments, and owing to the width of the ship it has been possible to fit five boilers athwartship. The boiler compartment nearest the machinery space accommodates the single-ended boilers, and these are arranged for running the auxiliary machinery while the ship is in port, as well as for the general steam supply when the ship is at sea.

In each of the five large boiler rooms there are two See's ash ejectors, and in addition there are four of Railton & Campbell's ash hoists for use when the vessels are in port. A large duplex pump of Harland & Wolff's own make is fitted in a separate room in each boiler room, the advantage being that the working parts of the pumps are not injuriously affected by dust. The boilers are fitted with the Ross-Schofield patent marine boiler circulators. The exhaust turbine, instead of being in the same engine room with the two sets of piston engines, as in earlier ships, is accommodated in a separate compartment abaft the main reciprocating engine room, and divided from it by a watertight bulkhead. In the reciprocating engine room there are two sets of main engines—one driving the port and the other the starboard shaft. In the wings there are the main feed and hot-well, bilge, sanitary, ballast and fresh-water pumps, and a contact and surface heater; while on the port side a space has been found for extensive refrigerating plant under the immediate observation of the engineers.

The two sets of reciprocating engines—one driving each wing shaft—are of the four-crank type, arranged to work at 215 pounds per square inch, and to exhaust at a pressure of about 9 pounds absolute. These engines are on the balanced principle. The high-pressure cylinder is 54 inches in diameter, intermediate cylinder 84 inches, and each of the two low-pressure cylinders 97 inches in diameter, the stroke being 75 inches in all cases. The exhaust steam turbine, by which the central screw will be driven, is of the Parsons type, to take exhaust steam at about 9 pounds absolute and expand it down to 1 pound absolute. The condensing plant is designed to attain a vacuum of 28½ inches (with the barometer at 30 inches), the temperature of circulating water being 55 degrees to 60 degrees F. The rotor is built up of steel forgings, is 12 feet in diameter, and the blades range in length from 18 inches to 25½ inches, built on the segmental principle, laced on wire through the blades and distance pieces at the roots, and with binding soldered on the edge as usual. The length of the rotor between the extreme edges of the first and last ring of blades is 13 feet 8 inches. There is, as has been

THE WHITE STAR STEAMSHIP TITANIC, SISTER SHIP OF THE OLYMPIC, ENTERING THE WATER.

* Welin davits are fitted throughout.

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said, no astern turbine, as the center shaft is put out of action when the ship is being manœuvred. The bearings, thrust and governor are of the ordinary type adopted in Parsons turbines. The turbine can be rotated by electric motor, and the usual lifting gear for the upper half of the casing and the rotor is also actuated by electric motor. The rotor weighs about 130 tons, and the turbine complete weighs 420 tons. The turbine shaft is 20½ inches in diameter, the tail shaft 22½ inches, each with a 10-inch hole bored through it.

The propeller driven by the turbine is built solid, of manganese bronze with four blades, the diameter being 16 feet 6 inches. It is designed to run at 165 revolutions per minute when the power developed is 16,000 shaft-horsepower. As usual with turbine condensers, the inlet is of the full length of the condenser, and is well stayed vertically by division plates. In line with these there are in the condenser corresponding division plates, which secure an equal distribution of steam over the whole of the condenser tube area. The pear shape concentrates the tube surface at the point where the largest volume of steam is admitted where it is most needed.

There are four sets of gunmetal circulating pumps, two for the port and two for the starboard condensers, with 29-inch inlet pipes and driven by compound engines of Harland & Wolff's own make. For each condenser there are two sets of Weir's air pumps of the "dual" type, both air and water-barrels being 36 inches in diameter by 21 inches stroke.

For generating electric current, both for light and power, four 400-kilowatt engines and dynamos are fitted in a separate watertight compartment aft of the turbine room at tank-top level. The engines, which indicate each about 580 horsepower, are of the Allen vertical three-crank compound, enclosed forced lubrication type, running at 325 revolutions per minute. Each set has one high-pressure cylinder, 17 inches in diameter, and two low-pressure cylinders, each 20 inches in diameter, with a 13-inch stroke. They take steam at 185 pounds pressure per square inch. The engines exhaust either into a surface heater or to the condenser. Each engine is direct-coupled to a compound-wound, continuous-current dynamo, with an output of 100 volts and 4,000 amperes. Their collective capacity is 16,000 amperes. The dynamos are of the ten-pole type, and are fitted with inter-poles.

In addition to the four main generating sets there are two 30-kilowatt engines and dynamos, placed in a recess off the turbine room at saloon-deck level. Three sets can be supplied with steam from either of several boiler rooms, and will be available for emergency purposes. They are similar to the main sets, but the engines are of the two-crank type. The distribution of current is effected on the single-wire system, and is controlled and metered at a main switchboard placed on a gallery in the electric engine room, to which the main dynamo cables and feeders are connected. The latter pass up through port and starboard cable trunks to the various decks, radiating from thence to master switch and fuse boxes grouped at convenient points in the machinery spaces and accommodation, from whence run branches to the distribution fuse boxes scattered throughout the vessel controlling the lamps and motors.

A complete system of electric lighting is provided, and electricity is also largely employed for heating as well as for motive power, including seventy-five motor-driven "Sirocco" fans, from 55 inches to 20 inches in diameter, for ventilating all the passenger and crew spaces as well as the engine and boiler rooms. All the fan motors are provided with automatic and hand-speed regulation.

The shell plating of the ship is remarkably heavy. It is mostly of plates 6 feet wide and of about 30 feet in length. The width tapers towards the ends. The laps are treble-riveted, and the shell strakes in the way of the shelter and boat decks have been hydraulically riveted. Also the turn of the bilge, where bilge keels 25 inches deep are fitted for 295 feet of the length of the vessel amidships. There are fifteen transverse watertight bulkheads, extending from the double bottom to the upper deck at the forward end of the ship, and to the saloon deck at the after end far above the load waterline. The room in which the reciprocating engines are fitted is the largest of the watertight compartments, and is about 69 feet long; while the turbine room is 57 feet long. The boiler rooms are generally 57 feet long, with the exception of that nearest the reciprocating engine compartment. The holds are 50 feet long. Any two compartments may be flooded without in any way involving the safety of the ship. The two decks forming the superstructure of the ship and the navigating bridge are built to ensure a high degree of rigidity. At the sides they are supported on built-up frames, in line with the hull frames, but at wider intervals. The deck houses are specially stiffened by channel-section steel fitted in the framework, and where, as on the boat deck, the public rooms pierce the deck, heavy brackets are introduced to increase strength against racking stresses when the ship is steaming through a heavy seaway. Expansion joints are made in the superstructure above the bridge deck at convenient points in the length—one forward and one aft, the whole structure being completely severed and the joints suitably covered.

The stern-frame was made by the Darlington Forge Company, and the total weight of the casting was about 190 tons, the stern frame being 70 tons, the side propeller brackets 73¼ tons, and the forward boss-arms 45 tons. The center propeller, driven by the turbine, works in the usual stern-frame aperture, while the wing propellers are supported in brackets. The stern frame is of Siemens-Martin mild cast steel, of hollow or dish section, in two pieces, with large scraphs, one on the forward post and one on the after post, connected with best "Lowmoor" iron rivets, 2 inches in diameter, the total weight of rivets being over a ton. They were all turned and fitted and specially closed with rams. There are in all 59 rivets in the forward and 54 rivets in the after scraphs. In the stern frame there is the boss for the shaft driven by the turbine, the lower portion of this part of the stern frame having a large palm cast on its extreme forward end, to give a solid connection to the after boss-arms and main structure of the vessel.

The rudder also has been constructed by the Darlington Forge Company, Ltd., and is of the usual elliptical type, of solid cast steel, built in five sections, coupled together with bolts varying from 3½ inches to 2 inches in diameter. The top section of the rudder is of forged steel from a special ingot of the same quality as naval gun jackets. On the completion of the forging an inspection hole was bored through the stock of the rudder in order to ensure that there were no flaws.

There are ten decks in the ship, named from the bottom upwards: Lower orlop, orlop, lower, middle, upper, saloon shelter, bridge, promenade and boat. The passenger decks—promenade, bridge, shelter, saloon, upper, middle and lower—are named alphabetically A, B, C, D, E, F, G. Two of the decks are above the molded structure of the ship. The lower orlop, orlop and lower decks do not extend for the complete length of the structure, being interrupted for the machinery accommodation. The bridge deck extends for a length of 550 feet amidships, the forecastle and poop on the same level being respectively 128 feet and 106 feet long. The promenade and boat decks are also over 500 feet long. The first class passengers are accommodated on the five levels from the upper to the promenade decks. The second class passengers have their accommodation on the middle, upper and saloon decks,

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and the third class passengers on the lower decks, forward and aft, and on the middle, upper and saloon decks aft.

The steering gear is fitted on the shelter deck, and is very massive, the diameter of the rudder stock—23½ inches—affording some idea of the dimensions. The gear is of Harland & Wolff's wheel-and-pinion type, working through a spring quadrant on the rudder head, with two independent engines, having triple cylinders, one on each side. Either engine suffices for the working of the gear, the other being a stand-by. The gear is controlled from the navigating bridge by telemotors and from the docking bridge aft by mechanical means.

The navigating appliances include, in addition to two compasses on the captain's bridge and one on the docking bridge aft, a standard compass on an isolated brass-work platform in the center of the ship, at a height of 12 feet above all iron work and 78 feet above the waterline. Adjacent to the bridge there are to be two electrically-driven sounding mchines, arranged with spars to enable soundings to be taken when the ship is going at a good speed.

The vessel is to be fitted with complete installation for receiving submarine signals. The lifeboats, which are 30 feet long, are mounted on special davits on the boat deck. The ship is designed for two masts, 205 feet above the average draft line, a height necessary to take the Marconi aerial wires, and to insure that these will be at least 50 feet above the top of the funnels and thus clear of the funnel gases. The masts are also for working the cargo by means of cargo spans, and in addition there is on the foremasts a derrick for lifting motor cars, which will be accommodated in one of the foreholds. There are three cargo hatches forward and three aft. All the hatches in the after part of the ship are served by electric cranes of the same make; two of these will be on the promenade deck; there being two small hatches to the hold below, so as to form a minimum of interference with the promenading space.

The first class passengers will be accommodated on the five levels from the upper to the promenade decks. The second class passengers have their accommodation on the middle, upper and saloon decks, and the third class passengers on the lower deck, forward and aft, and on the middle, upper and saloon decks aft. There are three elevators in the main companionway and one in the main second class companionway. For first class passengers there are thirty suite rooms on the bridge deck and thirty-nine on the shelter deck. These are so arranged that they can be let in groups to form suites including bedrooms, with baths, etc., with communicating doors. On each of these two decks, close to the companionways on either side, adjacent rooms are fitted up as sitting or dining room. In all there are nearly 330 first class rooms, and 100 of these are single-berth rooms. There is accommodation for over 750 first class passengers.

For second class passengers the rooms are arranged as two or four-berth rooms, the total number of second class passengers being over 550. For the third class passengers there is a large number of enclosed berths, there being 84 two-berth rooms. The total number of third class passengers provided for is over 1,100.

The first class promenades on the three top decks in the ship will be exceptionally fine. The bridge deck promenade is entirely enclosed. It is a space over 400 feet long, 13 feet minimum width each side of the vessel, and with a solid side screen fitted with large, square lowering windows. The deck above this is the principal promenade deck, and is entirely devoted to first class passengers. It is more than 500 feet long, and will form a splendid promenade, the width in parts exceeding 30 feet. The topmost, or boat deck, is also devoted to first class promenading, and is 200 feet long and the full width of the ship. The first class dining saloon is designed to accommodate 532 passengers, and ample smoke-room, restaurant, lounge and reading and writing room accommodation is also provided.

The second class dining saloon is situated on the saloon deck aft. It extends the full breadth of the vessel, with extra large opening pivoted sidelights arranged in pairs. The paneling of this room will be carried out in oak. The third class dining accommodation is situated amidships on the middle deck, and consists of two saloons well lighted with sidelights and will be finished enamel white.

Deck View of Battleship Delaware.

As the battleship *Delaware* was leaving New York harbor June 1 to cross the Atlantic to take part in the great Corona-

DECK VIEW OF THE U. S. BATTLESHIP DELAWARE.

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tion naval review at Spithead, our photographer, Edwin Levick, of New York, photographed the ship as she was about to pass under the Brooklyn Bridge. A reproduction of his photograph is shown herewith.

FERRY STEAMER PUPUKE.

Steamer *Pupuke* has been built at Auckland, New Zealand, for the Tahapuna Tram & Ferry Company, to run from the city across the harbor to O'Neil's Point, where the passengers connect with the same company's tram service to Lake Tahapuna, one of New Zealand's pleasure resorts.

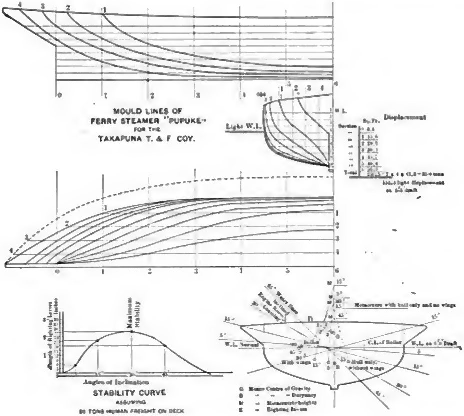
In making this trip the vessel has to cross the prevailing winds, which at times are very severe, and also across a tide of about three knots. For this reason the vessel was designed with the deck projecting on each side beyond the hull proper and then planked up and calked outside the struts so as to form airtight compartments, extending on both sides from the water line to the deck. By this means a very much larger passenger license was granted, the vessel took practically no more power to drive, and under bad weather conditions, when all the passengers accumulated on the lee side, the wings becoming submerged, moved over the center of buoyancy and increased the stability of the vessel. This feature was very noticeable when on one occasion the *Pupuke* took out about 500 passengers to witness some yacht races, when with passengers crowding to one side, both on upper and lower decks, the vessel only listed sufficiently to allow those behind to see over the people in front.

Another feature is the building up forward and aft of the superstructure to prevent the drafts usual on these vessels, caused by the vessel's progress. It has also proved itself beneficial in keeping off the spray in head-on weather. On the upper deck a matchlined bulwark is carried round fore and aft for the same reason. The hull itself is built on the diagonal principle, which, we believe, is peculiar to New Zealand,

THE NEW ZEALAND FERRY STEAMER PUPUKE.

for vessels up to about 150 feet in length, the reason being that the New Zealand kawri lumber is very suitable for this form of building. Believing this will interest wood shipbuilders, we will endeavor to describe the *modus operandi*, as follows:

After the keel has been laid, the garboard strake is laid up on each side, and edge bolted through from outside edge of one garboard to the other, the bolts passing through top of keel. Then assuming, as was the case in this ship, that the diagonal planking is to be two thicknesses of ⅞-inch planking, the floors are cut from hard wood and placed in position, leaving false blocks of 1¼-inch thickness between the floors and the keel, to be afterwards knocked out to allow the diagonals to pass through below the floors and over the keel.



LINES AND STABILITY CURVE OF THE PUPUKE.

Then having set up the temporary molds in position about 6 feet apart, the stringers are bent round the molds after being steamed and clamped up to the molds which, if of wood, are notched out to receive them, and the ends are secured to stem and stern posts.

The frame is then ready for the diagonals, which are 6 inches by ⅞ inch, they are steamed and quickly slid in between the keel and floors, and men on each side with clamps bend the diagonal right up to the deck line on each side and secure them to the stringers, the end of the diagonal on the port side rising at an angle of about 45 degrees from the keel and finishing at the deck line forward of amidships and the end on the starboard side rising aft of amidships, thereby forming a diagonal with the center line of the ship. This is continued as far up and forward as possible to insert between keel and floors, but when reaching the deadwoods the diagonals are cut and securely rabetted.

After laying this first diagonal the outside is coated with Stockholm tar and then the second diagonal is put on in the same way, but at the opposite angle; another coat of Stockholm tar, and on goes the fore and aft skin of 3 inches by 9 inches at the top of side, and on turn of bilge and intervening planking, 9 inches by 2½ inches. The hull is then thoroughly fastened with bolts and nuts, long ones through the stringers and short ones between, but through the diagonals. The keelsons having been put in can be then bolted through each floor and skin of ship, and, when the nuts are tightened, the keelsons, floors, diagonals and keel are all hove up good and sound. Bulkheads are then put in and secured, and the molds lifted out and the vessel sheathed, in this case with ⅝-inch Tobra (a New Zealand wood which resists the attack of worm), laid on felt. The result is a vessel that will stand a tremendous amount of wharf bumping and hard usage, and does not seem to be affected by being continually allowed to ground at the wharves.

The writer designed a vessel some years ago on this principle, and, up to this date, she is loaded three times a week with 200 tons of cement while resting on the bottom, and yet is absolutely watertight, as, of course, is necessary for the cement trade. There are vessels thirty years old still running in New Zealand waters which are built on this method and are sound yet.

The *Pupuke* is propelled with a compound surface condensing engine, having cylinders 13 inches and 26 inches by 18 inches stroke, with independent pumps and condensers and two boilers of the marine return tube type, with a working pressure of 130 pounds per square inch. Two boilers were fitted with a view to lowering the center of gravity and to allow the shaft to run between rather than under the boilers. The independent pumps and condenser were fitted with a view to getting away from the wharf with full speed, and to save fresh water from the dynamo at night while lying at the wharf.

The pumps are the writer's own design and have given good results in several vessels, the air, circulation, feed and bilge pumps being all worked from one cross-shaped crosshead by one cylinder operating through a piston rod into the center of the cross, and valve motion and eccentric motion being secured by return connecting rods to two small fly-wheels.

The vessel is well equipped with electric light from a Brush dynamo coupled direct to a Reader engine. The side lights and masthead lights are all electrically operated from the pilot houses. The passenger license is 774 passengers. The hull was built by Mr. George Niccol, shipbuilder, and the machinery by Messrs. George Fraser & Co. The electric lighting system was installed by Messrs. Fenn, and the hull and machinery built under the supervision of Mr. L. B. Harris, A. I. N A, the company's engineer

STEAMER SIOUX.

Steamer Sioux.

The steamer *Sioux* was built by the Moran Company, of Seattle, for the Puget Sound Navigation Company for service on the Seattle-Irondale-Port Townsend route.

She is a single-screw, steel passenger steamer, 150 feet long, propelled by a four-cylinder, triple-expansion engine, with independent auxiliaries. Steam is supplied by two Seabury water-tube boilers with equipment for burning fuel oil. The vessel has a speed of 15 knots, which is an unusual speed to be attained by a steamer of this size. The vessel is built entirely of steel. One of the novel features incorporated in the construction and arrangement of the hull and passenger accommodations is that the house on the upper deck is carried out to the sides of the ship with no space wasted in passageways on the outside of the house. The boat is fully equipped with dining saloon, smoking room, bar, etc., and is built in strict accordance with the United States Steamboat Inspection laws for ocean-going service.

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PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Concrete in an Old Hull.

Referring to Mr. Stein's inquiry in the April number as to the advisability of substituting concrete for other ballast in his iron hull, we can assure him from our own experience that there is absolutely no question as to its advisability. If well done, with the concrete carried well up in her bilges and bound to the hull by means of old bolts run through angle-iron frames, the bottom plating can wear out and yet have a good boat under one's feet.

The writer has concreted the bottoms of four of his own boats, and if I were building a new ship of either iron or wood, irrespective of size, would concrete her bottom, not as we formerly covered her bilges with from ½ inch to 2 inches of cement to prevent corrosion where it was impractical to get at the scale and paint, which was the sole reason for its being done, but to add longitudinal strength to hull and lessen the liability of the bottom being pierced by rocks, should she be stranded on rocky bottom. I doubt if our marine architects realize the vast increased strength and resisting power to abnormal strains a hull of reinforced concrete possesses.

Permit me to cite some actual experiences in the use of this, to the writer's mind, highly valuable building material. About fifteen years ago I purchased an iron steamer whose bottom plating, originally thin, had, by continual crossing over sandy bars, become very thin and almost worn through. We could not afford to replace her bottom, so we experimented with reinforced concrete, placing it about 10 inches thick, carrying it well up above the turn of the bilges, gradually lessening its thickness as we got higher. Through the angle-iron frames we drilled ⅜-inch holes, into which round rods were rove, over all placing the concrete, and made as perfect a bond as possible. Our aim was, and we still consider it the best, to tie the concrete bottom to the upper part of the hull. We considered them as two separate units, the success of the operation depending largely upon their being tied securely together. The job far exceeded our expectations. Afterwards when her bottom had become entirely worn through in places we considered the concreted part the very strongest part of the ship.

Here at Honolulu the writer bought a small schooner, built for and used for freighting. She had about 15 tons of scrap iron ballast in her bilges, into which dirt had been collecting for years. We desired to convert her into a yacht, and to get rid of the odor from the bilges we removed the ballast and took the bottom ceiling out up to and above the turn of the bilges. Along the top of the frames we laid old railroad iron, about 12 inches apart, covering all with concrete about 18 inches thick on the bottom, diminishing to 4 inches above the turn of the bilge. Our object was attained, in so much that we never again were annoyed by bad smells from the bilges. Two years later this boat went ashore on sharp lava rocks upon which the sea beat at times very heavily, and which no ordinarily-constructed hull could have remained intact for twenty-four hours without being crumpled and broken up as a tin can would be had she been built of iron, or if built of wood splintered into matchwood, but upon investigation it was found that her bottom and sides as far as the reinforced concrete had extended were intact. The outside planking and frames were torn and splintered into bits by the pounding on these sharp rocks, which appeared to have no effect upon the concrete bottom. It was as if the outside planking and frame was simply a form, which it was a fact, and that it did figure so far as the structural strength was concerned, the lower half of her hull having the appearance of an old-fashioned wooden chopping dish, every other vestige of the boat having broken up and disappeared, remained intact for months.

This experience convinced me that in reinforced concrete we had a cheap, strong and durable material which could be used in construction of floating property to advantage to a larger extent than at present. I have two vessels now in commission with reinforced concreted bottoms. They can pound rocks until the seas sweep everything above the waterline, yet their bottoms will be all right. It is a well-known fact that when a ship is stranded it is not often that we fear damage to the upper part of the ship's hull, but the crumping up and piercing of her bottom. Some years ago the writer superintended the repairs of a steamer of 4,000 tons capacity. Reinforced concrete was in her in such shape that she is running to-day, and when she goes into the scrap heap it will not be from weakness of her bottom.

We have had for a long time under consideration the construction of a vessel whose hull would be entirely of reinforced concrete. Stranding and the teredo would have no terrors for us then. The question of weights, thickness of material and best type of reinforcement are well worth the earnest attention of the marine architect and engineers. The ordinary angle-iron without reverse bars but with longitudinal angle-irons riveted to the frames at close intervals forming a skeleton, like an old-fashioned hoopskirt, is the idea I have in mind. For barges, scows, floating derricks, sectional dry-docks and the like, particularly if located where there are no dockage facilities, there is no question as to the advantage of using this material.

In Mr. Stein's case, where ballast is required, where the ship's bottom is corroded, there would be no mistake made in using reinforced concrete. He must use something for reinforcement—old iron rods, bolts, bars, etc., the longer the better for this work. We have used condemned railroad iron and found it well suited. A heavy mesh wire is very good. The prime feature is to see that it is well secured to the frame of the ship.

We will be interested to hear from other readers as to their experiences with concrete in this line. Fred. C. Miller.

Honolulu, T. H.

A Burst Condenser.

The walls of a surface condenser are subjected to an external pressure, due to the vacuum. The cast iron walls are stronger to an external pressure than to the internal pressure when, as in most cases, the stiffening ribs are cast on the outside of a condenser. From without the condenser is subjected to a compression stress and from within to a tensile stress. The compressive strength of cast iron is greater than its tensile stress. Therefore, the ribs on the outside of the condenser make it stronger to an outside than to an inside pressure. The same is true of the flat-valve chest cover. The stiffening ribs should never be placed on the outside for the above reasons, but this is often forgotten.

It is possible when the cylinder drains are led to the condenser that the pressure in it can become too high when the engine is warmed up. When the air pump is of the common type, with foot buckets and top valves, there is no danger, as these valves will lift, so that the excessive pressure is relieved. But when an Edwards patent air pump is provided there are not foot and bucket valves, as the air-pump piston covers the ports in the lines, the vapor cannot escape and the pressure may become so high that the large flat surface condenser cannot stand it, and burst. It is, therefore, necessary to have safety valves on the condenser, or on the under side of

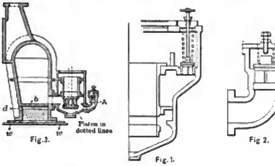

Fig.3. Fig. 1. Fig 2.

the air pump. In Figs. 1 and 2 such valves are shown. When the engine is started the water will lodge in the base of the pump and condenser. If the engine is started too quickly then water cannot easily escape, unless the safety valves have been fitted. In Fig. 1, no water is wasted when the valve lifts, but its action cannot be seen and it is not known if the valve performs its duty or not. In Fig. 2 some fresh water is lost, but the action of the valve can be seen and controlled. When these valves get to leaking, the latter arrangement of valve allows them to be easily repaired, and it is necessary to do this at once or the vacuum will drop. The valve in Fig. 1 will pass some water when leaking, but it will not affect the vacuum.

In starting the tug *M. B.* a sharp knock was heard, and it was impossible to get a good vacuum. On looking for the cause it was seen that water was running from the base of the condenser, showing that something must be cracked. On investigation it appeared that the engineer in charge did not understand the use of the valve, as in Fig. 2, and thought it a pity to lose fresh water, so he turned on the screw of the valve to prevent the waste and the trapped water cracked the condenser's bottom. A new condenser was too expensive for the owner; therefore, something else had to be considered and the following was resorted to: Along the length of the condenser some 1½-inch holes were drilled just under the bottom, on both sides. Wood pieces, Fig. 3 W, were placed all around the bottom flange. Then the whole base was filled with Portland cement. In a few days the cement set and dried thoroughly, and the engine was started and the repair showed that the method was quite satisfactory, as the vacuum could be held, and the condenser never afterwards gave any trouble.

Rotterdam. K. D.

Experiment with Retaining Pins.

In contributing one's experience to magazines that are to be read and discussed by the "salt water fraternity" one has to rely on personal experiences. I submit some few remarks on a difficulty that we once in a while meet, which has to be made good quickly when one is on a lee shore or in shifty currents.

In the instance I refer to the engineer of the ship was a long-legged—yes, and a long-headed party. I was about twenty-fifth assistant engineer at the time, and in making my oiling rounds, soon after going on watch, I detected a slight thud or pound in the low-pressure crank pin, which had previously been running cool and smooth, and, on feeling it, I found it had warmed up considerably, and I also took a nick out of my forefinger in feeling it. Either the jamb nuts had been left loose or the bolts had not been driven up tight, which is usually the case. Anyway, the crank-pin nuts slackened away while we were running, causing the shims and heavy

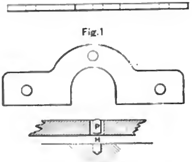

Fig.1

Fig.2

parting piece to flop up and down to the music of the thumping of the crank pin, which was making a rapidly-increasing noise. During the time it took me to think it over and to consider whether to stop and cinch up, the parting pieces, three in number, took advantage of my deliberation to shake loose from the bottom half brasses. As the retaining pins were not screwed in and had worked up into the shims and parting pieces, leaving nothing to hold them, they said "good-bye" and jumped out, striking a heavy, glancing blow on the condenser and landing in the crank-pit, all of which happened in a very few seconds, or parts of a second. Of course, the engine was immediately stopped, and I "ducked." After a survey was held and I got my hair to lie down again, I showed up with a big spanner and "butting-sack," and all there was to do was to take up on the pin just the way she was, hammer all up tight, leaving out the parting pieces altogether, and all this operation took about five minutes.

The remaining run to port was made in thirty to forty minutes. We arrived nearly on schedule time, where new shims and parting pieces were put in ready for the return trip. The attached sketches give an idea of the shims, and Fig. 1, and how the pin *P* worked out of the hole *H*, which is in the lower brace, as shown in Fig. 2. Now the moral of my story is: Have these retaining pins screwed in.

Winthrop, Mass. H. A. L.

A boiler plant waste meter is an instrument which comprises a number of important improvements over older instruments for increasing boiler plant economy. This invention is described as follows: Ordinarily CO_2 recorders work by sampling bells and the measurement of the volume of a sample of gas before and after the abstraction of CO_2. The Uehling waste meter operates on a distinctly different principle; *i. e.*, measurement by partial vacuum between the two apertures. Thus continuous charts are obtained on the recording gages, which can be placed at any distance from the machine proper (being connected to it simply by copper tubing); and, furthermore, simple indicators can be used connected to the instrument in the same way. Again, as the principle of vacuum measurement is used in the Uehling waste meter for measuring temperature as well as CO_2, all the information desired regarding waste gases going up the stack is obtained in the machine.

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Electricity for Marine Work.

We publish in this issue several articles which bring well down to date what has been accomplished during the past quarter of a century in the uses of electricity in the marine field, and they give a glimpse as to the great possibilities of the future of this wonderful power. Probably in no one field are the conveniences and advantages of electricity more evident than in the marine field. The dark holds aboard ship are easily made as light as day; stuffy quarters can be cooled and heated; darkness can be turned to light in an instant, and the whereabouts of the poor fellow who has fallen overboard located. A new language has sprung up, which, to the ears of an engineer of scarcely more than twenty-five years ago, would be senseless babble, and yet to-day we do not know any more as to what this wonderful force is than was known generations ago. Fortunately, however, we know how to generate the force, and how to properly harness it for its many uses. In our articles we show the many uses of electricity, not only for power, heating and lighting, but in its latest development—that of wireless telegraphy. Almost as important uses are shown in yards where vessels are built and repaired, and last, but by no means least, is the possibility of using this wonderful force as a prime mover for vessels of large sizes. It will thus be seen that electricity not only greatly adds to the convenience of the shipbuilder and those who operate the ships, but especially to the convenience and comfort of passengers, and vessels equipped with wireless telegraph are put in instant communication with all corners of the globe. All of these wonderful developments of the past twenty-five years lead us to speculate as to what may be the marvelous developments of the next twenty-five years.

Economical Handling of Freight.

The several communications published in another column give marked evidence that the article in our June issue regarding the economical handling of freight touched upon an important point. The only way to bring about any improvement in this important part of marine work is for the designers and builders of ships to work in harmony with those people who handle the freight at the shore end, and, judging by many private letters received, in addition to those published, there is a desire to bring about this conjunction of interests. The economical handling of freight seems to us, perhaps, the most important question from a financial point of view that is before the marine interests to-day, and we sincerely hope that those of our readers who have not already given this subject careful consideration will turn back to our June issue and note the points made by Mr. Harding and offer any further suggestions which may tend to bring about the much-needed improvements.

Use of Concrete on Board Ship.

In previous issues we have called attention several times to the uses of concrete in building vessels. In this issue we print a letter from Honolulu which tells of an unusual use of concrete in giving new life to old and wornout hulls. The great value of the letter lies in the fact that it does not deal with experiments, but with practical commercial results. It demonstrates that concrete is thoroughly reliable for repairs, and that by its use practically new hulls can be made out of old ones. We all know that concrete has for years been used to some extent in ships' bottoms advantageously. Evidently success in using this material depends upon the proper use of metal binding, wire-mesh, bars, rods, etc. There are many old vessels, no doubt, which could be saved from the scrap pile by the judicious use of this material. It has in its favor cheapness, reliability and permanency; it can be applied at any place with tools that can be carried with ease and obtained in any port; no great skill is required in using it, and it improves with age, which cannot be said of other materials.

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THE ECONOMICAL HANDLING OF FREIGHT.

The article published on page 237 of our June issue on the "Design and Construction of Freight Steamships from the Cargo Transferring Standpoint," has brought forth a great many communications from our readers. Unfortunately, most of them are not intended for publication. Following are a few which we have been permitted to print. There are many important points still to be brought out in this discussion, and we shall hope in a future issue to publish further discussion:

EDITOR INTERNATIONAL MARINE ENGINEERING:

The article by Mr. H. McL. Harding on the importance of arrangement for freight handling in the designing of cargo steamers is most interesting and absolutely true.

The trouble, so far as I see it, is that it is not to the shipbuilder's interest to spare sufficient time in developing a new construction, the results of which he must guarantee. If he builds something which has been proved successful in the past he escapes possible future trouble. Usually our freight steamers, or, in fact, all our steamers, are built by the oldest captain and engineer of the line putting their heads together with some favored shipbuilder, with the results mentioned by Mr. Harding. Of course, somebody has got to pay for the work of developing a new design, and the natural person to pay for this is the one who is going to most directly benefit; that is, the ship owner. Until he can see this, and is willing to spend the money to have such a design prepared, I do not think we can expect much relief. CLINTON H. CRANE

EDITOR INTERNATIONAL MARINE ENGINEERING:

The defects in design of freight steamships referred to by Mr. Harding in his articles in your June issue are mostly due to unknown conditions at the time the vessel was built, and, unfortunately, he compares vessels designed for straight-bulk cargoes to be delivered always at one point with vessels designed for general freighting business where the materials to be loaded or unloaded are unknown either as to quantity, weight or destination.

Mr. Harding cites, as defects in design, the building of officers' quarters, kitchen, mess room and even store rooms over the whole central portion of the vessel, thus greatly increasing the difficulty of reaching the cargo between decks. In this case he condemns what may be classed as the almost universal type of modern freight steamships for general ocean service. Let us see how far this condemnation is justified. For general service the type of cargo steamer with engines in the stern was long ago abandoned on account of the difficulty of trimming with cargoes of varied specific gravities. These conditions are not present in the special service required of freight vessels on the Great Lakes. The placing of the engines in the center of the ship is now the almost universal practice for ocean carriers, except in the case of carrying oil in bulk, when the conditions become similar to those affecting the Great Lakes traffic. The bridge deck, then, became the natural type, and in ordinary freight vessels the length of the bridge deck is little more than that of the space occupied by the engines, boilers and coal bunkers, and in nowise interferes with the handling of freight through the hatches. The space under the bridge deck thus becomes the most suitable for accommodating the officers and crew.

Mr. Harding advocates larger side cargo ports where side ports are used, and with only the handling of the cargo to consider the larger they are the better they will answer their purpose. The classification societies, however, are very particular, and properly so, in regard to side ports, admitting them only when full compensation has been provided for the material cut away. They are of great use in coasting steamers, especially those whose service includes passengers as well as freight. For general freighting business and only long-distance transportation, with facilities to handle freight of the most varied character, all handled by the appliances on the ship, I do not see how much improvement could be made on the ships of the American Hawaiian Steamship Company. The horizontal moving of freight between decks is a difficult problem, and many devices have been tried to reduce the labor. General freight cannot be piled to any great height, consequently the 'tween decks becomes a necessity, and whenever a vessel can be designed to carry bulk cargo that can be piled to any height, then the special ship, as we have on the Lakes, appears. If to this is added a definite point of loading and discharging, where special machinery can be installed on land, then the conditions are perfect for a design of ship that will offer the least resistance to being filled or emptied of the material she is designed to carry; but where the character of the cargo is unknown, and the points where it is to be loaded or discharged equally unknown, then the ship must be of a general type, the result of many compromises, not the best that could be designed for any fixed conditions, but the kind of ship that will meet all conditions fairly well in a general way, beside being entirely independent of all special shore-cargo-handling machinery. The great bulk of general ocean transportation is effected on such ships.

Hatches are being made larger as the size of vessels increases, and if the height between decks could be made about 10 feet electric travelers could be installed for horizontal movement to the hatches, all of which has been a matter of much thought on the part of both owners and builders. Steady progress is being made towards more economical handling of freight on ship board. The sorting of freight as it comes from the ship, especially those engaged in the coasting trade —and I am thinking just now of the Pacific Coast, where freight is received up to the hour of sailing and from many consignees—involves much costly handling. Often a lot of packages, delivered on the side of the dock in one lot from the cargo boom, will have to be divided and trucked to four or five different locations on the wharf. This is unavoidable in a general coastwise freighting business.

I have wondered if two-storied sheds on the wharves, with the outgoing freight arranged on the lower or wharf level and the incoming freight on the upper floor, would not be the better plan—both floors being served by a system of overhead travelers. If space were available at the land end of these sheds, teams and cars could be unloaded by arranging the system of travelers to extend over the railroad tracks and roadway, thus doing away with all hand-work and arranging outgoing freight so as to be readily reached by the ship's hoisting gear, and taking the incoming freight as it is landed on the upper floor, and either stowing it ready for delivery or carrying it direct to the teams or cars outside. Such an arrangement leaves the whole wharf space, both above and below, available for sorting and stowing freight. Such a scheme is already partly in use at many places, and given the necessary space and the proper design of wharf sheds, the cost of handling freight and the time consumed can be materially reduced. The problem as applied to general freighting is a difficult one, and progress will be slow in the future as it has been in the past. GEORGE W. DICKIE.

San Francisco.

EDITOR INTERNATIONAL MARINE ENGINEERING:

I have read with considerable interest what Mr. Harding has to say on the handling of freight. The article criticises somewhat severely the present method of handling freight in coastwise cargo steamers. As fast as terminal facilities are brought up to date there is no question but that the shipbuilder will be able to adapt the ship to the improved condi-

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tions, but as long as side ports are placed in new and improved vessels, absolutely regardless of the structural requirements of the ship and merely to suit some old wharf, it is hardly possible for the shipbuilder to do very much.

In connection with side ports taking the cargo from holds and 'tween decks, instead of the same going directly up through the ship and being transferred horizontally by overhead hoisting arrangements, as soon as such hoisting arrangements are in general use, trunk hatchways through passenger accommodation can always be arranged for. I would call attention to the fact that bulk carriers in the coastwise trade are all being built to suit modern handling facilities, such as coal and ore carriers. The writer of your article quotes Lake steamers as having clear decks amidships with no obstruction. These Lake steamers to which he refers are mostly in the bulk-carrying business, with machinery aft. This location for machinery is not advisable in general freight steamers, because questions of trim will come in, and if the vessel carries passengers may be serious enough to cause considerable discomfort. It should also be borne in mind that the Lake vessels can be very long, relative to their depth, owing to the smaller stresses set up by the motion of the water in the Great Lakes, as compared with that of the ocean.

Mr. Harding remarks that crews' quarters should be at the ends of the vessel, and clear decks amidships to avoid blind hatches. There is no reason why, in freight steamers, with machinery amidships, the crew's quarters should not all be in a double-story house on the weather deck. They will thus be in the most comfortable part of the ship, and at the same time get the benefit of all the air and light that can be obtained. As regards hatches, there is no reason why the whole upper deck along the center line should not be open hatchway, with just enough space between for winches and masts. Large hatches are coming more and more to the front in every design that is gotten out. When comparing the costs between manual and machine-handled freights, as is done by the writer in this article, some figures should be included showing the additional first cost of the machinery when making the comparison with manual labor.

In general, Mr. Harding's article presents a very interesting resumé of cargo-handling questions, but it should be borne in mind that the shipbuilder cannot go ahead of the terminal facilities. NAVAL ARCHITECT.

Philadelphia.

EDITOR INTERNATIONAL MARINE ENGINEERING:

The numerous articles that have been written by Mr. Harding and others on the mechanical handling of freight at terminals will undoubtedly result in some improvements, as these writers have put forth some very good ideas that must cause those in the business of handling freight to give some consideration and renewed activity.

Your article, and most others on this subject, have dealt mostly with generalities, and have neglected the small details involved which add so much to the cost. Vessels engaged in the transportation of ore and coal on which such remarkably low cost for transferring has been achieved receive their cargo by gravity and discharge it in uniform units by the use of grab buckets, and this material is discharged into a vehicle easily and quickly placed to receive it and easily and quickly removed. A vessel arriving at a pier with a miscellaneous cargo of, say, 2,000 tons cannot discharge its cargo by means of a grab-bucket, but almost every individual article must have a sling placed around it to receive the hoist hook. It is the placing of this sling around the packages that requires such a large force of men in the hold of a vessel and which brings up the cost of removal. The package is hoisted onto the pier at practically the same cost as a grab-bucket transfers its load. The 2,000 tons of cargo removed will necessitate the use of about 1,000 trucks to take it away from the pier on which it is unloaded, as the trucks will not average more than two tons each, whereas a coal or ore car will carry 50 tons. If these 1,000 trucks could be placed on the pier as easily and quickly as the coal or ore car can be placed to receive its freight, the vessel could place its cargo into the truck almost as cheaply as the grab-bucket places its load in the coal car. It is not possible, however, to accomplish this desirable condition, and therefore of necessity a considerable amount of the freight must be stored in piles on the piers, which means that after being deposited by the ship's machinery it must be moved to some other point on the pier where there is room to store it. This feature adds another heavy cost to the problem of delivery.

No doubt considerable saving could be accomplished by enlarged hatches on freight steamers, but to accomplish what Mr. Harding points out would require that the hatches be very much larger than the enormous hatches on Lake steamers. On the latter type of vessel the material is of a character that it will flow by gravity to a point where the grab-bucket can reach it. In the present state of the art of shipbuilding it is necessary to use some of the area of the deck, particularly amidships, in which to place the material necessary to give a vessel sufficient longitudinal and transverse strength to pass through heavy seas, and whatever area is allowed for this purpose will of necessity require some of the freight to be dragged in the hold, as Mr. Harding points out. This feature, while objectionable, adds very little to the cost of hoisting.

The serious problems to overcome are: First, to provide some method by which packages can be picked up by hoisting machinery in an economical way without injury to the packages, and, second, avoid storage and transference on the pier. Anyone who investigates this subject thoroughly will find that these two features, together with the classification involved, amount in cost to about 80 percent of the cost of delivering or receiving freight from the steamer's hold. These features, yet involved, would seem to be the ones to attack. F. L. DU BOSQUE.

Jersey City.

EDITOR INTERNATIONAL MARINE ENGINEERING:

The article by Mr. Harding in your June issue brings up a subject of great economical importance. It is self-evident that to remove a ton of freight vertically less power is required than to move it horizontally; that is, under conditions which are to be found aboard ship in its loading and unloading. It is conceivable that this might not be true in all cases, but in plain, everyday practice the statement stands.

In his description of a vessel especially designed with this idea of vertical hoist in view, the cost of removing cargo was cut from about 39 cents to 21 cents per ton. This is certainly a very satisfactory showing; but a further saving will be shown after the appliances and conditions are better understood. Marine men wisely look first to safety in ships. Valuable lives and cargoes are to be transported safely. While conservatism is commendable in the naval architect, has he not somewhat lagged behind in recognizing the great advance made during the last few years in the quality of material used in ships and the gain which is to be found in better forms in which the material can be secured? We certainly now have material which is of far greater strength than that obtained thirty years ago, and this is to be found in almost infinite variety of forms and weights, yet there is a clinging to designs which could be most advantageously changed, merely because they seem to have become recognized as satisfactory and are not changed from lack of boldness.

We must not, however, lay all this conservatism to the engineer or naval architect, or to those who handle ships. The constructors are seriously handicapped by classification

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societies as well as by the marine insurance companies. It is quite natural that those who write insurance base their rates on past experiences, and are not likely to be blamed for a desire to stick to that which they know of rather than to fly to that they know not of. A vessel is built with a view to obtaining fair returns on the money invested, and an increase of insurance is a serious matter. Yet the saving which apparently can be effected by more carefully considering freight handling, both as to its actual cost and a lessening of breakage, it seems, would place the shipping people in a position where, at worst, they could pay more for insurance if the increased facilities in handling freight brought into question the strength of the ship. When one looks at the very small proportion of hatch space it becomes apparent that the vertical lift, which we must admit costs less than the horizontal push and pull, is only applicable to a very small percentage of the cargo space. To obtain a vertical lift for the entire cargo is, of course, impossible. In one vessel, built expressly for economical handling of freight, only 68 square feet of hatchway was provided, which was about 1½ percent only of the entire cargo floor space of a single deck. Now there is no doubt but what a vessel could be designed with a very much greater hatch space than 1¼ percent. In fact, the very vessel referred to could by slight alterations be made to have 25 percent instead of 1½ of the cargo hatches.

The Lake steamers are constantly referred to as examples of the advantage of large hatches; but, of course, the cargoes of these vessels is stable, and never miscellaneous, and there is no fair comparison between a Lake ore-carrying freighter and an ocean-going freight-carrying steamer. Vessels have been built for ore-carrying across the Atlantic that have very large hatch proportions, and they have proved satisfactory except in one case, where the load was injudiciously distributed, and, of course, it is utterly beyond the naval architect's power to build a vessel which, if improperly loaded, will not, to a certain extent, be damaged. Where the composite vessel is to be considered, that is, freight and passenger, the inevitable engineering compromise has to be met. But it will not be many years before the freight and passenger traffic at sea will be as clearly divided as are the same traffics on shore.

It is difficult to get an expression from those actually employed in loading and unloading vessels, as what they say would be looked upon as a criticism of their superiors. The boat men say that the subject belongs to the naval architect and shipbuilder, and architect and shipbuilder in turn seem inclined to believe that to take the line of least resistance is best and to provide simply what is asked for rather than suggest something new. But it does strike one as absurd in a day when labor has become so expensive that we continue to place the cargo in a vessel practically as it has always been done in the past. The danger to the stevedore is an item, and it is not an imaginary one. Maiming or killing men must result in financial loss, and by a system of a direct hoist the danger of men being maimed would be considerably diminished and a corresponding decrease in expense follow.

It would seem that the shipping world has been content to push, haul and pull with main strength and awkwardness the cargoes of the ships, and that it is pretty nearly time that a change be made. W. D. Forbes.

New London.

Editor International Marine Engineering:

Mr. Harding says "by the latest methods the freight can be taken from the holds to cars, to warehouses, or to any portion of remote sheds without rehandling." A complete description of the "latest methods" would be exceedingly interesting and instructive. The writer does not know of any modern installation where this flexibility can be attained without rehandling, in any such capacities as are required in discharging or in loading an ocean steamship. In fact, it is my belief, after a comprehensive study of existing conditions, that the successful handling of miscellaneous package freight demands that *it shall be rehandled* on account of sorting, classifying and properly collecting and distributing the packages, unless all of it goes directly from ship to railroad cars, or vice versa. The port of Hamburg, Germany, has a large and modern equipment for unloading steamships, consisting of batteries of revolving cranes, which hoist the freight from the hold and deposit it on the dock or on cars—all freight deposited on the dock must of necessity be rehandled.

It would not be difficult to design a perfectly flexible system for loading, unloading, conveying and distributing freight in almost any manner desired without rehandling for a very small or limited capacity, employing only a few units, but for such capacities as would be required for handling ocean freight the arrangement becomes so complicated and the number of units so great that interference and confusion is the result. While I do not advocate the rehandling of freight as a general proposition, I do believe in rehandling it as a necessary evil in order to attain the desired results. Rehandling of freight when done in connection with a mechanical system does not spell the additional expense and congestion involved in rehandling in connection with the manual labor method. We must learn to distinguish between rehandling in conjunction with mechanical conveying and rehandling in connection with manual labor.

For the loading and discharging of ocean vessels we can do no better than follow the general scheme of handling coal and ore on the Great Lakes. The same principles can be applied in the same way with the necessary detailed modifications to suit the material handled.

For loading vessels the ore is brought to the dock from all directions in railroad cars and dumped into a storage bin alongside the vessel. The railroad cars may be considered as units of a conveying system, each coming from a different place, but all of them finally assembling on the dock and transferring their loads, not directly to the ship, but to the dock. The reason for this is that the entire cargo can be assembled on the dock ready to be loaded into the vessel in the shortest possible time. The ore is now rehandled; that is, other means are employed for putting it into the vessel. True, this consists only in opening the gates of the bins by machinery and allowing the ore to run into the vessel by gravity. However, the cars could have been dumped directly into the vessel, and it is often done this way, both in the case of coal and ore, but the process requires much more time, hence rehandling is resorted to without material increased cost for loading the vessel rapidly and efficiently.

Package freight should be handled in much the same manner. It should be brought to the piers in railroad cars and drays, and unloaded within range of the vessel-loading machinery if conditions permit, otherwise it may be unloaded by mechanical conveyors, which will bring it as well as freight from various parts of the pier shed, or warehouses within range of the vessel-loading machinery to which it will be transferred (rehandled) and put into the vessel at the maximum rate of speed. In order that the vessel-loading and unloading machinery should work at maximum speed and efficiency, its duty should be limited to transferring freight between vessel and pier, or cars or conveyors on pier which would collect or distribute the freight to distant points.

For the mechanical handling of freight there will not be required any new types of machines—it is rather a matter of applying well-known and well-tried devices to the handling of freight, and designing an entirely new and suitable type of steamship pier to accommodate such machinery, and also improving the design and construction of steamships to make their holds more accessible. M. B. Waterman.

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Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS.

	Tons.	Knots.		May 1.	June 1.
Florida	20,000	20¾	Navy Yard, New York......	92.7	93.4
Utah	20,000	20¾	New York Shipbuilding Co..	98.0	98.3
Arkansas ...	26,000	20½	New York Shipbuilding Co..	64.7	66.2
Wyoming ..	26,000	20½	Wm. Cramp & Sons.........	61-5	65.6
Texas	27,000	21	Newp't News Shipbuilding Co.	9.3	13.5
New York...	27,000	21	Navy Yard, New York......	0.0	0.4

TORPEDO-BOAT DESTROYERS.

Mayrant	742	29½	Wm. Cramp & Sons.........	96.5	99.4
Monaghan ..	742	29½	Newp't News Shipbuilding Co.	91.5	98.1
Walke	742	29½	Fore River Shipbuilding Co..	97.8	98.5
Ammen	742	29½	New York Shipbuilding Co..	99.2	100.0
Patterson ...	742	29½	Wm. Cramp & Sons.........	78.8	82.3
Fanning	742	29½	Newp't News Shipbuilding Co.	15.8	21.5
Jarvis	742	29½	New York Shipbuilding Co..	8.7	10.4
Henley	742	29¼	Fore River Shipbuilding Co..	10.0	10.9
Beale	742	29¼	Wm. Cramp & Sons.........	11.8	22.7
Jarrett	742	29½	Bath Iron Works............	19.6	31.2
Jenkins	742	29½	Bath Iron Works............	17.9	26.9

SUBMARINE TORPEDO BOATS.

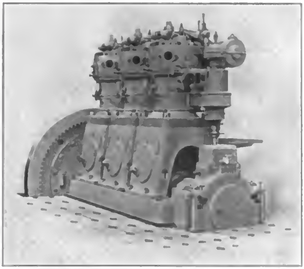
Seal	...	..	Newp't News Shipbuilding Co.	86.2	87.1
Carp	...	..	Union Iron Works..........	87.7	89.7
Barracuda ..	...	..	Union Iron Works..........	87.9	89.6
Pickerel	...	..	The Moran Co...............	84.2	84.6
Skate	...	..	The Moran Co...............	84.4	84.5
Skipjack	...	..	Fore River Shipbuilding Co..	85.8	91.1
Sturgeon ...	...	..	Fore River Shipbuilding Co..	85.0	89.5
Tuna	...	..	Newp't News Shipbuilding Co.	73.1	74.0
Thrasher ...	...	..	Wm. Cramp & Sons.........	38.8	41.5
Seawolf	...	..	Union Iron Works..........	23.8	31.2
Nautilus	...	..	Union Iron Works..........	23.8	31.2
Garfish	...	..	The Moran Co...............	21.8	27.9
Turbot	...	..	Lake T. B. Co...............	11.5	16.0

ENGINEERING SPECIALTIES.

Diesel Engines for Auxiliary Purposes.

The auxiliary most frequently used on board ship is that which generates electric current, and for this use the Diesel engine is most applicable. In ships where oil is used as fuel the same class of oil can be used for Diesel engines.

The Diesel Engine Company, Ltd., 179 Queen Victoria street, London, E. C., has brought out a high-speed multi-cylinder type of engine from 5 horsepower up. Every care has been taken to reduce weight yet maintain solidity, and



the balancing is such as to reduce vibration to a minimum. The arrangement for the supply of lubricating oil and cooling water is based on years of experience. The oil injected in the cylinder is ignited without the aid of any special apparatus. The compression of the air drawn into the cylinder is carried so far that the temperature reached thereby is sufficient to ignite and burn the spray of oil, and it is especially to be remarked that the pressure during the cycle does not exceed the compression pressure, whether the engine be working on the two or four-stroke principle. Great care has been taken in the selection of suitable material for the construction of the engines. The crank-shaft, of Siemens-Martins steel, is bedded in the bearings, lined with white metal, and to these the cylinders are rigidly secured by means of steel columns. The liners are made of close-grain cast iron, and the valves, which are all placed in the cylinder cover, are also cast iron, seated in removable seatings. A sensitive governor controls the fuel supply to the engine, and admits to the cylinder only the quantity which is required at the very moment.

Electric Motors for Shipyard Tools.

Messrs. T. W. Broadbent, Ltd., of Victoria Electrical Works, Huddersfield, are makers of complete electrical equipments suitable for shipyards and other work of a like nature. They have placed on the market a line of three-phase generators, delivering from 6 kilowatts at 750 revolutions per

minute up to 250 kilowatts at 375 revolutions per minute. They are of the rotating field type, with laminated magnet cores and poles and cast iron central yoke. The stators are borne on planed seatings on the bedplate. The stator is of the slotted type, with partly open slots, and the winding is very effectively ventilated. Each machine is excited from a small continuous-current machine, which is carried on an extension of the bedplate. They are built for a power factor of 85 percent, the rise of pressure, with fixed position of the field regulator, from full load to no load not exceeding 18 percent, and the rise of pressure on a lighting load only being 4 or 5 percent. The fly-wheel effect of the heavy rotors of the dynamos being driven at a high speed is very effective in keeping both voltage and frequency constant.

All motors are wound with wire and insulating materials that are unaffected by heat, therefore standing very large overloads. The rotor bars are electrically connected to the short-circuiting rings, and mechanically expanded after being driven into the holes in the short-circuiting rings, obviating the use of solder. All ratings of motors are conservative and are guaranteed to give larger overloads than usual.

Davidson Electrically Operated Triplex Pump.

The M. T. Davidson Company, of 154 Nassau street, New York, U. S. A., is making an electric-driven pump for ship use. It is of the triplex direct-drive type and has been supplied to some of the later naval ships of the United States. These pumps are used principally for fresh-water service, maintaining the required pressure automatically by the usual method of electric control. Our illustration shows a very compact pump, the position of the motor being such as to occupy space, practically, within the outside dimensions of the pump itself. It is thus self-contained, requiring no expensive

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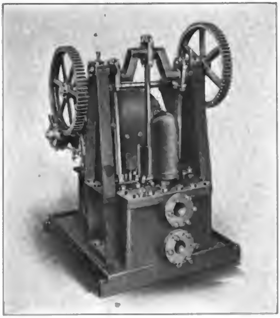
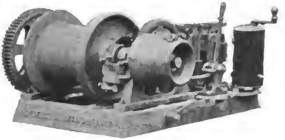
foundation. Three single-acting plungers of bronze or steel, working through deep stuffing-boxes, give ample bearing surface and prevent leaking. The crank-shaft, as well as the connecting rods, are of steel, the main bearings being babbitted and the rod ends fitted with half brasses. The gears are cast iron, accurately cut, and are usually provided with cases. The driving pinion on the motor shaft can be made of rawhide for quiet operation if desired.



Shipyard Winches and Capstans.

Messrs. Royce, Ltd., Trafford Park, Manchester, build a motor-driven winch which is a very compact design, the barrel, gear, motor, and control gear being all contained on a single cast iron bedplate. The barrel is arranged to run free on the shaft and is connected thereto by means of a clutch controlled by a hand lever. It is provided with a band brake, operated by a foot lever, so that it may be disconnected from the rest of the gear and loads lowered rapidly on the brake.



One end of the barrel shaft is provided with a warping drum. The motor, totally enclosed, is bolted direct to the baseplate and drives the barrel through a train of machine-cut spur gearing, the pinions being of mild steel, and where possible forged solid with the shaft. The brake drum is fitted to the motor spindle, the brake being of the band type, applied by a weighted lever and released by a double solenoid, so that the brake automatically applies itself when the circuit is broken and is released when the motor is started. In order to prevent the too sudden application of this brake a dashpot is fitted to the brake lever.

A special feature of the winch is the patent "slipper wheel" device in the train of gearing, consisting of a spur rim clamped between the two side plates by means of spring washers and arranged to slip in the event of the load on the barrel exceeding the normal, thus protecting the gearing and motor. Another important feature is that the bearings are self-aligning. The controller is of the tramway type, bolted direct to the baseplate and complete with separate resistances.

Direct-Driven Electric Light Sets.

An engineer would enjoy the study of the Messrs. Clark & Chapman, Ltd., engines, as shown on the illustration which we give. Here is found a most compact plant, which can be set almost anywhere on board a ship, and this company produces not only the open type, but inclosed type, which is preferable under certain conditions. It is always a question whether we want everything in the engine line where we can see it and get at it, or whether it is best to have it entirely inclosed. The inclosed engines of this company take but a moment to strip them of their covering, and then it is to be remembered that the care which has been given the design and the excellent workmanship used, and material selected, reduce to a minimum the necessity of more than an occasional touch on the bearings and constant and proper lubrication.

While the turbine engines are very popular for electric drive, we notice that the reciprocating engine of this type holds its own, especially where vessels have to go long distances and opportunities for repair of the steam turbines would, of necessity, be limited.

12 K. W. Speedway Gasolene Lighting Set.

This set is built by the Gas Engine & Power Company and Charles L. Seabury & Company, New York, for service aboard large yachts requiring considerable electrical power for winches, sail hoists, searchlights, etc. It is light and occupies small space, which is an advantage not only for marine work but in many stationary installations. The motor is four-cylinder, four-cycle, 6-inch bore by 6-inch stroke, being exactly the same as a regular Speedway marine motor of the same size. A few distinguishing points about the motor are as follows: Valves all operated by a single cam shaft, inlet being over the exhaust in a single-sided cylinder. The inlet is operated by a push rod and rocking lever. Valves are all solid steel, the inlets working in cast iron cages which are arranged for easy removal. All cams, rollers and pins sub-

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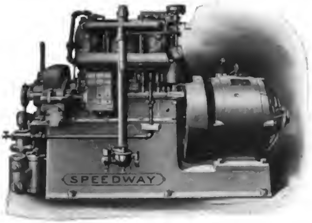
ject to excessive wear are case-hardened. Pistons are fitted with five spring rings and made light to eliminate vibration. Connecting rods are drop-forged steel. The upper ends are fitted with phosphor bronze bushings. The lower ends are the regular marine type, with bronze babbitted boxes. Cyl-



inders are ground standard and pistons are ground slightly taper, small at the top to allow for expansion. Ignition is the jump spark type, with current supplied by a high tension Bosch magneto. The motor is fitted with a nine-feed-forced feed oiler, a water-jacketed exhaust manifold, and Pickering governor driven from the cam shaft. This governor acts upon the throttle of an 1¼-inch Kingston carburetor, regulating to within 2½ percent between full load and no load.

Coupled direct to the motor is a Diehl 110-volt generator, wound for 600 revolutions per minute. The weight of this set is 2,400 pounds, and it occupies a floor space of 6 feet 6 inches by 2 feet 2 inches. The total height is 3 feet 8 inches.

An Engine Indicator.

What the engines are doing after a signal has been set from the bridge is made instantly known by the McNab indicator. This little appliance is being made by the McNab British Indicator Company, Queens Insurance Building, Liverpool, also in Bridgeport, Conn. It has the great advantage of being very simple, consequently reliable, and far from expensive either to buy or install. All there is to it is a small air pump attached to the reciprocating part of an engine, or by an eccentric if a turbine is used. The air pump is led up to an indicator in the pilot house, or anywhere on the bridge or alongside by ⅜-inch piping. The following is an explanation of how this valuable instrument works:

The engineer on receiving the signal to go ahead first throws his valve gear in the ahead position, and as the small indicator cock is attached to the valve gear he automatically opens the port on the indicator cock. The engineer then opens the stop valve, which starts the main propelling engine. This starts the agitator, which is connected to the engine, and works in unison. At every revolution of the propelling engine the agitator forces the air along the single air pipe through the cock, and then along the pipe corresponding to the direction of the flow. The displacement of air enters under the small piston. In the indicator glass tube, which drives it to the top of the tube at each revolution of the engine, indicating every rise and fall of the engine piston ahead or astern and registering every revolution. The ahead and astern indicators operate the same, only the direction of air is automatically altered from one to the other as the engine is reversed.

Oerlikon Electro-Hydraulic Portable Riveter.

This production of Maschinenfabrik Oerlikon, Switzerland, is credited with driving one thousand ¾-inch rivets in ten hours with three men, one at the machine and two bringing up and handling material. The apparatus can be employed either in shops or one outside construction work. It can be slung into any conceivable position on the crane hook, and it makes the work very easy to accomplish. No compressed air or hydraulic pipes are required, nor any pumping installations. The Oerlikon riveter, it can be seen, is independent of locality. It can be used wherever a flexible cable may be connected by means of an ordinary plunger switch to

an electric supply circuit. It is, therefore, adaptable for any standard or special jobs in factories or on outside work.

The riveter, combining prime mover and plunger in one apparatus, is tested at the works and carefully adjusted, and is therefore ready for use immediately on delivery, either in shops or on outside work—an additional advantage to commend it to users.

Siemens Brothers Searchlights.

A searchlight is an article which must be absolutely reliable or it is valueless. Messrs. Siemens Brothers Dynamo Works, Ltd., London, make one which has this prerequisite. In the

construction of the mirrors used in them the very best material is employed, and the workmen who are producing the lamps are thoroughly skilled in all operations from end

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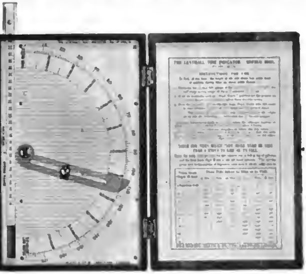
to end. The company supplies all styles and types of searchlights, and their business has reached its present proportion by the closest study of what is required and the ability to produce what is wanted in a thoroughly workmanlike manner. No detail has been overlooked, from the automatic feed mechanism to the ventilation of the lamp and insulation of the wires. The company is supplying the British Admiralty and War Office as well as foreign governments with their searchlights.

A New Nautical Instrument.

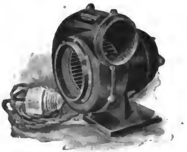
A tide indicator, put on the market by Messrs. Heath & Company, Ltd., of Crayford, London, is something marine men will appreciate in the highest degree, as by its use, almost at a glance, the water level above low water is shown without any calculations whatever. The instrument is made



in two styles, one of which we illustrate. As a proof of the reliability of the tide indicator, we might mention the fact that one has just undergone a practical test, extending over several weeks, on one of the steamships of the Trinity House, London, with very favorable results.

Ventilating Fans.

There is a growing appreciation of the advantages of good ventilation, so that there is an increasing demand for simple and inexpensive devices for the ventilation of staterooms, cabins, ticket offices, lavatories, toilets, kitchens and dining



rooms aboard ship. This demand is met by the Sirocco electric utility blowers, manufactured by the American Blower Company, Detroit, Mich.

These little blowers can be used as "buzzers," simply stirring up the air, adding to the comfort of the occupants of a room by keeping it in motion, or they can be so installed as to bring in fresh air from outside; or, on the other hand, to exhaust the foul air from the apartments. These small sets are valuable also in shipyard equipment for a variety of uses, such as cooling and ventilating small offices, engine rooms, boilers during repairs, and overloaded motors.

Because of the high mechanical efficiency of the Sirocco turbine type wheel, the electric current consumption is so small as to be almost insignificant. The smallest of these blowers uses less than half the current consumed by an ordinary electric lamp.

The Ross-Schofield Marine Boiler Circulator.

Many attempts have been made to promote circulation of water in marine boilers. The Ross-Schofield Circulator, manufactured by the Ross-Schofield Company, 39 Cortlandt street, New York, is the latest device to be put on the market for this purpose. Our illustration shows the furnace and combustion chamber of a Scotch marine boiler equipped with this system, in the installation of which no part of the boiler is drilled or otherwise damaged.

It consists of a steel plate, supported on the short stays,

completely enclosing the water space back of the combustion chambers, except at the top and between the furnaces at the bottom; steel plates, supported by the tubes, placed in front of the combustion chambers and on each side of each furnace or bank of tubes; a back hood and a front hood. Two spaces are thus provided, which operate in parallel, their superimposed curved hoods promoting longitudinal and elliptical circulation of the water by utilizing the natural force of the steam bubbles. These bubbles, passing up through the guiding compartments and issuing from the curved hoods, throws the ascending streams of water in a horizontal direction, eliminating the vertical mechanical projection of water particles, and promoting a flow which continuously draws the water from the lower and colder part of the boiler up between the guiding plates, thence propelling it longitudinally toward the front, rapidly establishing constant and effective circulation, which is maintained. The mammoth *Titanic*, among other trans-Atlantic ships, is equipped with this circulator. One company alone has ordered fourteen equipments.

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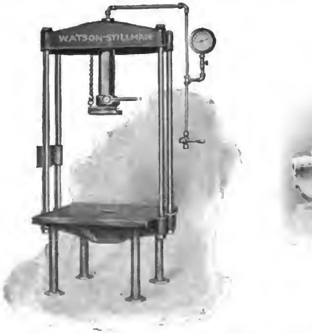
Watson-Stillman Hydraulic Press.

The Watson-Stillman Company, New York, has added to its line another hydraulic press which is specially adapted to forcing bearings, but is also a handy tool for general machine shop use. The weight shown on the left counterbalances



the ram, which can be handled independently of the pump by means of a rack, pinion and lever arrangement. A hole through the platen permits work to be projected or forced through. The capacity of the press reaches its maximum of 30 tons under a hydraulic pressure of 6,250 pounds per square inch, which may be produced by using either a hand or belt-driven pump attached to the pipe the cut shows. The length of stroke of the ram is 18 inches, and its diameter is 3½ inches. An 18-inch stroke suffices for most press fitting. So long a stroke is often desirable because it increases adaptability of the press.

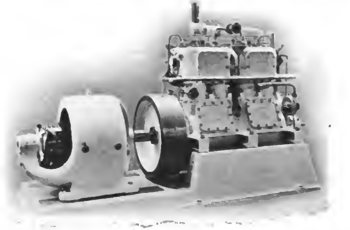
Steam Turbine Outfits for Electric Generation.

The turbine dynamos which Messrs. Greenwood & Batley, Ltd., Leeds, are supplying ships, yachts, etc., employ the De Laval system of turbine, which they own for England, for their drive. A late catalogue, just received, shows some very interesting and neat electric lighting sets, which will appeal to marine men on account of the small space they take up, their general appearance, and, above all, their reliability. This company does not build De Laval turbines above 600 brake-horsepower, but is prepared to furnish any output below the powers named, down to even as small power as 3 brake-horsepower.

Thornycroft Motor-Driven Power and Electric Light Plants.

John I. Thornycroft & Company, Ltd., London, are offering a complete line of centrifugal pumps and electric plants which are run by internal combustion engines. The lighting outfits have an electrical output of from 3.5 kilowatts up to 45.5 kilowatts, and their pumping outfits have a discharge of from 110 gallons per minute to 1,800 gallons per minute.

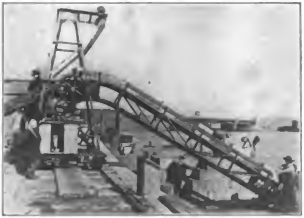
We illustrate an electric lighting set which, in the 3.5 kilowatt size, would measure 64 inches long, 40¼ inches wide and stand 20 inches high, while for the larger sizes named the measurements would be 146 inches long by 43 inches wide by 72 inches high. The combination of pump and generator, which is turned out by this firm, is one which should attract the attention of naval architects on account of its compactness, as this feature will make it most valuable not only for small vessels but for ships of all sizes. The John I. Thorny-



croft & Company are noted for their care of detail, and in such plants as we have referred to every precaution has been taken to eliminate things that are trappy, and most reliable outfits are the result.

Freight Handled Mechanically.

The accompanying view shows a Jeffrey portable conveyor which has been installed for the Vacuum Oil Company for delivering outgoing and receiving incoming light freight at the Sydney, Australia dock. This machine constitutes an unique freight-handling plant, electrically driven, with 1½-horsepower motor, capable of handling 1,000 cases or light packages per hour. The length of the boom is approximately 24 feet, and it is so arranged that it can be raised or lowered as may be necessary on account of the tide. The portable truck carrying the boom travels on a track extending the



entire length of the dock, allowing the machine to be placed at the most convenient point for unloading, or loading, as the case may be. This boom is equipped with a continuous-moving Jeffrey conveyor belt. It is upon this belt that the outgoing freight is delivered; the cargo placed on the belt by human labor descends to the barge, from where it is again handled and piled. The view shows the boom lowered, and gives a clear idea of the method of unloading. The boxes

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travel along on the belt and are delivered automatically to the waiting drays. This method has minimized labor, and is claimed to have reduced the cost of handling at least 50 percent. This machine was furnished by the Gibson, Battle Company, Sydney, Australia, agents for the Jeffrey Manufacturing Company, Columbus, Ohio.

Searchlights.

The Carlisle & Finch Company, Cincinnati, Ohio, besides making most admirable searchlights for marine use, can supply them for many other purposes, where a long-continued run is necessary, such as guarding wharves, furnishing light for loading or unloading vessels. Our illustration shows a 32-inch deck projector, but the company makes these up to a diameter of 38 inches and in endless variety of types, applic-

able to all styles and descriptions of vessels, and even for small launches. Carbon-fitting mechanism is very sensitive and the carbon carriers are supported on two parallel brass rods, and are moved towards each other by means of a right and left screw. This screw is actuated by a shunt magnet, and the length of the arc is maintained absolutely uniform, no matter in what position the mechanism is placed. No other projector possesses such an accurate and reliable method of feeding the carbons together as they are consumed.

All parts of the mechanism are below the metal shield, and the slender carbon holders are the only parts which are in the line of the light.

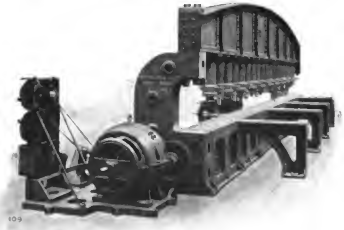
E. M. I. Cabin Fans.

Messrs. Hogan & Wardrop, of London, are making cabin fans which are designed with special care in order to take up as little headroom as possible, as this, of course, is of prime importance in ship work. The feature of these fans is the ease with which they can be attached and detached by simply turning the thumb nut. In many English ships the cabin fans are hired to the passengers for the trip and are not furnished, as is common on some lines. This point of detachability, therefore, is most advantageous. By means of the same thumb nut the angle of the fan can be changed so as to deliver air in any direction, and the volume of the air delivered can be evenly regulated, so there is no need of having either a storm or a dead calm, and this feature will be most highly appreciated by all who travel in warm climates.

Electric Drive for Shipyard Tools.

The patent electric drive for machines, as made by Messrs. Vickers, Ltd., Sheffield, claims many advantages, the chief being that the motor itself reverses and is directly geared to the driving screw or rack wheel of the machine. Other advantages can be stated as follows:

Absence of all trouble due to the use of belts; perfect control over the cutting speeds; increased output is obtained owing to the control of cuts; dispensing with a good deal of the mechanical gear which would otherwise be necessary.



The system is applicable for driving all classes of reciprocating tools, including every type of planer and large slotting and shaping machines. Messrs. Vickers, Ltd., have converted plate edge planers cutting both ways up to 60 feet per minute and table planers of all sizes from 3 feet 6 inches to 12 feet wide. We illustrate a plate edger fitted with the drive.

Brush Electric Lighting Set.

The Brush Electric Lighting Set is manufactured by the Charles A. Strelinger Company, Detroit, Mich. It consists of the Brush balanced two-cylinder, internal-combustion type of engine, direct connected to generator. The outfit is very compact and complete, including switchboard and all necessary instruments and ignition apparatus. Either gasoline (petrol) or kerosene may be used as fuel.

The regulation obtained is believed to be decidedly better than that of the average steam engine. The current may be used not only for lighting but for heating, cooking, pumping, ventilating and many other purposes. A plant of this kind is especially desirable to have as a reserve on vessels where wireless apparatus is used. Its compactness permits installation almost anywhere on an upper deck to be utilized in case of mishaps to the regular power plant.

The accompanying picture shows the launch *Calcite*, of Seattle. This is equipped with a Brush Electric Lighting Set, which not only furnishes electric light but the current for

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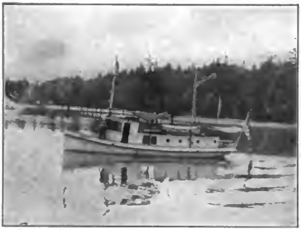
searchlights, four electric heaters and electric cooking apparatus. This launch is of heavy construction; is used for towing barges, sailing vessels, etc.; picking up logs, protecting

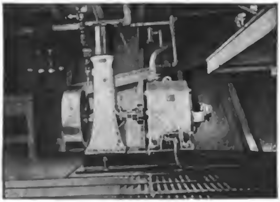


booms; also for transportation and pleasure purposes. The outfit is said to be giving excellent satisfaction, operating in the most quiet manner, being run by the regular ship's crew, none of whom is familiar with gas engines.

Lighting Set.

Lighting sets consisting of vertical self-oiling engines direct connected to standard makes of electric generators are placed on the market by the American Blower Company of Detroit, Mich. The enclosed frame of the engine protects it from dust and dirt, and as the enclosing panels are easily removed by simply turning a milled hand nut, the working parts are as readily accessible as in an open frame engine. These sets weigh inside of one pound for every 3½ watts output, which is as light as any engine can be made and still have ample strength for long and continuous service as is demanded aboard ship.

The engines used in connection with these lighting sets

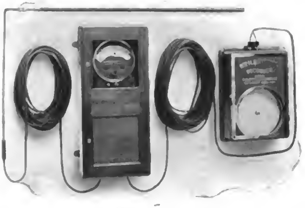


differ from all others in the system of lubrication employed. Every frictional surface is running on oil, there being no possible contact between metals, with the effect of almost eliminating wear. They will run for months on the initial supply of oil and without adjustments. The oiling is done by the engine itself. At the base is located a small pump, which even at the slowest speed delivers to each moving part a copious stream of clean oil. The oil flows by gravity to the running parts, and in returning to the base of the engine is filtered and cooled before being repumped. No oil is wasted, and this system insures a saving of four-fifths of the usual cost of lubrication.

Combination Indicating and Recording Pyrometers.

Engineers are quickly learning that the pyrometer has become a necessity in the heat treatment of steel. The thermo-electric pyrometer is the one which is most generally in use. It depends for its operation upon the phenomenon that if two dissimilar metals or alloys are joined and their junctions are at different temperatures an electric current is produced, flowing through the metals. Thus the electromotive force is a function of the difference of temperature between the hot and the "cold end" of the couple. It is, therefore, necessary that the couple should be made of sufficient length to carry the cold end beyond the influence of the radiation of heat from the furnace and the conduction along the thermo-couple and its protecting tubes.

In practice where the thermo-couple is extended a novel feature is that of separating the thermo-couple into two parts, one of which is called the fire end and the other the extension piece, these parts being joined together as near as practicable to the point where the thermo-couple passes



through the wall of the furnace in which the temperature is to be measured. The advantages of this separable junction are obvious, as it makes it possible to renew the fire end at a minimum of cost, and it also permits carrying the cold end to a point where the atmospheric temperature will remain practically uniform.

When very accurate readings are required an automatic compensator may be placed at the cold end. This compensator consists of a glass bulb with a short stem similar to an ordinary mercury thermometer. Two platinum wires are fused into same near its tip. These are connected within the flattened bore by a loop of platinum wire, thus completing the circuit. It will be seen that the resistance is increased or decreased as the mercury falls or rises. When the temperature falls at the cold end, the resistance in the compensator being increased, it prevents an increase in the electromotive force of the couple, and vice versa.

The illustration shows a combination of an indicating and recording thermo-electric pyrometer. It consists of a single fire end and extension piece connected to the indicating and recording instruments by suitable lengths of flexible duplex leads The fire end or thermo-couple is applied in the furnace at the point where the temperature is to be measured and the indicating instrument is placed at a point where the operator may easily view it; while the recorder can be placed in the superintendent's office several hundred feet away. These combinations are being used extensively, as they fill two requirements: First, they instruct and guide the furnace operator regarding the temperature at which he is running; and, secondly, they furnish the superintendent with a continuous record of those same temperatures and a check on the faithfulness of the operator in properly controlling them. These pyrometers are also made in portable form with special couples for taking temperatures of furnaces, flues, molten metal, etc. The above instruments and a complete line of recording instruments for temperature, pressure and electricity are made by The Bristol Company, of Waterbury, Conn.

PERSONAL.

A. L. Hopkins, who has been assistant manager of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has been made manager by the promotion of Mr. Walter A. Post from manager to president.

Capt. C. O. Tilton, for many years connected with the Atlantic Transport Line, has been made commander of the auxiliary naval vessel *Vestal*.

The delegates appointed to represent the Society of Naval Architects and Marine Engineers to attend the Jubilee of the Institution of Naval Architects, London, are as follows: Rear Admiral H. I. Cone, U. S. N.; Rear Admiral R. M. Watt, U. S. N.; J. R. Andrews, Charles Ward, Commander M. E. Reed, U. S. N.; Prof. William Hovgaard, E. P. Bates, M. S. Chace, Prof. C. H. Peabody and H. L. Aldrich.

TECHNICAL PUBLICATIONS.

Engineering Descriptive Geometry. By F. M. Bartlett, Commander, U. S. N., and Theodore W. Johnson, A. B. M. E., Professor of Mechanical Drawing, United States Naval Academy. Size, 6 by 9 inches. Pages, 159. Illustrations, 137. United States Naval Academy. Price, $1.50.

This work of Commander Bartlett and Professor Johnson seems to us to be ideal in its simplicity and clearness. It is so difficult for most minds to think in more than two planes, and probably the student is more embarrassed by trying to understand descriptive geometry than by any other branch of mathematics.

The few errors in the first edition have been corrected and some of the drawings have been modified. We have tried to write something which would give an idea of the true value of this book, but we find we cannot do better than copy from the preface of this work, and we compliment most heartily the authors. It says:

The aim of this work is to make Descriptive Geometry an integral part of a course in Mechanical or Engineering Drawing.

The older books on Descriptive Geometry are *geometrical* rather than *descriptive*. Their authors were interested in the subject as a branch of mathematics, not as a branch of drawing.

Technical schools should aim to produce engineers rather than mathematicians, and the subject is here presented with the idea that it may fit naturally in a general course in Mechanical Drawing. It should follow that portion of Mechanical Drawing called *Line Drawing*, whose aim is to teach the handling of the drawing instruments, and should precede courses specializing in the various branches of Drawing, such as Mechanical, Structural, Architectural and Topographical Drawing, or the "Laying Off" of ship lines.

The various branches of drawing used in the different industries may be regarded as dialects of a common language. A drawing is but a written page, conveying by the use of lines a mass of information about the geometrical shapes of objects impossible to describe in words without tedium and ambiguity. In a broad sense, all these branches come under the general term Descriptive Geometry. It is more usual, however, to speak of them as branches of Engineering Drawing, and that term may well be used as the broad label.

The term Descriptive Geometry will be restricted, therefore, to the common geometrical basis or ground work on which the various industrial branches rest. This ground work of mathematical laws is unchanging and permanent.

The branches of Engineering Drawing have each their own abbreviations and special methods adapting them to their own particular fields, and these conventional methods change from time to time, keeping pace with changing industrial methods.

Descriptive Geometry, though unchanged in its principles, has recently undergone a complete change in point of view. In changing its purpose from a *mathematical* one to a *descriptive* one, from being a training for the geometrical powers of a mathematician to being a foundation on which to build up a knowledge of some branch of Engineering Drawing, the number and position of the planes of projection commonly used are altered. The object is now placed behind the planes of projection instead of in front of them, a change often spoken of as a change from the "1st quadrant" to the "3d quadrant," or from the French to the American method. We make this change, regarding the 3d quadrant method as the only natural method for American engineers. All the principles of Descriptive Geometry are as true for one method as for the other, and the industrial branches, as Mechanical Drawing, Structural Drawing, etc., as practiced in this country, all demand this method.

In addition, the older geometries made practically no use of a third plane of projection, and we take in this book the further step of regarding the use of three planes of projection as the rule, not the exception. To meet the common practice in industrial branches, we use as our most prominent method of treatment, or tool, the use of an auxiliary plane of projection, a device which is almost the draftsman's pet method, and which in books is very little noticed.

As the work is intended for students who are but just taking up geometry of three dimensions, in order to inculcate by degrees a power of visualizing in space, we begin the subject, not with the mathematical point in space but with a solid tangible object shown by a perspective drawing. No exact construction is based on the perspective drawings which are freely used to make a realistic appearance. As soon as the student has grasped the idea of what orthographic projection is, knowledge of how to make the projection is taught by the constructive process, beginning with the point and passing through the line to the plane. To make the subject as tangible as possible, the finite straight line and the finite portion of a plane take precedence over the infinite line and plane. These latter require higher powers of space imagination, and are therefore postponed until the student has had time to acquire such powers from the more naturally understood branches of the subject

F. W. B.
T. W. J.

The Care, Operation and Management of the Parsons Marine Steam Turbine. By W. C. Nixon, Ensign U. S. N. Size, 6 by 9½ inches. Pages, 216. Illustrations, 20. United States Naval Academy, School of Marine Engineering, Annapolis, Md., 1911. Price, $1.50.

Another book on steam turbines would seem to most of those who have been interested in this subject a work of supererogation, but we will say that Mr. W. E. Nixon has given to his brother engineers the most interesting and instructive book that has yet been brought out on turbines. There is nothing in it mathematical, it is true, but the mathematics of

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the steam turbine have been pretty fully discussed. But from beginning to end it shows how thoroughly well versed is the author in handling turbines and what a gift he has in imparting his knowledge. The work treats only of Parsons turbines as fitted in the ships of the United States navy. It not only tells what the turbine should do but what it actually does that it should not, and, above all, how and what to do to correct the trouble if anything goes wrong. No clearer and more concise descriptions seem to us possible. The author is a member of the School of Engineering at Annapolis, and it certainly bodes well for this school that such a valuable production should emanate from it. We might add that this school of engineering is not for the cadets but for graduated officers after service both at sea and on land.

A Textbook on Steam and Steam Engines. By Andrew Jamieson, M. Inst. C. E. Size, 6 by 8 inches. Pages, 828. Numerous illustrations and tables. London, Charles Griffin & Company, Ltd. New York, 1910: D. Van Nostrand & Company. Price, $3.50.

The test of a work such as has been produced by Mr. Jamieson is found by daily turning to it for information. Such a test we have made and not found it wanting. In many ways the book warrants commendation. It is clear in its statements; admirable in its arrangement, each subject being kept by itself, and one does not have to turn back and forth in order to assemble the full information wanted. The examination papers and information concerning them is most interesting and valuable to applicants who are going up for examination before various boards. The work is up to the practice of to-day, and the history of steam is given most fully. Recognizing the value of the eyes in assisting to grasp explanations, illustrations have been used in profusion. We recall no book which has impressed us more, and we could say with truth that it is almost a library in itself of applied mechanics.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

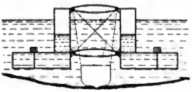
British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

19,173. OTTER BOARDS FOR TRAWL NETS. C. W. BROMPTON, GRIMSBY.

The otter board of this invention travels nearly in the direction of its length, the spreading action for the net being obtained by means of a hinged flap whose opening is limited by chains. The resistance to towing, due to lateral drag on the sea floor, is thus obviated.

18,535. FLOATING DOCKS AND MEANS FOR RAISING OR SALVING SUNKEN SHIPS, ETC. P. VON KLITZING, KIEL, GERMANY, ENGINEER-IN-CHIEF.

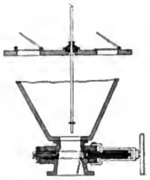
According to this invention two floats are connected at their upper ends in such wise that their distance apart can be varied for raising



a sunken vessel. The lifting ropes along one side are suspended from pulleys carried in bights in a common rope which passes over pulleys along the top of the float and is hauled in by winches for raising the vessel. Thus the strains on all the lifting ropes are equalized. Separately, the floats can be used for docking ships.

6,836. ASH EJECTOR SLIDES OR VALVES. W. C. KEENE, LIVERPOOL.

A sluice valve for ash ejectors comprises a plate working within a casing, having packing-grooves arranged across the working surfaces of the plate so that asbestos packing or the like can be compressed in the grooves by the screws. Ashes are fed into the hopper through



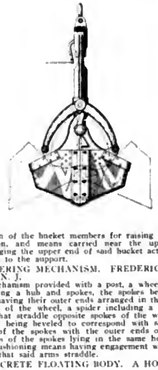
closable openings and fall upon the flap closed to cover the plate. On opening the latter the flap drops and allows water to enter as usual.

990,596. SEA ANCHOR. J. A. ROSVOLD, DEC'D. J. B. JACOBSEN, ADM., NOME, ALASKA.

In combination, a wave breaker adapted to float upon the surface of the water, a plurality of sea anchors connected in series, the first of the series being attached to said wave breaker, and the last of the series having a greater effective area composed of a rectangle with triangle attached to one side.

989,832. BUCKET. JAMES L. BUTLER, OF ALLIANCE, OHIO.

In a device of the character described, the combination of a pair of pivotally connected bucket members, a bucket support, a bucket actuating device slidably mounted upon the support and associated with the



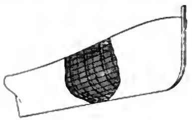
pivotal connection of the bucket members for raising and lowering said pivotal connection, and means carried near the upper end of said support for engaging the upper end of said bucket actuating device and locking the same to the support.

991,545. STEERING MECHANISM. FREDERICK ROUISS, OF JERSEY CITY, N. J.

A steering mechanism provided with a post, a wheel mounted on the post, and including a hub and spokes, the spokes being bent at their inner ends and having their outer ends arranged in the same horizontal plane as the rim of the wheel, a spider including a hub and pairs of diverging arms that straddle opposite spokes of the wheel, the arms at their inner ends, being beveled to correspond with said inclination at the inner ends of the spokes with the outer ends of the arms from the inclined parts of the spokes lying in the same horizontal plane as the wheel, and cushioning means having engagement with said arms and with the spokes that said arms straddle.

991,760. CONCRETE FLOATING BODY. A HOLM. CAMDEN, N. J.

A floating body having a skeleton frame formed with projecting eyes,



a network through which said eyes project, rods passing through said eyes over said network, and a cement cover arranged over said network and rods.

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International Marine Engineering

AUGUST, 1911.

THE BAR HARBOR STEAMER MOOSEHEAD.

The *Moosehead* was built for the Maine Central Railroad Company by the Bath Iron Works at Bath, Me. She was designed by the Bath Iron Works for the particular passenger service of the Maine Central Railroad Company between Mt. Desert Ferry and Bar Harbor, and other points in Frenchman's Bay, in connection with the railway service. This service is very similar to that maintained by the Central Railroad of New Jersey between New York City and Atlantic Highlands; by the Chesapeake & Ohio between Newport News and Norfolk, and by the New York, Portsmouth & Norfolk Railroad from Cape Charles to Norfolk. The *Moosehead* is intended to carry passengers, baggage, mail and horses, with little freight, and that of the highest class. She is a twin-screw steamer of the following dimensions:

Length over all.................	194 feet 11 inches.
Length load waterline..........	185 feet 10 inches.
Beam over guards..............	36 feet 8 inches.
Beam molded..................	30 feet 6 inches.
Depth molded..................	14 feet 6 inches.
Draft forward on trial..........	10 feet ½ inch.
Draft aft on trial..............	10 feet 8½ inches.
Mean	10 feet 4½ inches.
Displacement on trial...........	664 tons.
Area immersed 'midship section..	234 square feet.
Block coefficient................	.4066
Prism coefficient................	.552

The *Moosehead* is one of the finest finished vessels of her type in the country, as well as one of the fastest; 19 miles an hour being the contract speed and 19.75 being maintained on her four-hour contract trial. She has been very carefully designed throughout, and is classed A-1 for seventeen years with the American Bureau of Shipping. She is licensed to carry 800 passengers.

In order to obtain the necessary horsepower and the most suitable form of hull, to carry out the programme laid down by the railroad company, her model was towed at the naval experimental tank at the Washington navy yard.

The hull is of steel up to the saloon deck, steel bulkheads and sides forming the structure between main and saloon decks, instead of using wooden studding and sheathing, as is usually the case in vessels of this type. The engine and boiler casings are entirely of steel from the main deck to the top of dome, and the saloon deck is steel plated over the boiler room, in order to obtain air-tightness when the vessel is worked under forced draft. The joiner work on the saloon deck is reinforced by steel channel beams closely stayed, thus insuring an extremely rigid support for this joiner work in the decks, cabins, etc. Ample fire protection has also been had in mind by the contractors. The boat is of the flaring sponson shape, the main frames running up to the guards.

THE NEW PASSENGER, BAGGAGE AND MAIL STEAMER MOOSEHEAD, FOR SERVICE IN FRENCHMAN'S BAY.

There are five watertight bulkheads as follows: Fore peak, between forward hold and boiler room, between engine room and after hold, after trimming tank and transom frame bulkhead. A non-watertight bulkhead of steel has also been fitted between the engine and boiler rooms. Both boilers are installed in one fire room.

Aft of the engine room on the lower deck are staterooms for the porter, steward, cooks, assistant engineer and oilers. Forward of the boiler room on the lower deck are staterooms for the stewardess, crew's mess room, crew's quarters and firemen's quarters and enclosure for steam steering gear. In the extreme bow are the chain lockers and trimming tank.

The main deck is enclosed to the side of the vessel from the bow aft to the after end of the engine room, aft of which is a passage around the stern outside of the house. In this house are located the entrance hall, dining room, ladies' room and ladies' toilet room. From the entrance hall is a large stairway leading to the main cabin and saloon deck above. Passages run forward from the entrance hall on each side to the baggage space abreast the engine and boiler casings and forward of them. The galley, men's toilet and wash rooms and the chief engineer's stateroom are located just forward of the entrance hall on the passages. Forward of the boiler casing is the mail room and a wide staircase to the saloon deck, entrances to men's room and crew's quarters, crew's

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watercloset and lamp room. Wide gangways are cut in the sides of the house forward. On the saloon deck is a house containing a large cabin, at the forward end of which are two ample staterooms, each having a toilet room attached. A comfortable smoking-room is located at the extreme forward end of this house under the pilothouse. The purser's office is built in the main saloon, forward of the boiler casing.

As the *Moosehead* is for day service the saloon cabin is lighted by large plate-glass windows all around, forming a splendid observation room. There is also a very large deck space inside of this house and covered by the gallery deck, which deck extends from the pilothouse to the stern. Permanent seats are fitted around the rail and outside of house on the saloon deck. On the boat deck are the pilothouse, captain's, mate's, quartermaster's and purser's rooms. The boats are stowed on this deck.

Since the vessel is intended for a high class of service, particular attention has been paid to the joiner work, which in the ladies' room, dining room, entrance hall, smoking-room and saloon is of solid mahogany with mahogany carlins overhead in the dome, the spaces between the carlins being fitted with composite board in panel effect, painted in light green. The stairways at each end of the saloon leading to the main deck are also finished in solid mahogany.

Interlocking rubber tiling, in excellent taste, is laid in the smoke-room, pilothouse, lavatories, dining room and ladies' cabin. The main saloon and staterooms are carpeted in dark green and furnished with rattan sofas and chairs specially designed and built for this vessel.

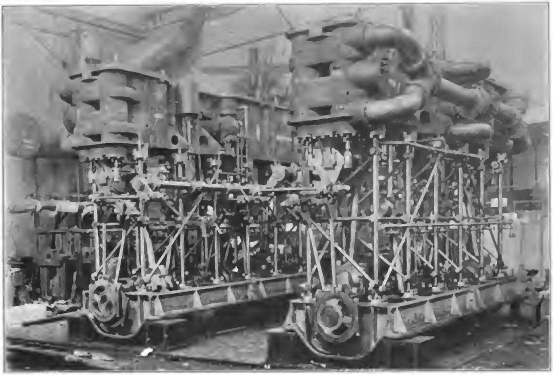
The electric fixtures throughout are of bronze, finished in verde antique. The electric plant consists of two generating sets, each turbine-driven, one of 25 kilowatts and one of 7 kilowatts, located in the engine room. A large searchlight is installed on the pilothouse.

The windlass is of the Hyde hand type, and a combined hand and steam steerer, made by the Hyde Windlass Company, is installed.

The plumbing throughout is of the highest class. The galley is equipped in many respects similar to the kitchen of a dining car, the service being conducted by the dining-car service of the railroad.

The interior communication system is installed by Cory, and consists of mechanical bell pulls, telegraphs, speaking tubes, fire alarms and apparatus to operate both the regular ship whistle and the locomotive whistle, the latter being for entering small harbors on her route, in a fog, on account of the peculiar echo it gives.

The propelling machinery consists of two vertical, four-cylinder, triple-expansion engines, each with one high-pressure cylinder 16 inches diameter, one intermediate-pressure cylinder 26 inches in diameter, and two low-pressure cylinders 30 inches in diameter, all with a common stroke of 24 inches. The cylinders are mounted on turned steel columns suitably braced, the crossheads working upon bar guides. All cylinders have piston valves, both the valves and the liners being ground. Steam reversing gear is installed. Steam is supplied by two Scotch boilers working at 170 pounds pressure and located in a closed fire room equipped with blower and engine. Each boiler is 14 feet 4 inches in diameter and 12 feet 7 inches long, equipped with three Morison furnaces 44 inches inside diameter. There is also an upright donkey boiler installed in the fire-room. One smoke pipe is fitted. The grate area of each boiler is 71.5 square feet, and the heating surface of each boiler is 2,722 square feet. The twin propellers are out-turning, and are solid bronze. Each has three blades, and is 8 feet 6 inches in diameter, 10 feet pitch. Pitch ratio, 1.176; projected area, 2620.8 square inches; disc area, 8171.3 square inches; disc ratio, .321.



MAIN ENGINES OF THE MOOSEHEAD, ERECTED IN THE SHOPS OF THE BATH IRON WORKS.

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In accordance with the terms of the contract the *Moosehead* was standardized over the Boothbay mile with the following results:

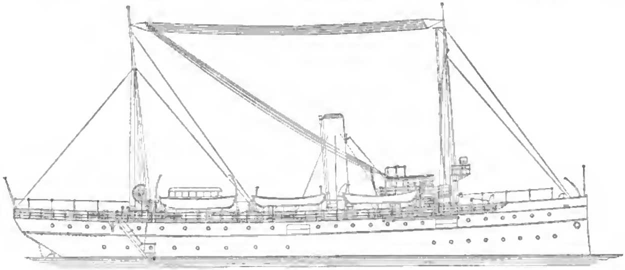
STANDARDIZATION TRIAL. S. S. MOOSEHEAD. BOOTHBAY MILE.

No. Run.	Direction.	Revolutions.			I. H. P.			Speed	Slip.
		Port.	Starb'd.	Mean.	Port.	Starb'd.	Total.		
1	N	115.3	113.4	114.35	174	176	350	12.46	4.1
2	S	105.7	99.4	102.55	159	141	350	11.25	3.8
3	N	109.5	135.6	122.55	98	283	381	13.38	4
4	S	150.3	153.9	152.1	382	478	860	15.96	7.69
5	N	156.2	161.3	158.75	447	544	991	16.95	6
6	S	170.3	170.9	107.6	605	649	1254	17.65	11.66
7	N	178.3	185.8	182.05	717	899	1616	18.83	9.65
8	S	183.8	189.4	186.6	827	967	1794	18.75	11.57
9	N	194.6	195.4	195	1131	1127	2258	19.65	13.1
10	S	196.7	198.0	197.25	1143	1124	2267	19.38	31.6

TWO NEW REVENUE CUTTERS.

At the last session of congress an appropriation of $250,000 (£51,400) each for two new revenue cutters was made. Plans have been prepared and specifications drawn for what is considered will be two of the finest ever constructed for this service. The ships will be duplicates in every particular, primarily to reduce the cost of construction, and, secondarily, in order to produce uniformity in the vessels of the first class.

The work of assisting vessels in distress and in searching for and destroying derelicts has grown to such an extent that these duties were given paramount consideration in deciding on the general type of vessel to be constructed. To that end there has been evolved a design of vessel which will give great seaworthiness, large steaming radius and, in general,



DESIGN FOR THE NEW UNITED STATES REVENUE CUTTERS.

Immediately after the standardization trial a four-hour run at full speed was maintained with the following results:

FOUR-HOUR TRIAL. S. S. MOOSEHEAD.

	Port.	Starboard.
Pressures:		
H. P. chest, pounds gage	167	167.
I. P. chest, pounds gage	74.6	51.7
L. P. chest, pounds gage	10.56	10.6
Vacuum inches	26.75	25.75
Air in fireroom, inches	1.	
Revolutions		
Main engines	200.55	201.75
Average	201.15	
Air pump	37.25	
Circulating pumps	469.	416.
Average	442.5	
Feed pump	21.25	
Forced draft blower	525	
Speed, statute miles per hour	19.75	
Slip, percent.	13.5	
I. H. P. total, main engines	2341.	

The *Moosehead* was to be delivered under her contract on May 15, and was finished ahead of time. She has been at the railroad company's wharves at Rockland, Me., being outfitted for service into which she entered on June 26.

During the fiscal year ended June 30, 1,527 vessels of 302,391 gross tons were built in the United States and officially numbered by the Bureau of Navigation, compared with 1,502 vessels of 347,025 gross tons for the fiscal year ended June 30, 1910. The decrease is due to a falling off of 65,000 tons in shipbuilding on the Great Lakes, anticipated in Secretary Nagel's report last year. The year's construction comprised 1,123 steam and motor vessels of 246,540 tons, 85 sail vessels of 11,398 tons, and 319 unrigged barges and canal boats of 44,453 tons.

to provide all usual appliances for the assistance of vessels in distress.

The principal dimensions of the new vessels will be:

Length over all	200 feet.
Length between perpendiculars	180 feet.
Breadth of beam, molded	34 feet.
Displacement at mean load draft	1,324 tons.
Draft, aft	15 feet 6 in.

Each will have a flush deck, fore and aft, and be schooner rigged with two pole masts. The stem will be slightly ram-shaped and the stern will be of the overhanging, elliptical type. There are two complete decks, the berth and spar decks, and outside of the machinery space at each end of the ship a partial berth deck. A double bottom extends under the fireroom, which will be utilized for boiler feed water. The only houses on the spar deck will be the pilot house and a small structure around the mainmast for an entrance to the cabin. The living quarters for the captain and the wardroom officers will all be on the main deck, aft; the warrant and petty officers will have staterooms forward on the same deck, while the crew will be berthed in galvanized iron pipe berths, instead of in hammocks, as is usual.

The new cutters will carry six boats, including an up-to-date surf-boat, all of which will stow between the two masts, thus leaving a clear quarter deck where towing lines may swing without obstruction. A large pair of towing bitts and a steam winch will be fitted just aft of the mainmast, as in the

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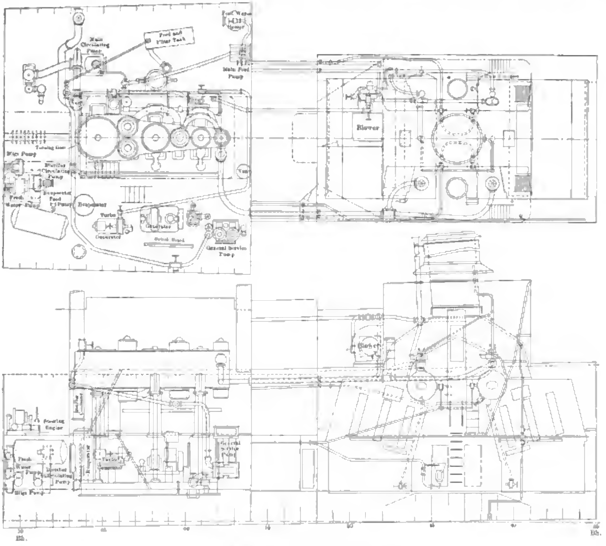
work of the revenue cutters it is frequently found advisable to tow derelicts or disabled vessels into port.

A large magazine, aft, abreast of the shaft alley on the starboard side, will provide safe stowage space for the ammunition to be used in the main battery of four 6-pounder rapid-fire guns and for the gun-cotton mines to be used for derelict destroying.

The new vessels will have a very complete electric installation, consisting of one 20-kilowatt main generating set for purposes of lighting, and one 8-kilowatt turbo-generator for the wireless telegraphy and emergency set. There will be one 24-inch and one 18-inch searchlight, an Ardois signaling apparatus and a 2-kilowatt wireless telegraph set of the latest type.

The propelling machinery will consist of two straight-tube watertube boilers, each containing about 90 square feet of grate and 3,150 square feet of heating surface, which will furnish steam at 200 pounds pressure for the main propelling engine. This will be of the vertical, direct acting, inverted, triple-expansion type, having cylinders 20 inches, 32½ inches and 54 inches in diameter, respectively, with a common stroke of 36 inches. All main valves will be of the piston type and it will be noted that their design is such as will reduce the volumetric clearance to a minimum. The surface condenser will be of the ordinary cast type, forming a part of and built in with the back columns of the engine.

A feature of the design is what is presumed to be the first auxiliary condenser ever designed to work in conjunction with the main condenser circulating apparatus. From the design it will be seen that the auxiliary condenser is of the same general section as the main condenser and forms a part of the housing of the high-pressure cylinder. In port, when the auxiliaries only are in use, the main circulating pump will circulate water through the auxiliary condenser by means of pipes connecting the water chests of the main and auxiliary condensers. This avoids the installation of two circulating pumps with the necessary complication of sea valves, pipe connections, etc. The main feed pump will be utilized as an auxiliary air pump and will discharge directly into the feed tank.



MACHINERY SPACE OF THE REVENUE CUTTERS.

There will be a feed water heater, a wrecking pump, ash ejector and, in general, all the accessories necessary for the requirements of a revenue cutter.

It is estimated that the main engine will produce 2,000 indicated horsepower, at the extreme, which should give the vessel a meximum speed of about 15 knots.

The very large bunker capacity for this size of vessel (300

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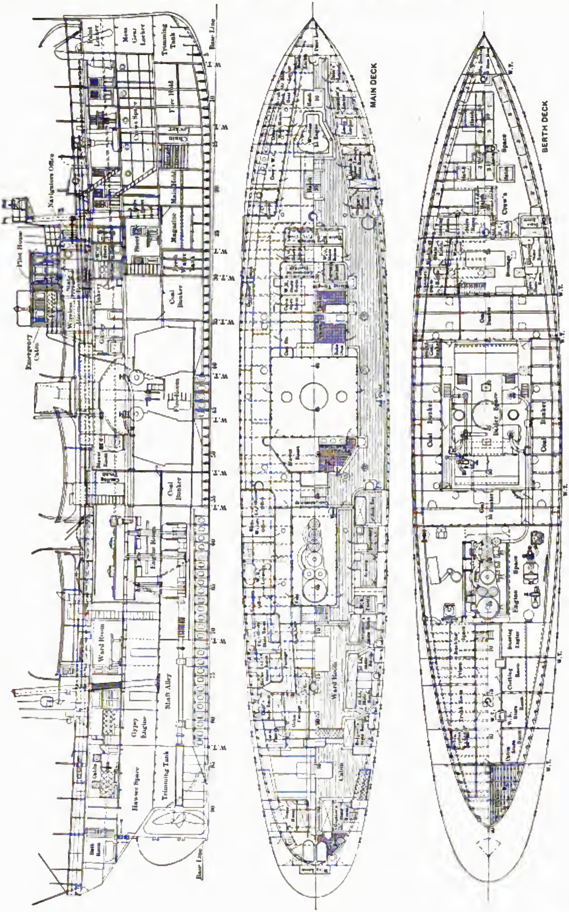


INBOARD PROFILE AND DECK PLANS OF THE NEW UNITED STATES REVENUE CUTTERS.

tons) will give them a cruising radius at economical speed of not less than 5,000 nautical miles, a much desired factor for long cruises in search of derelicts. The vessels will each carry about 16,000 gallons of fresh water.

Congress, as in the case of naval vessels recently authorized, required that these vessels should be built in accordance with the provisions of the 8-hour law. Proposals were solicited for ships of this design, but owing to the restrictions of the 8-hour law shipbuilders refused to bid. Upon modified plans for smaller vessels, embodying most of the essential features, the Newport News Shipbuilding Company has finally been awarded the contract for their construction at a cost of $244,000 (£50,000) each.

MISUNDERSTANDINGS CONCERNING BABBITT METAL.

BY A. A. GREENBURG.

The manufacture and sale of Babbitts has long been a prolific field for the impostor. He has invariably taken advantage of the prevalent ignorance of the purchaser and has done incalculable damage to the reputable manufacturer. The business, in fact, years ago came to such a point that firms who valued their reputation hesitated before entering this field of competition.

There is perhaps at the present time no term in the mechanical world so ambiguous and so misused as the term "Genuine Babbitt." It is popularly believed that "Genuine Babbitt" is the composition originally compounded and invented by Isaac Babbitt, to whom we are indebted for the invention of making soft metal linings for bearings. In United States patent No. 1,252, July 17, 1839, granted to him, a suitable composition is mentioned consisting of fifty parts tin, five parts antimony and one part copper. Now, what his patent specifically covers, and what he claims in the same, is simply the method of application of a soft lining in bearings. The formula given was for the purpose of making his specifications complete for patent office requirements. The value of his invention in his own mind related to the construction of bearings rather than to the production of an anti-frictional metal.

Later, Mr. Babbitt gave the question of the composition of his alloy some thought, and he realized that the hardest alloy consistent with other requirements was the best for him to use. The formula for his favorite composition, which, some years later, he sold to a Mr. Phillips, an American manufacturer, was quite different from that first mentioned in his patent, in that it contained ten parts tin, one part antimony and one part copper. At the outset, Mr. Babbitt himself had no exact composition he used for his linings; wherefore the term "Genuine Babbitt" cannot be used in the sense that it is Babbitt's original composition; and, further, it is impractical and cannot be used as a definite specification.

Still greater uncertainty is brought out by chemical analysis of the different metals sold under the trade name of "Genuine Babbitt." If the term ever meant anything at all it was simply this: that the preponderant constituent was tin and that its two other constituents were were antimony and copper.

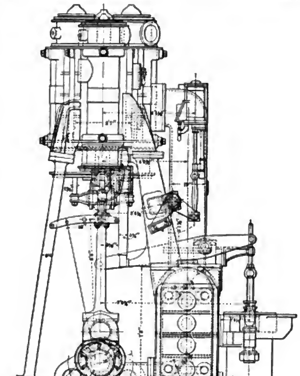
Until recent years the term generally implied that the composition was free from lead. This, however, is no longer the case, because the low cost of antimonial-lead as a by-product for the last fifteen years, and the constant increase in the price of tin, have weighed so heavily upon the manufacturers of "Genuine Babbitt," that to-day the term no longer excludes lead from its composition.

It is, therefore, apparent that this term has outlived its usefulness, and it has been suggested that it be given decent burial in recognition of the respect in which the term was once held. Engineers and machine builders realize that there is no such thing as one universal bearing composition that can be considered as the best and most serviceable alloy for all requirements. Bearing metals should be specified with the same degree of care and precision as any other metal used in the construction of modern machines.

Manufacturers offer alloys of widely different composition, and it is impossible to rely upon fanciful labels and brands. An illustration of this is found in the fact that many makers offer "Genuine Babbitt" of several brands and of as many different compositions. The greatest difference is probably in the matter of price, so that the buyer who desires a "Genuine Babbitt" may choose various grades, prices and compositions; still, they are all classed as "genuine."

Ethically, this is ridiculous, but practically it is not necessarily harmful. While apparently there should be only one "genuine," there is no reason to believe that Isaac Babbitt's formula of fifty years ago, if taken as a definitely exact composition, should apply to the completely altered bearing conditions of to-day.

There is certainly a great question as to the adaptability of any one formula to the wide range of conditions which must be provided for in these days, so that there is justification for the intelligent manufacturer in departing from any established formula; such action is due to an increased knowledge



END ELEVATION.

of the metals and metallurgical processes and the necessity for economical construction.

As a matter of fact, nearly all bearing metal requirements could be met with Babbitt's formula of ten parts tin, one part antimony and one part copper. The real merit of a bearing metal lies in its giving satisfactory service at a minimum first

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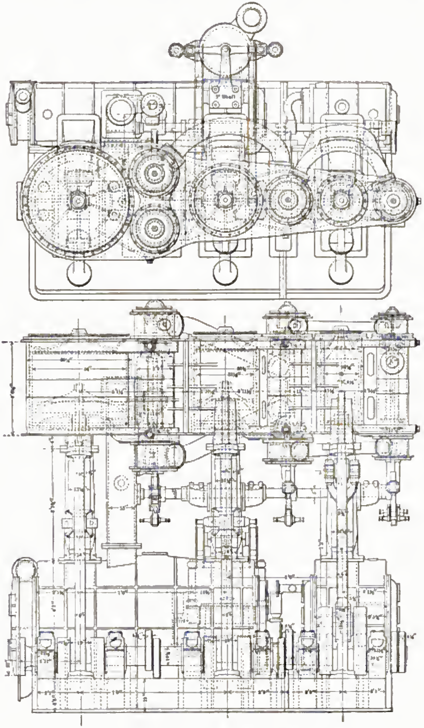
cost. There are, on the other hand, many service conditions where 87 percent lead and 13 percent antimony will answer just as well, and it is a sheer waste of high-priced material to use the former when the latter will do. This illustrates forcibly the extremes of Babbitt compositions. There are also a greater number of intermediate conditions where a very considerable loss is occasioned either by the use of a composition more expensive than is necessary or one that does not have the necessary mechanical qualities to meet the requirements. The metal should be hard enough so that it will not flow or be distorted under service conditions, and at the same time it should not be so hard as to be brittle in case the bearing should be subjected to pounding or unusual strains. The efficiency of the alloy, therefore, depends upon the quality of wearing surface that can be produced and maintained under service. A properly selected metal carefully applied, both as to design and workmanship, produces a bearing which with proper lubrication has no metallic contact while running. That



SIDE ELEVATION OF THE MAIN ENGINES OF THE REVENUE CUTTERS.

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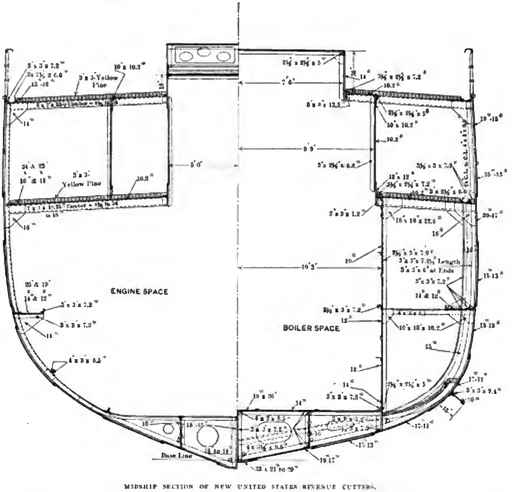
is, the journal and its bearings are separated from each other by a film of oil which mantained in operation; as soon as the movement of the journal is stopped the film of oil is gradually squeezed out and the metallic surfaces are brought into contact. Therefore, in selecting the metals for a bearing they should be sufficiently dissimilar, so that when starting the machine there will be no danger of scoring the shaft until the oil firm shall have been restored.

The heating of bearings is the principal cause of annoyance, and in cases where the metal punishment is so severe that heating cannot be avoided a metal of high melting point should be selected.

Manufacturing methods have a very important bearing on the serviceability of different alloys. The chemical analysis of a Babbitt, giving the constituents and their relative proportions, is, of course, of some value in determining the quality of Babbitt under consideration; but more important still are certain fundamental, chemical and metallurgical laws according to which the constituents should be united, and if these laws have not been observed a very inferior product will be the result. It is not the purpose here to give a metallurgical treatise but to suggest ideas that should be observed in the handling and applying of lining metals.

In general, these metals should be melted in an iron vessel, and kept covered as much as possible in order to prevent excessive oxidation. They should be heated considerably above their melting point before using, but must not be kept in a molten state at a high temperature longer than necessary. Overheating should be carefully avoided, and a good rule for general practice is to heat the molten Babbitt to a point where it chars a pine stick, at which temperature it casts perfectly. In cold weather the housing and mandrel should be warmed. However, it is not desirable to have the housing as hot as the molten Babbitt, since the slow cooling made necessary thereby would produce excessively large crystals and an undesirable molecular construction.

The analysis of service conditions is the first important step in the selection of the most economical Babbitt for any requirement. The variable conditions of applying a bearing, as well as the care, method and nature of lubrication, all have a distinct effect on the final results. A bearing properly fitted, having the journal perfectly true and polished and the surface accurately scraped, will work under far more severe conditions than could be imposed upon the same bearing if fitted carelessly or inaccurately; the same is true for poor lubrication. It is, therefore, impossible to lay down a definite set of rules for the exact maximum performance of the different alloys.



MIDSHIP SECTION OF NEW UNITED STATES REVENUE CUTTERS.

The final selection of the bearing metal, the design and construction of the bearing, should be left to one who has had experience, but a few general considerations of the subject should not fall amiss.

Where the service conditions are severe owing to great pressure, a metal having considerable compressive strength is necessary, regardless of what the speed may be, and this condition would require a relatively high percentage of tin. Where there is high speed and the pressnre light or moderate,

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a metal having a fairly high percentage of lead may be used. In the same manner, with intermediate conditions between pressure and speed, correspondingly intermediate compositions can be selected.

The surroundings of a bearing should also be taken into consideration if they are at all unusual. If a bearing is placed in a position where it is subjected to a gritty dust, a higher grade or a harder metal should be used than what would be required for the same service conditions where dust is not encountered. This is owing to the fact that a soft metal is liable to have imbedded upon its wearing surface the grit surrounding it, a difficulty which with a harder Babbitt is not so likely to occur.

Where a bearing is subjected to outside heat a better quality of metal should be chosen than would be necessary for the same bearing under cooler conditions. This is self-evident, in that all bearings, no matter how well fitted or perfectly adjusted and lubricated they may be, are, under full service conditions, warmer than the surrounding air, and the total work of friction, whether great or small, appears in the bearing in the form of heat. The heat given off by a bearing is a direct measure of the amount of the total working friction in that bearing.

The question of care and attention that a bearing receives should also be taken into consideration. A bearing that is lubricated at long intervals or with a poor grade of lubricant requires a higher grade of metal than that which would be required under more favorable conditions.

There is nothing very difficult in making Babbitt suitable to any kind of service. It is only necessary that the work be done by an experienced metallurgist. *Right here* is where we see the importance and value of dealing with a maker whose experience and reputation are above question, and who produces alloys of high quality and sells them honestly at fair prices.

NEW COLLIERS AND TUGS FOR U. S. NAVY.

On June 20 last bids were opened at the Navy Department, Washington, for four naval colliers and two tugs. In the number of colliers were included the two for which bids were received in November last, but which could not then be considered, owing to either an excess over the limit in the appropriation or to irregularities in the submission of the bids. The law governing the construction of these two colliers must conform with the provisions of an act entitled "An act relating to the limitation of the hours of daily service of laborers and mechanics employed upon the public works of the United States and of the District of Columbia," approved Aug. 1, 1892, which means in defined words an eight-hour workday.

The two colliers authorized by act of Congress, approved March 4, 1911, as well as the tugs above mentioned, are not subject to the act above cited, its provisions having been eliminated. The Maryland Steel Company, of Sparrows Point, Md., submitted the lowest bid for the construction of the colliers Nos. 11 and 12 (not subject to the eight-hour workday), their bid being $961,000 (£197,000) for each.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., submitted bids for the construction of all four of the colliers, Nos. 9 and 10 (subject to the eight-hour law) at $975,000 (£200,000) each, and Nos. 11 and 12 at $995,000 (£204,000) each. The ships being practically alike, the difference between the two bids would approximately represent the difference in cost of construction to this company under the eight-hour law as compared with standard practice.

The New York Shipbuilding Company, Camden, N. J., submitted the lowest bid for the construction of the two seagoing tugs at $194,000 (£40,000).

COLLIERS NOS. 11 AND 12.

Their chief characteristics are contained in the following: They are single-deck vessels, about 530 feet long, 65 feet beam and 27 feet 6 inches mean draft. Speed, 14 knots at load draft. All the ship's scantlings and arrangements of bulkheads, etc., will meet the general requirements of the American Bureau of Shipping.

In full-load condition the vessels must have a continuous sea speed of 14 knots when carrying 12,500 tons of coal, inclusive of bunker, with an additional 250 tons covering other items.

They have a double bottom extending under the cargo-carrying spaces, as well as under the engine and boiler rooms, while the forward and after-peak compartments will be arranged as trimming tanks. Arrangements for carrying fuel oil in bulk will also be provided for.

The vessels will be fitted with complete coal-cargo handling appliances, consisting of necessary masts, derricks, elevated rails, reversible winches, etc., arranged in such a manner as to deliver coal at rate of about 100 tons per hour from each main cargo hatch, making a total delivery of about 1,200 tons per hour. All necessary pumps, piping and connections will also be provided for handling oil cargo.

Each vessel will have an electric plant, electrically-driven ventilation fans, all suitable appliances for interior communications, such as engine and steering telegraphs, voice tubes and telephones.

An efficient pumping and drainage system will be installed for filling and emptying ballast and trimming tanks, together with a fresh and salt-water system for use in galleys and quarters. A steam heating system will be installed. Accommodations, with staterooms, will be provided for commander, executive and navigating officer, senior engineer officer, three watch officers, doctor, paymaster, two warrant machinists, besides crew's accommodations.

The propulsive machinery will consist of twin-screw, triple-expansion engines of the merchant marine type, and of adequate size for the speed stipulated. The boilers will be of the cylindrical type, with separate combustion chamber for each furnace. A donkey boiler will be fitted for use in port. All necessary auxiliaries will be installed, including evaporators, feed heaters, refrigerating plant, steam reversing engine, steam turning engines and ash hoists.

SEAGOING TUGS.

The general features for each of the tugs are:

Length between perpendiculars.....	175 feet.
Length over all.....................	183 feet.
Breadth, molded	34 feet.
Breadth, extreme over guards......	35 feet 6 inches.
Draft, trial condition, aft..........	14 feet.
Draft, trial condition, forward.....	15 feet.
Displacement	1,100 tons.
Total bunker capacity about........	435 tons.
Continuous sea speed..............	14 knots.

The vessels will be built to have the highest rating provided for by the rules and inspection of one of the registration societies. The ships to be fitted with all modern appliances, such as steam capstan and windlass, a reversible steam winch for each of the two cargo booms, steam steering engine, refrigerator and evaporator plant, electric plant and wireless telegraph apparatus, etc.

The propelling machinery for each will consist of a merchant marine triple-expansion engine and two cylindrical boilers, with all necessary auxiliaries.

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THE POWERING OF MERCHANT SHIPS AND DESIGN OF THEIR FORMS.

BY PETER DOIG.

To those who are familiar with the assembling graphically of progressive trial results in Admiralty constant form, the task of rendering the curves obtained amenable to law must seem one with much inherent difficulty. The Admiralty constant, or displacement coefficient, as it may be better termed, is familiar to all, being the value

$$K = \frac{D^{2/3} V^3}{H}$$

where D is displacement in tons, V speed in knots and H indicated horsepower. As is well known, this coefficient is not a constant, properly speaking; and it may be well at the outset to remind ourselves of the assumptions underlying it. These are: (*a*) That the resistance varies as the square (and consequently the work done as the cube) of the speed; (*b*) that the proportion between "useful" work, or work not wasted in overcoming machinery and propeller frictions, etc., and gross work of the engines, is always a constant fraction; (*c*) that resistance at any particular speed is proportional to wetted surface, or two-thirds power of the displacement, to which wetted surface is itself approximately proportional. If these were absolute laws then a certain unvarying displacement coefficient would be got at any speed of a given ship, and values varying only as the (displacement)$^{1/3}$ of different vessels would be the rule. The skin or frictional part of resistance varying as the 1.83 power of the speed, the foregoing would very nearly hold if all resistance were frictional between ships of no great difference in length; but the introduction of the wave-making phenomena alters this index considerably. Its value gets higher with speed until at very high velocities, where it again decreases. This gives the curve of displacement coefficients a typical form as plotted on a base of speed-length ratio $\left(\frac{V}{\sqrt{L}}\right)$ When the effect of greater relative waste of work at low speeds, due to lower engine efficiency, is allowed for, a curve is obtained starting high in value and decreasing until very high relative speeds are reached, where, in tropedo craft, for example (at $\frac{V}{\sqrt{L}}$ about 1.6), the line has an approximately level trend.

To clear the way towards some reconcilation of the greatly varying values found, it will be of help to consider the factors affecting it in ships of the same displacement. These may be taken: (1) Speed; (2) fullness or block coefficient; (3) proportions; (4) propulsive efficiency; (5) to some degree, owing to the lesser frictional resistanee per unit of surface with increased dimension, length, and (6) form, by which is meant the nature of the horizontal and transverse sections.

Though needing careful treatment in view of all these influencing factors, this coefficient method has maintained its position as a handy and flexible means of estimating power in all shipbuilding countries except France, where a similar but less satisfactory coefficient, involving the area of the fullest transverse section instead of the two-thirds power of the displacement, has been long in use. The writer is convinced that the displacement coefficient can be used in a more general way than is current, although it is no doubt being superseded by the more scientific methods of the model basin. As the naval architects and engineers enjoying the use of such an establishment form a very small number in the profession, the present paper, it is hoped, may be of help to the great majority debarred from such a luxury.

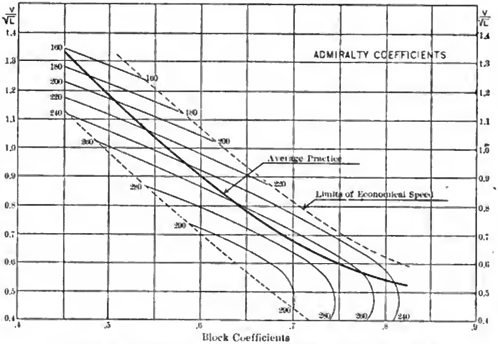

DIAGRAM SHOWING THE EFFECTS OF FULLNESS OR BLOCK COEFFICIENT AND SPEED ON DISPLACEMENT COEFFICIENTS.

An attempt has been made by the analysis of the coefficients obtained in the trials of a large number of merchant vessels to eliminate the effects of the factors enumerated above. As the ships considered are of different builders' designs, the forms should cover most of the practical variations from the normal; so that the effect of number (6) is, so to speak, automatically averaged in the process adopted. A computation of the effect of (5) assuming a standard length of 400 feet, and taking an average proportionate frictional resistance to total resistance (on which the effect directly depends), gives the following corrections:

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CORRECTIONS TO K FOR LENGTH.

	Percent		Percent
100 feet less...........	9	500 feet plus..........	1½
200 "	5	600 "	3
300 "	2	700 "	4½
400 "	0	800 "	6

By careful methods the propulsive efficiencies have been estimated for the different ships, using D. W. Taylor's and R. E. Froude's model screw experiments for propeller efficiencies. This disposed of number (4) in a fairly satisfactory manner, though its effect is very large. The propulsive efficiency, or ratio between the effective of "tow-rope" horsepower, and that indicated by the engines, is therefore a measure of the proportion of engine power not used up in the frictional and other losses at machinery and screws, and varies from about .45 to .60. Indicated horsepower absorbed in driving a given ship at a particular speed is inversely proportional to this figure, and it therefore follows that the displacement coefficient varies directly with it. It is plainly seen how great an effect may be produced on displacement coefficients of the same form with different propulsive efficiencies. In the case of number (3) the proportions considered were limited to $\frac{\text{breadth}}{\text{length}}$ values between .105 and .140, and $\frac{\text{draft}}{\text{beam}}$ proportion between .50 and .30. Most merchant ship practice lies in this region, and not much effect due to change of these values was traceable in the coefficients tried.

By plotting the trial coefficients corrected for (5) to 400 feet standard waterline length, and for (4) to .50 propulsive efficiency, on a base of block coefficients and ordinates of speed length ratio, curves were obtained showing the effects of fullness and speed on displacement coefficients. Hence in a more or less satisfactory way the effects of (6), (5), (4), and *for the porportions concerned* (3), are eliminated, leaving the influences of (2) and (1) shown on the diagram. A guide to its formation was found in the published tank results of D. W. Taylor, H. Sadler and others, by the reduction of the results of the forms experimented onto displacement coefficients of ships 400 feet long with .50 propulsive efficiency, some addition to the resistances being made for bilge keels, bossings, etc. It must be borne in mind that only forms falling within the range of proportions mentioned are represented by the diagram; so that shallow river craft, for example, are excluded. However, a great proportion of the mercantile marine, including most ocean-going and a large part of coastal and inland-water ships, are suited by the curves.

A progressive trial, when put down in displacement coefficient form, shows often a maximum value at speeds higher than that indicated by the diagram. This seems to be due to the lower propulsive efficiencies, through greater proportionate frictional waste at engines, at speeds lower than the maximum designed speed.

In setting down the coefficients at the full speeds attained in each ship it was found that they clustered along a line which has been marked average practice on the diagram. This gives what practice has sanctioned as the appropriate fullnesses for particular speed-length ratios. By taking suitable proportions (from similar vessels) a useful rough approximation to displacement may be got, where the known particulars are length and speed, or limiting draft and speed. The figures of size and displacement obtained will serve as a guide in the estimation of the weights of hull, machinery, fuel and deadweight carried; which total, of course, will equal displacement. The top line of the diagram represents the limits of economical propulsion, above which comparatively inordinate expenditure of power would be incurred, and the breadth of the diagram has been limited to the range of maximum trial speeds found in practice, though, as before remarked, these cluster more or less about the average practice line.

In estimating a likely displacement coefficient for a new design the writer has found the values in the following table useful. The multipliers given include the effects of length and propulsive efficiency for the classes tabulated; but it is suggested that possessors of data should find suitable figures for themselves:

TABLE I.

Type.	Length, Feet.	Screws.	Machinery.	Speed, Knots.	Block Coefficient.	Multipliers.
Coasters.	200 to 300	Single	Reciprocating	12 to 15	.50 to .65	.82 to .90
Freighters.	200 to 300	Single.	Reciprocating	8 to 12	.65 to .85	1.02
	300 to 400	Single or Twin.	Reciprocating.	9 to 15	.65 to .85	1.06
	400 to 600	Single or Twin.	Reciprocating	10 to 17	.65 to .85	1.12
Fine Passenger.	250 to 400	Twin.	Reciprocating	16 to 23	.45 to .60	1.07 to 1.14
	250 to 400	Twin or Triple	Turbine.	20 to 25	.45 to .55	1.00 to 1.05
Intermediate Liners or Mail Steamers.	400 feet upwards.	Twin.	Reciprocating	14 to 20	.60 to .70	1.04 to 1.09
		Triple.	Turbine or Combination.	16 to 20	.60 to .65	1.00 to 1.05
Fast Liners.	500 feet upwards.	Twin.	Reciprocating	20 to 23	.55 to .62	1.03 to 1.07
		Triple or Quad.	Turbine.	20 to 26	.55 to .62	1.00 to 1.06

As an illustration of the application of this table to the curves the case of a turbine-driven Atlantic liner, 760 feet long, 25½ knots speed, block coefficient .59, may be taken. $\frac{V}{\sqrt{L}}$ here is .925, and reference to the diagram gives 245 as the uncorrected coefficient for this fullness and relative speed. From the table it will be seen that this has to be multiplied by 1.05 (as the length of the ship is so great), and the value 257 is given. With a displacement of 37,000 tons the power necessary for the speed is

$$\frac{37{,}000^{2/3} \times 25.5^3}{257} = 71{,}500.$$

This ship is the *Mauretania*, and the above figure is a fairly close approximation to her shaft horsepower at the speed.

Perhaps the best way in which the diagram can be made useful is to estimate from exemplar or type ships. Trial data of vessels as near as possibly similar to the new vessel's size, method of propulsion, speed and fullness, may yet differ somewhat in the last two particulars; and here the value of the diagram will be evident. The $\frac{V}{\sqrt{L}}$ values and the block coefficients of the type ships and of the ship proposed (waterline lengths being used) are calculated and spotted on the curves, and the amounts, to be added to or subtracted from the displacement coefficients of the type ships, are seen. A figure, which is corrected for differences of speed and fullness, and averaging the propulsive efficiencies of the exemplar ships used, is then obtained. It remains to be observed that no trials of ships in adverse weather conditions, with foul bottoms or with emerged propellers, have been used in forming the diagram.

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TABLE II.

Block Coefficient.	Designed Speed. $\frac{V}{\sqrt{L}}$	Length of Parallel Middle-Body ÷ Length of Ship.	Curve of Cross Section Areas.	Forebody Waterline.	Nature of Forward End Transverse Section.
.86 to .76	.50 to .60	Minimum resistance with .38, 3% greater with .32 to Minimum resistance with .31, 3% greater with .44	Round at ends.	Round. "In other words easy buttocks at each end rather than full below and fine above." (Prof. Sadler.)	Round V'd rather than U'd.
.73 to .63	.63 to .85	Minimum resistance with .28, 3% greater with .40 to Minimum resistance with .10; 3% greater with .18 About 6-10 of p. m. b. in forebody.	Hollow forward end "with a given set of dimensions and displacement a long middle-body forward with a fine bow, but more gradual diminution aft." (Sadler.)	Hollow forward end. Rounder aft. Hollowness of waterline forward confined to about 15% ship's length from bow.	U'd or "clubbed."
.63 to .53	.85 to 1.10	Minimum resistance with .10, 3% greater with .18 diminishing to 0 at .6 block coefficient, below which p. m. b. seems undesirable.	Slightly hollow forward.	Slightly hollow forward end.	U'd.
.53 to .45	1.10 to 1.35	No p. m. b.	Hollow forward and aft	Straight, especially above 1.2 $\frac{V}{\sqrt{L}}$	V'd.

THE DESIGN OF FORM.

As the experimental researches of the Froudes, Taylor, Sadler and others on ships' models (see International Marine Engineering, 1905, p. 286; 1909, p. 319) have shown differences in resistance due to varying amount of parallel middle body, varying position of fullest section, and different nature of waterlines, etc., even in vessels of the same proportions and fullness, it can be seen that the writer's statement that only average forms are represented in the diagram is a reasonable one. It may here be of interest to sum up the main results of the experimenting of these authorities, and in doing so the dicta of R. E. Froude (Transactions Institute of Naval Architects, 1904) will be of great assistance in enabling us to concentrate on the major variables concerned. He says: "So long as no unfair features are introduced, such as may cause serious eddy-making, we may almost say that the resistance of a form is determined solely by (*a*) the curve of cross-section areas, together with (*b*) the extreme beam.* and (*c*) the surface waterline of the forebody; and if these are adhered to the lines may be varied in almost any reasonable way without materially increasing or decreasing the resistance at any speed."

* The effect of change of beam on displacement coefficient is not necessarily so great as on resistance. For, with given length, block coefficient, and $\frac{\text{draft}}{\text{beam}}$ proportion, displacement is greater with greater beam; so that (displacement)$^{2/3}$ in the denominator of the expression increases and offsets to some extent the increase of indicated horsepower following greater resistance. This probably explains to some extent the small difference found by the writer between the coefficients of ships with $\frac{\text{beam}}{\text{length}}$ proportions so diverse as .105 and .140, so long as block coefficient and speed-length value are the same.

It was long a widespread belief that fineness of midship section is favorable to speed. This is implicitly controverted by the foregoing statement, which has been corroborated lately in the Washington model basin. Naval Constructor Taylor says: "Among the very large number of model experiments we have made, we have had no results indicating any material influence of shape of midship section upon resistance," and that "the naval architect may vary widely midship section fullness without material beneficial or prejudicial effect upon speed."

It may be taken that (*a*) includes the parallel middle-body features, and obviously (*c*) determines the nature of the forebody transverse sections, a round waterline (*i. e.*, one convex outwards), meaning generally V'd sections, and a hollow waterline tending to give "clubbed" or U'd shapes. Some experiments of D. W. Taylor give the best proportions of parallel middle-body to length of ship for certain fullnesses; those of Professor Sadler on full forms give the effect of altering the waterline shapes, and, consequently, the transverse sections; and R. E. Froude's researches on hollow versus straight lines are now famous. The following table presents the main features of good forms; and it may be admitted that better results than indicated by the displacement coefficient diagram could probably be got in ships conforming to the requirements in Table II.

It is not suggested that these few particulars sufficiently define a good form for the purpose of design; but they will serve as a guide for betterment in working from previous designs, if carefully made use of. The characteristics of the various fullnesses shade into each other, but the divisions indicate approximately where one quality ends and the other begins.

Hitherto the accepted opinion has been against any hollowness in waterlines, but model basin experiment has proved their merit in certain cases. Mr. MacEntee has found, from the stream-line theory, that "hollow waterlines cause less wave-making disturbance than straight or convex waterlines, and that as the hollowness and fineness of waterlines are increased, the wave-making disturbance decreases to a minimum, after which, if the lines are made still finer and hollower, the wave-making disturbance again increases." Model experiments have verified the substantial accuracy of this theoretical result with moderate fullnesses and relative speeds; but with great fullness or great relative speed round or straight waterlines seem better. As the investigation of Mr. MacEntee was limited to average fullness and speed, and also to too dimensional treatment, the discrepancy is not serious.

The run of the stern of ship forms should, of course, be designed with a view to a good flow of water to the screw or screws; but otherwise from the standpoint of resistance alone, variation of sectional shapes in the forebody is generally of greater influence than changes of the afterbody form.

A Reversible 300 Horsepower 4-Cylinder Oil Engine.

The problem of designing reversible internal-combustion motors suitable for the propulsion of ships has been solved satisfactorily by Messrs. Fried. Krupp, Ltd., Germaniawerft. In fact, the 300 brake-horsepower Diesel motor exhibited by that firm at the recent International Motor Show at Berlin is reversible and capable of regulation within wide limits. The dimensions of this engine are as follows:

Cylinder diameter	13 inches.
Stroke	13 inches.
Maximum speed	450 r. p. m.

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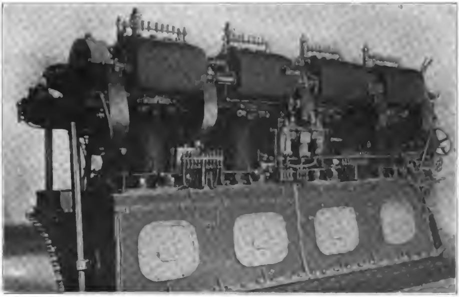
The motor is a single-acting four-cycle engine, the air drawn in during the first downward stroke of the piston being compressed during its upward stroke. At the upper dead point the fuel is introduced into the working cylinder by means of compressed air at 133 pounds pressure per square inch. During the first portion of the subsequent working stroke the work is performed.

Any kind of raw or distilled product of petroleum can be used as fuel; besides crude oil, naphtha, paraffin oil, gas oil, coal tar oil and oil gas tar have been lately employed in this engine.

The fuel consumption is one-third of a pint per indicated horsepower per hour, with fuel of 10,000 effective calories. The fuel is led from a tank to the fuel pumps, each of which supplies one of the four motor cylinders. The compressed air required for introducing the fuel is obtained by means of an air pump, and is stored at a pressure of 133 pounds per square inch.



SINGLE-ACTING, FOUR-CYCLE, REVERSIBLE DIESEL ENGINE OF 300 BRAKE-HORSEPOWER.

The control is effected by means of cam discs, levers, etc. The admission, outlet and fuel valves are actuated by a common controlling shaft, whereas a shaft located on the opposite side of the cylinder merely controls the outlet valves.

The motor is started by means of compressed air stored at a pressure of 440 to 515 pounds in two cylindrical steel vessels, the capacity of which has been calculated with a view to allowing the motor to be started sixteen times. The controlling levers are shifted into their starting position previous to starting the motor, and after reaching the speed required for ignition are brought back into working position.

An emergency regulator allows the motor to be stopped, in the event of a shaft fracture, by shutting off the fuel supply as soon as the maximum speed is exceeded.

The working cylinders are made of high-class bronze, and are designed with double walls, water-cooled; they are provided with cast iron liners. The base plate and engine frames are made of bronze castings. The main bearings are water-cooled. The driving gear is readily reached after removing special covers in the frame, which are kept closed during operation. The crank-shaft, connecting rod, pistons, etc., are made of high-grade special steel supplied by Messrs. Krupp.

The moving parts are lubricated by means of a compressed oil system, the cylinders being oiled by special pumps. The used oil is collected in the base-plate, and after being cleansed is used over again.

The cylinders and cylinder covers, as well as the exhaust conduits, are water-cooled.

A similar engine was fitted last year in the 25-ton tug *Rapido* of Messrs. Slomann & Company, of Hamburg. This vessel, built at the Lürssen shipyards, is propelled by a reversible six-cylinder motor designed on the system described.

The motor gives the tug a speed of 10½ knots at 400 revolutions per minute; the pull of the boat is 2,640 to 2,860 pounds at 6½ knots. The fuel consumption is only one-third of a pint per horsepower-hour, which compares favorably with that of the best stationary plants.

As demonstrated by the trial runs, made in the presence of a number of interested parties of the military and mercantile navies, the reversing of the motor is as quickly done as with a steam engine. In regard to economy, these motors, which can be readily constructed for any outputs (up to several thousands of horsepower), and are far superior to any steam engine plant, especially where there are frequent fluctuations in load, such as on board tugs, ferries, etc. In fact, the heat losses, unavoidable with steam during intervals of idleness, are done away with, and the motor is ready for operation at a moment's notice without being warmed up. A further advantage is due to the cheapness of the fuel, its less weight and bulk, and the corresponding increase in capacity which increases the radius of action of warships, while the simplicity in operation is such that no skilled labor is required. A further good feature which is of special importance in connection with passenger steamers and warships is the absence of any smoke and soot, the exhaust being entirely smokeless at normal speeds. Again, the crew of the vessel is not inconvenienced by heat radiation, the motors being cooled with water, which will be especially appreciated in hot zones.

Those countries which possess abundant sources of petroleum are likely to soon adopt this novel type of motor for the propulsion of their vessels.

The first 2,460-ton cruiser for the modern navy of China was launched at Barrow-in-Furness in July.

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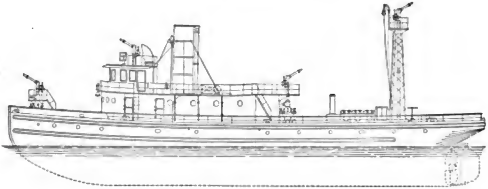
BALTIMORE FIREBOAT DELUGE.

The fireboat *Deluge* has been completed by the Skinner Shipbuilding & Dry Dock Company, of Baltimore, for the Fire Department of that city from designs of Mr. W. I. Babcock, engineer and naval architect, 17 State street, New York. The hull is of steel throughout, 120 feet over all, 109 feet 6 inches between perpendiculars, 28 feet molded beam and 15 feet molded depth, with five bulkheads, three of which are watertight. There is a single deck from end to end, with lower decks forward and aft of machinery space only, all of which are of steel complete without wood covering. The between decks forward is used for a hose room, with racks capable of holding 2,000 feet of hose, with a hatch through the deck forward of the pilot house fitted with rollers all around for passing the hose on deck. The hold under the hose room and the after peak form fresh-water tanks for make-up feed. The lower deck aft contains only the electric lighting set and lockers for the crew. There is a steel deck-house over the boiler room and coal bunker, the forward end of which is fitted up as a nozzle room with stairway to the steel pilot house above. The after end of this deck-house is extended over the central hose turret to make a platform for working a large monitor nozzle. A life raft is stowed on top of the deck-house. The steering engine in the pilot house is of the Queen City hydraulic type.

There are no living accommodations on the boat, the quarters for the crew being in the fire house on the pier.

In the engine room are placed two pumping sets with a guaranteed capacity of 4,500 gallons each at 150 pounds pressure. Each set consists of a General Electric Curtis steam turbine and a Worthington centrifugal pump, all on one bedplate and one horizontal shaft. Each turbine has its own surface condenser, circulating pump and wet and dry vacuum pumps, and all pumps are cross connected, so that either or both condensers may be used with either set of pumps. The main fire pumps are so arranged that they may be worked in series, delivering then 4,500 gallons per minute at 300 pounds pressure. The discharge pipes from the pumps are connected together and lead to a turret immediately over them, to another turret placed at the bow, with a branch to a monitor at the top of the pilot house, and to a monitor at the top of a steel lattice tower on the after deck, which is about 35 feet above the water line.

BALTIMORE FIREBOAT DELUGE, UNDERGOING TEST.



OUTSIDE PROFILE OF THE DELUGE, SHOWING ARRANGEMENT OF MONITORS.

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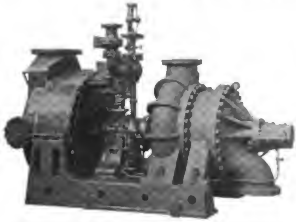
The engine room also contains the propelling engine, which is of the vertical, inverted double-cylinder, non-condensing type, with two cranks and having cylinders 20 inches diameter by 20 inches stroke, and is of very substantial construction. This engine drives a single four-bladed propeller 8 feet diameter, which is of cast steel.

Steam is supplied by two Scotch boilers, 12 feet 6 inches in diameter by 11 feet 6 inches long, allowing 170 pounds pressure, placed abreast of each other next forward of the engine

ONE OF THE THREE-INCH MONITORS ON THE DELUGE.

room, with fire room on forward side and coal bunker next to fire room. Each boiler contains two Morrison furnaces 48 inches in diameter, fitted with separate combustion chambers. The tubes are 2¾ inches diameter. The boilers are fitted with a system of heated forced draft, the blower being placed in a recess in the bulkhead at the forward side of the fire room, and is of the Sturtevant type. The vertical feed pumps are of the Blake type and the feed water heater a Reilly.

The center turret is fitted with twelve 3-inch connections for hose and the bow turret has two 3-inch and six 3½-inch connections. There are four monitors, as shown by the plans, one over each turret, one on top of pilot house and one on the tower aft. These monitors were furnished by Andrew J. Morse & Son, of Boston. The electric light plant has a 10



WORTHINGTON CENTRIFUGAL PUMP, DRIVEN BY A CURTIS STEAM TURBINE.

kilowatt General Electric standard marine set, with about eighty lamps distributed about the vessel, and an 18-inch searchlight on top of the pilot house. The engine room skylight and companionway are of steel complete, with a large number of circular lights, which, as well as the pilot house windows, are of wire-glass.

The pump test took place at the fire boat station in Baltimore harbor, when four 3-inch streams were thrown through the monitors continuously for six hours. The average water pumped during that time was 10,624 gallons per minute at a pressure of 145.5 pounds. The picture was taken during this test. On the trial trip, with 170 pounds of steam, and the wheel making over 150 revolutions, the engine developed 1,100 horsepower and a speed of 15 miles an hour was reached. Everything was so satisfactory that the Board of Fire Commissioners formally accepted the boat at the conclusion of the trial trip, and she went on her station and in regular service the same night.

AN OIL MOTOR FIREBOAT.

A little while ago the council of the London Fire Brigade, England, instituted a competition in order to find out the best design of fire float for use under the very special conditions of service which obtains on the River Thames. The enormous amount of wharfage and of factory buildings, repositories, etc., which congregate on the banks of that river rendered the provision of an efficient river fire service a most important matter, and every endeavor was used in order to utilize as far as possible the most modern fire-fighting mechanism. The result has now become known, and the well-known English firm of boat builders, Messrs. J. I. Thornycroft, Ltd., have now completed and handed over to the London Fire Brigade a motor fire float known as the Gamma, which is shown in our illustration.

The vessel, which is only 66 feet 6 inches long by 11 feet 6 inches broad, was constructed under the supervision of the chief officer of the London Fire Brigade, who worked out the design of the pumping arrangement. The design of the boat provides for motor propulsion and for driving two Gwynne high-pressure centrifugal pumps by the main propelling engine. Each pump has a capacity of 600 gallons per minute at 120 pounds pressure per square inch. Among the special conditions which the design attained was that of draft, which was not to exceed 3 feet 9 inches, and maximum height of any part, which was not to be above 7 feet from the waterline. The guaranteed speed with the two Thornycroft 85 brake-horsepower kerosene (paraffin) motors, driving twin screws, was 10 knots with fuel tanks full and an outfit amounting to 3 tons on board. As a matter of fact, carrying an excess load of 3 tons the boat averaged on trial 10 knots for four continuous hours, with a draft of 1 inch less than the maximum allowed.

The general arrangement of the vessel comprises a raised deck over the crew space and motor room, giving a clear headroom of about 6 feet 6 inches. The crew space has been made accessible from the after deck by a sliding companion, and accommodation has been provided for three men, with seat berths, table, cooking range, etc. A watercloset has also been provided. Reserve fuel tanks are arranged under the after deck in such a manner that the service tank can be filled by means of a semi-rotary pump. A hose room has been provided under the fore deck, fitted with the necessary racks, etc. This space, as well as the motor room, is heated by hot-water radiators operated from a boiler in the hose room. A storeroom has been arranged forward of the hose room for lamp stowage and for sundry fittings. Steering is effected by means of a hand-gear pedestal, with a brass-mounted teak wheel placed on the forward deck, and leads of wire rope are led to the quadrant aft.

Electric lighting has been provided throughout the vessel and to the navigating lamps. The machinery consists of twin sets of kerosene (paraffin) engines, each giving 80 brake-horsepower at 700 revolutions per minute, and Gwynne's high-

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pressure centrifugal pumps. Each engine is connected through a standard reversing gear to a dog clutch, which can connect the main engines either to the propellers or to the pump-driving shaft. The propelling engines have four cylinders, 8 inches bore by 8 inches stroke. They are fitted with a vaporizer of the U-tube pattern, which is arranged to be heated by the exhaust gases. A spirit carburetor is also fitted, so that the engine may be run on gasoline (petrol) with maximum efficiency. The engine is started up on compressed air, which is let into the cylinders on the firing stroke. Gasoline (petrol) is used as a fuel for the first few minutes until the exhaust is sufficiently heated to vaporize the kerosene (paraffin). This takes from five to ten minutes. Should there be no gasoline (petrol) available, the vaporizer can be warmed by a blow lamp. The lubrication is forced, oil being sucked by a small pump from the bottom of the crank case and pumped to the engine bearings through an oil cooler, through which some of the circulating water is by-passed. Ignition is by high tension and also by accumulator and "Lodge" igniter. The reversing gear is of the epicyclic type, the whole going round as one solid drum when in the ahead condition, and the outer drum being held by a brake when in the astern position, which causes the shaft to revolve in the opposite direction. Between the propeller shaft and reversing gear there is a dog clutch, by means of which the engines may be put in connection either with the propeller shaft or with a steel toothed wheel, which is in gear with a compressed paper wheel in the pump-driving shaft. The ratio of gearing is slightly over two to one. The pump-driving shaft is carried alongside the engine on bearings supported by the engine bearers, and drive the pumps through Voith flexible couplings.

The pumps are situated at the forward end of the engine room. These are of the movable high-pressure, four-stage centrifugal type. They run at about 1,450 revolutions per minute, the discharge and suction being 6 inches in diameter. There is a suction box built into the ship on each side, and these are connected by an 8-inch suction pipe, running across the ship, on which are two 6-inch branches to each pump. By this means both pumps can draw through either suction box while the other is being cleaned. A bilge suction box is fitted to the 8-inch suction pipe, with branches to each compartment on deck. There is a monitor or radial delivery, which can be turned in either direction, and also two valve boxes forward, on each of which are four 3-inch sluice valves for hose connections. Two combined electric lighting and air compressing sets are fitted, each of which consists of a 7½ brake-horsepower kerosene (paraffin) engine driving a Siemens dynamo and arranged for driving a Brotherhood rotary compressor through a friction clutch. These are used for pumping up the four bottles in which air is stored at 120 pounds pressure for starting up the main engines, blowing the whistle, etc. Each air compressor set is capable of pumping the air bottles up to 120 pounds in fifteen minutes.

The trials were of a severe character. The speed trial consisted of four hours' full speed trial, followed by maneuvering and turning trials, during which a measured half mile was run with the engines running at 350 revolutions per minute, which demonstrates the flexibility of these engines. For the pumping test each pump had to run for a period of ten hours during the first two hours, of which the output was to be 600 gallons per minute at 120 pounds pressure, and for the remaining eight hours 500 gallons per minute at 120 pounds pressure. Each electric light engine had to be run for four hours continuously. All these trials were carried out to the satisfaction of Lieutenant Sladen, the chief officer, and Messrs. Wells & Kemp, the consulting engineers of the London Fire Brigade. The advent of the motor boat fire-fighting service in Great Britain is therefore an accomplished fact, and in view of the competitive nature of the trials the superiority of the motor-propelled float over its steam rival seems assured.

MOTOR-DRIVEN FIREBOAT BUILT FOR THE SPECIAL CONDITIONS OF SERVICE ON THE RIVER THAMES.

The Italian steamship *Soperga* went ashore on Molasses Reef off Mobile, Ala., in April. The owner of the steam tug *Leroy* asserts that he made a contract with the captain of the *Soperga* to pull her off the reef. This apparently he could not do, and the assistance of other tugmen was asked. After trying in vain to get her off the wrecking vessel *Roosevelt* came along and claims to have floated the vessel. The several owners who joined in the efforts to get the vessel off the reef have libeled her, as no satisfactory arrangement for salvage could be reached.

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CARGO HANDLING AT SMALLER PIERS AND TERMINALS.

BY H. M'L. HARDING.*

The installation as illustrated is not for the larger terminals or where speed of transference is the most important consideration. For such freight movements the arrangement of the overhead tracks would be considerably modified with a larger number of conveyor hoists.

The purpose is to indicate that a plant could be installed of low first cost and of economical maintenance.

Each installation should be treated by itself from the engineering and operating standpoints.

It might be advisable to have the shed reach to the edge of the pier, or that there be traveling bridge cranes with loops (a modified gantry crane) between the shed and the side of the pier, the loop extending over the ship's hatches.

As stated, the following description applies only to the smaller terminals and is not for universal adaptation. This indicates only one method, but shows that the hoisting or lifting without hand labor is of the greatest importance in securing economy.

The overhead fixed track, as shown in the illustration, consists of an I-beam, upon which is a T-rail of light weight, supported about 5 feet from the sides of the building and arranged at the ends of the building in the form of a loop. Upon side-fixed tracks, corresponding to the usual crane tracks, which are parallel to each other, is operated a traveling shop crane of somewhat greater width between its girders than usual. This crane supports and has attached upon each side of itself a track, which track is so arranged with switches at each end as to afford a smooth passage anywhere between the crane cross tracks and the side-fixed tracks. These cross tracks are supported outside the crane girders, except at the end they join to form a loop and are attached beneath the crane.

In some cases, where there is little headroom, or in open yards, the movable cross tracks can be supported upon whole or half-arch traveling gantry cranes similar to the traveling bridges which support the usual hoisting and swinging mechanism of the harbor gantry crane.

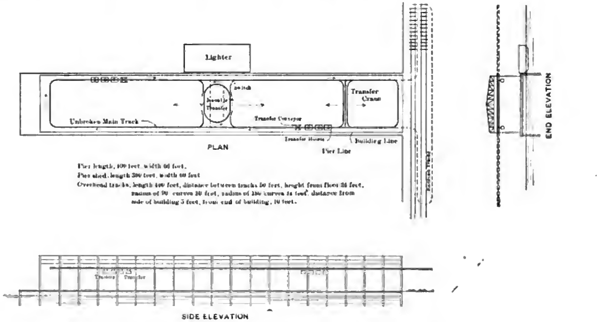
In addition to these outside cross tracks there are between the girders of the crane two straight tracks with extension ends, by which the freight can be taken from one side of the pier directly across in a straight line to the other side and deposited within the shed or upon lighters. When not in use they are drawn within the loop. These straight tracks are chiefly furnished when lighters are to be served.

By means of these movable or adjustable cross tracks every foot of floor space can be served by the overhead conveying machinery without rehandling and at the lowest first cost for installation.

The conveying and hoisting machinery, as shown, is arranged in trains, one transfer conveyor drawing after it three or more trailers with hoists. These are designated as transfer hoists. Each transfer hoist is arranged to raise from the draft, which has been taken from the hold in this case by the ship's winch, only those packages in that draft which have the same cross mark. Many managers prefer to use the ship's winches. If there should be four cross marks each transfer hoist would pick up packages having the same cross marks, and each of these four consignments would be conveyed and deposited anywhere upon the floor as may be designated by the cross marks. With four transfer hoists there could be four flatboards, slings, hooks or nets, one to receive each consignment, and all under the control of one transfer man.

This transfer man lowers and unhooks the load as soon as he arrives at the first cross mark pile, even though it be the third transfer hoist in his train, yet this can be lowered first, if desired. One controller is used with the four switches, one switch for each hoist. All four hoists can be raised or lowered at the same time.

By means of the loop track supported by the crane, the transfer conveyor can pass out over the desired location upon the floor and immediately return upon the other side of the loop to the starting point, using the one transfer crane. The two transfer cranes would give a greater rapidity of unit movements than one. The courses which may be taken by the transfer conveyor trains are indicated by the arrows. The



ARRANGEMENT OF A SMALL PIER FOR THE ECONOMICAL HANDLING OF CARGO.

* Terminal engineer.

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number of transfer trains can be increased and operated without any interference with one another and without any change in the installations.

The layout, as shown in the illustration, is not intended to nave the utmost flexibility and the full continuous rapidity of unit movements as when a more expensive layout is planned, but is for smaller terminals where the intense speed of the greater terminals is not so important as an installation of low first cost and small expense of operation.

At the larger terminals it may be said that rapidity of transference with maximum speed of hoisting is of the first importance.

The capacity of one train with four transfer hoists is about 8 tons. The working possibility of the train depends not so much upon the conveyor and hoists capacity of the transfers as it does upon the size and weight of the consignments. In Providence, the average weight of each rail-borne consignment is about 1,000 pounds. Each train for rail-borne freight would, therefore, average 4 tons per trip. For water-borne freight the tonnage per train per trip would be more, due to the greater weight of individual consignments. Each hoist has a capacity of 1½ to 2 tons. Two hoists combined will raise 4 tons.

By this installation of a plant for smaller terminals there can be effected a saving of at least 18 cents (9d.) per ton in manual labor, including tiering. If, therefore, 300 tons are handled daily it would make a net saving of $54 (£10 16s.) per day in manual labor, or $16,200 (£3,240). On account of the greater speed of loading and discharging the vessel, due to mechanical methods, there would be a greater saving due to this rapidity of movements than as above given as the manual labor saving, depending upon the equivalent of the charter value of the vessel. There would be a greater proportional saving where a larger tonnage is transferred.

By means of a system of simple rollers, which can be placed in position by two men, the freight can be moved easily by gravity from between decks to the hatches more economically and much more rapidly than has been the usual custom. Two or even more ships' winches should be simultaneously operated at each hatchway. From the diagram it will be noticed that every square foot of floor space can be served, including tiering; that there will be no manual labor of rehandling, and that there will be a good degree of continuous rapidity. Should the freight be discharged or loaded at the side ports, the transfer hoists would take it from or deliver to platforms just outside these side ports.

By a more expensive installation the cargo can be taken directly from the ship's hatches in the transfer hoists, which are equivalent to a traveling ship's winch, to any consignment pile or lighter without using the ordinary ship's winch and without any intermediate steps.

The advantages of the gantry crane, which is so extensively installed at many ports over the ship's winch, is not so much the economy in moving the freight from the ship's hold as is its longer inreach from the ship's side.

A standard gantry crane will serve a semi-circular area with a maximum radius of about 45 feet.

The cost of swinging the freight over the ship's side is not the great expense. It is rather the assorting, distribution and transferring by manual labor from the ship's side to the consignment piles (marks and cross marks) within the shed and tiering or to the lighters, which work would be accomplished by the transfer hoists in one train, under the control and direction of one man.

It is the purpose of the attached diagram to indicate how greater economy and rapidity can be attained at smaller terminals by the use of mechanical methods at a low cost of installation.

TWO NEW CHESAPEAKE BAY BOATS.

The *City of Baltimore* and the *City of Norfolk*, recently completed by the Maryland Steel Company for the Chesapeake Steamship Company, are among the finest examples of the luxury to which the traveling public is becoming accustomed and demanding. The designs for these vessels were made by the Maryland Steel Company under direction of Mr. Key Compton, president of the Chesapeake Line, and embody the results of his long experience in the managing and that of the builders in designing and constructing various types of vessels. The general dimensions are as follows:

Length over all....................	310 feet.
Length between perpendiculars.....	296 feet.
Beam molded	46 feet 6 inches.
Beam over guards.................	60 feet.
Depth molded	18 feet.
Draft loaded	13 feet 3 inches.

The hull is constructed of mild, open-hearth steel, classed special survey, American Bureau of Shipping, on the usual frame and reverse frame system, with flat plate keel, bilge keels, continuous center keelson and a lower and main deck. The main deck is of steel over the engine and boiler space. Guards are supported by plate knees with slatting on edge. The stem, stern-post and rudder are of best hammered scrap iron. There are seven bulkheads, five of which are watertight.

The accommodations for passengers are most elaborate. There are 120 staterooms, having two metal berths each, ten bedrooms with brass beds and showers, six bedrooms with brass beds and private bath communicating, and eight bedrooms which have a communicating room with double berths. In addition there is a president's room with private bath, a lounge, smoking room or lobby, barber's shop, purser's office and wireless room. The dining saloon is located on the galley deck forward, with pantry and galley immediately aft of same on port side. The general finish is old ivory throughout the saloons; the lobby is finished in selected mahogany, as well as all main starways. Onamental metal balustrades are fitted on all stairways and around the wells. The lounge is finished in old ivory. Opening off the lobby is a commodious bar. All staterooms are fitted with independent heat and running water. The baths and showers are fitted for hot and cold, salt and fresh water. All toilet fixtures are of the very best obtainable. Baths and showers are tiled. Over the well in after saloon is fitted a large skylight with ornamental ceiling, and over main stairs are large ornamental glass domes. The floor of the lobby and dining saloon and treads of all stairs are covered with interlocking rubber tiling. The saloons are carpeted, and all staterooms except those with showers are carpeted. The bedrooms with showers are fitted with hardwood floor and rugs.

All outside staterooms and bedrooms are fitted with intercommunicating telephones and the inside rooms with return call bells. Telephones are also fitted in the president's room, purser's office, bar, wireless and dining rooms, and in the captain's room, chief engineer's room and engine room. The captain has commodious quarters, consisting of office, bedroom and private bath immediately aft of the pilothouse. The first and second officers are immediately aft of this. A private stairway leads from this deck to the gallery deck. The pilothouse is large and roomy and has mechanical telegraphs, engine indicator and running light indicator installed. The chief engineer has a large room on the port side of the main deck just aft of the lobby.

The vessels are fitted with steam windlass, steam steering engines and steam elevator engines. In addition to the steam steering gear an auxiliary hand gear is fitted aft on the saloon

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THE CITY OF BALTIMORE, RECENTLY BUILT FOR SERVICE ON CHESAPEAKE BAY.

deck. The life-saving equipment and fire-fighting apparatus are in excess of the United States Steamboat Inspection Rules. There are four elevators for freight service extending from the main deck to the lower hold. The vessels are well lighted throughout by means of bracket fixtures and standards on newel posts of all principal stairways. Current is derived from turbine-driven generators.

Each vessel is propelled by a four-cylinder triple-expansion engines, the cylinders are 24-40-47-47 inches diameter by 42 inches stroke. The boilers are of the single-end Scotch type, 15 feet 6 inches diameter by 10 feet 10 inches long, with three furnaces 44 inches diameter. There are two feed pumps of the simplex vertical piston type, 12-7½ inches diameter by 24 inches stroke, and one fire pump 12-7 inches diameter by 12 inches stroke, duplex vertical, and one sanitary pump for supplying water to the deck as well as water service to the engines of the horizontal duplex type 6-5¾ inches diameter by 6 inches stroke, and one fresh-water pump supplying water to the fresh-water head tank for deck service of the horizontal duplex type, 5¼-4¾ inches diameter by 5 inches stroke. There is one circulating pump, 12-inch suction and discharge, driven by a 9-inch by 9-inch engine. There is one injector for feeding the main boiler, 2½ inches diameter double tube, and one donkey injector for feeding the donkey boiler and washing down, 1¼ inches diameter. There is one feed-water heater of the Griscom Spencer multi-coil type, using exhaust steam from the auxiliary machinery. There are two turbine generators of 30 kilowatts capacity each, of the Terry type, and one generator of 4 kilowatts capacity for port use with reciprocating engine. An open filter box of about 425 gallons capacity and an ash ejector of the hydro-pneumatic type, 6 inches diameter. Attached to the main engine is an Edwards air pump, 22 inches diameter by 14 inches stroke. There are also two bilge pumps attached to the main engine, 4 inches by 14 inches stroke. There is a refrigerating machine forward of the Brunswick type, cooling 5,400 cubic feet room space, and is used for refrigerating perishable cargo and also for domestic use.

The Bureau of Navigation reports 175 sail and steam vessels of 27,225 gross tons were built in the United States and officially numbered during the month of June. Of this tonnage, 61 percent was built on the Atlantic and Gulf coasts and 29 percent on the Great Lakes. The largest vessels were the *Quincy A. Shaw*, of 6,336 gross tons, built at Lorain, Ohio, and the *Hilton*, of 3,102 gross tons, built at Newport News, Va.

BIG BRITISH KEROSENE-ENGINED CRAFT.

BY J. RENDELL WILSON.

A NEW MOTOR OIL CARRIER.

Very few motor commercial boats were more successful on trials than the tank vessel, *Royal Standard*, recently built to the order of the British Petroleum Company by Messrs. John I. Thornycroft & Company, Ltd., of London and Southampton. Destined for service on the lower Thames in connection with the owners' riverside storage tanks, she is constructed of ¼-inch steel plating, and is a fine looking craft for a tank boat. Her fully loaded draft is 4 feet 9 inches. She is 100 feet long between perpendiculars, with a 17-foot molded beam, and has a molded depth of 6 feet 3 inches. As she is intended for river and estuary work only, her design was developed to provide a perfectly flat bottom, with modified V sections forward and wall sides, but with a sharp angle on the bilge.

Her installation is a six-cylinder Thornycroft motor of the four-cycle type, 6-inch bore by 8-inch stroke, developing 70 horsepower at 750 revolutions per minute on kerosene (paraffin) fuel. But the machinery is of special interest, as a solid propeller is driven through a reverse gear and a two-to-one reduction gear, the latter being by Reynolds' silent chain. Furthermore, the whole transmission system, together with the reversing mechanism, is enclosed in a water-cooled casing; an excellent practice, which is very rarely found in internal-combustion engine craft. The engine is on the same center line as, and directly overhead of, the propeller, and the cylinders are all cast in pairs, with all the valves directly operated by a cam-shaft driven by gearing off the crankshaft. Hand starting gear is fitted, and the engine can be started up by one man; but to prevent over-exertion a shaft is carried fore and aft along the cylinders to which a second handle can be fitted in a few seconds. Lubrication is on the pump-gravity system, which the engine builders have found most efficient for marine work. A pump sucking from the crankcase sump delivers to a main pipe running alongside the cylinders, and to each cylinder two small branches are carried, feeding the oil into small cups, thence through piping to main and big-end bearings. This allows a chokage to be instantly detected and the obstruction cleared with wire.

Great care has been taken with the cooling water circulation. A rotary pump delivers the water direct to the exhaust box jacket, thence to the cylinders, through the gear and transmission casing jacket, round the silencer, and finally

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overboard. Regarding the fuel, kerosene (paraffin) is used for general running, with gasoline (petrol) for starting, and under normal conditions the consumption is about 5 gallons per hour. The fuel tanks have a capacity of 100 gallons, carried in two main tanks, which gives a cruising radius of nearly 350 nautical miles. As gasoline (petrol) is used for starting, great precautions for safety have been made. This fuel is contained in a 25-gallon tank on the forward bulkhead of the engine room, and is filled from deck through a funnel, fitted with a gauze strainer, screwed directly into the tank. The kerosene (paraffin) supply is also gravity feed, and there is a

THE MOTOR-DRIVEN OIL TANK VESSEL ROYAL STANDARD.

13-gallon tank close by the gasoline tank, and which is fed from the main tanks by a hand-worked semi-rotary pump.

With regard to the general accommodation arrangements of *Royal Standard* there is a roomy forecastle, with seats, locker space, store, etc., aft of which is a cofferdam bulkheaded off, which with a second cofferdam aft and the engine room, provides sufficient buoyancy to render the vessel unsinkable. Next to the forward cofferdam are three oil tanks having a total capacity of 150 tons of oil cargo. Each tank has a pierced baffle or splash bulkhead running fore and aft; and over each tank is an expansion chamber about 5 feet square,

SIX-CYLINDER THORNYCROFT ENGINE FOR THE ROYAL STANDARD.

standing about 12 inches above the deck. Aft of the tanks is the second cofferdam, then comes the engine room, and right aft is a large store. A short pole mast is stepped forward, and over the engine room there is a large cowl ventilator, forward of which is a sheltered steering wheel. During the trials a speed of very nearly 7½ knots was obtained with 100 tons of oil aboard, and with the engine running under the normal revolutions. Needless to say she passed the trials to the entire satisfaction of every one concerned, and is a type of vessel that could well be built in larger numbers.

A ROYAL MAIL MOTOR SHIP.

Probably the largest kerosene (paraffin) engined passenger vessel in the world is the Royal Mail motor ship *Lochinvar*, belonging to the David MacBrayne mail and passenger fleet running the Western Highlands of Scotland. There are, of course, bigger passenger vessels fitted with Diesel engines, but the foregoing statement applies to craft equipped with kerosene (paraffin) motors. Altogether there are three motor ships in the MacBrayne fleet, the other two, *Comet* and *Scout* being slightly smaller. They are by no means new craft, as the service has been running regularly, but unobstrusively, for nearly four years.

Lochinvar, the latest addition, is a triple-screw steel ship, built at Barling in the early part of 1908. She is 142 feet 2 inches long over all, by 24 feet 1 inch beam, with 7 feet 5 inches depth, and her tonnage is 178 gross.

She is fitted with three six-cylinder Gardner kerosene (paraffin) engines, each developing slightly over 100 horsepower on the brake; that is to say, a total of about 350 indicated horsepower. Solid propellers are driven through a reverse gear coupled to each engine, and the power installed gives her a speed of 12 knots. Two auxiliary motors are fitted, one of 15 horsepower, driving a dynamo for supplying current to the electrical deck gear and for lighting the vessel; while the other, of 7½ horsepower, is required for the compressor, compressed air being used for starting the main engines. A small funnel is fitted aft, to which the exhausts are carried. The passenger accommodation is excellent, there being an upper promenade deck extending the length of the ship, except about 15 feet forward, and there is an excellent dining saloon, also a lounge. In addition to royal mail and passengers she carries a large amount of cargo, and often live stock. Since she was put into commission she has been running very successfully between Oban, Tobermory and Salen, maintaining a very regular and efficient service. The same may be said of her sisters, *Comet* and *Scout*, which are in service in neighboring districts.

An order by the Postmaster-General of the United States was issued on July 21, relating to the establishment of an ocean mail service by 16-knot steamers between leading Atlantic and Pacific ports in the United States and the ports of Colon and Panama. It is provided that the service shall begin in the fall of 1914, so that by aid of the Panama Canal a fast weekly service will be furnished from Atlantic to Pacific ports.

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SOME FURTHER NOTES ON CAVITATION.*

BY S. W. BARNABY.

On the occasion of our last International Congress in 1897 I read a paper on "The Formation of Cavities in Water by Screw Propellers at High Speeds."† This was a re-statement of the theory of cavitation which had been brought before the Institution of Civil Engineers by Sir John Thornycroft and myself two years previously. In order to prevent the formation of these cavities we proposed to limit the thrust per square inch of projected surface to about 11¼ pounds per square inch in the case of propellers having approximately the same shape of blade and pitch ratio, and the same depth of immersion as those of the destroyer *Daring*. It was explained that somewhat higher pressures than this could be allowed for screws of finer pitch ratio, or having deeper immersion, or for screws in which the shape of the blade departed from the ellipse, being made broad at the tips. At the time this limit of 11¼ pounds pressure per unit of surface was suggested the use of turbines for marine propulsion was not contemplated, and it has been found, as might have been expected, that the uniform turning moment obtained with a turbine enables a higher thrust to be used.

In the case of a direct-driven propeller, where it is necessary to submit to some sacrifice of screw efficiency, in order that the turbine may run at a sufficiently high rate of revolutions for economical working, a thrust of about 13 pounds is accepted, and found to give a good compromise, although I believe that incipient cavitation is then present, causing an increase of slip, because the revolutions usually exceed by 2 or 3 percent the number which would be estimated from the tables based on model experiments.

It will be noticed that in addition to this more uniform turning moment all the conditions suggested in the paper referred to as likely to permit of the use of a higher thrust than 11¼ pounds, are present in the turbine propeller as now made. For example, the tips of the blades usually have much greater immersion than in the screws driven by piston engines, because of their small diameter; also the pitch ratio is very fine; and, lastly, the area is thrown as much as possible out towards the tips of the blades. I also pointed out some years ago‡ that the thrust of propellers driven by four-cycle explosion engines should not exceed 8 to 9 pounds per square inch, because, unless a large number of cylinders are employed, the very irregular turning moment of these engines causes cavitation to occur at lower thrusts than in the case of double-acting steam engines. I refer to this because some criticism has lately been expressed concerning the accepted theory of cavitation, on the ground that it had been proved that some propellers would stand a higher thrust than 11¼ pounds without cavitating, and that some cavitated at a much lower thrust. It is a mistake to suppose that 11¼ pounds was intended to apply to all cases.

It has been suggested that the peripheral velocity of the propeller is a better criterion of the approach of cavitating conditions than thrust per unit area. I will give my reasons for not concurring with this view. The peripheral velocity at which cavitation commences is not by any means constant, but varies both with pitch ratio and "abscissa" value or slip ratio to a much greater extent than does thrust per square inch.

In Table I. are shown the cavitating speeds of three-bladed, turbine-driven propellers, having a developed area of 0.74 disc area, assuming a limiting thrust of 13 pounds per square inch of projected area.

FIG. 1.

FIG. 2.

In Table II. I give the peripheral velocities of the same screws at these cavitating speeds, and it will be seen that they vary from 4,800 to 17,280 feet per minute.

I have drawn a thick line round those figures in the table which lie within the limits of usual turbine practice; that is, I include pitch ratios lying between 0.8 and 1.0 and "abscissa" values lying between 9 and 13. Within these circumscribed limits the peripheral velocities only vary from 10,550 to 15,000 feet, and this probably explains why an impression has been formed that peripheral velocity is a safe guide in the design of turbine screws, an average value of about 12,000 feet being recommended. This corresponds with an "abscissa value" of 11 and a pitch ratio of from 0.9 to 1.0, which are about the conditions usually aimed at, and so far it would be correct to design for this tip speed, provided the developed area of the blade was about that given in the table. But if the blades are made wider than this, if, say, they have a projected area of 0.75 disc area instead of a developed area of 0.74 disc area, which latter is the area ratio used in Tables I. and II., then the peripheral velocities may be considerably increased.

In Table III. I have worked out the preipheral velocities for this projected surface ratio within the same limits of "abscissa

* Read at the Jubilee Meetings of the Institution of Naval Architects, July 6, 1911.
† Trans. I. N. A., Vol. XXXIX., p. 139.
‡ *Marine Propellers*, fifth edition, p. 58.

value" and pitch ratio. They range from 11,600 to 15,900 feet per minute.*

The peripheral velocity of the wing screws of the destroyer Tartar, which had this projected area ratio of 0.75 was 14,850 feet per minute. Very much lower velocities than these would have to be employed for propellers driven by geared turbines at lower revolutions, because, as will be seen from Table II., the permissible tip velocity decreases rapidly with increase of pitch ratio. On the other hand, a thrust of 13 to 14 pounds would be equally suitable for direct-driven or geared propellers.

Commander C. W. Dyson, U. S. N., in a very interesting series of papers containing a large amount of valuable information on the trials of United States warships which he has contributed to the proceedings of the American Society of Naval Engineers, states that thrusts as high as 16 pounds per square inch of projected surface have in certain cases been recorded in turbine propellers giving a fair amount of efficiency. This is so much higher a thrust than I have ever known to be put through a screw with good results that I think it possible Commander Dyson may have a different way of calculating the thrust. In any case, it is not exactly measurable, and depends on the estimate which is made of the value of the propulsive coefficient and of the thrust deduction. He also states that the thrust per unit of projected area does not appear to be so important as the thrust per unit of disc area in affecting efficiency. I think the explanation of the improvement in efficiency which he finds accompanying a reduced pressure per unit of disc area is that turbine propellers are nearly always made of too small a diameter for good efficiency in order to get high revolutions for the turbines, and the efficiency of the propeller would almost always be improved by increasing the diameter and reducing the revolutions, but at the expense of the combined efficiency of screw and turbine.

TABLE I.

CAVITATING SPEEDS OF THREE-BLADED SCREWS. ASSUMING 13 POUNDS THRUST PER SQUARE INCH AND DEVELOPED AREA = 0.74 DISC-AREA

Pitch Ratio.	Nautical Miles per Hour.					
0.8	42.7	36.1	30.7	26.1	22.7	19.7
0.9	43.6	35.8	31.4	26.7	23.1	20.2
1.0	44.5	37.5	32.0	27.3	23.5	20.7
1.1	45.4	38.2	32.6	27.8	24.1	21.1
1.2	46.2	38.9	33.2	28.3	24.5	21.4
1.3	46.8	39.5	33.7	28.7	24.9	21.7
1.4	47.4	40.0	34.2	29.0	25.2	22.0
1.5	48.0	40.5	34.5	29.4	25.5	22.2
1.6	48.5	40.9	35.0	29.7	25.8	22.4
1.7	49.0	41.3	35.3	30.0	26.0	22.5
1.8	49.3	41.6	35.5	30.2	26.2	22.7
1.9	49.6	41.9	35.7	30.3	26.3	22.8
2.0	49.9	42.1	35.8	30.5	26.4	23.0
2.1	50.1	42.2	36.0	30.7	26.6	23.1
2.2	50.2	42.2	36.2	30.8	26.7	23.3
2.3	50.3	42.5	36.3	31.0	26.9	23.4
2.4	50.5	42.7	36.5	31.2	27.0	23.5
2.5	50.6	42.8	36.6	31.4	27.0	23.5
	7	9	11	13	15	17

Abscissa Values.

Mr. D. W. Taylor,† in the book he has just published on "Speed and Power of Ships," contends that the accepted theory of cavitation is inadequate, and that tip velocity and shape of blade section are the prime factors involved. There is no doubt that both have a very important influence on cavitation, and especially the latter. Mr. Taylor is so competent an experimenter and so high an authority on all matters connected with propulsion, that one would hesitate to question any opinion he may express on any subject coming within the scope of tank inquiry, but it is well known that propellers cannot be made to cavitate in a tank under ordinary conditions,

* The assumptions made are 10 percent wake and 10 percent thrust deduction, 50 percent propulsive coefficient, 85 percent blade correction; proj. area = .75 disc area; thrust 13 pounds per square inch.
† Naval constructor, U. S. N.

TABLE II

TIP VELOCITIES IN FEET PER MINUTE AT CAVITATING SPEEDS OF THREE-BLADED SCREWS, ASSUMING 13 POUNDS THRUST PER SQUARE INCH, AND DEVELOPED AREA = 0.74 DISC-AREA

Pitch Ratio.						
0.8	17,280	15,000	13,450	12,300	11,370	10,580
0.9	15,720	13,800	12,450	11,350	10,490	9,760
1.0	14,500	12,820	11,590	10,550	9,720	9,100
1.1	13,500	12,000	10,800	9,850	9,000	8,500
1.2	12,650	11,250	10,150	9,250	8,500	8,000
1.3	11,900	10,580	9,600	8,720	8,060	7,580
1.4	11,290	10,030	9,100	8,260	7,690	7,170
1.5	10,700	9,550	8,650	7,850	7,320	6,800
1.6	10,190	9,100	8,250	7,500	7,000	6,500
1.7	9,700	8,700	7,890	7,170	6,710	6,210
1.8	9,300	8,350	7,550	6,880	6,440	6,000
1.9	8,900	8,000	7,250	6,610	6,200	5,770
2.0	8,550	7,700	6,950	6,370	5,950	5,570
2.1	8,220	7,400	6,680	6,150	5,750	5,400
2.2	7,900	7,180	6,450	5,950	5,570	5,220
2.3	7,650	6,920	6,250	5,790	5,400	5,070
2.4	7,380	6,690	6,090	5,640	5,230	4,930
2.5	7,150	6,460	5,950	5,520	5,100	4,800
	7	9	11	13	15	17

Abscissa Values.

TABLE III.

TIP VELOCITIES IN FEET PER MINUTE AT CAVITATING SPEEDS OF THREE-BLADED SCREWS, ASSUMING 13 POUNDS THRUST PER SQUARE INCH AND PROJECTED AREA = 0.75 DISC-AREA.

Pitch Ratio.			
0.8	15,900	14,400	13,030
0.9	14,850	13,400	12,250
1.0	13,960	12,650	11,600
	9	11	13

Abscissa Values.

and very special means have to be taken to get the phenomenon to exhibit itself with model screws.

Mr. Parsons was able to observe it in a special tank with heated water having a vacuum over the surface, and it will be remembered that he confirmed generally the results I had obtained by calculation. Mr. Taylor has not followed this method, but has made experiments with a special form of blade which cavitates freely in cold water, and with the pressure of the atmosphere upon the surface, but the instrument he used could hardly be called a propeller, because it is far outside the limits of all existing practice. The pitch ratio is as fine as 0.3, and the blades are unusually narrow and thick. Now, even at 0.6 pitch ratio the efficiency of a propeller has dropped from a maximum of 0.74 to 0.58, and no propeller has ever been made, so far as I know, with so low a pitch ratio as 0.3, because under such conditions it is simply churning the water. This model cavitates so vigorously that the thrust becomes negative above a moderate number of revolutions, and if used as a propeller it would only need to be driven fast enough to actually reverse the direction of the motion of the vessel.

Cavities first begin to appear at as low a tip speed as 3,000 feet per minute, and the thrust becomes negative at a tip speed of between 5,000 and 6,000 feet. With this special "cavitator" Mr. Taylor has been able to measure the pressure at different parts of the face and back of the blade by means of a very ingenious arrangement of pressure gages, and he has found that there is a reduction of pressure at the leading edge of the driving face of his blade, and he expresses the opinion that cavitation is only injurious when it occurs at the driving face.

It seems to me that this conclusion has been arrived at somewhat hastily, and requires much further proof before it can be accepted. I think the reduction of pressure which was observed on the driving face was due to the abnormally fine pitch ratio in conjunction with a thick and narrow blade, and I do

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not think it is possible for cavities to form on the driving face with ordinary pitch angles and blades of normal section.

The photographs taken by Mr. Parsons of his propeller when cavitating, under conditions properly representing those found in practice, show most clearly that the cavities are at the back of the blade. (See Fig. 2.)

I thoroughly agree with Mr. Taylor that it is of the utmost importance that the blades should be very thin at the leading edge, and it may even be advantageous to make the edge thinner than will stand the water pressure unsupported, and to stiffen it with circumferential ribs as he recommends, but I do not think he has made out a case in favor of taking tip velocity as a criterion in preference to pressure, because he has himself shown that cavitation will under special circumstances begin at as low a velocity as 3,000 feet, and I have shown that in the case of the *Tartar* the tip velocity was as high as 14,850 feet with good results.

It will be observed that Mr. Taylor's cure for cavitation is the same as my own, namely, very wide blades, although he arrives at it by a different line of reasoning. He thinks that "face cavitation begins to spread slowly with increase of tip speed, so that the wider the blade the greater the area of the face whose thrust is not nullified by cavitation."

As already stated, I doubt the existence of face cavitation on a properly designed propeller, although it can evidently exist on an instrument specially designed to cavitate, and I still think that the great waste of power admittedly caused by cavitation is due to cavities at the back of the blade, and that these affect the efficiency, because at least half, and usually the major portion, of the thrust is due to the suction of the blade back, and this is lost as soon as the water breaks away from the back. Sir John Thornycroft has suggested to me that efficiency is also probably affected by the fact that when cavitating the propeller is working in a medium of less density, because the air bubbles extracted from the water forward of the screw form part of the stream passing through the screw's disc, as clearly shown by the spirals in the photographs (see Figs. 1 and 2), and thereby reduce its density.

It may be objected that I bring forward no fresh proof that thrust is a safe guide, and that the tip velocities I have given in the tables are based on the assumption of a fixed limit of pressure. This is quite true, and perhaps further experiment only can settle the question. I must, however, say I have found it a very satisfactory method of fixing the blade area, and have seen no reason to doubt the soundness of the theory on which it is based.

I am glad to learn that Mr. Parsons is making a special tank of a much larger size than that with which he made his previous experiments, but arranged to work under the same conditions of hot water relieved of the atmospheric pressure, in which he will try models of actual propellers, and I think judgment should be reserved until the results be obtains are made known.

(Photograph by the New York Shipbuilding Company.)

UNITED STATES BATTLESHIP UTAH ON TRIAL TRIP.

Trials of the Utah.

The United States battleship *Utah* completed her official trial trips over the Rockland, Me., course on June 26. She is fitted with Parsons turbines, driving four shafts, and is a sister ship of the *Florida*, now building at the New York navy yard. Both of these ships are equipped with Babcock & Wilcox watertube boilers, fitted for burning both coal and oil. The *Utah* is about 98.5 percent finished, and is expected to go into commission in August.

On her maximum trial run she developed a speed of 21.63 knots, while the average speed during this run was 21.28 knots, when the turbines were running at 329.17 revolutions per minute. The contract speed for this ship is 20.75 knots, which was made on an average of 315 revolutions. The engines developed 28,477 horsepower at maximum speed. The standardization trials covered about twenty runs at average speeds of 10.55, 12.01, 16.8, 19.05 and 21.28 knots per hour. The trials were satisfactory and of great credit to the builders of the vessel, the New York Shipbuilding Company, Camden, N. J.

From the returns compiled by *Lloyd's Register of Shipping*, it appears that, excluding warships, there were 496 vessels of 1,476,394 tons gross under construction in the United Kingdom at the close of the quarter ended June 30, 1911. The tonnage now under construction is about 102,000 tons more than that which was in hand at the end of last quarter, and exceeds by 358,000 tons the tonnage building in June, 1910. The figures are the highest reported in the Society's Quarterly Returns, being 62,000 tons more than the previous record total, which was reached in September, 1901. The figures for June, 1909, have been practically doubled in the last two years.

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TYPE 3. For engine housings, engine bedplates, air compressor bedplates, air compressor framings, hand wheels, gears, rudder bearings, stuffing boxes, windlass gears, windlass drums, bearing brasses, bushings, spiral gears, port lights, air pumps, reducing valves, etc., etc.

TYPE 4. For whistles, radiator valves, also for forging purposes.

TYPE 5. For plug cocks, steam traps, thermostats, etc.

TYPE 6. For forged pump rods, bolts, valve stems, hose couplings and all kinds of fittings to be riveted. This type is also produced for rolling and drawing.

TYPE 7. For general hardware, quadrants, railings, name plates, indicators, hatches, grease cups, oil cups, gauges, stanchions, engine telegraphs, controller fittings, etc.

TYPE 8. For air compressor cylinders, oil pumps, injectors, exhaust headers, exhaust valve bodies, elbows, tees, water jacketed bearings, gas mufflers, hydraulic valves, hydraulic valve fittings, steam valves, etc. It is a high pressure Steam Metal.

TYPE 9. A special metal used in ship bells, electric bells, electric gongs, fire bells and gongs, submarine signal bells, etc.

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1	71,000	28,500	32.0	27.8	1 Inch
2	65,400	28,400	38.5	31.1	1 Inch
3	65,100	34,400	18.5	17.2	1 Inch
4	56,900	22,800	57.5	43.7	1 Inch
5	59,500	22,000	52.0	37.6	1 Inch
6	51,100	18,100	65.0	45.3	1 Inch
7	59,200	23,000	50.0	39.1	1 Inch
8	32,000	17,500	21.0	18.8	1 Inch
9	62,940	32,960	8.0	17.0	1 Inch
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OUR PRESENT KNOWLEDGE OF THE VIBRATION PHENOMENA OF STEAMERS.*

BY KONSUL DR. O. SCHLICK.

In view of the apparent impossibility of dealing scientifically with the vibrations which made their appearance with more or less intensity in every steamer, these were, up to about the beginning of the eighties of last century, regarded as an unavoidable evil. With the gradual increase in the engine power and speeds of steamers, however, the cases in which the vibrations assumed an exceptionally violent form became more and more frequent, and greater attention began therefore to be given to this phenomenon. Twenty-seven years ago, at the spring meeting of the Institution of Naval Architects (1884), I had the honor of reading a paper "On the Vibration of Steam Vessels," and I believe this was the very first publication of an attempt to give a scientific explanation of vibration phenomena. The contents of this paper mainly consisted in the proof, then given for the first time, that vibrations were in no way caused by weakness of the hull of the vessel, but that they were chiefly produced by the inertia forces of the reciprocating parts of the machinery when these occurred at periods corresponding with those of the bending oscillations of the hull in the vertical plane. In this paper, therefore, the principles underlying the action of the inertia forces and the phenomenon of resonance were investigated.

In 1891 Mr. Yarrow conceived the happy idea of letting the engine of a torpedo boat run with the propeller shaft uncoupled, so that only the inertia forces exerted by the reciprocating parts of the machinery came into play. It became clearly evident that the vibrations which appeared had their origin in the synchronism of the inertia forces with the bending oscillations of the longitudinal axis of the vessel in her vertical middle-line plane. Further investigations led me to study the dissimilar behavior of the various types of engine met with in practice, and of the influence exercised by the position of an engine in a vessel, according as only vertically acting inertia forces, or tilting couples, or both of these together, came into play. Amongst other things the remarkable fact was established that the ordinary triple-expansion engine, in spite of the considerable exertion of vertical inertia forces and tilting couples which characterized it, was, under certain circumstances and when it was placed in a particular position in the vessel, harmless as regards the setting up of vibrations. I succeeded further in constructing a simple formula which made it possible to determine the number of the vibration-oscillations beforehand, and thus to avoid the critical number of revolutions in the first design of the engine.

As soon as it was recognized that means for the avoidance of the vibrations must be provided, not by the shipbuilder, but by the marine engineer, the efforts of the latter became directed to the destruction as far as possible of the action of the inertia forces, and the result of these was the invention of the balanced four-crank engines, which were proposed by me in 1894, and very speedily attained general adoption under the title of the "Yarrow, Schlick and Tweedy System." With the creation of the balanced reciprocating engine the first act in the solution of the vibration problem was in a manner brought to a conclusion. The extremely violent vibrations which are to be attributed to the action of the inertia forces of the reciprocating parts of the machinery can, with the exception of a small residue, always be avoided by correct balancing. After this short historical review I should like to proceed to show with what phenomena we have to reckon in vertical reciprocating engines. To this point I shall give very brief expression, as I am no doubt right in assuming that the more important of the matters entering into the discussion are well known.

If a single-screw steamer be equipped with an unbalanced vertical engine, there will in most cases arise (with a particular number of revolutions) vibrations, which consist in a bending of the longitudinal axis of the vessel in a vertical plane, in the course of which two nodes are formed. Thehe two-node vibrations are termed "vertical vibrations of the first order," and are said to be of single frequency. The latter expression is intended to convey the fact that the hull of the vessel makes a number of oscillations per minute exactly corresponding with the number of revolutions of the engine. If the revolutions per minute advance beyond the critical number the vibrations disappear, only to appear again in a violent form at a number which is generally less than twice as great. Three nodes now appear. This is called the "vertical vibration of the second order." The frequency, however, remains single, since the numbers of vibrations and revolutions coincide with each other here also. In very rapidly-running engines, indeed, vibrations of the third order with four nodes may also, in exceptional cases, be observed. So far as I am aware, the presence of vibrations of a still higher order has not been established with certainty.

Engines which develop only vertical mass forces, such as vertical engines with single cranks, provided they be placed exactly at node points and the critical number of revolutions be not considerably exceeded, so that no vibrations of a still higher order with more nodes situated at other points are set up, can never produce vertical vibrations. On the other hand, when engines of a description that produce tilting couples but no vertical forces are placed at a node point, they cause violent vibrations, provided they reach the critical number of revolutions belonging to the order of vibration in question. This is, for instance, the case with engines having three cranks set at 120 degrees with each other and having all moving parts of the same weight. Ordinary triple-expansion engines with three cranks set at angles of 120 degrees with each other and four-crank engines with cranks set at 90 degrees with each other, which produce vertical inertia forces as well as tilting couples and generally make the vessel vibrate very violently, can, strange to say, under certain circumstances remain quite passive.

The conditions under which this takes place are as follows: At the two extreme positions of the oscillating longitudinal axis of the vessel, tangents may be assumed to be drawn from the positions of the engines, which then intersect at a point a short distance behind the node belonging to the order of vibration in question. When the product of the weight of the vertically mass multiplied by the distance of the corresponding piston axis from the point of intersection of the tangents mentioned is the same for each cylinder, no vibrations will occur.

In the case of twin-screw vessels with pairs of exactly similar independent engines, interference phenomena will, as may readily be understood, be set up as a consequence of the vertical forces produced by them. If the reciprocating pistons of analogous cylinders be moved simultaneously in the same sense, the inertia forces thereby produced supplement each other, and very violent vertical vibrations ensue. Since, however, the two engines do not move with exactly equal speeds of revolution, the crank of the one will, after a little while, have forged ahead of that of the other by 180 degrees, and the two sets of inertia forces produced will then work simultaneously in opposite directions and thus counteract each other, so that the vertical vibrations will, for a short time, disappear. Since, however, the two engines are placed at a certain distance apart in the athwartship direction, the vertical inertia forces now acting in opposite directions form a couple

* Read at the Jubilee Meetings of the Institution of Naval Architects, July 5, 1911.

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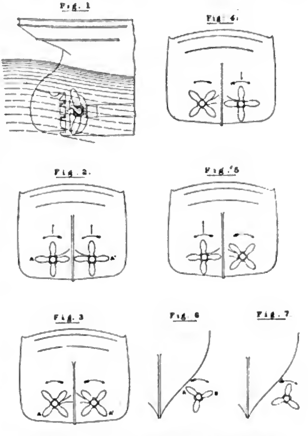
which give the section of the hull in way of the engines a lateral oscillation similar to that of the rolling motion of the vessel. These oscillations are communicated to the whole vessel in the form of torsional vibrations, and are of the single order of frequency of the number of revolutions per minute of the engine. When unbalanced engines are fitted in twin-screw vessels, periodically alternating vertical and torsional vibrations appear, and the period corresponds with the time in which one engine outstrips the other by a complete revolution. When correctly balanced engines are fitted, there is, of course, no further cause for the vertical and torsional vibrations of single frequency here illustrated. True, we shall see further on that both kinds of vibrations of higher frequency may notwithstanding be observed in a mild degree, and that weak vertical vibrations of single frequency also occur here and there.

As already mentioned, the vibration problem was in 1894 regarded as solved by the balanced reciprocating engine, and, indeed, as a matter of fact, vibrations of single frequency never occur in vessels equipped with these engines in anything like the degree formerly experienced. After the main evil was removed, however, it was found that weak tremors, which had formerly been masked by violent vibrations and thus escaped notice, were still present. The demands in regard to the quiet behavior of a steamer had become considerably greater, and I was now confronted with the question as to what might be the cause of these residuary vibrations, and how they could be removed.

In regard to the nature of these residuary vibrations, the following observations may be made. In most cases vertical vibrations (bendings of the longitudinal axis in the vertical plane) of frequency still showed themselves, though to a considerably less violent degree, and in twin-screw steamers they also occurred in periods. The appearance thus presented was that of the engine being still incompletely balanced. In addition, vibrations showed themselves, which, though of small amplitude, were still unpleasantly felt, because their frequency was very great—generally threefold and fourfold.

It cost me much time and trouble before I could determine the cause of these phenomena with certainty, and I owe large debts of gratitude to the Stettiner Maschinenbau Actien-Gesellschaft Vulcan, the Hamburg-Amerika Linie, and the Norddeutscher Lloyd for the ready willingness with which they allowed me to pursue these investigations, and for the obliging manner in which they lent assistance. In the first instance, the experiment was repeatedly made of allowing the engines of the large Atlantic liners of the companies named to run at their critical numbers of revolutions with their propellers uncoupled, and under these conditions not even the least suspicion of the vibrations otherwise experienced was felt. This proved conclusively that the residuary vibrations were not caused by defective balancing. The causes, then, had to be sought elsewhere. It would be going too far were I to describe here the exact manner in which I set about my experiments. I first sought, by the help of the pallograph, designed by myself, to determine in which positions of the cranks the maximum amplitude occurred which again should enable a conclusion to be come to as to the position in which the impulse reached its maximum, since the latter must always be a quarter of an oscillation in front of the maximum oscillation amplitude.* It very soon appeared that the vertical vibrations could not by any means be brought into fixed relation with a particular adjustment of the cranks. In the individual vessels the maximum amplitude occurred in connection with different positions of the cranks, and even in one and the same steamer the conditions changed as time went on. On the other hand, it became clearly aparent that the instant at which the ends of the vessel passed through the middle point of their upward swing, and therefore also the instant of maximum impulse, always coincided with that at which a particular blade of each propeller (the experiments were conducted almost exclusively with twin-screw vessels) assumed an almost exactly horizontal position, *i. e.*, when both were moving simultaneously downwards from the uppermost position.



DIAGRAMS SHOWING ACTION OF PROPELLERS CAUSING VIBRATION.

The assumption is here made that the propellers turn outwards, as it is generally expressed. When, on the other hand the blades in question stood at different angles, *i. e.*, when one of them pointed horizontally inwards, while the other pointed horizontally outwards—a case which occurs when one engine has forged ahead of the other by 180 degrees—the vertical vibrations of single frequency disappeared, or at any rate reached their minimum. While, then, one engine was advancing to a point a full revolution in front of the other, the vibrations diminished from a maximum to a minimum and then rose again to a maximum. The explanation of this phenomenon is that one blade of each of the two propellers meets with a greater tangential resistance than the others, and the cause of it is to be found in the very slight excess of pitch of the blade in question. The difference in the pitch is so small that it can rarely be detected by the help of the ordinary appliances ("pitchometer").

To understand this clearly we must picture to ourselves that the acceleration of the water by the propeller is already in

* The first experiments made in connection with these investigations were conducted by myself at the trial trip of the Atlantic liner *Deutschland*. I laid these before the Institution of Naval Architects in June, 1901, in my paper "On Some Experiments Made on Board the Atlantic Liner *Deutschland*" during her trial trip. In subsequent experiments the method was materially improved.

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some degree imparted to it before the particles reach the leading edge of the blade. The angle at which the propeller blade cuts the threads of water flowing towards it (slip-angle) must therefore be a very small one—probably about 3 degrees. When the pitch angles of the different blades are not exactly the same, the one that has a very slightly greater pitch than the others has a considerably greater tangential resistance, while another one with smaller pitch may turn in the water almost without resistance, or, so to say, without load. While the blade with the greatest resistance moves, in the course of a revolution, from the upper position downwards, it imparts to the propeller shaft an upward pressure and endeavors to draw the after part of the vessel upwards, thus producing vertical vibrations of a period equal to that of the time of revolution of the engine; that is to say, vibrations of single frequency which are generally of the first order, and thus have two nodes. The occurrence of vertical vibrations of single frequency may thus, in vessels with balanced engines, be quite naturally explained.

Now, just as a difference in the pitch of the propeller blade may suffice to produce vibrations of single frequency in steamers with balanced engines, so also can a like difference destroy the vibrations of single frequency set up by the action of the inertia forces of an unbalanced engine when these two causes of vibration always act in senses contrary to each other and are approximately equal in their action. As I have already explained in detail in my paper of 1884, "On the Vibration of Steam Vessels," this may sometimes be easily attained by turning the propeller in coupling up the shafting in such a way as to make a different angle with the cranks.

The striking vibration phenomena which were observed on the occasion of the experimental trials with different angular positions of the cranks in H. M. S. *Terrible*, find their simple explanation in slight differences in the pitch of the propeller blades. That differences in the pitches of the individual blades may to a high degree be detrimental has long been known; but trifling ones of this kind, the very existence of which could scarcely be demonstrated, were not thought to have so much influence. But the result of these investigations also has the further effect that it clearly shows what great differences there are in the tangential pressures exerted by individual propeller blades, and, at the same time, in the stressing of the latter. The blade fractures which so frequently occur may thus find an explanation of the simplest kind. It is evident, also, from these considerations, how necessary it is, in all cases in which it is desired to avoid even the smallest vibrations of single frequency, and to obtain a specially good efficiency from the propeller, that the blades be machined, so that exact equality of these as regards both form and pitch is attained. When propeller blades are exactly adjusted the vibrations of single frequency disappear, provided always that the engines are correctly balanced; and since, by the help of the pallograph, every blade can be picked out which produces a tangential pressure differing from that of the rest, vibrations of single frequency can also be avoided in every case.

An attempt has also been made to connect the cause of vibrations of single frequency with inequalities in the turning moments. Theoretical investigations, however, have shown that the vibration-producing impulses of this kind do not suffice to produce the effects observed, and exact observations have shown this to be correct.

In all twin-screw steamers, again, an analysis of the diagrams drawn by the pallograph gives periodically-occurring vertical vibrations of fourfold or threefold frequency, according as the propeller has four blades or three. In steamers which were originally fitted with three-bladed propellers, and showed vertical vibrations of threefold frequency, these latter gave place to vibrations of fourfold frequency as soon as the three-bladed propellers were replaced by four-bladed ones.

The explanation of this phenomenon is as follows. The relative motion of the water flowing along the after body of the vessels does not take place exactly in the horizontal direction; but, on account of the large stern wave, it follows a sternwards rising curve, as shown in Fig. 1. In consequence of this each propeller blade meets with greater resistance when it has moved down from above till it is about horizontal; that is to say, when it has reached the position denoted by A and A_1, in Fig. 2, than when it is in the position opposed to this. Now, when the two four-bladed propellers simultaneously assume a position in which one of each of their blades points horizontally outwards, as shown in Fig. 2, an upward pressure is given to each propeller shaft. These two forces combine in endeavoring to raise the after body. Their magnitude diminishes considerably, however, when the two propellers have turned 45 degrees further round, and thus reached a position such as that shown in Fig. 3. This process is repeated four times for every revolution of the engine (or three times in the case of three-bladed propellers), and accordingly produces vertical vibrations of fourfold (or threefold) frequency.

When, in the cases of four-bladed propellers, one of the two engines has outstripped the other by an angle of 45 degrees, it follows that while one blade of the one propeller is pointing horizontally outwards, and thus assumes the position of greatest resistance, two outer blades of the other propeller form angles of 45 degrees with it, as shown in Fig. 4. The two inclined blades will then together exert a somewhat smaller upward pressure on the shaft than that of the horizontal blade of the other propeller. When both propellers have turned through a further angle of 45 degrees, the analogous forces again come into action, with the difference, however, that the two propellers have exchanged positions. In this manner there are produced during a single revolution eight upward impulses, which act on the after body of the vessel and accordingly produce vibrations of eightfold frequency, these being, it is true, generally of very small amplitude and scarcely discernible.

The upward impulse acts on the starboard and port sides alternately, as illustrated in Figs. 4 and 5, and, as may easily be seen, sets up at the same time torsional vibrations of fourfold frequency (threefold in case of three-bladed propellers). When, after a while, the one engine outstrips the other by 45 degrees more, the vertical vibrations of eightfold frequency disappear and give place to others of fourfold frequency; at the same time, however, the torsional vibrations also disappear, and so on till, with another advance, made by the one engine, of 45 degrees more, the game begins afresh. In this way the periodical increases and diminutions of the vibration phenomena may be explained. The results obtained during my long years of investigation have so often been confirmed by experience that not the slightest doubt can now be entertained as to their reliability.

In order to facilitate a general review of the subject, I shall once more briefly recapitulate the phenomena which occur in a modern twin-screw steamer equipped with correctly balanced engines. A steamer of this class generally shows periodically recurring vertical vibrations of single frequency arising from the defective pitch of one blade of each propeller. When the propellers are machined these vibrations disappear. Further phenomena take the form of vertical vibrations of frequencies, the number of which is in each case equal to that of the blades of one of the propellers, periodically alternating with other vibrations the frequencies of which are twice as great. Simultaneously with these last-mentioned vertical vibrations torsional vibrations occur of

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frequencies equal in number to the blades of the propellers. Every twin-screw steamer shows torsional vibrations per minute *exactly equal in number to the product of the revolutions multiplied by the number of the blades of one of the propellers.*

If a single-screw steamer equipped with a correctly balanced engine be considered, vertical vibrations of single frequency will first make their appearance, when, by reason of defective pitch, one of the propeller blades shows greater tangential pressure than the others. A further characteristic is that of vertical vibrations of a frequency which corresponds with the number of the blades of the propeller, and in addition torsional vibrations, usually of considerable severity, occur, the frequency of which is likewise equal to the number of the blades. All these different vibrations, however, show no periodic increase and diminution such as are found to exist in the twin-screw steamers; their intensity remains constant.

The torsional vibrations of the single-screw steamers, however, are due to a different cause from that which operates in twin-screw steamers. In the case of the former, each propeller blade experiences the greatest resistance when it is in its upper vertical position or somewhat beyond this in the direction of rotation. The difference in the tangential pressure which the blade has to exert during a revolution is, in this case, considerably greater than in the case of the propeller of a twin-screw steamer. Since, however, the masses of the moving parts of the machinery, as in the case of a fly-wheel, seek to preserve a uniform speed of rotation, an increase of torsional stress will, each time that a blade passes the screw frame at the upper vertical position, be imparted to the shafting and thence to the engine seating, and will endeavor to incline the section of the vessel at the position occupied by the machinery in a sense opposed to that of the revolution of the propeller. In this manner an impulse is given which tends to produce torsional vibration.

In accordance with the foregoing, the torsional vibrations of single-screw vessels take their rise at the part of the vessel occupied by the engine and not at the after bearing of the propeller shaft, as in the case of the twin-screw steamers. This also explains the circumstance that torsional vibrations generally occur with considerable intensity in the fore body, while in twin-screw steamers they diminish gradually towards the fore body.

With the balancing of reciprocating engines, which came into fashion about the year 1894, everything that was possible was done for the removal of vibration, and the severe vertical vibrations formerly observed in unbalanced engines were, in fact, eliminated.

The periodical torsional vibrations of threefold or fourfold frequency occurring in the manner described above were still very unpleasantly felt, especially in swift passenger steamers. Although in the twin-screw steamers, which are principally dealt with here, they had their origin entirely in the propeller, and made their way into the fore body of the vessel, so that they made themselves felt very unpleasantly, especially in the saloon. Endeavors have, of course, been made to get rid of this evil, but these have been attended with only a comparatively small degree of success; for the only means at our disposal for the removal of these torsional vibrations consists in the prevention of resonance, or, in other words, in the avoidance of the critical number of impulses. The simplest means of attaining this end is the alteration of the number of the propeller blades, provided that, in view of other considerations, this appears permissible.

When a twin-screw steamer fitted with three-bladed propellers shows very severe torsional vibrations, the evil may in nearly every case be almost entirely removed when the propellers are replaced by others with four blades. On the other hand, I have observed that in the case of a very large steamer the vibrations almost entirely disappeared when, in deference to a proposal of mine, the four-bladed propellers were replaced by three-bladed ones. A measure of this kind, however, is sometimes attended by unpleasant secondary phenomena. For the altered frequency of impulse attained with an altered number of blades not infrequently coincides with the critical number of impulses for vertical vibrations of higher order. It then becomes possible to almost avoid the torsional vibrations, but their place is taken by vertical vibrations which are of threefold and fourfold frequency according to the number of blades borne by the propeller. These latter vibrations are, it is true, generally less unpleasant than the torsional ones.

In such a case, and when it is desired to avoid the expense of replacing the existing propellers by new ones with other numbers of blades, there is still another way which, it is true, only brings partial success, as a rule. It consists in the alteration of one of the propellers, assumed to be fitted with adjustable blades, by a modification of its pitch as compared with that of the other, so that at the normal speed of the vessel the one engine has the greater number of revolutions per minute by about 5 to 7 percent. The period within which the torsional vibrations advance to a maximum and return to a minimum again is by this means considerably shortened, and the vibrations never then attain the intensity experienced in the case in which the two engines work with almost exactly equal numbers of revolutions. This is explained by the circumstance that, under such conditions, the intensity of the impulse increases with great rapidity and reaches its maximum before the oscillating masses can be accelerated to such a degree that even an approximate approach can be made to the amplitude of oscillation which would be attained if the impulses had been continued with equal intensity for a considerable period of time.

The same principle underlies the endeavor to reduce the torsional vibrations of twin-screw vessels by giving four blades to the one propeller and three to the other. In some instances this method has been attended with appreciable success. It will probably be unnecessary to add that, in connection with the methods last described for diminishing the vibration, the speed of the vessel is always to some extent unfavorably affected.

With the introduction of the steam turbine the vibration phenomena entered into a new phase. Since, in the case of the turbine, every periodic action of the inertia forces in a direction at right angles to the longitudinal axis of the vessel becomes impossible, and since, further, the turning moment is completely uniform, all the disturbances which set up vibrations in the unbalanced reciprocating engine are entirely avoided. It was accordingly at first asserted, even by professional men, as an immense advantage of steam turbines, that they could not impart any vibration to vessels so engined. This view, to which frequent expression was at one time given, proved how little the vibration phenomena were understood at that time. The vibrations due to the propeller must, in turbine steamers, occur in a manner analogous to that in which they show themselves in steamers equipped with balanced reciprocating engines; but, by reason of the relatively very high speed of revolution of the propellers in these vessels, the frequency of their vibration per unit of time must be considerably higher.

For instance, if a three-bladed turbine propeller makes 200 revolutions per minute, and there are only two propeller shafts, 600 (or 1,200) vertical vibrations per minute will be set up, and these figures will increase to 800 (or 1,600) when the propellers are of the four-bladed description. The number of revolutions of 200, however, must be regarded as

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almost the lower limit, and it is met with only in large steamers. In most cases from 400 to 500 revolutions per minute have to be reckoned with, and in such case frequencies of vibration up to about 1,500 to 3,000 per minute, or twenty-five to fifty oscillations per second, occur.

The amplitude of these vibrations, which are caused by the propeller alone, is, under like conditions, generally smaller in turbine steamers than in steamers with reciprocating engines, since in the former the work imparted during one revolution, and consequently also the vibration-producing impulse is less in inverse proportion to the relative numbers of the revolutions. The extremely high frequency of the vibrations of turbine steamers, however, involves great inconvenience to the passengers and crew and is a drawback for these vessels.

It is, on the other hand, a favorable factor that the unpleasant torsional vibrations do not extend over the whole length of the vessel, as they often do in steamers equipped with reciprocating engines. This phenomenon may be explained as follows: In theory the speed of transmission of the torsional oscillations of the longitudinal axis of a vessel is, for steamers of like types, the same. Now, when the frequency of the oscillation per unit of time is comparatively low, as, for instance, in vessels equipped with reciprocating engines, a few large waves will make their appearance in the longitudinal axis; that is to say, only a few nodes for the torsional vibrations will show themselves. If, on the other hand, the frequency be very high, as in the turbine steamers, a large number of small waves and a good many nodes will be formed. Now, since the assumption may fairly be made that, on account of damping action, the vibrations will cease after a certain number of oscillations, or, in other words, that, after reaching to a distance from their origin corresponding with a certain multiple of their wave-length, they will cease to be perceptible, the point at which the vibrations will no longer be unpleasantly felt will, in turbine vessels, be considerably nearer the after end of the hull than in steamers with reciprocating engines.

The use of torsion indicators to determine the horsepower developed by steam turbines has supplied a means for obtaining interesting information in regard to the fluctuations in the resistance to which the propeller blades are subject during a revolution. It may, for instance, be assumed that one of the outer propellers of a turbine steamer with three or four shafts is arranged as shown in Figs. 6 and 7, and that it has three blades. If the torsion angle of the shafting be measured at the instant at which the propeller is in the position illustrated in Fig. 6, *i. e.*, in which the tip of a blade is nearest to the skin of the vessel, a higher value is obtained than in the case in which the torsion angle is measured in the position shown in Fig. 7. This is explained by the circumstance that the tip of the blade lying nearest to the skin takes hold of the layer of water drawn along by the wetted surface in consequence of the forward motion of the vessel, and that the particles of water at this point move forward at a considerable speed. At this instant the blade in question meets with considerably greater resistance, and a greater twisting of the shaft must accordingly take place at the instant when the propeller assumes the position illustrated in Fig. 7, *i. e.*, when the tips of two blades are further removed from the skin of the vessel.

This increased resistance of a single blade acting unsymmetrically produces, somewhat in the manner already described, a one-sided pressure on the after bearing, which, together with the pressure exerted by the propeller on the shaft at the other side of the steamer, produces torsional vibrations. These vibrations occur with special vehemence because the distance apart of the two shafts, and therefore also the arm of the couple thus produced, is considerably greater than, for instance, in the case of twin-screw steamers.

Further, when it is realized that, in consequence of the large stern wave, the water flows to the propeller, not exactly in horizontal lines, but in a curve which rises somewhat in the sternward direction, it will be further evident that the direction of rotation is not a negligible matter in contributing to vibration. If a rotary motion in the outward direction be assumed, as indicated by the arrow in Fig. 6, the blade *A* will, for the reason alluded to above, experience in the first place an especially high degree of resistance in the position shown, and will in consequence exert a downward pressure. But in this position the blade *B* also meets with a greater tangential resistance, because it bears against the particles of water of the stern wave which are here curving upwards, and accordingly produces an upward axial pressure. The pressures produced radially to the shafts by the blades *A* and *B*, respectively, thus in part neutralize each other. If, on the other hand, the direction of rotation of the propeller be reversed, *i. e.*, the latter turn inwards, it will readily be seen that neutralizing of the radial pressures of the kind referred to does not take place, and the arrangement will in consequence be attended by vibrations of somewhat greater severity.

In turbine steamers there is an additional circumstance which tends to increase vibration. This is the inclination which usually has to be given to the propeller shaft, because, by reason of the large diameter of the turbine casings, their inboard ends usually lie considerably higher than in a vessel with reciprocating engines. As a result of this, the direction of motion of the water flowing towards the propellers makes a still greater angle with the axis of the latter than with which it already approaches them in the rising course of the stern-wave, and strong vibrations are set up in the manner already explained.

From what has been said, it will no doubt be clear that, for the removal or diminution of the vibrations in turbine steamers, in reality only one method remains, viz.; that of the prevention of resonance, or, in other words, of the avoidance of the critical number of revolutions for the vertical as well as for the torsional vibrations. A reliable prediction of these critical numbers of revolutions, such as that which my formula enabled me to make in steamers with reciprocating engines, has up to the present, unfortunately, not become possible. In particular the determination in advance of the critical number for the torsional vibrations still presents great difficulties. I have, indeed, busied myself for some time with this problem, but I am not yet sure whether I shall succeed in finding a practical solution of it.

In view of the high frequencies which occur in turbine steamers, one great difficulty lies in the circumstance that the critical frequency numbers for the successive orders of vibration lie comparatively near each other. It may, accordingly, very easily happen—in the case, for instance, in which the torsional vibrations are avoided by an alteration of the numbers of revolutions—that vertical vibrations make their appearance, and *vice versa*.

In the foregoing I have avoided all theoretical mathematical investigations, since they are of little or no value in actual practice and do not provide us with any serviceable means for the removal of the vibrations. What I have said here can only be regarded as a short abstract of the most important questions which have to be dealt with in connection with the vibration phenomena. Were a treatment of the whole question to be attempted it would probably occupy ten times as much space as the present paper.

Every one who is a member of the Society of Naval Architects and Marine Engineers will regret the ill health of the secretary and treasurer, Captain Baxter, and feel that his loss is a personal one.

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THE RATIONAL APPLICATION OF TURBINES TO THE PROPULSION OF WARSHIPS.*

BY MONSIEUR A. C. E. RATEAU.

During the last ten years we have assisted at a considerable development of turbine engines in all navies. The success of these engines has been assured, because they are the only ones which enable us to solve the problem of speed, since the demand for high speed in every class of vessel increases daily. They have, however, other qualities which add considerably to the value of ships fitted with these engines. These qualities are principally endurance, the elimination of hull vibrations, economy of fuel at high speeds, and the fact that the engines are always ready and require no overhauling.

Great importance must have been attached to these qualities to justify the adoption of these engines, as they have the grave fault of showing a low efficiency at ordinary speeds, which reduces by one-half one of the principal factors of the naval value of ships, viz.: the radius of action.

This reduction in radius of action does not have the same importance for all naval powers. To Great Britain, whose wise policy has given her in all the seas of the world bases of supply not far distant from one another, endurance and constant readiness for action are qualities undoubtedly preferable to all others; consequently the British Admiralty adopted turbines as soon as they were available, and they can, even now, continue to use them without other inconvenience than the extension of the fuel supply and the improvement of the means of utilizing the same.

Other nations are not in the same position as regards turbines. They would have to provide in times of war the important convoys of supply, which, however well organized they may be, would form but an uncertain means of assistance, and would reduce the offensive naval war strength of the fleet by the number of the fighting units necessary for their protection. For these nations, therefore, the adoption of turbines has, far more than for Great Britain, meant increased expenditure, and they also have to suffer inconveniences of a strategical nature, which the greatest financial sacrifices can only reduce.

It is not surprising to find that some countries openly regret having followed the example of Great Britain, and that one of the most powerful of these is about to replace turbines by reciprocating engines for her new battleships. One may well hesitate to adopt such a radical course as to forego the advantages of turbines. Makers of turbines are, therefore, endeavoring to make these engines more economical at low speeds. The solution of the problem has been sought by making the propeller shafts revolve independently, so as to keep the turbines at a constant speed of rotation, thus securing a good efficiency; the transmitting gears are in such cases designed with toothed wheels or electric motors.

Even admitting that by the introduction of these means of transmission there will not be a considerable loss of efficiency, their employment will always entail a certain complication and weakness, and the machinery so designed will lose two qualities that are most highly appreciated, viz.: strength and simplicity.

In the present paper it is proposed to leave out of consideration these methods of transmission and to keep to the study of what may be done with steam engines only, turbines and piston engines. By suitably combining them, it appears possible to improve greatly upon the actual consumption of steam, especially at reduced speeds. Turbines are now as well understood as reciprocating engines. We know that from the point of view of efficiency their advantages are limited by certain conditions. The piston engine has, in fact, an excellent efficiency when the steam has a pressure of 15 to 30 pounds per square inch, but it becomes bad if the expansion is carried too far.

To utilize the expansion up to a pressure approaching those obtained in the condensers we must have cylinders of large dimensions, the attainment of which is impossible, and in which, moreover, friction losses and condensation would absorb the theoretical gain obtained by the increase of expansion. Turbines, on the contrary, have their best efficiency at low pressures, and are able to utilize the expansion beyond the condenser pressures; while they give rise to great losses at high pressures due to the friction of the revolving parts in the steam space, also to leakages through the clearances between the moving and stationary parts. Marine turbines are further restricted to low velocities, instead of being able to utilize those which are best for a good efficiency. It is obvious, therefore, that if we can have an arrangement of combined engines, arranged in series, in which the reciprocating engines utilize the energy of the steam only up to the limit of expansion suitable for a good efficiency, leaving to the turbine the duty of utilizing the expansion down to condenser pressures, we shall then have an engine much superior, whatever be the speed of the ship, to one consisting exclusively of turbines or reciprocating engines.

Ever since 1900 we had foreseen the necessity of a combination of the two kinds of engines. At the meeting of this institution of 1904* we described the arrangement installed, according to our ideas, by Messrs. Yarrow & Company on board a small torpedo boat. In this arrangement the reciprocating engines and the turbines were independent; by working the reciprocating engines only we could obtain very economical results at low speeds. But we must take account of the qualities as well as the faults of each engine; we have managed to gain some advantages, although we cannot eliminate all the faults.

In 1906 we fitted the French destroyer *Voltigeur* with an improved arrangement of engines. The power is distributed on three shafts (center shaft reciprocating engine, with turbines on wing shafts). The engines are so designed that when going at full power the distribution is equal on these shafts. Up to a speed of 20 knots the reciprocating engines exhaust into the turbines, but above this speed the engines become independent. We would, therefore, have realized a perfect engine up to a speed of 20 knots if the reciprocating engines and the turbines had been designed solely with the view to obtaining better results by working by stages; but, instead of this, they were designed more particularly with the object of obtaining the maximum efficiency at full power.

However this may be, the *Voltigeur* has undeniably demonstrated the superiority of the system; because below 20 knots the consumptions are slightly above those obtained in destroyers of the same class fitted with reciprocating engines. Above 20 knots, notwithstanding the presence of the reciprocating engines (which under such conditions are not advantageous), the consumptions remain less than those of all other destroyers even with turbines only. This is due to the superior efficiency obtained with multi-cellular turbines. See Figs. 1 and 4, showing the arrangement of machinery of the *Voltigeur*, and the comparative curves of consumption of the *Voltigeur*, *Chasseur* (with reaction turbines) and *Carabinier* (with reciprocating engines). In the author's opinion the best arrangement is the following:

COMBINED ENGINES FOR BATTLESHIPS AND CRUISERS.

The propulsive power is distributed on four shafts, each pair (port and starboard) being worked by an absolutely inde-

* Read at the Jubilee Meeting of the Institution of Naval Architects, July 5, 1911.

* Trans. I. N. A., Vol. XLVI., p. 168.

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pendent set of engines. In each set a reciprocating engine drives the wing shaft and exhausts into a turbine which drives the inner shaft.

The reciprocating engines and the turbines are designed to develop a power equally distributed on the four shafts when running at maximum speed. At cruising speeds the reciprocating engines develop much more power than the turbines. The reciprocating engines should naturally be able to run ahead and astern without engaging the turbines. This design includes an exhaust direct to the condenser; this exhaust opens at the moment when the normal exhaust to the turbines closes by means of two connected valves. These valves are operated automatically when starting, thus avoiding any error or loss of time. It appears unnecessary to introduce astern turbines on the center shafts, but this could be arranged without much difficulty.

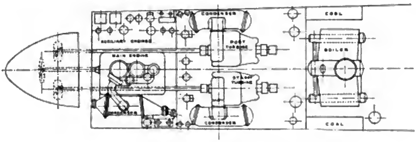

FIG. 1.—MACHINERY ARRANGEMENTS, DESTROYER VOLTIGEUR.

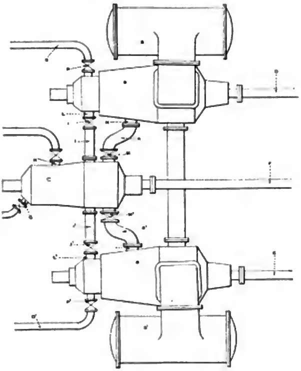

FIG. 2.—IN PRACTICE THE POSITION OF EACH TURBINE IS ARRANGED ACCORDING TO THE DISTRIBUTION OF BULKHEADS AND WEIGHTS.

With such an arrangement the following advantages are obtained:

(1) *Maximum Speed.*—For the same weight of machinery relatively to the propelling engines, there will be an increase of the maximum power from 15 percent to 20 percent, which corresponds to an increase of speed from 5 percent to 7 percent of the maximum speed, say, 1 to 1.5 knots for battleships intended for 20 knots.

(2) *Cruising Speed.*—At this speed the consumption will probably be less than that of ships with reciprocating engines only, and it will not reach one-half of that with turbines. By comparison with the latter the radius of action will be doubled, or, if prefered, it may reduce the fuel supply in the same proportion.

(3) *Maneuvering.*—When maneuvering in port it will be found that the arrangement of wing shafts driven by the reciprocating engines is a more favorable one than that of vessels with two or three propellers driven by reciprocating engines only. When maneuvering in squadrons, stations will be as easily kept as by other ships, because the regulation of speed can be adjusted by the operation of the stop valve on the reciprocating engines.

ARRANGEMENTS OF TURBINES FOR SCOUTS AND DESTROYERS.

It will be readily understood that, although the distribution of the propelling machinery on four shafts does not present any inconvenience in large ships it is difficult to achieve in the scout and destroyer classes.

If it is intended to apply the combined system in these small vessels it will be necessary to adopt an arrangement with three shafts similar to that of the *Voltigeur*, in which, at certain speeds, the reciprocating engine on the center shaft will exhaust into the wing turbines; but, in order to retain sufficient maneuvering qualities, it will be necessary to put astern turbines on the wing shafts and a direct exhaust from the reciprocating engine to the condenser, so as to make this engine independent for maneuvering in harbor.

This arrangement may perhaps be thought complicated. To simplify it we may adopt the arrangement recently installed on the White Star Line vessels: two reciprocating engines driving the wing shafts and both exhausting into the same turbine, placed on the center shaft, and, when maneuvering, direct to the condenser. But the almost universal opinion is that it is wise to give up entirely the use of reciprocating engines for scouts and destroyers. These ships must be capable of developing at full power a considerable speed; they must therefore always be ready to pass from an ordinary cruising speed (14 to 16 knots) to very high speeds. On the other hand, the number of men composing the crew is limited through lack of accommodation, and it is necessary, without greatly reducing their offensive value, to limit to the strictest minimum the numbers of the engine and boiler room personnel.

The various conditions involve the use of engines and boilers of great flexibility and strength, and requiring the least manual effort; under these circumstances turbines and liquid fuel are essential. The difficulty is to have a good

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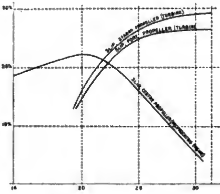

FIG. 3.—CURVES SHOWING THE SLIP OF THE PROPELLERS IN RELATION TO SPEED, DESTROYER VOLTIGEUR.

efficiency at ordinary cruising speeds. In order to overcome this the cruising turbine, which utilizes the expansion of the steam between the receiver pressure and the corresponding pressure at the exhaust into the high-pressure turbine, has been designed for the required speed. But the power developed by this cruising turbine being very small, it is not possible to make it work a propeller shaft by itself. It is, therefore, always placed on a shaft already driven by one of the main turbines. The result has been that the speed of rotation of this cruising turbine, which should be high in order to obtain a good efficiency, has been reduced by the speed of rotation of the main turbine, an obviously low speed, since it is proportional to that of the ship, and also because the cruising turbine does not come in except at moderate speeds of the ship. The efficiency, therefore, is always poor.

On the new French destroyers there are only two propelling shafts, each shaft being driven by an independent turbine, as has been the practice since 1898, when the torpedo boat *No. 243* was used for experiments on the adoption of turbines for small ships. The results of these experiments were communicated by the author to this institution in 1904.

The old cruising turbines, high-pressure and low-pressure, have been fitted in the same casing, end to end, thus obtaining all the advantage of great simplicity; but it is evident that the "cruising" part of these large turbines cannot give better results than the cruising turbines of engines arranged in separate groups.

To avoid these inconveniences, and the use of toothed-wheel gears or electric motors, we have proposed the following arrangement, in which the high-pressure turbine maintains constantly at low vessel speeds a relatively high velocity of rotation and, in consequence, a higher efficiency:

ARRANGEMENT OF TURBINES.

The ship is propelled by three screws; each shaft is driven by a turbine; only the two wing turbines being arranged for going astern (see sketch, Fig. 2). The center turbine *C* is fitted with a steam inlet at the forward end *G* and with a by-pass *H*. The exhaust of the turbine *C* is connected with pipes *I*, *I'* to the inlets *L*, *L'* forward of the turbines *A* and *B*, and also by pipes *K*, *K'* to some points *N*, *N'* farther aft in

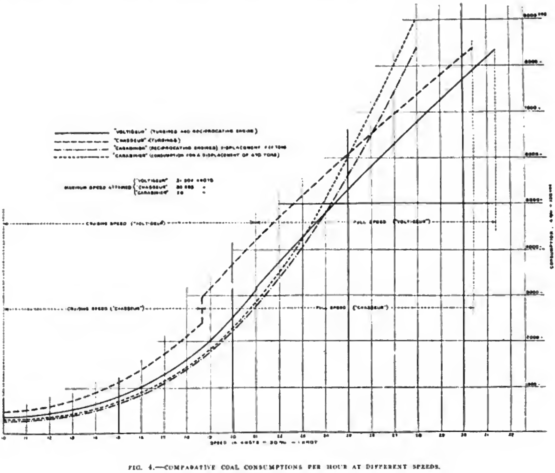

FIG. 4.—COMPARATIVE COAL CONSUMPTIONS PER HOUR AT DIFFERENT SPEEDS.

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the parts of the distributors of these turbines; these have, further, an inlet of live steam forward through the pipes *O*, *O'*. All these pipes are fitted with valves.

When cruising at 15 knots, for example, the valves *M*, *M'*, *P* and *P'* being shut, the turbine *C* receives steam through *G*, and exhausts into the forward end of the turbine *A* and *B*, which receives no other steam. If the speed has to be increased we open the by-pass *H*; the connections of the turbine *C* with *A* and *B* remaining the same. For higher speeds, steam will be admitted through *O* or *O'* into one of the turbines *A* or *B*, or both, if necessary; but to avoid having compression at the exhaust of the turbine *C*, the exhaust is let out forward at *N*, *N'* in the turbines *A* and *B*; when the valve *M* opens it must at the same time close the valve *J*. In these conditions the live steam, after having worked in the first wheels of the turbines *A* and *B*, mixes with the steam exhausting from *C*, and the whole works in the last wheels.*

Thanks to this arrangement the turbine *C* always works at great speed, but the power developed on the three shafts will not be equally distributed, as at low speeds the center shaft develops relatively more power than at high speeds. If, for example, the power produced at a moderate speed on the shaft *F* is 44 percent of the whole, and on each wing shaft *D* and *E* 28 percent, the proportion at high speed may become 16 percent on *F* and 42 percent on each shaft *D* and *E*. The variations of slip correspond to these variations of power.

At low speeds, nearly all the power being on the center shaft, the slip of its propeller is great, say from 25 percent to 30 percent, while the slip of the wing propellers is small. The conditions will remain similar so long as the live steam is admitted to the center turbine only. When live steam is admitted into the wing turbines the work produced by the center turbine increases very little, the increase of power being almost entirely due to the wing propellers. Their slip increases at the same time as that of the center screw decreases, and the speed of rotation of the latter rises far less quickly than that of the wing screws. The best results have thus been obtained, namely, that at ordinary cruising speed a center turbine does duty as a cruising turbine having a very high speed of rotation.

While cruising it is not necessary to have both condensers working. The exhaust of the turbines *A* and *B* can be advantageously connected by means of the pipe *T*, which is of ample section to maintain an even pressure between the two condensers. In this way, during a long run at low speed, we can economize the motive power necessary to work one of the sets of pumps.

The arrangement which has just been described is not more complicated than that which consists in putting two independent turbines on two shafts only. It has the advantage of being lighter and of entailing less steam consumption at cruising speeds. At high speeds it has the same advantages as the well-known systems of equally distributed power on three shafts, in which the center shaft is driven by a high-pressure turbine, and the wing shafts by low-pressure turbines, which do not receive any other steam than the exhaust of the high-pressure.

The maneuvering qualities of the ship are increased principally for borbor work, where a great advantage is gained by the action of the center propeller on the rudder; in fact, it is only necessary to steam ahead with the center propeller, while the others are maneuvering ahead or astern, and to join the exhaust of the turbine *C* with any point of the pipe *T*. This extension of maneuvering qualities is all the more important, as, with the increase in length of destroyers, it becomes more and more difficult for them to enter and moor in a harbor without the aid of tugs.

* This is exactly what happens in the Rateau land turbines, compound type, a great number of which are working in factories.

Necessity for Careful Design of Propellers.

In the above description we have purposely left out the question of propellers, which requires particular attention. It will not be inappropriate to conclude this paper by an account of the method of calculation for propellers in those two particular cases. We shall confine ourselves to describing the difficulties.

For the arrangement of turbines only it is not sufficient to make a design suitable for one speed only. If, for example, we are only requiring to have the best efficiency at high speed, where the three shafts have about the same number of revolutions, the same design for the three propellers may be adopted. At low speeds, on the other hand, the center turbine develops a power relatively greater than the others, and its propeller revolves faster than the wing ones; in order, therefore, to obtain a suitable efficiency for cruising speed, the center propeller, generally smaller than the others, must be very carefully designed.

In the case of the combination arrangement, with reciprocating engines and turbines, the former develop at low speeds relatively high in comparison to those developed by the turbines; this difference decreases in proportion to the increase of speed, and almost disappears at the maximum speed. The slip of the propellers of the reciprocating engines decreases when that of the turbines increases. In designing propellers these peculiarities must be taken into account, and also the difficulty of associating for the same work propellers whose pitches are very different.

The curves in Fig. 3 show the data obtained during the official trials of the *Voltigeur*, and they indicate the importance of the variation of slip. The slip of the propeller of the reciprocating engine increases up to a speed of 20 knots; because up to this speed nearly all the power is supplied by this engine, and also because of the influence of the stern wave, which on the measured mile where the trials were made became defined in the neighborhood of 24 knots.

Above 20 knots the turbines come into operation, and the slip of the propeller of the reciprocating engine decreases until it reaches a very small value at the maximum speed. Just the contrary happens with the slip of the wing propellers, which is zero at the start, and increases rapidly until it reaches 26 percent and 28 percent. Notwithstanding this relatively high value for the slip of the wing propellers at the maximum speed, the efficiency of the machinery remains good, as is shown by the excellent results obtained at the trials.

The *Voltigeur* has really obtained a speed of 31.4 knots, instead of 28 knots required by the contract specification.

Let us also point out the remarkable difference in the increase of slip of the wing propellers, although they are similar and symmetrical. This difference certainly arises in great part from the fact that the powers developed by the two wing turbines are not equal; also, because owing to the presence of the center screw, the stream lines of the water as it reaches the wing propellers are not symmetrical.

The trial of the Melville-McAlpin, Westinghouse reducing gear on the new naval collier built at Sparrows Point, Md., we understand, has been most satisfactory, and should this gear prove a success, which it is fair to suppose it will, the matter of providing large powers by means of internal-combustion engines will be greatly simplified and greater economy effected.

The naval collier *Neptune* has another feature which is well worthy of notice, and that is that the control of the turbines is in the hands of the officer of the bridge. We do not mean by this that the engine room force is done away with or it is reduced, but if the conditions are such that it is required to act quickly on the bridge as regards starting, stopping or reversing the turbine, it can be done, and, to our mind, this is a most advantageous feature and a commendable one.

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PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Plotting Condenser Tubes.

When laying out condenser and water tubes this simple method for finding the hight of the equilateral triangle can be advantageously followed:

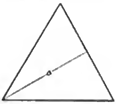
$$a = \text{pitch of tubes} \times \sin 60 \text{ degrees}$$
$$= .866024\,P$$
$$= \text{say } .866\,P$$

which can be laid off on the slide rule very easily. In connection with this it may be proper to give the following table of standards, which accord very closely with general practice:

Diameterr	5/8	3/4	1
Area per foot of length	.164	.196	.2618
Pitch for composition tube sheets	15/16	1 1/16	1 5/16
Pitch for cast iron tube sheets	1	1 1/8	1 3/8
Thickness of sheet	1	1 1/8	1 1/4
Total length of ferrule	15/16	15/16	15/16
Depth of lap	3/4	1 3/16	1
Number of threads per inch	16	16	16* / 14†
Outside diameter of tap	7/8	1	1 1/4* / 1 5/16†

* Commercial. † Commercial standard.

Tubes usually project 1/8 inch beyond the edge of the tube sheet. When circulating water has practically no pressure a



LAYOUT OF CONDENSER TUBES.

No. 20 gage tube can be used. When under 150-pound pressure No. 18 gage should be used, and when over 150 pounds pressure a No. 16 gage tube should be used. In estimating tube areas it is customary to consider the total length of the tube and to neglect intermediate space on the tube sheets. To correctly design condensers the calculation should be based on the amount of heat to be taken care of, temperature range and work in rate of transmission through cooling surface. But a very successful empirical rule is:

$$\frac{\text{pounds of steam to be condensed}}{10} = \text{cooling surface.}$$

For high-vacuum condensers this rule does not hold. The ordinary commercial cast iron condenser for small work usually sells for approximately $1 (4 shillings) per square foot of cooling surface.

San Francisco. E. N. PERCY.

Steam and Exhaust Pipe Work on Board Ship.

In marine engineering more than perhaps any other branch of application of steam, the importance of proper arrangements of pipe work and an adequate regard for strength of construction is distinctly felt. In the first place, should any defect occur while a vessel is at sea there is not only less opportunity for careful repair than in shore practice owing to the fact that engineering facilities are so limited, but any breakdown involves a very serious risk of further damage owing to the total or partial stoppage of the vessel, possibly in circumstances of extreme peril. Added to this, however, is the fact that the extreme economy of space which is necessary on board ship brings in its train two evils, one being that in many cases dangerous expedients are resorted to in order to crowd the pipe work into the narrow limits assigned to it, and the second is that, should any portion of the pipe work carrying steam at high-pressure fail, the risk to human life in such confined situations is a very serious matter. When, in addition to this, it is remembered that the constant pitching and rolling of the vessel puts a series of strains upon the pipe work connecting the various portions of its machinery which tends towards the breaking of joints or the fracture of the material of the pipe work, it is a very remarkable thing, which speaks highly for the care which is usually shown in construction, that so few serious accidents occur through the failure of pipe work in vessels while they are at sea. As, however, the price of safety is eternal vigilance, it may be useful to detail one or two breakdowns of steam and exhaust-pipe work which have occurred on ship board, together with their causes so far as can be ascertained, and the means that were adopted in order to effect either a temporary or permanent cure. The value of such an investigation will be that not only will sea-going engineers have some indication as to the parts of their pipe work which must be subjected to careful observation and may have one or two hints which may be new to them as regards the treatment of effects, but also the designer of marine plant may possibly benefit by a statement of the practical defects which have fallen to the lot of those who go down to the sea in ships.

One of the most common causes of trouble in steam-pipe work, and one which may lead to disaster of the most serious magnitude, is the splitting of the pipe to a greater or less extent along its length. This may be due either to an inherent defect in the pipe itself, or to its improper use while the vessel is in commission. As an instance of the first-mentioned cause may be taken a breakdown which occurred on a copper deck steam pipe. This pipe was very thin and the split was interesting from the fact that it did not occur upon a brazed pipe, as it was solid drawn. Owing, however, to the fact that upon one side of the tube it was rather too thin for safety, and also because the steam was suddenly turned on, thus giving full pressure to the pipe with a species of shock, the tube split at a bend, as shown in the sketch, Fig. 1. The action of the steam was intensified by the fact that steam had previously condensed in the pipe, and the water so formed had rushed along with the fresh steam, giving a water-hammer blow at the bend. The tube was too thin to allow of the usual clamp and joint to be placed upon it, so that it was repaired by first tapping the edges of the split together, as shown in the second illustration and then soldering upon it a Muntz metal patch of the shape shown in Fig. 3. This repair was then strengthened by winding a length of thin copper wire along the whole length of the patch and a little distance beyond on either side, the turns being placed close together, and finally the whole wire-bound arrangement was run up with solder as shown in Fig. 4. This method of repairing a split pipe is found to give a thoroughly satisfactory and permanent job if it is properly done, as it will not split again at that part under any ordinary circumstances.

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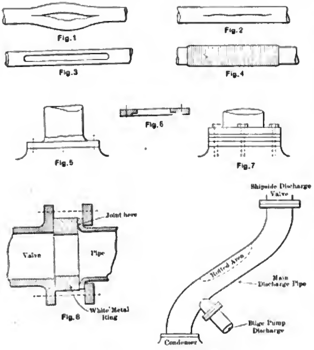
The illustration of the second point, which was mentioned—that of palpably improper use—was a split which occurred on a winch steam pipe, owing to the fact that the pipes were left full of water in cold weather owing to an omission to open the drains when work was finished the previous night, and the winches run off. Next morning, when the steam was turned on somewhat too suddenly, the pipe split longitudinally over a distance of about eight inches. The repair was made by making three sets of semi-circular pieces of iron to the outside radius of the steam pipe, each set consisting of two similar pieces provided with end lugs. These were provided with bolt holes, and a piece of asbestos cloth, 10 inches long and wide enough to pass entirely round the steam piping, was covered with manganesite paste and placed over the split. In order to cover this cloth, two pieces of 1/16-inch sheet iron, 10 inches long, were bent to a semi-circle, so that when butted



TROUBLES WITH STEAM AND EXHAUST PIPES.

together over the asbestos they formed a complete shield. The clamps were placed over these and bolted together, forming a very tight and sound repair. In order to prevent any further occurrence of such trouble special care was taken to see that the winches were always run off and the drains left open when work was finished.

It may be as well here to interject a word of advice to young engineers. The above paragraphs will show the danger of steam pipes, particularly on deck, bursting owing to frost and to sudden admission of hot steam. If in cold weather an engineer makes a practice of running off the steam out of the pipes, winches and auxiliary machinery while the ship is in port, it will save many a cold morning's work in putting on clips, blank flanges and other repair accessories. As soon as work on deck is finished for the night all the winches and small machinery should be set running slowly and all drain cocks on both steam and exhaust pipes should be opened. The boiler stop valves should then be shut and the winches will go until the steam has run out of the pipes. The intermediate or deck stop valves should then be shut down, but care should be taken not to screw these down too tightly upon their seats, as there might be trouble in opening them on the following morning if a hard frost supervened. The winches and auxiliary plant stop valves should, however, be left open just as at the conclusion of work, in order that any condensed water can get out of the pipes through the drains.

Another very fruitful cause of trouble in steam-pipe work is, as mentioned previously, vibration, due to racking on the ship, and this often manifests itself in the "necking" of the pipe work; that is to say, the formation of a fracture all round the circumference of the pipe close up to one of its flanges. This is probably due to the fact that at such points the free vibration of the length of pipe imparted to it by shock to the boat is checked by a rigid resistance due to the increased diameter of the pipe work at the stiffening flange. Two cases of necking may, with advantage, be described, together with the means adopted to overcome the trouble. The first occurred on a ship which was running light and which met heavy seas, causing the engines to race. In this way the whole ship vibrated and the vibration caused the main discharge pipe to split right round its circumference close to the flange connecting the discharge pipe to the condenser, as shown in Fig. 5. The engines were, of course, stopped at once, and the pipe was sprung up a little by means of a block and tackle. When the joint between the flange and the condenser top had been broken, the broken piece of pipe remaining in the flange was taken out and a recess was cut in the bottom of the flange to a depth equal to the thickness of the pipe itself, and for a radial distance of about ½ inch, as shown in Fig. 6, outside the inner bore of the flange. The ragged edges were then filed off the pipe, and the flange was put on to the pipe with the recess downward and placed in such a position that the pipe stood through the flange for about half an inch. This protruding piece of pipe was next heated by means of a brazing lamp and tapped over gently with a hammer until it was flush into the recess. In order to make up the difference of a length between the pipe as it originally was, and that which it had after repair, three pieces of ½-inch plate, which was the only material available, were cut to the same size as the flange and drilled with holes having the same position as the holes in the flanges. The old studs were then drawn out and new studs were made of a sufficient length to go through the three pieces of plate and the flange. The whole arrangement was then assembled, as shown in Fig. 7, a joining of rubber insertion being placed between the flanges and all the plates. When this had been done the engines were started and the voyage was continued without any further mishap, the vibration being taken off the discharge pipe by means of securing it with blocks and tackle. At the conclusion of the voyage the repair had answered so well that nothing further was done to it except to fit hangers to the pipe in place of the block and tackle.

The other example of a necked pipe occurred on the main steam pipe of a coasting steamer. The cause of this was again vibration, due to the fact that the boiler and engine did not appear to be sufficiently stayed and the ship was running light. In this case the pipe was only broken half round its circumference close up to its flange and the means taken to make the repair were practically the same as those described above. The flange being cut off and cleaned out in order to allow the pipe to come through, this was then beaded over for a distance of about half an inch. It was not in this case, however, necessary to cut an annular recess in the flange, as a white metal ring was cast, about 1¼ inches thick, and having an outside diameter sufficiently small to fit inside the bolt circle. The inside diameter was made slightly smaller with the bore of the pipe. The face of this distance piece was then filed up and thin insertion joints were put on each side of the ring, and therefore between the valve and the flange of the pipe as

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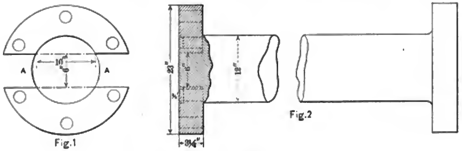
shown in Fig. 8. The whole arrangement was then drawn up tight with long bolts in the usual way, and this repair was sufficient to carry the boat home to port. It was rightly considered that the piping arrangement at this section was too rigid, inasmuch as the original pipe was practically straight. In order to give further freedom to the arrangement and to obviate any undue strain on the pipe work, due either to expansion and contraction, or to the shifting of the engine or boiler, a large expansion bend of the usual U-form was substituted and stays were also fitted to the engine in order to make it more rigid.

A very instructive breakdown upon a main discharge pipe may be recorded, inasmuch as it illustrates the danger of endeavoring to cut down the original cost of pipe work on board a vessel. In this instance, the main discharge pipe, which was made of copper, had a branch added to it for the purpose of accommodating the bilge pump discharge pipe, which was also made of copper. The object of this arrangement was probably in order to save the cost of a few yards of fairly small diameter copper piping and a ship side discharge valve, inasmuch as there was quite sufficient room for the bilge pump to have a discharge of its own; and, as a matter of fact, in the repairs following upon the occurrence to be described the bilge pump was given a separate discharge to the ship side. As a result of this first arrangement the main discharge pipe gave out while the ship was at sea along the portion marked "rotted area" in the sketch, Fig. 9. Inasmuch as the bilge pump sent all the oil, grease and other impurities through the main discharge, the acids contained in these substances attacked the copper of the pipe along the portion where they impinged most freely, and this trouble was not detected until the pipe entirely gave way. The engines, of course, had to be stopped, and upon examining the pipe it was found that nothing could be done to repair the pipe in the usual way by clamping Muntz metal sheets round it and interposing joining material, as the joint was far too weak. As a matter of fact, it was feared that it would collapse altogether. As, however, it was necessary to get the ship home again a temporary repair was effected in the following manner: First of all, long canvas bandages were made and sewn together so as to form a continuous band. This was then dipped into boiling Stockholm tar, and the bandage, while hot and sticky, was wound round the pipe not only over the rotten portion but over some little distance above and below it. The idea underlying this procedure was that the tar by setting hard upon the copper would tend to keep any loose parts together and in their place. The next step taken was to obtain some strong grain sacks, which were cut open and sewn round the pipe in such a manner as to form a loose envelope. This allowed sufficient space between the tarred lengths of canvas on the pipes and the covering envelope of sacking to allow of soft Portland cement being run into the space between them, the lower end of the sacking being, of course, lashed close to the pipe to prevent the cement from running out. The cement was thus worked round the pipe to a thickness of about 2 inches all round, and when this was set there seemed a possibility that an efficient repair had been effected. In order to make certain, however, rope was wound over the top of the previous work and the weight of the whole construction was suspended by means of a strong canvas sling and ropes from the roof of the engine room. When the cement was properly set the engines were started and the voyage was completed without any further mishap. The repair could only be considered a temporary one, inasmuch as when the pipe was stripped of its cement sheath it collapsed completely.

There is no doubt that a considerable amount of useful information of a practical character can be written concerning the behavior of pipe work at sea if space permitted, but the above examples are sufficient at the present time to show not only the very various causes of trouble to which such pipe work is subjected, but also to the ingenuity which is sometimes necessary in order to bring the vessel home to port under adverse conditions. From both these points of view, however, it is hoped that these notes are not without value.

Repairing a Broken Shaft.

I don't know what broke our intermediate length of shaft on the *Clara Belle;* but it broke, and we were towed into a West Indian port. I wanted to get a new shaft quickly, but there was little chance, I thought, but I found a length, which had been taken from some old steamer, which was an inch larger ours. The flanges were large, so we could drill new bolt holes all right. The worst was it was too long by 2 feet, but I had to do something, so I made the coupling shown in my sketch. Now what I want to know is, if my coupling is not as strong as my 11-inch shaft? I argue that, as the area of 11 inches is 95,033 square inches, I am as strong with the area of 10 by 6 inches, or 60 inches square, or really a little bit more, and I am backed up on each side with about 8½ inches of coupling, which coupling is bolted fast to its mate, and the three bolts hold each half up solid. Now how can this break down?



COUPLING FOR REPAIRING A BROKEN SHAFT.

I may say that when I got home they didn't take out the shaft and this is our third year. Some fellows think I should have brought the halves of the couplings together and not left the opening *A A*, and and I would have been stronger, but that would have cost a lot more.

Now, Mr. Editor, put it up to your readers, who know all about figuring strains (and then go and find out what some other chaps have done to make sure) and see what they have to say.

New York. COUPLING.

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Matters of Interest from the Jubilee Meeting of the Institution of Naval Architects.

The name of Schlick, Barnaby or Rateau on a paper is quite sufficient to assure that matters of importance will be most interestingly set before the engineer, and we give in this issue three papers by the above-named gentlemen as read at the Jubilee meeting of the Institution of Naval Architects, held in the early part of July in London.

Dr. Schlick's paper on the "Phenomena of Vibration of Steamers" finishes with the following: "I have avoided all theoretical mathematical investigations, since they are of little or no value in actual practice. * * * Were a treatment of the whole question to be attempted it would occupy ten times as much space as the present paper." We all should have been delighted if Dr. Schlick had given us ten times as much as he has, and certainly in his rather brief paper he has brought forward, in a most lucid manner, the causes for vibration in ships. We are surprised, indeed, to have him write as he does on mathematical investigations, as above all men he is qualified to speak on this subject with authority, and we are inclined to think that he belittles his own magnificent ability in this direction. Certainly practical results have followed his past mathematical efforts.

Mr. W. S. Barnaby, who is a member of the Council of the Institute, gave a paper on "Some Further Notes on Cavitation," in which he limits the thrust per square inch of projected surface of the propeller to about 11¼ pounds to prevent cavitation, that is under certain conditions, and he combats the idea that periphery velocity of a propeller is a better criterion than the thrust per unit area, and he considers that further experiment only can settle the question whether the thrust is not a safer guide than the tip velocity. Such experiments, he says, are being made under special conditions to settle the question. Mr. Barnaby draws attention to the advantages of the more uniform turning moment of turbines and that the irregular turning moment of four-cylinder engines brings the figures 11¼ down to 8 or 9 pounds per square inch. Here is a thought for those interested in internal-combustion engines.

Monsieur Rateau suggests certain arrangements of turbines in combination with reciprocating engines. He draws attention to the fact that the navies of the world could not all have their ships engined in like manner, as conditions demand, in some cases, a far greater radius of action than in others. We can hardly agree with Monsieur Rateau when he asserts that the turbines "are always ready and require no overhauling." He does not evidently like the new system which introduces mechanism between the prime mover and the propeller shaft, whether it be a geared or an electric reduction. He proposes to put the reciprocating engines on the wing shafts with the idea that in maneuvering they are more advantageous. This would simplify the turbines by not demanding any reverse rotor. He points out the advantages of the steam turbine under certain conditions and the advantage of the reciprocating engines under others, and decides that their combination is the one which should be used, with the exception of the scouts and the destroyers. In speaking of reduction gear, Sir C. A. Parsons considered the floating cradle not a good thing, stating that all that was needed was end play in the pinions.

In the discussion of turbines for warships, Admiral H. I. Cone, U. S. N., in his usual direct way, wanted to know whether the expediency of a combination of reciprocating engine and turbine warranted the introduction of the extra difficulties? Mr. A. E. Seaton, in speaking of the turbines, admired the tenacity of purpose of turbine builders. If it had not been for this, he asserted that it might have been laughed out of existence, as have other appliances, but he was very much in favor of the turbine because he thought it was the best means of fighting the internal-combustion engine.

Other papers presented at the meeting we hope to give later.

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LEGAL DECISIONS REGARDING MARINE WORK.

Lien for Repairs in Foreign Port.

Although a charter party contains a provision that repairs shall be made at the expense of the charterers, a repairer who makes repairs on a vessel in a foreign port under a contract with the charterers, but confirmed by the master and with the knowledge of the managing owner of the vessel, is entitled to a lien if the provision was not known to him and he was not notified of it.—*The O. H. Vessels, Circuit Court of Appeals, Third Circuit.*

Collision Between Steamships.

Cross suits for collision were brought by the owners of the steamships *Aurelia* and *Umatilla*. The collision occurred in the daytime in the bay about 2,000 feet from the San Francisco piers. The *Umatilla* had backed from her pier to go out, and when 1,000 feet off gave a passing signal of two whistles to the *Aurelia*, which was in sight inward bound for Oakland. The *Aurelia* answered the signal, but the *Umatilla* continued to back for two or three minutes at full speed without giving any signal of the fact. The *Aurelia* did not materially change her course until the vessels were too close together to avoid collision. Both vessels were held to be in fault, the *Umatilla* for failing to give the proper signal to show that her engine was going full speed astern, and the *Aurelia* for failing to keep a proper lookout, which would have enabled her to avoid a collision, notwithstanding the *Umatilla's* fault.—*The Aurelia, District Court, U. S. California.*

Passing of Title of Vessels to Government as Constructed—Government Contracts Construed.

A corporation entered into a contract with the United States for a sea-going suction dredge, a revenue cutter and a cruiser. Certain creditors filed a bill in the Virginia Chancery Court asserting liens under the supply lien law of the State, averring the insolvency of the contracting corporation and asking for a receiver, which was made. He took possession. On final appeal to the Supreme Court of Appeals of Virginia it held the supply liens superior to any claim of the government. In the case of the dredge two of the five judges dissented, holding that the title to the dredge had passed to the United States.

The case came before the Supreme Court of the United States on writ of error, and the judgment was reversed as to the dredge and affirmed as to the revenue cutter and the cruiser. Section 211 of the specification for the dredge provided that the parts of the vessel paid for under the system of partial payments should become the property of the United States. Section 212 provided for insurance against fire and marine risks at the contractor's cost to the amount of each partial payment.

The government contended that the vessel was to become the property of the United States as fast as it was paid for. This view the court upheld. The fact that a government inspector had the power to reject or approve the materials did not of itself work the transfer of the title of a vessel. But if the contract express the intention that the builder shall sell and the purchaser shall buy the ship before its completion, and this purpose is expressed in the contract, it is binding, and the title passes. A contention that Section 212 did not show an intention to protect the title transferred to the government, but that the insurance was required for the government's security

It was held that this provision was not inconsistent with Section 211. Nor was it found inconsistent that bond was taken for the performance of the contract. A provision that the contractor was to be responsible for and pay all liabilities for labor and material incurred in the prosecution of the work was not inconsistent with the passing of the title in parts as paid for.

The question then was the right of a State lien law to fasten upon the property of the United States. It was held that the property of the United States could not be seized or encumbered under State lien laws. The dredge, as fast as constructed, became one of the instrumentalities of the government, and could not be seized under State laws to answer the claim of a private person.

In the case of the revenue cutter there was no such stipulation as to passing of the title on partial payments. The Secretary of the Treasury was authorized to make partial payments, and a lien was reserved on account of such payments by a joint resolution of Congress of May 5, 1894, which law was to apply to future contracts for vessels for the Treasury Department. The government contended that this resolution made a statutory lien by authority of the United States. But the Supreme Court did not agree to that contention. A bond was given by the contractor for the proper construction of the vessel, which provided that the contractor should promptly make payments to other persons supplying labor and materials. The court held that this requirement was a distinct recognition on the part of the government that the contractor might become indebted to other persons who might become entitled to liens upon the property.

The case of the cruiser was held to be controlled by the same principles as that of the revenue cutter. In that contract there was no provision for taking title to the vessel; it was stipulated that, on certain conditions, the title should vest in the United States as collateral security, and a clause of the contract provided for the release of liens before partial payments should be required. The court held that this contract also was made in recognition of the rights of those who should furnish work or materials for the vessel to secure their claims by liens which it was made the duty of the contractor to provide for in order to protect the title of the United States. —*United States v. Ansonia Brass & Copper Company et al., United States Supreme Court.*

Salvage—Question of Danger Through Breaking of Intermediate Valve.

In an action on behalf of three Humber tugs for alleged salvage services to a steamship, it appeared that the vessel was driven up more to the northward than her course should have been, and she missed the Spurn light. On the question as to whether the steamship was ever in any danger the evidence showed that when the engines were stopped, and before the vessel anchored, the engineer ascertained that the main engine valve was broken. He sent up information to the bridge, and subsequently went up himself. The chief engineer was a very capable engineer and a good and reliable witness, and according to his evidence the ship was never in any danger at all by reason of what had happened to the valve. He said he could work the engines by means of the main boiler valve without difficulty, and that it made a difference of not more than half a minute between moving the engines by means of the main boiler valve and moving them by the main engine valve. He said there was never any hitch and never more than a quarter to half a minute's interval between receiving and executing an order. That information was before the captain. It was held that the steamship had not been in any danger, and judgment was given for the defendants.—*The Calyx, 27 Times L. R., 166.*

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COMMUNICATION.

More Remarks on Cargo Loading.

Editor International Marine Engineering:

In reading International Marine Engineering for June, all interested in the subject of loading and unloading vessels must be set thinking, and the subject is one of vital importance, but it is not one on which data are readily obtained.

I am assured that in England the cost of a 40-foot vertical lift, coupled with a swing of 100 degrees and lowering, costs a little under 2 cents a ton of 2,240 pounds, which is about a penny. This cost covers the power and the man to handle the boiler and hoist, but does not include any handling on the ship or on the dock. It is, so to speak, the mechanical power cost. It is difficult to get even a moderately correct idea of the cost of moving a ton from its position in the hold to the hatchway, as obstructions intervene at times, and at very best the working conditions are disadvantageous. We should say that a 40-foot move horizontally would be about the maximum in an ordinary freight ship, and that two men could move a ton 40 feet in ten minutes with the usual ship appliances. If this time is taken as reasonably correct, the cost would be about 12 cents, or 6 pence, or about six times as much as the vertical hoist, which bears out Mr. Forbes' assertion of the economy of the vertical lift, as referred to in the article by him.

Handling freight is a good deal like many other operations, as, for instance, work in a machine shop, the time getting ready to do something often outruns that occupied in actual work, so in getting the cargoes out of vessels there is an unreasonable loss in moving cargo into a position to hoist.

Mr. Crane gets at an "obstruction" in referring to old captains and favored shipbuilders, but I do not quite agree with him as to some one having to pay for the new design. It is, of course, true that a set of blue prints costs a lot less than a set of drawings and tracings, but Mr. Crane, as a recognized designer, could, I feel sure, suggest to many of his clients changes the cost of which would be only on the designing side, and such cost would be made up by the advantages gained. Here is an opportunity where such a good helmsman as Mr. Crane could steer his clients on a better course.

When Mr. Harding advocates larger side ports I think he is considering in general a less satisfactory solution than larger or more hatches. He clearly shows how this question of modified design in freight steamers is not being acted upon, even with the knowledge of what such modifications would result in in a money-saving way. He makes a most practical and very wise suggestion that naval architects should spend, not a few hours on board a ship or in the freight house, but a week, from morning to evening, and then he thinks something would be done, and there is no doubt of this, that something would be done by the naval architect if he had to continue to work under the present conditions of loading and unloading vessels and unloading the freight on the docks. In Mr. Du Bosque's remarks he brings forward a most important point; that of being able to pick up the packages or sling them without injury. Here is one of the small details to which he calls attention, and they are of the utmost importance. No one knows this better than a man who has had Mr. Du Bosque's training and experience. The detail is, in fact, the all-important point. The best and most convenient hoisting apparatus in the world, even if it were run most economically, would he absolutely valueless if in its use the goods were injured.

Mr. Dickey draws attention to the classification companies' rigid demands as regards side ports, and even if they were provided we come up again against the horizontal movement or the vertical hoist question. If Mr. Dickey got a free hand I think his two-story shed idea would be worked out into something good. The suggestion of the "Naval Architect" as to crew's quarters is excellent, but the most important statement he makes is that there is no reason why the whole upper deck along the central line should not be open hatches. If this is so, and knowing who the "Architect" is I have no doubt of it, it is evident that something can be done at comparatively small cost, in better design.

Mr. Waterman calls attention to the diversity of cargoes. Of course, this counts much in the way of costs, as a certain amount of sorting has to be done at both ends of the route; but he points out that nothing new or novel is needed in the way of conveyors and other devices for handling freight, as there are now on the market some most reliable and practical devices to be had for the paying, and here seems to be just the point on which matters stick; that is to say, on the paying. I call attention to the lack of tact shown by some who have articles for sale, which, if installed, would be advantageous, and which customers are ready to put in, but they have been frightened off by the salesman who is unacquainted with the shipping business. In the case I have in mind the salesman wanted to have both the docks and the vessels handed over to him for a matter of two or three weeks, which, of course, could not be considered; therefore nothing was done.

Now we are crying out against high prices and howling still louder for our dividends, and shipping people are not having the easiest time in the world to make the dividends so much desired.

In some cases I have known that a certain class of freight, principally fruit, formerly shipped by water, is now going "all-rail," because of rough handling in stowing aboard ship doing so much damage that the value of the freight dropped to an extent that it paid to consider a more expensive means of transportation. Now in such cases is it not possible to have crates, specially designed, to be swung onto the ship in bulk? True, these crates would cost money, but if the design was properly considered I think, even with the disadvantage that probably most of the crates would be returned emptied, the system could be employed advantageously, as the sorting of articles at one end of the route for a customer would probably be done only once, or various shipments to a single consignee could be sorted and, so to speak, bulk crated.

Let us hope that this very interesting subject will be responded to by many of the readers of International Marine Engineering, whose experience certainly has been such as to place them in possession of facts, and a full discussion should result in a better understanding of the subject and lead to better methods.

Onlooker.

PERSONAL.

Mr. L. D. Mosley was appointed on June 20 chief engineer of the Metropolitan Steamship Company, with headquarters at Boston, Mass. Mr. Mosley's well-deserved promotion will be a matter of pleasure to his friends, as he has been at various times chief engineer of the finest passenger steamships on the North Atlantic coast, including the fast turbine steamers *Harvard* and *Yale*.

The Westinghouse low-pressure turbine, wherein the steam pressutes are exactly balanced, thus obviating the use of dummy rings, is a modification in turbine design which certainly makes toward simplicity and economy.

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TECHNICAL PUBLICATIONS.

Steam Turbines. By Joseph Wickham Roe, M. E. Size, 6½ by 9½ inches. Pages, 137. Illustrations, 77. Numerous tables. New York-London: McGraw-Hill Book Company. Price, $2.

Professor Roe offers this work on steam turbines to the student, whether at a school of engineering or in the engine room. It is concise, but the information given can be supplemented, as the Professor has adopted the excellent method of giving references, which are generally available. At the end of each chapter details of construction of various makes of turbines are shown. It is, of course, supposed that the student is somewhat versed in mathematics, but if he is not, he will not regret buying the work, as there is much explained therein which requires no mathematics whatever.

Gas Engines. By W. J. Marshall and Capt. H. R. Sankey, R. E. Size, 6 by 8½ inches. Pages, 278. Illustrations, 127. Price, $2.00.

We hardly believed it possible that there was room for another book on gas engines, but after reading the results of the labor of Messrs. Marshall and Sankey we feel that a very valuable addition has been made to the literature concerning what is at times a very provoking prime mover, and to those who study this work many of the provoking actions of a gas engine will become things of the past. "Mysterious action" is only a very easy name for pure ignorance, and there seems to be a determined resentment to thoroughly understand gas engines, and one would believe they take more satisfaction in guessing at what is the trouble than understanding its cause. The illustrations in the book are most admirably clear, and we recommend it with confidence to all who have anything to do with internal-combustion motors.

Power. By Charles E. Lucke, Ph. D. Size, 5½ by 8 inches. Pages, 304. Illustrations, 223. New York, 1911: Lemcke & Buechner. Price, $2.00.

Professor Lucke's book is an admirable one for every student to read at the very outset of his engineering studies. In a most pleasing manner the reader is carried from the past into the present concerning prime movers, and the way is paved for more minute and exact study of the various power producers. If the student could understand everything which is written by the Professor he would have lost his right to the name and have become an engineer, but where the work seems especially valuable in our eyes is in the admirable way in which it awakens in the reader a desire for further knowledge, and certainly such a sentiment is the desire of every instructor, and we are glad to know that such a book is obtainable, and we advise even those who are not engineers, but interested in the subject, to read it, as they will be thoroughly well repaid.

Directory of Shipowners, Shipbuilders and Marine Engineers, 1911. 813 pages. The Directory Publishing Company, Ltd., 15 Farringdon avenue, London, England. Price, 10s.

This valuable directory has gained much in its ninth passage through the press, and the new edition, which has been thoroughly revised and brought up to date, has gained some twenty pages. The utility of the book is beyond question to all who are associated with shipbuilding and shipping, as it enables instant reference to the vessels of the various owners and also to the *personnel* of the marine world.

In a large number of cases in the current edition the following particulars relating to boats have been added: Cubic capacity of holds and bunkers, loaded draft on summer freeboard and year when built. It is the intention of the publishers to insert these additional particulars against all boats in future. A list of marine engineers and naval architects, with their telegraphic addresses and telephone numbers, has also been included.

The Naval Annual, 1911. Edited by T. A. Brassey, A. N. N. A. Size, 6 by 9½ inches. Pages, 472. Numerous illustrations. London, W. C., 1911. J. Griffin & Company.

The Naval Annual, 1911, edited by Lord Brassey, G. C. B., gives information which shows the progress of the world's navies during the past year and much detail of construction, but, of course, in navy affairs exact details are always difficult to obtain, and often quite impossible for obvious reasons. The German navy seems particularly careful in this direction. In our opinion, we do not believe that this secretiveness amounts to very much. No military man works on the idea that his enemy is anything but worthy of his steel, and suppression of details are only momentary.

The labor of those who lent their aid to Lord Brassey has been most admirably performed, and due acknowledgement is given Mr. John Leyland and Commander C. M. Robinson, R. N., who had to work at excessively high-pressure in reviewing the progress of the navies and estimating their comparative strength, owing to the regrettable accident to the author, which affected his eyes. Mr. Alexander Richardson writes with his usual interest on engineering matters, and Sir Cyprian Bridge, G. C. B., gives the naval view on the London Declaration. Mr. J. R. Thursfield answered the remarks, and Mr. James R. Corbett on the tactics of Trafalgar, while C. M. Robinson, R. N., writes on the evolution of the battleship since the *Dreadnought* type has come to the fore. It is, of course, difficult, in fact, almost impossible, to give this book its due, as to cut out any of the text is to decrease its value, and yet it is quite impossible to give it in *ex tensio*.

We must admit it is not clear to us why a battle fought 106 years ago, under conditions which could not re-occur, should be commented upon in this naval year book, as it certainly is the "last" utterance on modern navies. Interesting, indeed, are Mr. Thursfield's explanation of Lord Nelson's Trafalgar tactics, but this does not explain the introduction of the matter in Lord Brassey's book.

No one is more conservative than the seafaring man, and he should be, but it does seem to us most curious how some useless things are clung to by navy men. This is instanced by the continued use of the designation "B. L." in connection with the description of guns. No other type could be found in any English modern battleship, therefore why cling to its use either in print or on the breech of the gun, which, of course, would speak for itself?

The points which Lord Brassey's book seem to bring most to the fore are: 1. The assistance which the navies of the colony will render England. 2. The use of internal combustion and steam turbines as motive power. 3. The question of submarine. 4. One-calibre gun ships. 5. Gains in accuracy of fire.

The assistance of colonial navies and their value seem to be points accepted, and there can be no doubt but that the establishment of works for building vessels for these navies in Australia, Canada or other colonies would be most satisfactory for the people and of the very greatest military advantage, and the various colonies seem to be quite willing to furnish funds to carry on the work.

The Declaration of London seems to have been considered advantageous, provided it is shown that foreign governments will stand by its ratification and not pay as little attention to it as was given to the Berlin Treaty.

The question of accuracy of fire is, of course, a determining factor in large guns and long range. In fact, if no hits are made there is no use of any size of gun, and this has been most thoroughly understood and appreciated, and gunnery has

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been advanced most satisfactorily. Lord Brassey says: "It is not the number of ships nor the number of guns they carry that will win battles, but the number of effective hits the gunner will make when the target is firing back." No one who has been under fire will take any exception to his Lordship's assertion. The firing back has a most decided influence. Lord Brassey gives high praise to Sir Percy Scott, vice-admiral, and Rear Admirals Frank T. Hamilton and Richard A. Peirse, inspectors of target practice, for the satisfactory results which, under their guidance, have been brought about. The range in firing in ten years has increased from 1½ miles' range to 5 miles, with a great gain in the number of hits at the last-named distance.

In the navigation of the air most nations have given the subject consideration, either with a view of having some aerial vessels of their own or preparing themselves to repel any attack from same. A very large dirigible was completed in England in 1911, it being 512 feet long. It is of the non-rigid type. Just what is the belief of naval men as to the true military value of airships in naval affairs is certainly not clearly brought out by the author.

Submarines and submergibles are a type of design which have to be counted upon in future naval warfare, and, of course, the usual controversy on this subject will go on. The general idea seems to be that very great advance has been made in this class of vessel, and that they will be increased in numbers. Certainly the submarine is no longer considered the idea of a crank, as many can well remember was the case. It seems to be not merely a good "scarecrow" but a practical weapon of offense. Many acts of extreme heroic sacrifices have been brought to notice of those who have manned this type of vessel, actions which bring the tears to one's eyes, and even if the life of many have gone out it has not been in vain. But even in spite of these most regrettable occurrences there seems to be no lack of men to volunteer for service in what must be classed as a risky vocation. Safety devices of various kinds are being tried, some proving successful, and there is no doubt as the years go on the serious accidents of the past will not be repeated.

The motive power of naval vessels is a question which has to be settled from the standpoint of military demands. The internal-combustion engine is under trial, and its advocates have great hopes, and so far it must be admitted great strides have been made in perfecting it, and yet there are many who say that it is not a prime mover to be considered for a vessel of war, and the extensive experiments carried on by quite a number of builders are pronounced by Mr. Richardson "wholly negative."

The steam turbine stays to the fore and various makes are now being tried out, and the usual brisk controversy as to respective merits in a merry war of words is going on concerning them. Which type will be found most effective when all things are considered for navy work is a question which time must answer, but that great improvements may be looked for is beyond doubt. Yet there is a decided tendency not to look upon the reciprocating engine as quite as dead as many have supposed to be. Geared turbines are now being tried, and before the next Annual is printed we should certainly know something absolutely as to the final cost of installing, keeping up and running turbines with reducing gear.

Oil burning is a success beyond any question, but there seems to be a little nervousness as to a possible serious advance in the cost of oil fuel, and that its wide distribution from the various ports of the world will not be rapidly increased.

There seems to be a strong set towards larger guns of a single caliber for ships. The question can be settled finally only after actual warfare, and even then there would be the unconvinced. The gun must be coupled with accuracy of fire, and no one questions the result of an engagement if a large percentage of hits can be made by the large guns. But this accuracy of fire can only be made possible by an increased precision in the range finder, and evidently there is great room for improvement in this instrument, and it seems to us that on its further refinement and perfecting rests the settlement of greater range and heavier weapons.

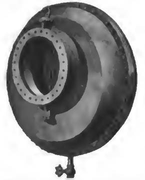
The torpedo does not come in for as prominent a place in weapons of attack as it did years ago. It seems now to be more a weapon of last resort for defense, as is the use of the ram. Still there has been a great increase in the range of torpedoes and a great increase in the accuracy of fire, and, of course, these facts will have a reviving effect on this weapon, and we are inclined to think that its very presence makes towards nervousness, and that most sailors would feel more at ease in an engagement if they knew that there was absolutely no possibility of a torpedo attack.

ENGINEERING SPECIALTIES.

Separators in Connection with Live and Exhaust Steam.

The old idea of prevention instead of cure works out very well in mechanics, and it is a wonder why a steam separator is not just as much a part of all steam systems as is the pipe itself. To prevent the many ill effects of uncontrolled steam is worth while

The Cochrane separator made by the Harrison Safety Boiler Works, Philadelphia, Pa., has been long enough before the public to thoroughly prove its value as a preventor of trouble in steam plants. People seem to forget, or at least fail to recognize, that by use of the separator smaller steam pipes may be used with the corresponding advantage of less first cost and



less radiation, which is not a momentarily expenditure, but the source of constant and unnecessary waste, and, further, by its use a less cost of upkeep is to be met, as the water hammer is greatly reduced, and when it does occur it is far less destructive.

This article can be used with the reciprocating engine advantageously, and even more so on steam turbine plants. There is a pretty general idea that a steam turbine is absolutely free from all possible troubles, that there is no trapping of water or knocking off cylinder heads or anything of that kind, and that it can be run with steam of any kind. Steam mixed with oil or water is extremely disadvantageous to steam turbines, and on this account the use of a separator is of great importance.

Ship Furniture in Steel.

The Art Metal Construction Company, Reneo, 26 Holborn Viaduct, London, E. C., is making a specialty of metal furniture and fittings for use on board ship, eliminating wood entirely. Our illustration gives an idea of the neat appear-

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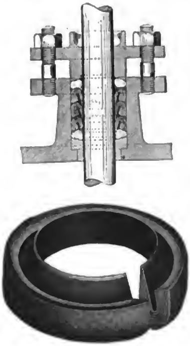
ance of this product. There is no question as to the added safety in case of fire, both in naval and merchant ships. The weight, which one would suppose would be excessive, is not greater than the ordinary construction. There is no swelling and sticking of doors or press drawers, or the annoying

creaking of wooden partitions in heavy weather. The doors are built hollow and filled with asbestos, thus adding to their fire-resisting value.

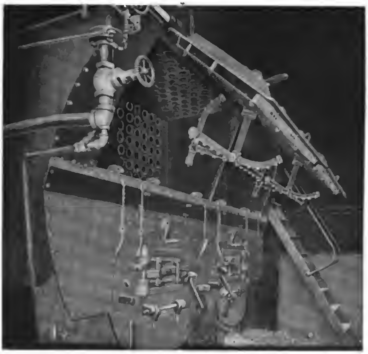
Automatic Piston Packing.

The H. W. Johns-Manville Company, New York, has secured control of the American rights to the well-known English packing called Sea Rings. The general style of this packing is shown in the accompanying illustration. It consists of a wedge of laminated asbestos, flax or duck turned over upon itself. The rings are believed to be entirely automatic, and to give satisfaction under all sorts of conditions. They exert no pressure on the rod except when there is a tendency of leakage past them, and the pressure exerted is never more than what is required to suppress leakage. The rings are designed to withstand temperatures up to at least 600 degrees F., and work on horizontal as well as vertical rods. Although intended especially for marine engines, these rings can also be used on pumps, air compressors, hydraulic machinery, etc. They are recommended highly where superheated steam is used.



A New Front End Soot Blower for Marine Boilers.

The "Diamond" Power Specialty Company, of Detroit, Mich., are again in the front with a brand new type of soot blower which is especially designed for marine boilers. The general construction of this blower, as will be noted from the illustration, is such as to have the blower attached to the smoke-box door in such a way that when the door is opened the entire blower mechanism is withdrawn, thus leaving the boiler end entirely free for repairs, inspection, etc. Another important feature is the fact that the blower can be operated from the outside. This is done by means of the handle which controls the oscillating motion of the arms. These arms are fitted with jets in sufficient quantity to thoroughly cover each tube end, and in the swinging motion the outside tubes, which are most frequently neglected, are specially favored. Attention is also called to the fact that the cross-arms permit of cleaning both the air tubes and fire tubes at the same time. Where it is desired to install this blower on boilers already in use, and where it is not deemed advisable to have special hinges furnished, the pipe line connection is slightly changed whereby it crosses below the door instead of above. This makes a union necessary which may be broken when the door is to be opened.



Considerable interest is shown in the question of loading and unloading ships and providing facilities at terminals for this work, and the question is one which has had closer attention on the lakes than on the sea coast, for the reason that bulk cargoes are general there, consequently are far easier to handle, but coast conditions demand different treatment. There is certainly a very large volume of business awaiting handling-apparatus builders, and we are surprised that several appliances, which are already on the market, are not more speedily adopted, as they long ago have passed the experimental stage, and their installation is not exceedingly expensive.

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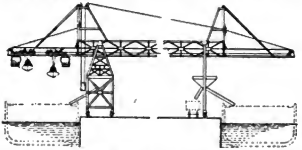
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

994,004. APPARATUS FOR ELEVATING, TRANSPORTING AND DISCHARGING MATERIAL. NIKOLINE JOHNSON, OF MILWAUKEE, WIS., ADMINISTRATIX OF OLE JOHNSON, DECEASED.

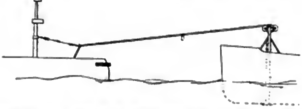
Claim 2.—An apparatus for elevating, transporting and discharging material, comprising a track, a carriage provided with a material holding receptacle adapted to travel on said track, a cable connected to said carriage and extending in the direction of the line of travel of said carriage, another carriage mounted on said track and provided with a material holding receptacle, and a cable connected to said last



mentioned carriage and extending in the direction of the line of travel of said carriage, both cables extending substantially parallel with relation to each other for a certain distance and each cable also extending in the direction of the line of travel of said carriages beyond the carriage other than the one to which it is connected. Forty-two claims.

994,171. CARGO-HANDLING APPARATUS. ONOFRE LINDSAY, OF VALPARAISO, CHILE.

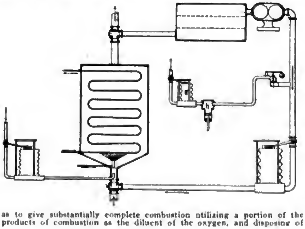
Claim 2. A cargo-handling apparatus, comprising a cableway having one end fixed and the other end movably supported, a counter-



poise releasably connected to the said other end, and an endless haul rope engaging the counterpoise and the said fixed end. Eighteen claims.

994,407. PROCESS FOR UTILIZING STEAM ENGINES FOR THE PROPULSION OF SUBMARINES. GEORGE FRANCOIS JAUBERT, OF PARIS, FRANCE, ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY.

Claim 1. The method of supplying motive power for the propulsion of submarine vessels without disclosing their position, which consists in generating steam by heat resulting from the combustion of a mixture of diluted oxygen and hydrocarbon vapor in such proportion

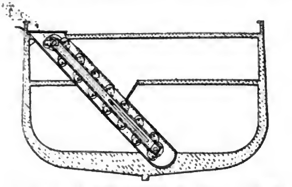


as to give substantially complete combustion utilizing a portion of the products of combustion as the diluent of the oxygen, and disposing of the remainder of the products of combustion by condensation of the water vapor and absorption of the carbon dioxid. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

1,785. DISCHARGING ELEVATOR. J. C. TRAINOR, DUNEDIN, NEW ZEALAND.

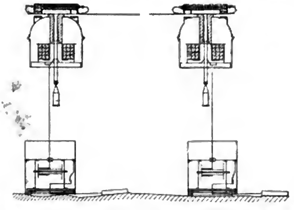
By this invention the elevator is arranged to pass through the various holds and has a casing composed, on its upper side, of slidable doors. The hatches are free for any cargo not lifted by the elevator. Material can be brought to the main elevator by supplementary elevators. An ordinary bucket ladder is used having the bottom tumbler fixed, but the upper part slides out telescopically and is also hinged so as to project



over the bulwarks. The elevator is intended for "colliers" or other ships that carry suitable cargo. It works freely under any cargo, and by moving away any of the removable covers any hold may be emptied in any order desired. In ordinary elevators it is usual to lower the material to the bottom, so that all is lifted the whole height, but here the material is lifted from the top only of each hold, so that much less power is needed in consequence.

12,733. SUBMARINE MINES. VICKERS, SONS & MAXIM, LTD., AND G. E. ELIA, LONDON.

According to this invention the mines are arranged in a row, each being joined by a cable with an adjacent mine and provided with means whereby, when a vessel strikes the cable joining two of the mines, each mine is separated from its outer adjacent mine, so that only the two mines are displaced. When a vessel strikes the cable between two of the mines the cable is pulled and one of the strikers is retracted by means of the ropes; the tension on which then increases until a pin joining the stem with the head is sheared, and each head is impelled forward by its spring and fires the cap of each charge of the projectiles.



These projectiles are then forced through the discs, cutting the cable and ropes at the outer side of each mine, and admitting water to flotation chamber. The casing, containing the detonator and the firing gear of each mine being mounted on the cable by means of a pulley, now drops until a union, which joins the rope to the cable, meets the pulley and prevents the casing becoming detached. This casing is then drawn upwards into a passage; separates this chamber from the anchor by operating a detaching device and finally, by coming into contact with the bush in the passage, causes a striker to be retracted until the tension shears a pin connecting the stem with the head, whereupon the latter fires the detonator, which in turn ignites the bursting charge contained in the flotation chamber.

6,235. PORTABLE VENTILATOR FOR SHIP'S SIDE PORTS. H. HARPER, BELFAST.

This consists of a plate of wood, glass, etc., having on each side, just below the center and near one end, a hinged piece which can be opened out for securing the plate to the sides of the porthole or window, so that it may project vertically from the ship's side and at right angles with it a sufficient distance to catch the wind. At one end of this plate there are projections to prevent it from being forced out of the porthole. When the wind is ahead it strikes upon this plate, passes into and around the cabin and out on the other side of the plate, thus ensuring a continuous current of pure air under these adverse conditions.

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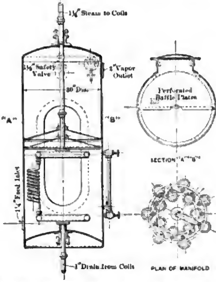

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TRADE PUBLICATIONS.

AMERICA

Packings are described in a handsomely illustrated catalogue published by the Mechanical Rubber Company, Cleveland, Ohio. The latest publication of this company consists of section "D" of their loose-leaf catalogue, and the advantages of having a catalogue in this form are stated to be facilty of enlargement and timely correction, because the rapid increase of uses of forms, stocks and sizes of articles in all departments which make a complete line of mechanical rubber goods are such that permanently bound books cannot be authoritative for more than a very short time. The Mechanical Rubber Company makes packings for every conceivable purpose, and copies of their publications, which will be sent free to any of our readers who will mention International Marine Engineering, should be in the hands of every engineer.

Tobin bronze is described in a catalogue published by the Ansonia Brass & Copper Company, 99 John street, New York. Among the various uses for which this bronze is said to be especially suited in the marine field are pump piston rods, yacht shafting, rolled plates for rudders, condenser tube sheets, seamless tubing for condensers, deck bolts and ship fastenings, pump linings, bolts, nuts, screws, rivets, etc. "Tobin bronze is a combination of copper with other metals. When rolled hot it is remarkable for its high elastic limit, tensile strength, hardness and uniform texture. Its tensile and transverse strength is the same as ordinary mild steel, and it is adapted for a variety of purposes where a strong, non-corrosive metal is required. When used in the form of rolled plates, bolts and rivets in contact with salt water, it has given most favorable results. When finished it has a bright golden color."

Centrifugal pumps are the subject of catalogues just issued by the Goulds Manufacturing Company, Seneca Falls, N. Y. "Guided by many years' experience in all branches of centrifugal pump work, we have combined in the Goulds new reliable, single-stage centrifugal pumps all the details which must be employed to produce thoroughly high-class machines. The pumps are so designed that the total head pumped against and the quantity of fluid handled can be varied considerably without affecting the mechanical efficiency. The standard single-stage, single-side suction, horizontal shaft centrifugal pump, known as Fig. 3,000, is arranged for belt drive by means of pulley. In many cases preference is given to direct-connected units, and therefore it is possible to arrange these pumps for direct connection to electric motors, steam engines, steam or hydraulic turbines. Direct-connected units are provided with rigid or flexible couplings as conditions demand."

Marine engineering specialties are described in an illustrated catalogue issued by the Jerguson Gage & Valve Company, 88 Broad street, Boston, Mass. Among the leading specialties made by this company is a reflex water gage for use on marine, locomotive and stationary boilers, separators, tanks, etc. "The water appears black and the steam space white. This effect is obtained by grooving the glass. The reflex gage assures quick and accurate reading of the water level, as the water always appears black, and white indicates immediately the absence of water; this feature is a guard against boiler explosions. They are safe at the highest pressures and are protection to workmen, as the glass does not fly when disabled, rendering protecting devices, such as wire netting, etc., superfluous. They also save loss of time and annoyance replacing broken tube glasses. Repairs can be made without disturbing the connections, and they can be easily applied to any boiler without change of fittings. Look at an ordinary glass tube gage when full of water, and when empty, and you will find that one cannot tell if it is empty or full, rendering serious mistakes possible. The reflex gage will always appear black when full of water, and white when empty; no mistake possible. The reflex gage involves a simple and fundamental principle of the law of optics, namely, the total reflection of light when passing from a body of greater refractive into one of less refractive power. When grooves are cut at the proper angles into the surface of the glass all light from the vacant space back of the glass will be eliminated. At the same time the passage of light through that portion of the grooves covered by the water or other liquid in the gage is permitted. Thus a sharp, clear line will mark the height of water above which the air or steam space has a bright, silvery appearance, while the water takes the color of the background in the chamber, and as black is selected for contrast, the presence of water in the gage is always indicated by black and the steam or air space white."

When writing to advertisers, please mention International Marine Engineering.

Stockless anchors are described in a catalogue issued by the Baldt Anchor Company, Chester, Pa. These anchors are made of the finest quality of open-hearth steel, and are extensively used in the United States navy for vessels of all types.

Pop valves and steam gagea are described in illustrated catalogues published by the Ashton Valve Company, Boston, Mass. These valves and gages are guaranteed to be of the finest quality and to give unequaled and perfect satisfaction. "They have been the acknowledged standard for thirty-five years."

Lap-welded steel pipe is the subject of a bulletin published by the American Spiral Pipe Works, Postoffice Box 485, Chicago, Ill. The manufacturer claims that, due to its method of welding and annealing, its pipe has remarkable strength, and is especially suited for gas, vacuum and high-pressure hydraulic work where absolute tightness is essential.

A pneumatic flue welder and swedger is described in a catalogue published by the Draper Manufacturing Company, Port Huron, Mich. This double-cylinder welder is said to be especially adapted for railroad work. "A 2-inch flue can be welded and swedged in about five seconds with one heat and with a perfect weld, smooth and even, and leaving the flue an even thickness."

Valves of many kinds, unions, flanges and packings are among the great variety of marine specialties published in catalogues issued by Crane Company, Chicago, Ill., Circular No. 79 deals in part with the merits of cast steel as compared with forged steel flanges, and the statement is made that there is no question that either cast steel or forged steel flanges have abundant merit and are equally satisfactory for all purposes for which they are regularly used. Crane Company has made tests to determine the physical properties of each, and the results are given in this catalogue.

"The Plant and Its Products" is the title of a handsomely illustrated pamphlet of 48 pages, published by Pawling & Harnischfeger Company, Milwaukee, Wis. The pamphlet states that this company's plant is probably the most modern and complete in the world for the building of traveling electric cranes. It was erected in 1905, and with its storage yards, railroad sidings, etc., occupies a tract of 20 acres. The main factory building is 414 by 360 feet, and all of the buildings, with the exception of a pattern storage, are of steel with brick walls and saw-tooth roofs.

Catalogue 16, published by the Standard Tool Company, Cleveland, Ohio, describes among other tools two reamers that the manufacturer recommends for heavy boiler work. "They are splendid tools for use in pneumatic holders, and are furnished with taper shanks and squared shanks, carbon and high-speed steel. The points are tapered to facilitate entering the work, and the flutes are wide enough and deep enough to have plenty of chip room. Send in a trial order for some of these reamers. Like 'All Shield Brand' tools they are guaranteed—you can't lose."

"3,000 degrees of heat cannot fuse this firebrick cement" is the statement made in a catalogue by the H. W. Johns-Manville Company, 100 William street, New York, regarding J-M high-temperature cement No. 30, which is used as a binding material in firebrick structures, and is said to absolutely prevent their collapse when subjected to excessive heat. This cement is especially recommended for setting up firebricks; for setting up and fixing side walls and bridge walls of boilers, furnaces, etc. The company claims that it saves at least 50 percent in maintenance cost, and that it is far superior to fire-clay and similar materials.

A process for treating iron and steel to prevent rust is described in a booklet published by the Eastern Rust Proofing Company, 224 Third street, Long Island City, N. Y. "As the subject of the prevention of rust is of great importance to all manufacturers, dealers in and users of iron and steel, and as we know we have the best and cheapest process for its prevention, we respectfully hereby ask that you carefully peruse the facts set forth in this pamphlet, and thereafter give our process such investigation as you may desire in order to verify the statements we make therein. This you may do by personally visiting our offices, where we have numerous samples of our work on exhibition, the larger portion of which were treated over two years ago, some of which have been (during such period) constantly in the open air subject to the action of the elements and the salt sea air; by coming to our furnaces and seeing a demonstration, or by sending us samples of your product for us to treat in order that you may make your own tests; either one or all three as you may desire."

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SEPTEMBER, 1911.

SIDE-WHEEL FERRYBOAT SAN PEDRO.

The *San Pedro* is a steel double-ended side-wheel ferryboat owned by the Atchison, Topeka & Santa Fe Railway Company, built by the Union Iron Works Company in San Francisco, Cal., under the supervision of Robert Forsyth, consulting engineer, 1020 Merchants' Exchange, San Francisco. The contract for the vessel was let April 27, 1910; she was launched Feb. 1, 1911, and went into commission May 15, 1911. The *San Pedro* connects the Atchison, Topeka & Santa Fe Railway system at its terminal, "Point Richmond," with the ferry depot at foot of Market street, San Francisco, a distance of about 7 miles, and is fitted up for the conveyance of passengers, baggage, mail and express matter. The dimensions of the boat are as follows:

Length over guards	259 ft. 6 ins.
Length outside of rudder posts	248 ft. 6 ins.
Beam molded	36 ft. 0 ins.
Beam over guards	64 ft. 0 ins.
Depth molded at side mid-length	18 ft. 0 ins.
Depth molded at center mid-length	18 ft. 6 ins.
Displacement	1,353 tons.
Total number of passenger seats	782

The vessel is divided into compartments by seven bulkheads, as follows: Two peak tanks to carry fresh water, two holds, one compartment with fuel oil tanks in hold and restaurant with kitchen 'tween decks, one compartment with fuel oil tank in hold and crew's living quarters in 'tween decks, one compartment for engines and one compartment for boilers.

The main deck has through passage for teams and seats for 168 passengers. It has entrances to holds, restaurant and living quarters of the crew, which are below the main deck; also steel enclosures to the machinery and boiler spaces. Men's toilet rooms are located on each side of the vessel, with crew's wash room, lamp room, mates' store rooms, room for steward and a bar room. Steam steering engines are on this deck directly under each pilot house; a combined hand and steam capstan is on each end of the vessel on this deck outside of the deck house.

The upper deck is reached by two corner stairways at each end of the deck house. Entrance to the saloon is through two large sliding doors. The saloon is enclosed for 96 feet in length, the middle portion is enclosed out to the side. The floor is covered with magnesite composition of a terra-cotta color matching with the mahogany of the seat, and is well filleted at outer edges, giving a very sanitary floor. The toilet room for ladies is on this deck. Seats outside are provided for about 180 passengers at each end; a longitudinal bulkhead, well glazed, gives the required protection to passengers who prefer the open air.

NEW SIDE-WHEEL FERRYBOAT FOR PASSENGER, BAGGAGE, MAIL AND EXPRESS SERVICE.

The amidship part of the saloon has a dome of 98 feet by 31 feet, rising vertically at sides about 28 feet, where it is fitted with art glass. The roof is formed by pleasing double curves, giving an airy, roomy and pleasing appearance to the whole. The finish of the saloon is white with a little carving touched with gold, mahogany polished seats and window sashes, and the floor, toning well with mahogany, gives a very attractive appearance.

On each end of the hurricane deck is placed a pilot house, 12 feet by 12 feet, fitted with steam and hand-steering gear, telegraphs, electric call bells and speaking tubes to the engine-room, electric call alarms to crew's quarters and main deck, electric communication between each pilot house, and speaking tubes to the main deck, whistle pulls, searchlight controller, engine revolution tell-tale, and a switchboard specially arranged to cut off any lights that may interfere with the vision of the navigator.

Immediately adjoining the pilot house are the officers' rooms.

The machinery of the *San Pedro* is as follows:

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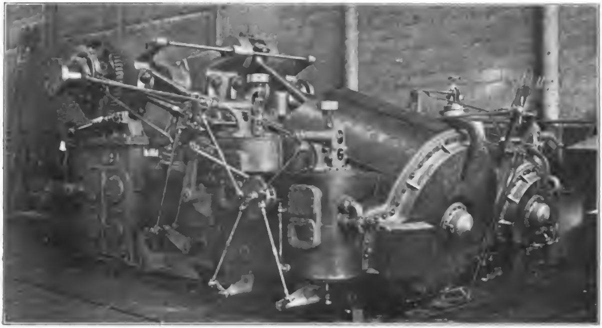

DIAGONAL COMPOUND ENGINE OF THE SAN PEDRO, SHOWING THE ARRANGEMENT OF VALVES.

Diagonal compound engine	38" — 77" x 66" stroke
Indicated horsepower	2,000
Condensing surface	4,000 sq. ft.
Feathering wheels diameter to center of floats	16' 0"
Size of floats	10" x 8' 6"
Number of floats	8
Babcock & Wilcox water-tube boilers	4
Total heating surface	9,332 sq. ft.
Working pressure	150 lbs. per sq. in.
Fitted to burn oil fuel.	
Circulating pump engine (runner 12")	10" x 10"
Reversing engine	[illegible]" x 22½"
Turning engine	7" — 7" x 6"
Two electric light engines, 25 K. W. generator, from General Electric Company	9½" x [illegible]"
Two steam capstans	7" — 7" x 8"
Two steam steering engines	8" — 8" x 8"
One Dow air pump, walking-beam type	20" dia., air; 12" dia., steam; 12" stroke
Two Dow fresh-water feed pumps	10" — 6" x 18"
Two Dow fresh-water feed pumps, horizontal duplex, with automatic control	3" — 3" x 3"
One Dow fire and bilge pump, vertical	12" — 10" x 12"
One Dow sanitary pump, vertical, with automatic control	6½" x 6" x 10"
Two Dow oil pumps, horizontal duplex, with automatic control	6" — 5" x 10"
One Metropolitan injector for boiler feed	2"
Six ejectors for draining bilges	1½"
One feed-water heater, with 400 sq. ft. of heating surface	1" x 8' 0" copper tubes
One feed and filter tank.	
One steam separator in engine room	3' x 9'

All steam pipes, feed pipes and sea connections are of copper. Auxiliary exhaust, bilge, fire main and fuel oil pipes are of galvanized iron.

The main engines are fitted with poppett valves operated through the usual Stevenson reversing links, the admission valves having the cut-off trip operated by a third eccentric, while the variable adjustment of the cut-off point is conveniently controlled by levers on the working platform. The whole arrangement is very satisfactory and suitable for ferry service where prompt reversals are necessary. Oil fuel tanks have a total capacity of 10,000 gallons.

The *San Pedro* is a highly satisfactory ferry, very complete, very pleasing to travel upon, and makes quite an attractive addition to the already great equipment of the Santa Fe Railway system.

Mr. Henry M. Seeley has been appointed steamboat inspector for the port of New York.

Curtis Marine Steam Turbines for the Italian Scout Cruisers Nino Bixio and Marsala.

The Fore River Shipbuilding Company, at Quincy, Mass., has just shipped from its works to the Officine Meccaniche, Naples, Italy, three of six Curtis turbines for the Italian cruisers *Nino Bixio* and *Marsala*. The turbines were loaded at Quincy on the lighter *Commissioner* of the Merritt & Chapman fleet and taken to New York, where they were shipped on the steamer *Perugia*, sailing July 22 for Naples.

Each of the vessels for which this machinery was built has three turbines, each driving a single screw, one on the center line of the ship and two at the sides, as in ordinary twin-screw arrangement. The turbines at 450 revolutions will develop 8,000 horsepower each, and 22,500 horsepower will give the vessels a speed of 28 knots.

The turbines are technically called 80-inch 16-stage turbines; that is, the mean diameter of the rotating drum is 80 inches, and the steam is expanded sixteen times from boiler to condenser. The turbines are extremely simple in construction, no part being in motion except the one main revolving shaft, with its wheels and buckets inside the casing. On the shaft are a series of wheels and a drum carrying at the periphery rows of buckets on which the steam impinges as it passes through from boiler to the condenser. Between each row of revolving buckets are stationary guide buckets, rigidly fixed to the interior of the casing for the purpose of guiding and giving the proper direction to the steam before it impinges on the revolving blades. There is also a series of nozzles disposed between the various stages, with openings so designed as to control the velocity and pressures of the steam in its flow from stage to stage, in such manner that the entire energy of the steam is gradually utilized and absorbed in turning effort as it passes through the turbine from end to end.

For reversing there are wheels with several rows of buckets and nozzles, formed exactly as those just described but with the angle of buckets in the opposite direction, all within the same casing. These wheels are located at the exhaust end of the turbine, and therefore when going ahead simply revolve idly in vacuum. When backing, steam is shut off from the

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head end and turned into the astern end, passing through these reverse buckets, reversing the motion, the turbine shaft turning in the opposite direction and the ahead wheels and drum revolving idly in vacuum.

The thrust of the propeller is taken directly by steam pressure on the end of the drum itself, thus practically eliminating friction. There is a thrust bearing formed directly on the end of the turbine casing to take up the inequalities of thrust, the entire design resulting in one complete self-contained structure.

Each turbine when completed was connected to the test boiler and condenser, run and tested in the shop before shipment. The turbines were fitted complete with valves, piping and fitting for operating, and for drainage and lubrication, etc. The total weight of each turbine was 100,000 pounds, the outside dimensions being 21 feet 6 inches long and 9 feet 4 inches in width.

STEAMERS SOUTHPORT AND WESTPORT.

The Eastern Steamship Company's new boats, *Southport* and *Westport*, were built by William McKie, of East Boston, Mass. Both of these vessels are to be used on the Boothbay division for freight and passenger traffic.

The general view of this vessel shows a ship-shape-looking product. The general dimensions are:

Length between perpendiculars	131 feet 5 inches.
Length over all	138 feet.
Molded beam at waterline	20 feet 6 inches.
Beam outside of guards	29 feet.
Depth amidships top of floor to top of deck beam	9 feet.
Draft forward, loaded	4 feet 6 inches.
Draft aft, loaded	8 feet.
Timber construction	

ONE OF THE MAIN ENGINES FOR THE SOUTHPORT AND WESTPORT.

The engines were built at the Atlantic Works, East Boston, and are triple-expansion, with cylinders 10½ inches, 17½ inches and 28 inches, with a stroke of 18 inches. They run at 200 revolutions per minute. A glance at the illustration will show the design. Each engine is fitted with piston valves on the high-pressure also on the intermediate and low-pressure cylinders. Stevenson link motion is used, also steam reversing gear. Taylor watertube boilers furnish steam at 150 pounds. Each boiler has a grate surface of 58 square feet and a heating surface of 2,150 square feet. The pumps and condensers are all independent. The circulating pump is of the centrifugal type. The boiler feed pump is controlled by means of a float in the filter box. The air pump is of the single-cylinder double-acting type. This has the advantage of light weight and occupying small space.

On her trial trip the *Southport* made an average of 1½ miles over the contract speed of 14 miles per hour. We understand

ONE OF THE NEW STEAMERS BUILT FOR THE BOOTHBAY DIVISION OF THE EASTERN STEAMSHIP COMPANY.

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that the *Westport* did equally as well, showing the excellence of the design.

Special attention is called to the overhang, as shown in the thwartship section. The sponsons were built out 4 feet with special construction. This method of building the sponsons and strengthening them is unusual, and is one of the important features of these boats.

The combination hand and steam steering engines were built by Williamson Bros., of Philadelphia, and the capstan-windlasses were furnished by the Hyde Windlass Company, Bath, Me.

The boats are lighted by electicity, the electric outfits being supplied by the Sturtevant Company, Hyde Park, Mass.

RECAPITULATION OF REPORTS OF TRIALS WITH ANTI-ROLLING TANKS AT SEA.*

With the increased size of the transatlantic steamers one would be led to surmise that the question of sea sickness would not be as serions a subject as in days gone by. Yet anyone who has ever been afflicted with that always ludicrous but frightfully uncomfortable sensation will admit that anything which could prevent it would be received most gratefully by the traveling public.

The efforts that have been made to use an anti-rolling device date back a considerable time. The old *Inflexible* in the early 80's was experimented with, and, if we remember right, several later attempts were made to use the idea of employing free water to prevent the rolling of a ship. Lately Herr Frahm has given accounts of experiments made which seemed to prove very satisfactory. Diagrams taken show a decided gain in the stability of a ship's deck with the anti-rolling tanks as applied to the steamship *Ypiranga*. Undoubtedly such experiments if they prove successful, as they evidently have, would point towards a more stable platform for guns, and consequently the navy would be greatly interested in this set of experiments; and the transatlantic liners seem to have taken up the subject with the hope of decreasing the uncomfortable sensation of sea sickness.

Many conditions must enter into the application of these tanks. "Practically the midship position (we are quoting from Herr Frahm's paper) will be always preferred, because it is the broadest part of the vessel, and besides the yawing of the ship, *i. e.*, lateral sheering under the impetus of cross seas, is less evident here. These sheering motions may possibly diminish the efficiency of the tank by accelerating the movement of the water obtained in cross connection; but this is only likely to happen in a stiff vessel with a high period of frequency, which consequently requires the cross communication to be rather wide. On normal vessels, *i. e.*, not too stiff, the tank may be well placed fore and aft. Instead of only one large tank two or more smaller ones may be employed, placed in different parts of the ship. As to the height above the waterline, no general rule can be established. The best efficiency will be obtained by placing the cross connection above the center of gravity. In this case the hydrodynamical action of the water in the connection will increase the statical action of the side tanks. On the other hand, it would be quite possible to place the connections below the center if the tank can be enlarged accordingly. This increase in size will be small in ships with slow periods, but more important in a stiff vessel with comparatively short periods."

It seems that this question of anti-rolling tanks is being taken up with great interest by British builders, and that several vessels are under construction so fitted. The report is that in one case, in the Bay of Biscay, the steamship *General* was rolling 14 degrees on either side when the tanks were out of action. Then the following experiments were made: (*a*) The smaller fore and aft tank, which was fitted forward, was put in action, with the result that the heeling angles were at once reduced to from 7 to 8 degrees, or practically a reduction of 50 percent. When the after tank, which was a large one, was put in action, the rolling was reduced to 3 degrees in either direction. This certainly shows a most decided gain.

It is asserted in this same article that by calculation it is quite possible to build passenger ships, with the usual high superstructure, up to 130 feet beam, with a draft of 34 to 36 feet, which with the aid of the anti-rolling device will be perfectly steady, the necessary water required being only 1.3 percent to 1.1 percent of the displacement. This, it is claimed, will decrease the traverse stress in the hulls, and improve the steering and maneuvering qualities of the ship, and prevent loss in speed in unfavorable seas.

It is further stated, and this we consider a very great point, that this system of anti-rolling tanks can be fitted without great additional cost into existing ships, which undoubtedly would add to their sea-going qualities. Further improvements are also hinted at, which, of course, would be welcome, and for men-of-war they would be particularly advantageous, as they would dispense with the cross connection. In this arrangement the wing tanks, though specially shaped, and the dimensioned holes in the shell plating have direct communication with the sea. With this form of tank, which in model experiments has given good results, further information will be given, and it is understood that the system will be tried on a large scale very shortly.

In the article from the *Engineer* referred to, Professor Biles asserts that the credit for the use of these tanks belongs to Sir Philip Watts, although since his time great progress has been made, and it was he who first fitted them, we understand, to the *Inflexible*.

It is interesting to note that Sir William White says that the reasons why the system was given up after the trials with the *Edinburgh* and *Colossus* were twofold: "First, the noise and shock on the under side of the deck upon which was the living space, and, secondly, that these ships did not roll heavily under average conditions."

It is rather interesting to note that failures of the past are being made successes of the present in a number of cases, and here certainly is one which illustrates the fact most clearly.

*Abstract from a paper at the Institute of Naval Architects.

Oil Engines and Thermal Efficiency.

While it would be about as erroneous to recommend an engine on its thermal efficiency alone as to entirely disregard it, the fact that the engines with the highest thermal efficiency to-day are in the great minority seems at first thought a peculiar state of affairs. But a careful analysis of all the advantages and disadvantages of each type would show that the general practice is justified.

Credited with a thermal efficiency varying from 38 to 42 percent, the Diesel engine is in this respect ahead of any other internal-combustion motor or gas engine, turbine or reciprocating engine, but its comparatively high cost and maintenance, together with the care necessary for its operation, have stood in the way of its general adoption. Though less efficient, the other types of engines have flourished because they have been produced at a reasonable figure and have comparatively low maintenance charges.

In their desire to produce a successful commercial oil engine, manufacturers have generally not sufficiently considered the most important factor in obtaining the high Diesel efficiency, *i. e.*, compression. As a result the average oil engine is a low-compression engine.

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With the low cost of kerosene (paraffin) and the distillate oils, together with the increasing cost of gasoline (petrol) of poor quality, the possibilities of an improved design of oil engine are many.

It is understood that an oil engine approximating the fuel economy of the Diesel has recently been produced. It is claimed that it incurs a comparatively small up-keep expense, and the selling price per horsepower installed is reasonable. This engine uses a compression somewhat higher than usual, atomizing the fuel mechanically without an air compressor. The results of any tests on these oil engines will certainly prove of decided interest.

GAS ENGINES; THEIR DESIGN AND APPLICATION.

BY E. N. PERCY.

The design of a gas engine is determined partly by the conditions under which it is to operate, partly by limits of facilities of manufacture and very much by the ideas of the local market as to what a gas engine should be like, regardless of correct design. In connection with this it is quite frequent that one finds a local market demanding an open type engine, another with an enclosed crank case. The first may demand solid head engines and the second separate head engines. One market may demand multiple cylinders cast in one piece and the other single cylinders, there being no overwhelming advantages, so far as the writer can see, in favor of any one of these designs but many arguments both for and against same.

Of the technical conditions determining the engine design the more important are amount of fuel to be used, purpose for which the engine is intended, space available, limits of weight, importance of economy, importance of wearing qualities and limits of cost.

FUELS.

Fuels may be summed up generally in two classes: liquids and gases; solid fuels not being as yet directly available for internal combustion engines. Among the liquid fuels might be mentioned crude petroleum and its various products, alcohol and ether. Among the gaseous fuels, or fuels which may be converted into gas, may be mentioned coal, coke, oil residuals and heavy hydrocarbons. In fact any organic substance whatever may be converted into combustible gases by proper treatment, with the allowance and acknowledgment of the fact that this department of engineering is as yet not fully developed.

The first two conditions overtop and determine all the others; the other, in fact, being dependent on fuel and the purpose to which the engine is destined. At this stage of very rapid progress made in the gas engine world, the principal fuels are the various well-known products of crude oil, although gas producers for solid fuels are becoming more and more a recognized factor of the industry.

Oil.—The two greatest classes into which oils divide themselves, so far as the gas engine man is interested, are asphaltum base and paraffin base. The words paraffin base and asphaltum base refer to the hydrocarbon series of which the oil is composed. In paraffin base oils there is less residual and heavy hydrocarbon than in the asphaltum base oil. The asphaltum base oil contains very largely all heavy hydrocarbons of the lower series in which there is a very large proportion of carbon as compared to the hydrogen (*i. e.*, bitumen, pitch, tar, etc.). These compounds, after being heated and after having dissociated the lower constituents, seem very readily, when exposed to severe heat, to change their chemical form, so that a lighter hydrocarbon is given off and pure carbon or even a heavier hydrocarbon remains. This is what happens in all attempts to use crude oil directly in the cylinders of internal combustion engines. That type of engine which seems to have got the nearest to solving this problem has admitted water to the engine cylinders in one form or another, the real result being to break the water up into these compound gases, thus providing more hydrogen for the heavy hydrocarbon; both being in a nascent condition, under the influence of the extreme temperatures they combine and form a lighter and more volatile hydrocarbon, or the hydrogen combines with the free carbon deposit from the heavy hydrocarbon, both forming a lighter hydrocarbon subject to the action of oxygen in the usual manner. However, even this type of engine is only partially successful, inasmuch as it can only make use of certain kinds of crude oil, it being impossible to use any crude oil having foreign material, or even any great amounts of heavy hydrocarbon in suspension, because, in the first place the foreign material makes clinker particles which score the cylinder; second, the heavy hydrocarbons are more or less in suspension and, as solid or highly viscous masses, cannot be sufficiently separated or subdivided by any known method to effect complete combustion, the result being heavy deposits in the cylinders; furthermore, if these same hydrocarbons be subjected to heat in any considerable degree before entering the engine cylinders, it will only result in heavy deposits of carbon or hydrocarbon.

Crude petroleum as it comes from the well is a very complicated substance, and the first physical feature to be taken care of is the sediment which settles from the petroleum. This is usually taken care of at the well and need never be looked out for by the consumer. All the various products of petroleum, benzine, gasoline (petrol) and naptha have a flash point below 73 degrees F., meaning that they have to be heated to more than this temperature to obtain ignition from a match, electric spark or other source. Next come the illuminating oils, such as kerosene (paraffin), white rose and other effervescents, having a flash point of approximately 150 degrees and more than 73 degrees. The next product is gaseous oil or fuel oil, usually used for gas making and also for internal combustion engines. These oils have a flash point of 190 degrees.

Gasolene (petrol), as classified by the Standard Oil Company, has a specific gravity of 76. It is the most common fuel used for small internal combustion engines. It carburets usually at ordinary temperatures, is volatile, yet not so much so as to make it uncontrollable; while its heat value is less than that of the heavier hydrocarbons it is more cleanly and more highly standardized. On account of its volatility it is more dangerous than the heavier hydrocarbons, and every precaution should be taken when handling it.

Alcohol has many of the carbureting characteristics of kerosene (paraffin) and its distillates, and when used under proper conditions with heated air or heated carburetors it is a useful and cleanly fuel and much safer than gasoline (petrol).

The use of any liquid fuel in vaporizing carburetors of hydrocarbon engines, either by injection or carburetion, is limited; first, because only comparatively highly-priced fuels can be used, and second, because the tendency to pre-ignite with the heat of compression prevents the use of such economy as might result from having a high compression. It should be explained at this point that the hydrocarbons and their vapors in themselves do not have a tendency to pre-ignite more easily than the principal gases from producers or other sources, but with liquids or vapors it is not possible to furnish readily and continually a mixture weak enough to be perfectly safe under conditions of high compression, whereas with weak producer gases and gas where the calorific value is not too high it is easily possible to maintain a weak economic mixture capable of standing high compression without pre-ignition; in fact, with weak producer gas and proper design it would not be possible to have a dangerous pre-ignition. With carbureted vapors, or the spray of liquidated hydrocarbons, it is possible to pack into a cylinder of an engine so great an amount of fuel that the heat generated from an explosion can be quite dangerous if the compression is too high.

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On the other hand, with a gaseous fuel, the volume occupied is so great that it becomes a real problem to get sufficient fuel into the cylinder to maintain an equal amount of power; as a matter of fact, a given size engine operating at a definite speed will give about 20 percent less power than with the vapor or spray of liquid hydrocarbon. Furthermore, the gaseous fuels prove somewhat slower than the vapors, requiring a longer stroke, less piston speed and an additional time.

Hence, from the above facts, it is a simple deduction that for large economical power we must look to the gas and not to the liquid hydrocarbon engine. It is probable that this engine will be of a little slower speed and somewhat heavier than the engines in use to-day, but, at the same time, it is hardly likely that it will resemble the ponderous engines used in Germany and in some parts of America.

Gases.—In general, so far as the gas engineer is concerned, gases will divide themselves into two classes, weak gases and strong gases. Among the strong gases are the natural gases, as fine illuminating gases, acetylene, water gas and gases especially made by retort methods. In general, these are either hydrocarbon gases or carbon in composition with some element other than oxygen. These gases may run 500 British thermal units per cubic foot; some run slower. Weak gases include producer gas, blast furnace gas by process of coke ovens, waste products of gas works, metallurgical furnaces and other less common sources. These gases run from 100 to 125 British thermal units per cubic foot and are more or less diluted with inert gases or non-heat producing gases. All of the strong gases, when considered as fuel for large engines, are expensive and impractical either because, as in the case of natural gas, they are confined to a locality or because the processes for making are cumbersome, or because so much of the heat value is driven away in by-products in the form of coke, tar, etc., thus eliminating them from further consideration as fuels for gas engines on a large scale. Of the strong and weak gases it has been practically proved that the weaker gases are both thermally and commercially more efficient than the strong gases. It is understood that this efficiency includes the thermal and commercial efficiency of the plant manufacturing them. Of the weaker gases blast furnace, coke-oven by-products are confined to particular localities and are valuable fuels when they can be procured and can be used successfully in any producer gas engine, with slight changes; hence we will consider all gas engines in their relation to the gas producer exclusively and local hydrocarbon engines in their relation to gasolene (petrol), kerosene (paraffin), and the distillates only.

GENERAL AND COMPARATIVE FEATURES OF DESIGN.

For a description of each of the many gas engines in common use and for a history of the industry, the writer refers to Grover, Donkin, Clerk, Methot and others.

Of the various cycles in use the most predominating one is the four-cycle, four-stroke engine taking in a charge of fuel and air mixed, vaporized by the engine, but exploding same within the cylinder after combustion and ignition. Ranking next in popularity is probably the injection type, which, from the nature of its cycle, is confined to liquid fuels, these being sprayed directly into the cylinder by various methods. Special types of this cylinder include the Diesel, which compresses to 800 pounds or more, igniting its charge by the heat of compression, the jet of oil being cut off by the governor at various points in proportion to the load carried. Other injection engines ignite with hot tube or incandescent globe or flame.

The two-cycle engine is made in many forms, the aim being to obtain an explosion at every revolution. As all injection engines other than the Diesel are confined to the lighter distillates, they cannot be seriously considered in connection with large powers of the future because of the prohibitive cost of distillate in any form.

Two-cycle engines, as at present constructed, are inefficient mechanically because of wide ports, piston rings that are not tight and faulty lubrication. They are uneconomical because of fuel leakage and mixture of fuel with the out-going air. The present accepted type of engine of any cycle for ordinary purposes is of the vertical or horizontal design, with trunk piston, internal piston pin and single-acting cylinder. There may be one or more cylinders governed by much the same conditions as in the steam engines, the best practice calling invariably for the four-cycle, four-stroke type; a little more advanced type of engine equally successful in every way is found with a double-acting cylinder exploding on both ends. This type may now be found doing good service in all parts of the engineering world. For power purposes these cylinders are usually arranged tandem throughout; two, three or four in a row connected up by the very heaviest construction, the details of which will be considered later.

The lighter vertical, high-speed type of the double-acting engine is also built. Both of these types resemble steam engines very much, inasmuch as they are double-acting, having cross-head with all moving parts in full view, there being no external leakage of gas, smoke or odors, and the external moving parts are lubricated in a clean manner without the usual leakage of oil or soot from above. It is quite probable that the gas engine of the near future will follow mechanically along the design long ago found most practical through steam-engine practice, the double-acting engine giving twice the power for practically the same weight of material, and the cost and fuel consumption being less than for two engines of the single-acting type and being more economical because the cylinder walls are hotter at the ends of the expansion stroke.

There is no doubt but that new cycles are not only possible, but probably will soon be recognized. In connection with this reference should be made to the able paper, Evolution of Internal Combustion Engines, by Prof. Reeve, published in the Transactions of the A. S. M. E., in December, 1907. In this paper are ably shown the thermal dynamic possibilities of several possible cycles, including the outside compression type of engine, in which the fuel may be burned either within the cylinder of the engine or between the compressor and the engine. In this valuable paper are given further the proper sizes of compressors and engines for various specified conditions which are quoted in Table 1.

Prof. Reeve notes in connection with his various calculations that for an outside compression cycle with combustion between the two cylinders under the normal conditions of operation about four-tenths of the gross power developed would be necessary to operate the compressor. It is doubtful whether much less than this amount of power is consumed by the horizontal four-cycle engine when all things are taken into consideration. Assuming that the engine was supposed to develop from 160 to 200 horsepower, and that the compressor's resistance was about 67 horsepower, the table shows the various net horsepower delivered for the various powers developed. This valuable paper gives much more information in relation to the ratios between compression and explosion for the various cycles and the probable losses for various prospective cycles.

TABLE 1.

MOTOR'S POWER.	COMPRESSOR'S RESISTANCE.	NET POWER DELIVERED TO SHAFT.
Horsepower.	Horsepower.	Horsepower and Percent of Rating.
200	67	133
167	67	100
133	67	66
100	67	33
67	67	0
33	67	—34
0	67	—67

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It is not the purpose to make any profound study of thermodynamics; still, it is advisable to point out in a practical way the limitations of the various cycles. In the first place, all known objects, conditions, states and elements have two factors through which we study them; the first being their quantity, amount or mass; the second being their state, tension or pressure. Thus in a solid object we have mass and density. With electricity, which is a condition, we have amperage, measuring the amount or mass of that condition, and voltage, measuring its tension and pressure.

Heat being also a condition instead of a substance, we measure its tension or temperature in degrees, and the mass or amount in British thermal units or other suitable unit. Temperature is a familiar term, but the amount or mass of heat is something to which particular attention must be paid; for instance, despite the tremendous temperatures of the gases during and after explosion in a gas engine cylinder, they will collapse, as noted by Prof. Reeve, when introduced into a second cylinder for the purpose of compounding. In fact, it is almost impossible to remove these gases from any chamber into which they are exploded by any practical means because of their immediate collapse, and yet steam, at a much lower temperature, may be led into two, three, four and five cylinders successively, doing its work there and retain energy.

Simple calculations, based upon the well-known properties of steam on the one hand and upon the amount and calorific value of the fuel in the gas engine on the other hand, will show that with the cylinder first filled with gas and secondly filled with steam for the space of one stroke, the usual amount of heat escaping from the gas into the water jacket, the steam will have more heat value than the body of gas. The reason for this is that the heat of the steam has breadth or mass; while the heat of the gas has only height or temperature. It is a common thought for the non-scientific engineer that the latent heat of water to steam is lost, an idea which is entirely erroneous, as this heat, while not expressed in temperature, is expressed as mass or entropy measured in British thermal units, and gives the steam the power to expand without collapsing. Hence we can easily deduct that it is impossible to invent any cycle in which combustion or expansion do not take place in the same chamber, unless some means are adopted whereby the temperature of the gases may be reduced and their heat mass expanded in the same proportion. The advantages will be, first, less loss because there would be less difference in temperature between the gases and the walls confining them; second, it would in all probability be possible to reduce the gas to such a temperature that it would not be necessary to cool the walls of the expanding cylinder; third, as the heat mass of the gas body is increased it would be possible to lead it through two or more cylinders for expansion or even through a gas turbine.

A practical objection in connection with new cycles, or the outside compression type of engine, is the enormous compressor required.

With the gas engine, as with all other machinery, the most valuable feature of its existence is practical development, the theory always being far in advance of the actual commercial development; an engine of any cycle or design being a really valuable machine only when it has eliminated the usual troubles of an experimental engine. This being of primary importance, we come to the secondary considerations of economy and technically correct design.

After settling upon the horsepower of an engine the next decision must be the bore and stroke. These bear various proportions to each other and to the horsepower depending upon the piston speed, revolutions per minute, type of engine, compression, wearing qualities, pressure generated and temperature. The piston speed varies widely and may be taken in general as follows:

	Feet per Minute.
Automobile engines	600 to 1,000
High-speed motor boat and light two-cycle engines	600 to 800
Heavy marine engines of the latest practice for tugboat and heavy work, less than 100 horsepower	400 to 600
Marine engines of the heaviest type, 100 to 1,000 horsepower	300 to 500
Commercial horizontal stationary engines	400 to 700
Stationary horizontal engines of the most solid and conservative type of several hundred horsepower or more, three, four and five stroke	600 to 900

Piston speed considered separately from reciprocation is purely a matter of lubrication, and with proper cooling, improved lubrication apparatus, etc., these values may be greatly exceeded, but they represent present practice.

The relation of power and stroke to each other is dependent upon revolutions per minute, combustion and fuel used.

Liquid hydrocarbons and the strong gases being quicker burning and more easily ignited require shorter stroke, less combustion and more revolutions. The weak gases being slower burning and less easily ignited require longer stroke, greater combustion and a less number of revolutions. Thus, in regard to bore and stroke the engines may be divided into two classes, the quick-running hydrocarbon engines and the slow-running gas engines. Of the various engines we have the following table, showing ratios of bore to stroke:

TABLE 2.

Style of Engine.	Bore.	Stroke.
Automobile	1	1
Commercial gasoline and oil	1	1¼ to 1¾
Heavy gas engines	1	2 to 4

Having approximated the piston speed and the ratio between bore and stroke, and having decided upon the type of engine, its wearing qualities, whether it is to be high or low speed, and so forth, the horsepower and compression must be settled upon simultaneously. For purposes of design, the strain which the maximum compression generates usually is taken at three and one-half times the maximum compression pressure.

In the design of gas engines and the distribution of metal it is very necessary to take into account the temperatures to which the parts will be subjected and explosions to be expected. With short cylinder, high-speed engines of comparatively small power, the cooling effect is so great that, with a fair amount of jacketing, no trouble need be looked for; but, with long cylinders, large diameters and the consequent high temperatures, it is easy to forecast that the cylinder body will become heated enough to fracture the surrounding outer jacket unless it is left free to expand.

HORSEPOWER.

There are several methods of arriving at the horsepower of a gas engine, but, in any case, it is much more difficult than with a steam engine. Naturally the old steam engine formula,

$$\frac{PLAN}{33{,}000} = \text{horsepower},$$

applies in the case of the gas engine, provided a person carefully remembers that N is equal to the number of explosion strokes only. However, it is almost impossible to obtain a correct indicator card from the gas engine, partly because of the violence of the explosions

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TABLE 3.

Type.	Bore.	Stroke.	R. P. M.	Cubic Feet of Mixture per Minute.	Brake H. P.	Mean Pressure.	Cubic Feet per H. P.	Compression.	Fuel Used.	Amount per H. P. per Hour.
	Inches.	Inches.								Gallons.
Four-cycle, two-cylinder, vertical	6	10	282	45 7	16 8	90 4	2.72	67 5	Gasolene	.16
			285	46 25	18 8	91 6	2 46	67 5	Alcohol	.21
			286	46 40	18 4	86 1	2.52	87.	Alcohol	.16
			285	46 25	18 3	83 2	2.52	87.	Gasolene	.15
			282	47 5	16 8	80 9	2.72	110.	Alcohol	.16
Four-cycle, single cylinder, vertical	6	8	340	22 23	5 91	.....	3 76	128.	Gasolene	.31
			350	22 90	6 08	.....	3 76	128.	Gasolene	.14
			358	22.9	6 08	.....	3 76	128.	Alcohol	.18
			348	22 8	6 68	.....	3 41	128.	Alcohol	.18
			344	22.5	6 6	93 5	3 41	128.	Alcohol	.17
Two-cycle, single cylinder, horizontal	7	8	335	59.7	1.52	.....	3.95	84.	Kerosene	.35
			308	55.	6.42	.....	8 6	84.	Kerosene	.15
			356	63.5	7.42	.....	8 6	84.	Alcohol	.23
Two-cycle, two-cylinder, vertical	6	7	360	.....	14.4	50 5	2 86	32.		
Two-cycle, four-cylinder, vertical	6	7	440	.....	30.24	50.5	3 3	32		
Two-cycle, two-cylinder, vertical	7¼	8½	340	.....	21 75	85.4	3 08	24 3		
Two-cycle, three-cylinder, vertical	7¼	8½	360	.....	36 0	85.4	3 05	24 3		
Two-cycle, four-cylinder, vertical	7¼	8½	360	.....	44 2	85.4	3 21	24 3		
Two-cycle, two-cylinder, vertical	8½	10½	320	.....	34.14	96 0	3 42	23 8		
Two-cycle, three-cylinder, vertical	8½	10½	320	.....	56.	96.0	3 04	23 8		
Two-cycle, four-cylinder, vertical	8½	10½	...	.....	.....	.....	.....	.....		
Two-cycle, two-cylinder, vertical	10½	13	280	.....	60.0	.....	2 9	.....		
Two-cycle, three-cylinder, vertical	10½	13	290	.....	90.0	.....	2 9	.....		
Two-cycle, single cylinder, vertical	5	5¼	450	.....	4 95	193.	2 96	13 2		
Two-cycle, two-cylinder, vertical	4½	5¼	400	.....	9 6	155.	2 48	17 6		
Two-cycle, four-cylinder, vertical	4½	5¼	...	.....	.....	.....	.....	.....		
Two-cycle, single cylinder, vertical	5½	6½	430	.....	7.09	92.	2 96	24 3		
Two-cycle, two-cylinder, vertical	5½	6½	425	.....	12.75	80.	2 85	26.5		
Two-cycle, four-cylinder, vertical	5½	6½	...	.....	.....	.....	.....	.....		
Two-cycle, single cylinder, vertical	6½	7½	400	.....	9 6	90.	2 62	24 0		
Two-cycle, two-cylinder, vertical	6½	7½	376	.....	18.32	90.	2 13	24 0		
Two-cycle, three-cylinder, vertical	6½	7½	...	.....	.....	.....	.....	.....		
Two-cycle, four-cylinder, vertical	6½	7½	...	.....	.....	.....	.....	.....		
Two-cycle, single cylinder, horizontal	5½	9	291	18.0	6 13	102.	2 74	.....	Gasolene	.21
	5½	9	290	17 9	5 03	86 1	2 94	.....	Gasolene	.13
Two-cycle, single cylinder, horizontal	5½	10	312	19 0	2 09	45.	9 1	.....	Gasolene	.27
	5½	10	312	19 0	5 22	73.	3 64	.....	Gasolene	.20
Two-cycle, four-cylinder, vertical	4½	5½	660	77.0	26 3	.....	2 93	.....	Gasolene	.16
	4½	5½	780	91 0	29 2	.....	3.11	.....	Gasolene	.17
	4½	5½	680	79 4	27 7	.....	2 87	.....	Alcohol	.20
	4½	5½	670	78 2	27 3	.....	2 87	.....	Alcohol	.21
Two-cycle, four-cylinder, vertical	4½	5 3/16	648	65 24	18.0	.....	3 62	.....	Gasolene	.13
	4½	5 3/16	610	61 24	18 0	.....	3 4	.....	Alcohol	.19
Two-cycle, single cylinder, vertical	4	4	500	8 75	2 25	.....	3.89	.....	Gasolene	.29
	4	4	500	8 75	2 50	.....	3.5	.....	Alcohol	.37

damaging the indicator, causing sinuous lines, and partly because the revolutions of the average commercial gasoline engine are faster than possible for the average indicator to take care of. It is not possible to forecast the mean pressure of a gas engine except by empirical formulæ, it not being possible to compile any theoretical formulæ, for the reason that a slight change in the water circulated or a difference of the conductivity of the oils in the different engines, or many other uncontrollable factors, would operate to change the tension of these very sensitive gases, whereas high temperature and small entropy render them liable to great variation, there being no practical formula that could possibly cover these variations. Never has there been an empirical formula whose constants could be relied upon except after long experience by a particular engineer with a particular class of engine.

One theoretical method which is more correct than many of the more complicated ones is to calculate the heat value of the fuel used and to multiply by the empirical constant representing the thermal efficiency from that particular class of engine as nearly as possible under the conditions under which it is expected to operate.

The writer has found the most satisfactory method of all to be that of cubic feet displacement per horsepower per minute. This is a fairly constant factor for given compression and given fuels. It seems to vary, so far as any practical amount is concerned, with compression alone. From a large number of practical tests with all kinds of engines, partly from theory and partly tabulated from the experiments of others, the results given in Table 3 were gained.

It will be noted from this table and from the results of the tests that commercial hydrocarbon engines average 3 cubic feet displacement per hour, and that this displacement varies approximately in an inverse ratio to the compression. This could be expressed in the form of a formula as follows:

$$\frac{Area \times stroke}{1728 \times C} = \text{horsepower},$$

C being the constant which varies above and below 3 cubic feet. On engines of high compression it will go as low as 2½ cubic feet and on engines of low compression it will go to 3½ and 4 cubic feet, or even more.

(*To be continued.*)

Coal Handling Gear on the U. S. Collier Neptune.

The Maryland Steel Company, which built the collier *Neptune*, adopted the Marine transfer manufactured by the Lidgerwood Manufacturing Company, 96 Liberty street, New York, because it presented an opportunity to employ an economical form of structure on board the ship, both in weight and in cost of fabrication. Square booms of steel are used instead of round ones, and a structural steel mast or tower is used in place of the usual round steel mast. Instead of tying these structural steel towers or masts there is employed a stiff member of inverted U-section. This member forms a trackway running lengthwise of the ship, and it also forms a support over each hatch for the overhead block of the transfer. A carriage running on this girder enables one to pick up coal from any of the hatches and deliver it to any other hatch or to the bunkers of the collier.

The Lidgerwood Company designed a new type of winch and control for operating the clam-shell bucket in its vertical and horizontal motions. With this type of control one winch hoists the bucket vertically and the other swings it horizontally in either direction. The two winches are independent of each

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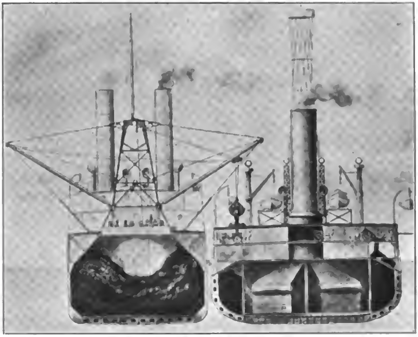
other, and can be worked separately or in union, each two winches being controlled by one operator. Only three levers are involved in the operation of the two winches—a hand and a foot lever for the bucket winch and a simple hand lever for the swinging winch. This control is extremely simple. Lifting a lever on the bucket winch causes the bucket to be raised, lowering the lever lowers the bucket, and putting the lever in mid-position stops the bucket. The swinging winch is operated in the same manner. Lifting the lever swings the bucket outboard, lowering the lever swings the bucket inboard. When this lever is placed in mid-position a steam brake is automatically set which will hold the swinging block or carriage so as to prevent movement of the bucket in either direction due to its load. Each winch has two drums. In the bucket winch the closing rope is attached to one drum and the holding rope on the other. In the swinging winch one drum operates the in-haul, the other the out-haul. The friction drums have patented metallic frictions with air-cooling passages of the Spencer Miller type. These frictions are not affected in any way by heat or weather, and their lifting power remains practically constant.



SECTION THROUGH THE COLLIER NEPTUNE AND A BATTLESHIP, SHOWING METHOD OF COALING.

Owing to the limited space aboard ship and the amount of power it requires to operate the clam-shell bucket smoothly and rapidly it becomes necessary to use high steam pressure. Because high steam pressure is employed, namely, 150 to 175 pounds per square inch, piston valves are used. With the employment of these valves excellent balance is obtained. The friction of the valve is small, and the troubles which are experienced with eccentric rods on ordinary high-pressure winches are believed to be eliminated, as is also excessive wear, which makes the piston valve desirable aboard a ship when only a few men are available for repairs or adjustment. The gears on all of the winches are of steel. The pinions are of bronze, and both have machine-cut teeth. This makes a practically noiseless running winch.

During the preliminary trials round trips were made as rapidly as two per minute from the bottom of the hatch, while 100 to 110 trips per hour will deliver the required guaranteed capacity.

Testing Corrosion Resistance in Tubes and Fittings.

That the anti-corrosion value of brass and bronze tubes and fittings can be accurately determined by laboratory tests is shown in a paper read before the American Brass Founders' Association by William Vaughan, of Arthur D. Little, Inc., chemists and engineers, of Boston.

Corrosion may be defined as the effects produced upon a metal by the combined action of air and water, with or without the stimulus provided by the various impurities in the water or in the atmosphere. These corrosive effects are explained on the basis of: (1) Chemical action alone; (2) electro-chemical action, which may be caused by stray electrical currents from an outside source or by galvanic action, due either to included impurities or to the varying proportion of the different elements constituting the alloy. The main difference between two actions is in intensity. Effects that take months under the first can be accomplished in six or eight hours by the second. Accelerating the chemical action by an electric current gives, therefore, a comparatively simple method of determining the relative resistance to corrosion of the various metals.

On May 15, 1909, nine different kinds of tubes were installed in a surface condenser by the writer, twenty-five of each kind being inserted in vertical rows and designated alphabetically by punch marks at the top of the row. The remaining tubes in the condenser, some 3,400, were of "admiralty metal" (untinned), having the following composition:

	Percent.
Copper	70
Zinc	29
Tin	1

In all cases the failure took place by severe pitting and grooves running lengthwise of the tubes. In many cases small holes penetrated through the entire thickness of the tube. A large part of the failures was with tinned tubes, due probably to the electrolytic action set up between the metal and the tin wherever defects occurred in the tin coating. The pure

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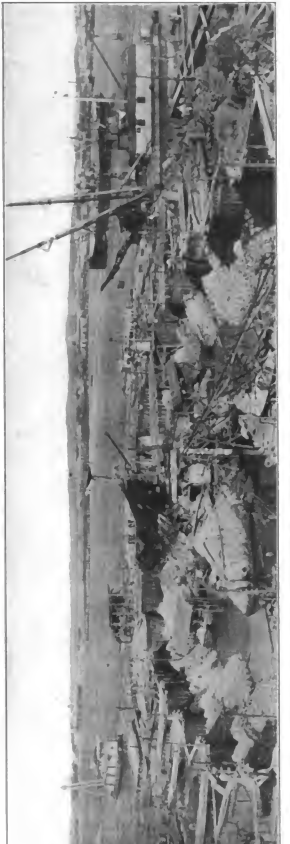

COFFERDAM SURROUNDING THE WRECK OF THE MAINE PARTIALLY DEWATERED.
(Photograph by Underwood & Underwood, New York).

copper tubes were particularly susceptible to corrosion, while the copper zinc tubes were much more resistant. The 60/40 and the 66/33 tubes showed practically no difference. The so-called "admiralty metal" appeared to resist corrosion better than the other brasses, and this, too, was indicated in the experiments, as the addition of a small amount of tin tended in most cases to diminish the rate of corrosion. A large amount of experimental work still remains to be done on alloys, but it is to be hoped that investigations will be carried out to such an extent that in the not distant future the employment of alloys which are rapidly destroyed by corrosion will be due to carelessness or willful intention and not to lack of proper information.

WORK ON THE WRECKED BATTLESHIP MAINE.

The battleship *Maine*, which has lain in Havana harbor for the past thirteen years, is now attracting a great deal of interest since the actual work of dewatering the cofferdam has begun. We show two very interesting views of the condition which has been revealed lately of the vessel. The work on the construction of the cofferdam was started last fall by the Board of Engineers, headed by Col. W. M. Black. The cofferdam consisted of twenty steel cylinders, each 50 feet in diameter, formed of the Lackawanna interlocking steel sheet piling. These steel cylinders were placed tangent to one another with arcs of piling connecting them on the outer face. To insure the stability of the cofferdam 20,000 tons of stone was deposited against the inner wall. The piling was driven by steam hammers of the Arnott type, built by the Union Iron Works, of Hoboken, N. J. The effect of the explosion, as shown by the illustrations, is far greater than was generally anticipated, and the barnacles on the bow of the *Maine* tell the story of what semi-tropical waters do to the submerged part of a ship.

General Bixby reported his opinion of the explosion as follows:

> "The destruction of the *Maine* was caused by the explosion of three magazines. A portion of the deck over the magazines was blown upward and laid backwards. No explosion from the outside could have caused this result. What the primary cause of the explosion was will never be learned."

For removing the water within the cofferdam two large centrifugal pumps, electric driven, with double suctions, were used. They were especially built for the work by the Jeanesville Iron Works Company, Hazelton, Pa. The larger of the two pumps has 14 inches suction and 12 inches discharge; the smaller has 10 inches suction and 8 inches discharge, the discharge being, respectively, 4,000 and 1,800 gallons per minute against a head of 65 feet maximum and 5 feet minimum. The main castings of the pumps are of a special grade of cast iron; the impellers are of special bronze and the shaft is steel, bronze covered. The motors are 100 horsepower General Electric make, running 1,200 revolutions per minute, three-phase, 60-cycle, 220 volts, with a compensator for the large pump and a 50-horsepower motor for the smaller pump. Each pump is connected to its motor by a flexible coupling of pin and rubber buffer type. The pumps are mounted within the inclosure, and the current is obtained from a power-house on shore. The double suction construction gives a perfect rotative balance, thus eliminating all difficulties encountered from end thrust. The castings and bushings are split horizontally, thus permitting inspection to be made without breaking any pipe joints or deranging alinement of the plant. Two ring-oiling bearings with split renewable bushings are used, one on each side of the pumps, entirely separated from the casting by deep stuffing-boxes, making it impossible for grit or dirt to work into the bearings. The impellers are the inclosed type, chipped and filed to a finish, and fitted with re-

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THE WRECKED BATTLESHIP MAINE.
(Photograph by Underwood & Underwood, New York).

newable bronze wearing rings, which when worn can be easily removed. The engineering work taken as a whole has been very successful. The method of doing the work is unique, but it reflects great credit upon those who have had it in charge.

Referring to INTERNATIONAL MARINE ENGINEERING, March, 1908, and May, 1908, our readers will find complete drawings and description of the second-class battleship *Maine*, together with an account of the explosion and the report of the naval court of inquiry regarding this disaster.

THE SOVEREIGN'S MACHINERY.

The remarkable showing of the yacht *Sovereign*,* built for Mr. M. C. D. Borden by the Gas Engine & Power Company and Chas. L. Seabury & Company, Con., Morris Heights, New York, has attracted much attention to this craft. The fact that this, the fastest yacht in the world, as far as we know, with an actual speed of 35 miles an hour, is fitted with reciprocating engines, calls attention to the following specifications:

Engines—Two Seabury four-cylinder, triple-expansion steam engines, 13½ inches diameter high-pressure, 20¾ inches diameter intermediate-pressure, and two low-pressure cylinders, each 26½ inches diameter, having a common stroke of 13½ inches. Each engine develops 2,500 horsepower at 500 revolutions per minute, with 350 pounds steam pressure.

Cylinders—Are of fine grain cast iron, cast with stanchion lugs and valve chest at the side.

Valve Chests—Are fitted with cast iron liners for piston valves. High-pressure and intermediate-pressure cylinders are each provided with one piston valve, and each low-pressure cylinder with two piston valves.

Cylinder Heads—Of cast steel ribbed and provided with bosses for relief valves.

Valve Gear—Consists of a side shaft running in bearings on the bedplate. This shaft is provided with cranks for each valve, and is driven from the crankshaft by means of three steel gears.

Reverse Gear—Of the regular Seabury type with bronze spiral sleeve operated by a hand lever.

Pistons—To be of forged steel dished, except the high-pressure, which is cast iron. Steel pistons to be provided with solid cast iron rings.

Piston Rods—Of special high-grade steel, tapered at the piston end and threaded to screw into the crosshead with lock nut.

Crosshead—Of solid forged nickel steel, babbitted for the wrist-pin bearing.

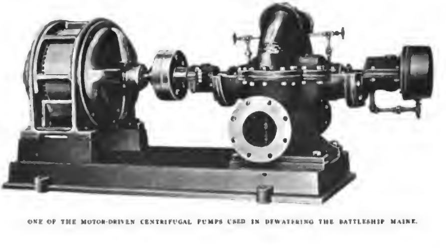
Crosshead Guide—Of cast iron, water-jacketed, with bronze backing gibs.

Framing—Consists of ten steel stanchions, well braced with diagonal fore and aft and athwartship braces. To the stanchions are bolted two steel guide rails to which are bolted the main guides.

Bedplate—Of cast steel sections bolted to steel angle-bars. Main bearings are babbitt lined and provided with cast steel caps secured with special steel studs.

Crankshaft—Of nickel-steel, finished all over, in two sections, with flange coupling for connecting line shaft.

* See description INTERNATIONAL MARINE ENGINEERING, June 1911, page 222.



ONE OF THE MOTOR-DRIVEN CENTRIFUGAL PUMPS USED IN DEWATERING THE BATTLESHIP MAINE.

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Thrust Bearing—Of the horseshoe type, with roller bearings interposed between collars forged on shaft and cast steel horseshoes.

Connecting Rods—Of the regular marine type, of nickel-steel I-section with forked upper end and hollow steel wrist pin forced into eye. The lower end is a T-head, with manganese bronze babbitted boxes bolted on with special steel bolts.

Lubrication—By means of a McCord forced-feed lubricator of thirty feeds with leads to all important bearings.

Lagging—Cylinders to be well lagged with magnesia and Russia iron top. Heads to be filled with magnesia and covered with a brass plate.

Throttle Valve—Of the balanced lever type, to permit quick closing. To be constructed of cast steel.

Steel Steam Pipe—5¼-inch I. D. with separator and expansion joint in the line, both of steel.

Condensers—Of special type for securing economical working with small surface; ½-inch tubes except in way of incoming exhaust, these tubes being ⅝ inch. Condenser constructed of Muntz metal and copper, 9 feet long, 3 feet in diameter, one for each engine.

Boilers—Two Seabury watertube boilers, 15 feet long, 10 feet wide, 9 feet 6 inches high, containing 3,950 square feet heating surface each and 110 square feet grate surface. Boilers constructed in the main of ¾-inch O. D. tubing, except the three rows next to the fire, which are 1-inch O. D. Heater constructed of special drawn cast steel tubing. Boiler is double-ended, dry pipes take steam from two domes on each boiler. Designed to carry 350 pounds of steam, with an air pressure of 3 to 4 inches of water.

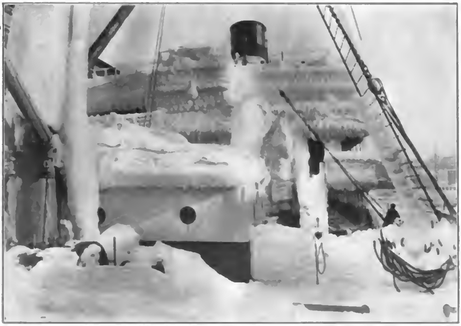
Pumps—Two Blake feed pumps for each boiler, 7½ inches by 5 inches by 8 inches, duplex, one in engine room and one in fire-room. Pump in engine room draws from the hot well, and is automatically governed by float valve. Pump in fire-room for emergency and make-up feed. Auxiliary air pump, Blake featherweight, 4 inches by 8 inches by 6 inches, simplex.

THE JOHN SHARPLESS AFTER WINTERING ON THE GALLOUP ISLAND SHOALS.

Cooling Pictures for Summer Use.

The steamer *John Sharpless* went aground on the Galloup Island shoal in Lake Ontario Dec. 9, 1910, and remained all winter. The accompanying illustration shows the vessel as she appeared in the first week in April, when she was floated by the wrecking firm of Baker & Reed, Port Huron, Mich. When the steamer went aground she had on board 70,000 bushels of corn, shipped from Chicago and destined for Ogdensburg, N. Y.

The *Canada* did not go ashore, but the accompanying picture shows that there was not much need for mechanical refrigeration on board when she entered Boston harbor one cold winter day some time ago.



THE STEAMSHIP CANADA IN WINTER DRESS.

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THE SUBMARINE VESSEL.

BY K. DIETZE.

No fundamental changes have taken place in the modern submarine boat within recent years. The trend towards a type lying midway between the first serious productions of the older designers of submarines and the extreme submersible exemplified by the French *Narval* becomes more and more pronounced. A general review of the submarine and submersible question and a simple analysis of the general conditions of the problem may here be of interest.

At an early period in the history of the submarine boat, remote as its first beginnings are, the experience was gained that a state of suspension of a body under water is possible only in theory, and that practically every excess of weight, however small, suffices to make it sink and every inconsiderable excess of buoyancy to make it rise. This is due to the uniform specific density of the water within the range of depth which practically comes in question for the movements of a vessel below the surface. Very different from this is the case of an aerostat, which always remains at a certain definite height in the air, depending, apart from accidental influences, entirely upon its weight and upon the gas with which it is filled. For the specific density and with it the buoyancy of the air becomes less with every increase of height, it being considerably compressed in the lower strata by its own weight. If W be the weight and V the volume of a balloon, γ_w the specific gravity of its gas filling, and γ_l that of the air at the intended height of suspension, then, approximately,

$$V \times \gamma_l = W + V \times \gamma_w;$$

$$W = V\,(\gamma_l - \gamma_w), \text{ and } \gamma_l - \gamma_w = \frac{W}{V},$$

If, as in Fig. 1, the specific density γ_l of the air be now set off as a function of the height H above mean sea level (Curve a) and the specific density γ_w of the gas filling, which, with

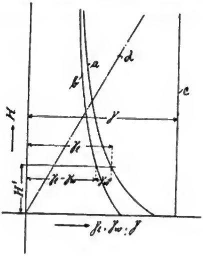

FIG. 1.

increase of height, is subjected to the same alterations as those of the air, be set back from Curve a (Curve b), it becomes possible (V being assumed constant) for every condition of loading to determine the approximate altitude H' by the calculation of the value of $(\gamma_l - \gamma_w)$, due to the weight and the finding of the corresponding point in the $(\gamma_l - \gamma_w)$ Curve b. Water, however, is practically incompressible; that is to say, its specific gravity γ does not alter with increase of the depth H (Curve c). Consequently, since γ is itself constant, the volume V cannot, in the submarine boat, be taken as constant for a different height of suspension with varying weight W as in the case of the balloon. Similarly it is not possible to find a value of γ corresponding with a particular condition of loading W from the equation $V \times \gamma = W$ (values of V and W corresponding with those for the balloon being assumed to exist). From this it will be clear that the existence of a state of suspension for a boat under water, while theoretically possible in itself, does not depend on the depth of immersion H.

The hydrostatic pressure $p = \gamma \times H$, which increases gradually with the depth, and which, similarly to the aerostatic pressure, is produced by the weight of the columns of water above the particles at the level H, takes the form of the

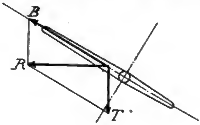

FIG. 2.

inclined straight line d without influencing the γ (curve c) in any way. This pressure renders impossible the use of the ordinary ship form for submarine vessels. The salient feature of a submarine boat must accordingly be a completely closed-in, boiler-like hull, and a circular form of section for this is found to be the one best able to resist the external pressure of the water. The first serviceable vessels of the older pure submarine type, therefore, in many respects, resembled the ordinary fish-torpedo, the invention and practical development of which did much to help them forward. The form of the longitudinal section of the torpedo has been adopted by many designers also, while others have altered the profile of the hull proper by the addition of more or less symmetrical excrescences. The midship sections of these older submarine boats—or, more correctly, their largest transverse sections—were arranged in many cases at the half-lengths of the vessels, and in others at points further forward. In general these arrangements depended on considerations of strength, resistance and stability.

Now since, as already stated, it was practically impossible to produce a state of suspension at any depth below the surface, it became necessary for the safety of boat and crew that diving be done with a small reserve of buoyancy, which may be called the permanent surplus, which then had to be forcibly overcome by special mechanical means. To effect this, appliances of all kinds have been tried. Of these, only that of horizontal diving rudders has survived; for the fitting of special screw propellers for diving and other devices of the kind has been given up. True, the slight tactical advantage of being able to dive vertically had therewith to be dispensed with, since the horizontal rudders worked only when the boat was moving ahead or astern. Nowadays two or three pairs of these rudders are commonly distributed over the length of the vessel; when one pair only is applied they are fitted, as in the case of a torpedo, at the after end, and if possible in the wake of the propeller, where they work very efficiently. The effect of the diving rudders may be seen in Figs. 2 and 3. If in the case most commonly met with in which two pairs of rudders are fitted, C represents the above-mentioned permanent surplus, and T_a and T_b be the vertical components of the rudder blade resistances R, we can set

$$2 \times \frac{T_a}{2} + 2 \times \frac{T_b}{2} = C.$$

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Further, if a and b be the distances of the centers of the hydro-dynamic resistances (practically the centers of means distances) of the surfaces of the diving rudders from the vertical axis through the center of buoyancy F and weight G, we have

$$2 \times \frac{T_a}{2} \times a = 2 \times \frac{T_b}{2} \times b \text{ and } \frac{T_a}{T_b} = \frac{b}{a}.$$

The assumption is here made that the permanent surplus C lies in the vertical axis referred to. Otherwise a trimming moment $C \times x$ would also have to be overcome by the diving rudders during submergence. To this must be added another moment, which may be called the "moment of propulsion." If P be the component of the propeller thrust (see Fig. 3) in the

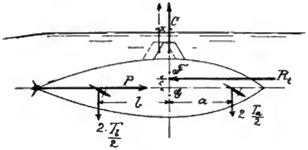

FIG. 3.

line of longitudinal motion, and R_t the total resistance of the boat, with all rudder pressures, erections and appendices in the submerged condition, R_t will not, as a rule, fall in the direction of P, but, in view of the complicated resistances of the extensive erections, may generally be assumed to act at a somewhat higher level. This at once establishes the couple $R_t \times c = P \times c$, the tendency of which usually is to raise the fore end of the boat, and which likewise has to be compensated by the action of the diving rudders. The last given equation thus takes the general form:

$$2 \times \frac{T_a}{2} \times a - 2 \times \frac{T_b}{2} \times b \pm C \times x \pm P \times c = O.$$

The so-called permanent surplus buoyancy C, which is usually represented by the whole or part of the volume of the conning tower situated on the top of the hull, amounted, in the pure submarine boat of older design, to from ¼ to ½ a ton. It will at once be seen that this small surplus of buoyancy by which, during surface runs, the boat would alone project above water, would not suffice to provide the necessary seaworthiness and security. It became necessary, then, for the by far the most frequent surface runs to raise the boat higher out of the water; that is to say, to provide a certain freeboard, *i. e.*, a larger amount of reserve buoyancy, which for diving must be capable of being reduced to the ordinary surplus C by the taking in of water ballast. As regards buoyancy, then, three different conditions of the boat have to be distinguished (see Fig. 4):

1. For surface runs the normal surface condition, in which displacement $(D\gamma)$ = weight of vessel (W).

2. The half-submerged or awash condition, in which the full amount of the ballast water Q has been taken in, and the reserve buoyancy d is thereby destroyed. Here $(D + d)\gamma = W + Q$.

3. The submerged condition, in which the surplus buoyancy C is also overcome by the vertical components of the pressure of the diving rudders. Here

$$(D + d + C)\gamma = W + Q + \left(2 \frac{T_a}{2} + 2 \frac{T_b}{2}\right)$$

In contradistinction to the pure submarine boats of older design, which during surface runs already swam on their circular sectioned hulls and which had to find room for the necessary ballast water Q within the latter (see Fig. 4a), the whole of the water is in the extreme type of submersible banished from the inside of the inner hull and accommodated in external tanks. These latter, which represent such a marked new feature in the development of the submarine boat, were introduced by the former French Chief Constructor Laubeuf, who in the design of the *Narval* (Fig. 4b) arranged an entirely new outer skin round the hull proper to take the water ballast. It may readily be imagined that the space within the hull of the pure submarine boat of the older type was very much taken up by the requisite machinery, accommodation and crew, so that little room remained for the ballast water. The reserve buoyancy d, which is equal to the ballast in amount, could, in consequence, not be very large; it was only about 8 to 10 percent of the surface-run displacement. The earlier submarine boats could, in consequence, not be marked out for any very extensive use—they were only fair weather weapons of defense. The *Narval* design changed all this at one stroke. The reserve buoyancy could be increased to any desired extent, limits being put to it only by considerations of resistance and of the time taken to dive.

The *Narval* brought a further very considerable improvement with her in so far that, by means of the added outer skin, it at once became possible to make use of the old well-tried ship form for submarine vessels. In surface runs, indeed, the older submarines showed some very objectionable peculiarities. In the first place, they shipped a great deal of water, and in the second, they showed a strong tendency to cut under the surface. It became necessary, therefore, on surface runs to trim them by the stern by means of ballast, thus destroying a part of the reserve buoyancy and increasing the resistance. In the submersibles the latter of these drawbacks is avoided and the former considerably reduced. Meanwhile the stability conditions are, at least at the small

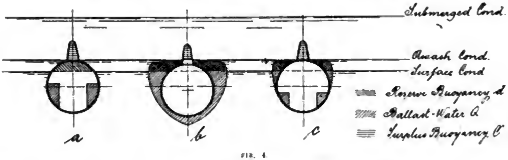

FIG. 4.

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angles, considerably improved, the freeboard increased, and the range of vision enlarged.

The *Narval* may be looked upon as an "extreme" design, in so far as practically the whole of the ballast water is removed from within the hull proper and placed in the external tanks. In the modern submersible (Fig. 4c), to which the designs of most of the navies now assimilate, only part of the ballast water, although the greater part, is arranged externally, while the rest is retained within the inner hull, so as to trim the vessel in the awash condition and to bring about an exact balance of the surplus buoyancy. The external tanks thus became somewhat smaller than in the *Narval*, a large part of the deadweight represented by the outer skin was saved, and in spite of this the remaining reserve buoyancy (30 to 50 per-cent of the surface-condition displacement) and the similarity to ordinary ship form were sufficiently preserved (Figs. 4c and 5). The permanent surplus buoyancy is increased to about 1.5 to 2 tons. In the fore body the modern submersibles are almost exactly like torpedo boats, while the after body takes a somewhat different form, approaching to the well-known tetrahedron model. This form of after body offers many advantages: including greater initial stability, improved conditions of resistance, wider play for variation in the diameter of the propeller and more efficient working of the latter, because the water can very easily flow into it. Further, the facility of course-keeping in the vertical plane during subsurface runs is favorably influenced by the above-mentioned form of model, as will be seen further on. Extending over the whole boat is an erection, for the most part in tunnel form, exposed on all sides to the water, containing all the pipe leads. In many cases the erection is curved upwards in the fore body, whereby good working of the boat in a seaway is ensured. The inner hull accommodates itself as far as possible to the outward shape of the vessel; the pointed ends, forward and aft, have been cut off and replaced by strong, boiler-end shaped bulkheads. In the center of the pipe-lead tunnel, the top of which is utilized as a light platform deck, rises the conning tower, with its erections and appendages, which is itself strongly built to resist pressure and frequently armored. In it are the communication appliances, the periscopes, the steering gears, the central cocks for working the ballast tanks, depth manometers and the electrically-worked distance indicators of the compasses. The latter are often arranged outside the boat, on the one hand, because in the completely enclosed steel inner hull or in the conning tower the lines of force of the earth magnetic field are rendered almost immune, and on the other, because the effects of the free eddy currents within the boat, which are set up by the extensive electric installations, are thereby removed as far as possible. The possibility of vision is, unfortunately, still dependent on the makeshift assistance of the periscope, which can be withdrawn into the tower or into the interior of the boat. Windlasses or capstans may eventually be worked by electricity. When anchors are carried at all they are usually of the mushroom description, and capable of being drawn completely into their hawse-pipes, thereby these adapting themselves best to the shape of the boat. Life and working boats have been entirely banished from the submarine vessels; only on practice runs on which no dives are to be made are single small boats occasionally carried.

The motor question cannot yet be looked on as solved in a uniform manner. For surface runs, however, the heavy oil motor may be considered to have finally established itself, and its recent practical improvement has done a great deal towards the development of the submarine boat in general. Preference is shown in particular to an engine resembling the quick-running Diesel motor, which, even in France, where perhaps the greatest number of experiments with different surface motors have been made and return has repeatedly been made to the old, well-tried steam engine, appears to be finally accepted. Small height, short and compact build, very small weight and absolute reliability in working are demanded; the exhaust pipe, or opening, is placed for the most part as high as possible at about the after end of the pipe-lead tunnel, in order that the more powerful motors may during good weather be capable of being used in the awash condition also. For subsurface runs, of course, electric motors are used which have to be continuously fed from a storage battery. This latter is filled with peat moistened with acid, and is usually completely cased in, and provided with small tubes in order that the acid may not easily run over when the boat is inclined in either the transverse or the longitudinal direction, and that the gases developed in filling and during consumption of current may be able to escape. Connection is established between the individual motors by means of electro-magnetic couplings, one each of which is arranged between the oil motor and the electric motor, and between the latter and the propeller shaft. The electric motor is so arranged that it can be used as a dynamo, driven by the oil motor for the charging of the accumulators; it is for the most part completely cased in, but in way of large cooling openings wound round with wire, so that any explosive gases that may be ignited at the sliding contacts are confined to the interior of the motor. The starting of the oil motors may be effected by means of the electric engines or by compressed air, a sufficient quantity of which is always carried by the vessel or can be produced on board. In regard to the voltage, it is not found desirable to exceed 220, on the one hand, for the safety of the crew and the prevention

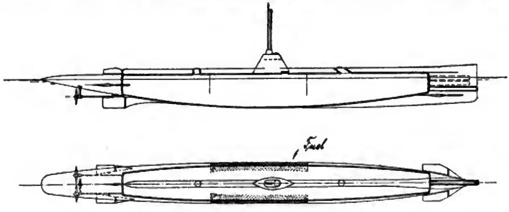

FIG. 5

of short circuit, and on the other in order not to affect the compasses, which at the best are very unreliable.

In addition to its well-known advantages for ordinary vessels, the sub-division of the engine is further of special advantage for sub-marine boats, because the smaller units can be more conveniently accommodated in the inner hull; and, moreover, in a submarne boat in submerged condition the turning action of a single screw must be especially unpleasant. Now, although in the newer type of submarine boats faultlessly reversing heavy oil motors have been largely introduced, it has not been found desirable to dispense with the adjustable propeller blades. In engines of more than 200 to 250 effective horsepower this is, no doubt, an unsatisfactory makeshift, which, however, it is not thought advisable to dispense with, because the power of the oil motors cannot, for surface runs, be varied within sufficiently wide limits, and because the previous determination of the under-water power, *i. e.*, the suitable number of revolutions of the propeller designed for surface work is so difficult that the possibility must be provided of determining the maximum speed under water for each individual boat by experimental variation of the pitch of the propeller, without the power of the motors having to be reduced.

Cases are also met with of threefold and fourfold subdivision of the horsepower, by which various combinations become possible. With three screws, for instance, the central engine could with advantage take the form of a larger, more slowly running oil motor (with small dynamo for feed purposes), to be used alone for surface running, whereas the two outer ones were electric motors to be reserved for diving. These two outer motors could, however, in addition be connected with oil motors of small power, so that for surface running all three propellers could be set to work without it being necessary to bring the accumulators into play. On the other hand, the parts played by the propellers and their motors in connection with submerged and surface runs may, on occasion, be interchanged, the screw or screws not doing work being in each case allowed to run free. Similar combinations can, to a more extended degree, be resorted to with four propellers. All such variations depend on the calculation of the most favorable manner of overcoming the resistances. We here come to one of the most complicated and important theorems connected with the submarine boat.

For surface work the determination of the engine power necessary for a given speed, of course, presents no greater difficulties than in the case of an ordinary vessel; the Middendorf formula is said to give good results for modern submersibles, when the power otherwise necessary is increased by 30 percent to allow for the exceptional appendages of boats of this class, including in particular the torpedo exit excrescences and flaps. A good approximation is also given by the formula $I.\ H.\ P. = \dfrac{(\text{area of midship section}) \times V^3}{m^3}$; in surface trim the coefficient m ranges between 3.1 to 3.3 for modern type boats with $L : B$ from 10 : 11.5, this embracing all additional resistances.

For the determination of the resistances for the under-water runs, however, all the ordinary aids of this kind become useless, and only model experiments corrected by constants obtained from actual experience enable a prediction to be made for the under-water power of a boat of a particular type. This is also to be expected. The effect of the complicated tower formation, the diving rudders, and the pressures on these, and the rest of the appendages, such as the tunnel, the forecastle, etc., cannot be put into figures. Very roughly speaking, an average boat of 300 tons surface displacement for 8 to 9 knots under-water speed requires as much power as for a speed about 12 knots at the surface, the resistance of the horizontal rudders being in the former case included. As already observed, however, this uncertainty as to the speed that will be attained is got over by the adoption of adjustable propeller blades. With this the number of revolutions of the electric motors can be regulated at will. Meanwhile it must not be lost sight of that for the employment of the electric motor as dynamo a particular number of revolutions is necessary, which the oil motor must, while developing the necessary power, be such as to admit of. There can be no doubt that for under-water work the old submarine boats with their circular-sectioned hulls, so long as these were not deformed by the fitting of external oil tanks, as in the modern English designs, gave better propulsive results than the present-day submersibles. This is probably the reason why many of the naval administrations have so long adhered to the pure submarine boat with its evident disadvantages. But the modern submersibles are so dimensioned that the resistance keeps within reasonable bounds, even under water.

The accommodation of the ballast water in external tanks apparently offers advantages of such importance that a slight increase of resistance which accompanies it is willingly accepted. What has been said in the foregoing about the ballast tanks will in general, with slight alterations, apply to the oil tanks also. In cases in which oil motors were applied to the old submarine boats, these latter tanks had also to be arranged within the hull. In the submersible boats they have made their way with the ballast tanks to the outside, their most suitable position being at about half-length of the boat, so that in case of an unequal consumption of fuel the slight leverages with which they act admit of the smallest possible trimming moments (Fig. 5). Just as the removal of the ballast tanks to the outside brought with it an increase of the reserve buoyancy, so also the same maneuver with the oil tanks enabled these to have a much larger capacity; thus the radius of action of the modern submersible is, on the surface, far greater than that of the old submarine boats. Under water the case is different. Here a speed of about 9 knots and a radius of action of about 30 knots have to be made the most of. The space won by the removal of the ballast and oil tanks had to be used for the accommodation of the storage battery, which, as a result of the considerable increase of the displacement and the consequent increase of the under-water horsepower, became much more bulky. On the other hand, the surface speed was increased to 16 knots, and it will be seen that the modern submersible is, under surface conditions, becoming more and more a serviceable weapon of offense.

(To be concluded.)

Tonnage and Trade of the Port of London.

The increase by periods of ten years in the tonnage of British and foreign vessels entering the port of London from foreign countries and British possessions and coastwise (excluding vessels from the Medway) to discharge cargo, establishes the fact that, notwithstanding the gains made in other countries, the port of London still occupies a unique place in the world's shipping, as the following statement giving the tonnage entered for 1889, 1899 and 1909 shows:

YEARS.	From Foreign Countries and British Possessions, American Tons.	Coastwise. American Tons.	Total. American Tons.
1889..............	8,456,000	4,852,000	13,308,000
1899..............	10,571,000	6,664,000	17,235,000
1909..............	12,999,000	7,246,000	20,245,000

In the annual report of the port authorities the statement is made that the tonnage of ships which used the London docks during the year ended March 31, 1910, largely exceeded that of any previous year, and it is thought that the new schedule of dock rates, which went into effect on Jan. 1, 1911, will cause considerable additional shipping to enter the port.—*Daily Consular Reports.*

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A Twin Hatch Steamer with Central Deck Ballast Tank.

In these days only those vessels which are carefully designed with a view to economy of working expenses and equipped with the most expeditious means for working cargo can hope to be kept fully employed. It is, therefore, imperative on the part of owners, as well as shipbuilders, to be keenly alive to any proposed improvements in the design and equipment of ships. One of the latest ship constructions is the invention of Mr. E. W. Ashby, a Tyneside naval architect, whose aim are arranged from the tank to the sides of the ship. These beams could be placed diagonally similar to the members of Warren girders in vessels designed to carry oil in bulk, preventing most effectually the increased tendency to work in such a ship, due to the nature of the cargo. Web plates are placed inside the tank to transmit the thrust, while the necessary support is secured by wide-spaced, strong pillars, braced in order to connect the tank rigidly to the remaining structure. A center-line bulkhead could be substituted in oil steamers, in which vessels the deck ballast chambers would be useful

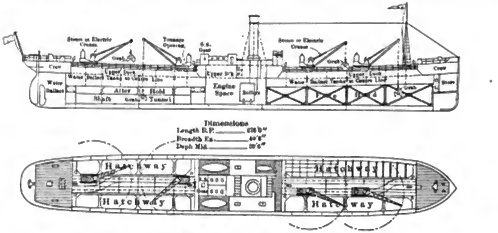

FIG. 1.—GENERAL ARRANGEMENT OF CENTRAL DECK BALLAST TANK STEAMER.

is to embody in a cargo vessel costing approximately the same as one of usual construction possessing equal dead-weight capacity several important advantages.

Referring to the illustrations, Fig. 1 represents the general appearance of the vessel. The distinguishing feature is the arrangement of continuous side hatchways on the deck, having deep coamings extending unbroken between the poop, bridge and forecastle. The outer coamings are fitted as close as possible to the sides of the vessel consistent with strength. Between the inner coamings is situated the working deck of the ship, raised considerably above the ordinary deck level, leaving 1 foot or less of these coamings standing above. This deck is continuous between the erections and can be gradually sloped as it approaches the bridge or poop in order to get the necessary tonnage openings in the end bulkheads of such erections. Between the hatches and below this deck is situated a water-ballast chamber, extending down below the molded depth level and having sloping sides meeting at the base. This tank, as will be seen in Fig. 2, is continuous forward and aft of the machinery space, the longitudinal strength being amply preserved by the bridge side and deck plating, extending considerably beyond the ends of the tank. It will also be observed that the bridge sides are in line and continuous with the outer coamings of the hatches. On the central raised deck, instead of the customary discharging gear composed of winches and derricks, etc., portable steam or electric cranes are used, moving along lines of rail attached to the deck and arranged to work self-filling and discharging grabs. This equipment, in conjunction with the long hatches on either side, will enable bulk cargo, such as coal, to be discharged with the minimum amount of labor. The cranes would possess all the usual motions and be constructed with warping drums, dispensing with the needs of winches for maneuvering the vessel in harbor.

The bollards, ventilators and other gear are also placed on this deck.

Referring to the midship section, Fig. 2, it will be seen that to preserve the transverse strength at the deck strong beams for trimming purposes. It will be noted that half beams are not necessary, the flanged beams being of sufficient size to support the small width of deck. At the top of the hatchways are placed the usual webs, spaced 4 to 5 feet apart, supporting the wood or steel covers. Fig. 1 shows the arrangement of a steamer of handy size carrying about 3,000 tons dead weight, Fig. 2 being the midship section, while the group of three sections, Fig. 3 and the annexed table of data, compare the

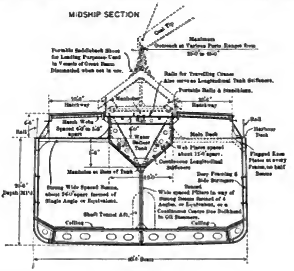

FIG. 2.—MIDSHIP SECTION.

capabilities and advantages of the different arrangements of hatches and water-ballast tanks. The particulars given have been carefully based on those of a vessel of normal construction, having the usual poop, bridge and forecastle, with two ordinary-sized hatches in each well.

The advantages claimed for this construction are numerous. Considering first the structural arrangement, the vessel has

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greatly increased longitudinal strength, due to a much larger percentage of the steel work at the deck being utilized in resisting longitudinal stresses than is ordinarily the case of steamers constructed with the usual hatches and winch platforms; moreover, the stiffening of the central tank longitudinally instead of transversely, as with side tanks, adds to the longitudinal strength. This would allow much greater length to depth than usual, also allowing the dead weight to be carried on a reduced draft of water relatively to that of a vessel of normal construction. The water ballast capacity is about equal to that secured by the same vessel if constructed with top-side wing tanks, about half of the total ballast being carried at the deck, and the compartment being arranged along the center line of the vessel would prove free from straining and leakage. The actual capacity of the tank, of course, is to some extent governed by the width of hatches required. The disposition of the ballast and its influence on the metacentric height and draft in ballast, as shown by the data given, should produce a steadier and more comfortable ship when in such trim, without undue strains. Perhaps the most important advantage gained by this method of construction, viewed from the shipowners' standpoint, is the increased immersion allowed this type of vessel by constructing the deck ballast tank partly above the molded depth level, which, in conjunction with the continuous side hatchways, forms a substantial erection, connecting up the ordinary erections and giving extra strength and reserved buoyancy, so that with little increase in the weight of steel structure over that of the normal vessel a valuable reduction of the freeboard, and therefore a considerable increase in the dead-weight capacity of this ship, is gained, by the arrangement of the hatches and the formation of two trunks or feeders to the hold proper,

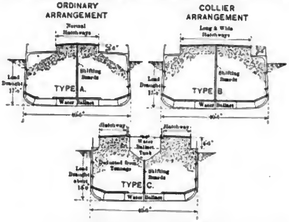


Fig. 3.—Comparison of Types.

COMPARISON OF TYPES.

Item.	Type A.	Type B.	Type C.
1. Total estimated weight of steel....Percent	100	102	103.5
2. Weight of ship completed.............Tons	1,310	1,350	1,350
3. Dead-weight capacity...................Tons	3,110	3,070	3,410
4. Net tonnage ....Tons	1,030	1,130	1,020
5. Total cubic capacity, including bunkers (and top-side tank)............Cubic feet	154,850	162,550	176,060
6. Cubic capacity, excluding bunkers..Cubic ft.	148,400	156,100	169,900
7. Capacity available for untrimmed coal cargo ....Cubic feet	112,900	138,800	141,000
8. Total water-ballast capacity............Tons	765	765	1,295
9. Mean draft with ballast and permanent bunkers	9' 10"	10' 2"	12' 0"
10. Metacentric height, with ballast and bunkers	8' 0"	7' 9"	4' 3"
11. Deadweight ÷ net tonnage..........Tons	3.02	2.72	3.34
12. Total cubic capacity (5) ÷ net tonnage, Cubic feet	150	144	173
13. Capacity for untrimmed coal cargo (7) ÷ net tonnage ....Cubic feet	110	123	138
14. Total cubic capacity (5) ÷ deadweight, Cubic feet	50	53	51.5
15. Capacity for untrimmed coal cargo (7) ÷ deadweight ....Cubic feet	36	45	41.5
16. Deadweight ÷ weight of steel (1), Percentage	100	96.5	106
17. Total cubic capacity (5) ÷ weight of steel (1) ....Percentage	100	108	110

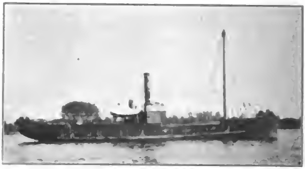
enabling such a ship to carry full cargoes of grain in bulk and dispensing with the necessary bagging otherwise required by law, while the expense of fitting shifting boards at the center line is reduced to about half, as the quantity required is necessarily small, the deck tank taking the place of the upper portion of these boards. By tapering the tank practically to a point at its lower extremity, and having the hatch coamings closer than usual to the sides, a self-trimmer is produced. Compared with other types, a greater percentage of the hold and hatch space can be filled without any trimming.

The Wrecking Submarine Boat Vulcan.

The *Vulcan* was designed by the French government to assist in case of accident the submarine vessels of their navy, and her building was kept very secret, but we were able to obtain a photograph, which we give in this issue. She is designated, however, in the French navy not as a wrecking boat for submarines but a steam lighter. Her dimensions are as follows:

Total length	141 feet.
Extreme breadth	22 feet 6 inches.
Draft	11 feet 10 inches.
Indicated horsepower	450
Speed	11 knots.

She is built entirely of steel and very stoutly. She is double bottom fore and aft, this double bottom having a height of 4 feet most of her length. The compartments adjoining the engine and boilers are watertight. She is divided into eight longitudinal compartments. She is fitted with a single


Steam Lighter Used as a Wrecking Boat for Submarines.

marine boiler, which furnishes steam to the main engines and the auxiliaries.

Her main engines are triple-expansion with three cylinders, making 105 revolutions, giving a speed of 11 knots.

On her trial trips she ran over 12 knots. She is fitted, it will be noticed, with davits in the bow, the use of which is apparent.

Just how this vessel will act when needed is a question which is yet to be settled.

Recent Trials of U. S. Battleship Utah.

With the recent trial of the *Utah* the United States Navy Department is in possession of data of three Dreadnoughts which, while not identical in size or power, are sufficiently near to enable valuable and instructive comparisons to be made.

The *Delaware* and *North Dakota* have identical hulls and are nominally of the same power. The *Utah* is of the same length as the other two, but has 3 feet more beam and about

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18 inches more draft, so her displacement is nearly 2,000 tons greater. She is fitted with Parsons turbines.

In the case of these three ships the boilers are Babcock & Wilcox, of standard construction, as supplied to the United States navy for large vessels. The boilers of the *North Dakota* and *Delaware* have 1,439 square feet of grate surface and 61,950 square feet of heating surface. The *Utah* has 1,428 square feet of grate surface, with 64,308 square feet of heating surface.

The following are the results of the *Utah's* official trials at three rates of speed, but it will be noted that the horsepower is only on the main shafts of the turbine and does not include the auxiliaries:

Duration of trial (hours).....	4	24	24
Number of Parsons turbines in use	4	5	6
Speed developed (knots)......	21.04	19.2	12.02
Shaft horsepower	27,038	17,150	3,938
Revolutions per minute.......	323.4	281.7	172.5

The *Delaware* on trial made a maximum speed of 21.56 knots, with 29,043 horsepower for all purposes. The *North Dakota* made 21.01 knots, with 32,307 horsepower for all purposes.

Economical Results Obtained with a Loading Plant.

The enormous savings which can be made with modern loading appliances are shown by figures covering the performance of a new type of crane erected for the first time at the Grasbrook Gas Works, Hamburg, the characteristics of which can be seen in the illustration. The figures will be found of special interest, as a comparison is made with former mechanical appliances instead of with manual labor.

In bringing the jib of this crane into working position it does not drop in the usual way, as its special support on two hinged rods enables it to slide under the tackle, and thus make room for the action of the grab. Thus on sailing vessels the otherwise frequent and extensive repairs to the tackle are avoided, and on steamers there is no danger of collision with the wires for wireless telegraphy. The whole work, in particular the changing from one ship's hold to the other, is much simplified, so that the working pauses are reduced to a minimum. The result of this is an extremely good average capacity, which was assumed at 75 tons per hour for each crane, although, as a matter of fact, an hourly capacity of 100 tons has been attained, and even considerably more when the conditions have been favorable and the hatchways of the steamers of sufficient width.

The statement of the savings made is even more remarkable. Formerly the coal vessels were unloaded by means of a hydraulic and a steam crane, by lowering small trucks of 1-ton capacity into the ship and loading them by hand. During this operation two men were required to control the cranes, with an additional laborer on the steam crane, two men to direct the trucks, and twenty men to shovel in the coal, or a total of twenty-five hands. The discharge of the coal, including transporting to the coal sheds over an average distance of about

A NEW TYPE OF CRANE FOR WHICH GOOD RESULTS ARE CLAIMED IN LOADING STEAMSHIPS.

The Argentine Republic Minister of Public Works has signed a contract for the construction of a drydock at Puerto Belgrano capable of holding the large battleships now being constructed in the United States for government of Argentina. The cost will reach $6,369,000, and the work is to be completed in three and one-half years, meeting the rapidly increasing demands for docking facilities for naval and mercantile vessels.

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390 feet, cost about 6¼d. per ton, and about ½d. extra for steam and lubricating material, so that the total cost of discharging came to about 6¾d. per ton.

Compared with these figures, the attendance on the two unloaders already erected (two further cranes are at the present time in course of construction) is very insignificant, as only two crane operators and four men in the ship—or together six men—are required, representing a saving of no less than nineteen hands. The cost of discharge and transportation to the sheds now amounts to about 3d. per ton, with an extra 1¼d. for current, which will, however, later fall to about ¾d., so that about 3¾d. will be paid instead of the 6¾d. under the former arrangement. This represents a saving of about 50 percent on working expenses, or a profit per annum of about $6,570 (£1,350), assuming the present traffic of 100,000 tons.

In addition to this amount the allowance for reduced time required for unloading, which is calculated at fixed standards, must be taken into account. The time allowed varies according to the size of the steamer, but averages thirty-six hours per 1,000 tons, and an allowance of 6s. is made to the gas works for every hour saved. Now, assuming an average capacity of 100 tons per hour for each unloader, 1,000 tons can be discharged in five hours with the two cranes already erected, or an average of thirty-one hours for 1,000 tons, or more than 2¼d. per ton; even in practical work on a large bulk of coal there was found to be an actual saving of 1¾d. per ton. To keep on the safe side we will therefore take the latter figure as a basis, and even this shows a saving for reduced time in discharging of about $3,407 (£700) per annum, which is increased to about $9,733 (£2,000) by the reduction in the sum paid for wages.

When the gas works are fully built to consume 360,000 tons per annum, the actual saving will be no less than $3,504 (£7,200). As soon as the two new cranes are completed the plant is also intended to transfer coal from seagoing vessels into barges, as shown in the illustration, for the use of the gas works Barmbeck and Billwärder. For this service an allowance will be made to the Grasbrook works of about 8¾d., this rate including about 2¾d. for the cost of current. The profit here will therefore be about 6d., or, including the saving for reduced time in unloading, 7¾d., which would represent a further profit of about $28,226 (£5,800) on a yearly consumption of 180,000 tons. The total profit accruing per annum is therefore no less than $63,265 (£13,000), which would cover the entire cost of the plant in about one year's time.

This plant has been constructed by Messrs. Adolf Bleichert & Company, London and Leipzig.

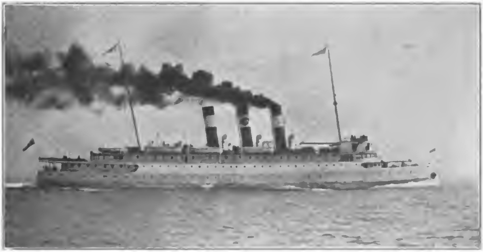
TWIN SCREW PASSENGER STEAMER PRINCE RUPERT.

The *Prince Rupert* was built by Swan, Hunter & Wigham Richardson, Ltd., at Wallsend-on-Tyne, to the order of the Grand Trunk Pacific Railway Company of Canada. R. L. Newman superintended the building of this vessel and another similar one. These steamers inaugurate a new service between Prince Rupert, which is the western terminus of the Grand Trunk Pacific Railway, and Vancouver, and thence to Victoria at the southern end of Vancouver Island, and onwards to Seattle or Tacoma.

The steamer has a smart appearance with its straight stem and cruiser stern. There are two pole masts and three funnels, the center one bearing the flag service of the company, viz.: a maple leaf in a circle traversed by a band bearing the initials G. T. P. The rounded cruiser stern has been adopted in order to obtain the best lines to give high speed. On service the ship will run at 17 to 18 knots an hour, though about 19 knots may be attained. The principal dimensions of the *Prince Rupert* are 320 feet over-all in length, 42 feet 2 inches in breadth, with a depth of 18 feet to the main deck. The ship is built to the highest class under the British Corporation survey, and also complies with the Board of Trade regulations for passenger steamers. The gross tonnage is 2,850. The engines and boilers, with Howden's forced draft, were constructed by the Wallsend Slipway & Engineering Company, Ltd. The former consist of two sets of triple-expansion engines, balanced on the Yarrow, Schlick and Tweedy system.

On the shelter and shade decks are staterooms of two berths each for about 220 first class passengers. There are also a few sets of staterooms *en suite* on the shelter deck amidships. Second class passengers are carried on the main deck forward. When occasion arises about 1,500 excursionists can be taken on board. A pleasant feature of the first class accommodations are two spacious corridors running fore and aft, one on each side of the engine casing, and to enhance the general appearance light is given from several domes in a long roof, which also has a clerestory. This design, besides affording plenty of light and ventilation, gives a lofty appearance to the interior. The dining saloon on the main deck is at the extreme after end of the vessel. The rounded shape of the cruiser stern makes a handsome room, which is furnished and paneled in oak. Instead of having large tables there are several small ones placed in bays. Immediately forward of the dining saloon are the stewards' pantries and the kitchens.

At the after end of the shade deck is a handsome smoke-



STEAMSHIP PRINCE RUPERT FOR THE GRAND TRUNK PACIFIC RAILWAY COMPANY.

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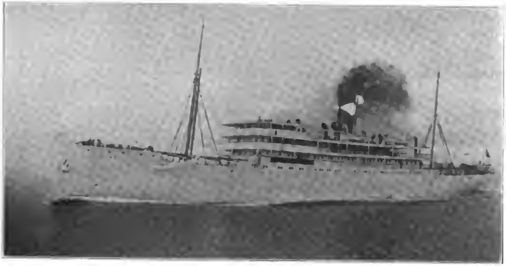
room for first class passengers, paneled in fumed oak. The second class smoke-room is at the forward end of the shelter deck. There are special accommodations for ladies in the shape of a music room, daintily furnished in light colors, the painting being white enamel. The main staircase is a notable feature, the paneling of the walls being in white enamel and the balustrades of wrought iron elegantly designed. The promenade on the shade and boat decks is spacious. On the shade forward of the funnels is the observation room, paneled in maple and sycamore. This room is specially lofty and well lighted by very large square windows, allowing passengers to have an uninterrupted view of the scenery en route. The cabins in all the deckhouses have wide rectangular sliding windows, provided with jalousie screens. The *Prince Rupert* has a wireless telegraphy installation, refrigerating machinery for ship's stores and dairy produce, electric light and steam heating throughout. The rudder is of the balanced type, wholly below the waterline, and is actuated by a telemotor steering gear.



STEAMSHIP METAPAN DESIGNED FOR THE WEST INDIAN FRUIT TRADE.

FRUIT STEAMSHIP METAPAN.

The *Metapan* is the twelfth vessel built by Messrs. Workman, Clark & Company, Ltd., Belfast, for the Tropical Fruit Steamship Company, Ltd., Glasgow (Messrs. Clark & Service, managers), and, like her sister vessels the *Santa Marta* and *Almirante*, has been specially designed and constructed for the West Indian fruit trade. She is 394 feet in length and has a gross tonnage of over 5,000 tons. A special feature of the vessel is the accommodation for over 100 first class passengers. The staterooms are roomy, arranged for two and three persons, and include a number of special rooms with iron bedsteads and artistic furniture and having lavatories adjoining. The public rooms include a large, well-lighted dining saloon, with tables arranged on the restaurant system; a spacious entrance hall, arranged so as to mitigate as far as possible the congestion which frequently occurs at time of embarkation; a luxurious music room, opening off the entrance hall, and a comfortable smoke-room. All these rooms have been arranged and furnished with a view to securing the utmost comfort and pleasure of the passengers, the furnishings and decorations being of the most luxurious and artistic character, while the lighting and ventilation of all the rooms, private and public alike, have received most careful consideration.

The cargo space is divided into eight compartments, which have been thoroughly insulated and arranged for the carriage of fruit cargoes in bulk, and the preservation of these cargoes is ensured by the installation of an efficient plant of refrigerating machinery for the provision of cooled fresh air, which is delivered through ducts to each of the compartments by electrically-driven fans, thus securing the maintenance of an equitable temperature at all times. Access to the holds is by four large hatchways, equipped with steam winches, derricks and other appliances necessary for expeditiously dealing with a general cargo and fruit in bulk, while a special steel derrick is provided for lifting exceptionally heavy weights. The vessel is propelled by a set of improved triple-expansion engines, supplied with steam from five single-ended steel multi-tubular boilers working under forced draft. The *Metapan* has been built under special survey for the highest class in the British Corporation Registry of Shipping, and fulfills the requirements of the British Board of Trade and the United States Steamboat Inspection Service.

This vessel is a striking example of the embodiment in one design of the features developed in recent years to provide for the comfort and safety of passengers and the economical distribution and handling of freight. The trials and the initial voyage of the ship proved the efficiency and reliable action of her propelling machinery.

ENTRANCE HALL ON THE METAPAN.

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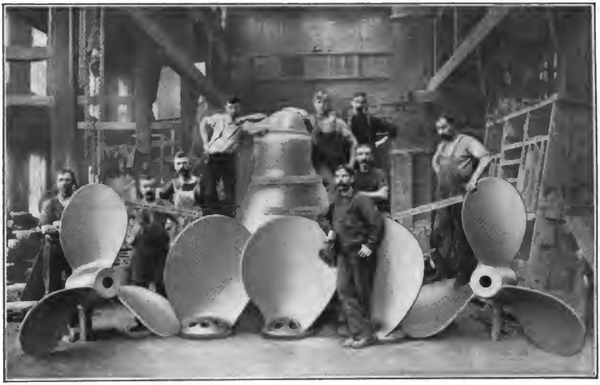
—PROPELLERS—

WHAT IS THE FIRST REQUISITE FOR A PROPELLER?
A HIGH GRADE COMPOSITION METAL.
WHAT ARE THE ESSENTIAL CHARACTERISTICS OF THIS METAL?
GREAT STRENGTH, TOUGHNESS AND NON-CORROSIVENESS.
HOW CAN THESE ESSENTIALS BE GUARANTEED?
BY USING VICTOR VANADIUM BRONZE.



Like few other high grade compositions, Victor Vanadium Bronze is non-corrosive in salt water. It is very strong and tough, as well as ductile, showing a tensile strength of 70,000 lbs., and an elastic limit of 40,000 lbs., and it has a very close molecular structure.

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VANADIUM METALS COMPANY

GENERAL OFFICES - - - - PITTSBURGH, PA.

FOUNDRIES - - - { EAST BRAINTREE, MASS.
GROTON, CONN.

New Vessels for the Porto Rican Service.

Steamships *Corozal* and *Montoso* have just been added to the fleet of the Porto Rico Line. The design and specifications for these vessels were prepared under the direction of Mr. Franklin D. Mooney, vice-president of the line, by Theodore Ferris, of Cary Smith & Ferris, the New York architects. The vessels were built by the Newport News Shipbuilding & Dry Dock Company. The contract for both vessels was let on July 12, 1910; the keel of the *Corozal* was laid on September 28; the vessel was launched on December 31, and left the builder's yard on February 19. This is a record of 188 working days from contract to completion.

The vessels were designed for the sugar and general merchandise trade, with a steel lower deck, cargo ports, large hatches and a specially complete outfit of winches and cargo booms. The dimensions are as follows:

Length over all	347 feet 7 inches.
Length (Lloyds)	334 feet 5 inches.
Beam, molded	46 feet 9 inches.
Depth, molded to main deck	25 feet.
Load draft	20 feet.

The vessels were built under special survey of Lloyds and to their highest class. They make a speed of 10 knots in service when loaded with about 4,700 tons deadweight. This speed is maintained on a consumption of 22 tons of coal per day. The vessels have a complete double bottom all fore and aft, a complete lower deck, and the main deck is flush with the steel bulwarks. There are two tiers of steel houses amidships, with teak pilot house above and a small steel house aft. There are two masts and two derrick posts, with a total of eighteen cargo booms, one of which is designed to handle 30-ton loads. The booms are served by eleven winches. Two of the cargo hatches have a length of 26 feet, two 23 feet 10 inches and one

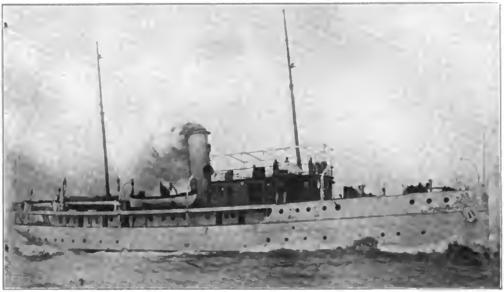
A RECENT ADDITION TO THE FLEET OF THE PORTO RICO LINE

AFTER DECK OF THE MONTOSO.

FORWARD DECK OF THE MONTOSO.

13 feet. The beam stanchions are wide-spaced, with girders, and a watertight bulkhead is fitted to divide the fore hold. There are four cargo ports on each side for trucking freight from the lower deck. The machinery is located amidships, with a large cross bunker below the lower deck. The space between the lower and main decks abreast the machinery casings is arranged for carrying either coal or cargo. The total space under deck available for cargo is about 236,000 cubic feet. The officers have very complete quarters in the 'midship houses. The firemen and seamen sleep in the after house and mess amidships.

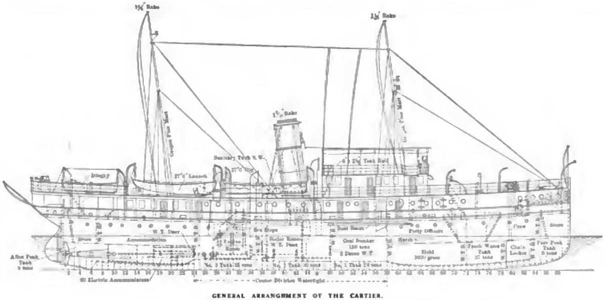
The machinery consists of three single-ended Scotch boilers built for 190 pounds working pressure, natural draft, and one triple-expansion engine with cylinders 21½ inches by 36 inches by 63 inches diameter by 42-inch stroke. The steam auxiliaries are unusually complete. The propeller is of the sectional type with manganese bronze blades. In accordance with the general custom the main machinery was built at the shipyard, and the detached pumps, except the circulating pump, together with the deck machinery, were built by outside manufacturers. The machinery develops about 1,300 indicated horsepower in service at sixty-nine revolutions per minute. A third vessel of identical design is under construction at Newport News for the same line, building under the supervision of the designers. The three pictures give an excellent idea of the general appearance of the vessels and of the unusually complete cargo-handling appliances.



STEAMSHIP CARTIER RECENTLY BUILT FOR THE HYDROGRAPHIC SERVICE OF THE CANADIAN GOVERNMENT.

CANADIAN SURVEY STEAMER CARTIER.

The twin-screw steamship *Cartier*, built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at their Neptune Shipyard, Walker-on-Tyne, for the hydrographic service of the Canadian government, is illustrated in the accompanying engravings. The *Cartier* has been specially designed for survey work principally on the eastern shores of Canada, and in its design and equipment regard has been paid to the fact that on



GENERAL ARRANGEMENT OF THE CARTIER.

occasion voyages will be for long periods. The general particulars of the vessel are as follows:

Length	173 feet 6 inches.
Breadth	29 feet 1½ inches.
Depth, molded to upper deck	15 feet.
Gross tonnage	555.7 tons.
Net tonnage	234 tons.
Deadweight capacity	230 tons on 11 feet.
Displacement	1,035 tons.
Draft	12 feet 8 inches.
Service speed on trial	11½ knots.

The *Cartier* is fitted with twin-screw triple-expansion engines, with cylinders 11½ inches, 18 inches and 31 inches by 24 inches stroke; is supplied with steam by two cylindrical multi-tubular boilers, 10 feet 6 inches diameter and 11 feet 6 inches length, having a pressure of 185 pounds, and working under Howden's system of forced draft. As will be seen by a reference to the drawing there are many watertight compartments in order to ensure the safety of the vessel when in uncharted waters. On the lower deck, aft, is accommodation for the hydrographic staff, consisting of saloon, bathrooms, living room and four staterooms; and, forward, on the same deck is accommodation for the petty officers, seamen and firemen. On the main deck, aft, is a deck saloon and messroom for the hydrographic staff, with pantry and stewards' stores adjoining, and forward is the messroom for the navigating and engine staff, with pantry and stewards' stores and two staterooms for the second and third engineers and mate. In the forecastle side houses is wash-room and bath-room accommodation for the crew and petty officers on the port side, and carpenters' shop and coal storage on the starboard side, while immediately under the forecastle is storage room for gasoline in tanks. On the shade deck is a "Lucas" sounding machine, arranged on the bulwark rail on the port side, and towards the center, abaft the main mast, is a double-cylinder vertical sounding winch, constructed by Messrs. Clarke, Chapman & Company, Ltd., of Gateshead-on-Tyne. This winch has cylinders 5 inches in diameter and 6 inches stroke, and is fitted with whipping drum 9¼ inches in diameter keyed directly onto the crankshaft. The drum is fitted outside of the frame clear of the engine, while the other end of the shaft is fitted with brake hand-wheel. The winch has reversing valve, screw-down stop valve, etc., and is mounted on a cast iron bedplate with a trough cast on it to prevent oil and water running over the deck. Amidships on this deck is the chartroom and pilot-house, with bedroom and day room for the sailing master. The chart room, 15 feet by 7 feet, is fitted with a special drawing table, 5 feet by 10 feet, built in three thicknesses of pine, the front and frame being of oak. There is accommodation for a total crew of forty-three, including officers and engine men. The auxiliary machinery consists of a steam windlass (Clarke, Chapman & Company), steam and hand-steering gear, by John Hastie & Company, Ltd., of Greenock, and a refrigerating engine of the No. 3 single vertical marine (CO_2) type, by Messrs. J. & E. Hall, Ltd., of Dartford, Kent. There is steam heating throughout the vessel, and in all rooms and toilets, with the exception of those under the forecastle, are steam radiators, each having 25 square feet of heating surface for every 1,000 feet.

As the *Cartier* may be required to work in extremes of temperature, an elaborate system of ventilation has been introduced. In shallow water the staff of the *Cartier* will leave the steamer and conduct surveys in launches and boats, afterwards returning to the vessel to work up their observations. Accordingly, there are provided two gasoline (petrol) launches, each 27 feet by 6 feet 7 inches by 3 feet, as also two gigs, 27 feet by 6 feet by 2 feet 5 inches, and one dinghy, 18 feet by 5 feet 4 inches by 2 feet 2 inches. The steam winches, provided for the housing of the boats, are arranged with special leading blocks, so that they may be used for hoisting any one of the four boats. There is an electric searchlight on the bridge, and the other special outfit of the vessel comprises a standard compass of the Lord Kelvin navy pattern, while the steering compasses include a Ritchie standard compass and a Wilson & Gillie compass. The *Cartier* was built from the designs and under the superintendence of R. L. Newman, of Victoria, B. C., consulting naval architect for the Canadian government.

French Turbine Steamer Charles Roux.

The most notable feature of this new addition to the French mercantile fleet is her turbine machinery, the first to be installed in so large a French-built steamer. Her speed of 20 knots will reduce the cruising of the Mediterranean from Marseilles to Algeria very considerably. In fact, she will make the passage in twenty hours. The following are her general dimensions:

Length over all	400 feet 8 inches.
Length between perpendiculars	378 feet 5 inches.
Beam	45 feet 7 inches.
Depth	26 feet 2 inches
Draft, forward	15 feet 1 inch.
Draft, astern	20 feet 4 inches.
Displacement, full load	4,610 tons.
Gross register	4,104 tons.
Net register	3,055 tons.
Indicated horsepower	10,000
Mean speed in service	20 knots.

Accommodations for passengers on this steamer are superior to those of *La Provence*. The hull is built of mild steel from latest improvements in order to obtain the highest rating in the French Bureau Veritas.

A double bottom has been worked from stem to stern, with a total capacity of 197 tons of water, which is quite sufficient to give the vessel the best trim. She is divided into eleven watertight compartments and fitted with watertight doors, which may be closed from the navigating bridge in forty seconds.

Vertically, she is divided by three steel decks, worked from end to end. The twin deck is used for third class passengers; the main deck for first, second and third class passengers and crew; the spar deck by the first and second class passengers only; the promenade deck is used exclusively by first class passengers.

The turbine engines are by far the most interesting part of the ship. They are located in a special watertight compartment, situated very far aft. They require considerably less room than the reciprocating type of engine, and are at the same time extremely simple to handle.

These turbines drive three propellers, 6 feet 3 inches in diameter each, with a pitch of 5 feet 7 inches, and they are run at 440 revolutions per minute.

The central propeller is driven by the high-pressure turbine, and the two outboard propellers are driven by low-pressure turbines.

Steam is supplied to the main engines as well as to all auxiliaries by eight cylindrical marine type boilers fitted with the Howden forced draft. They were built by the Chantiers de l'Atlantique, and the turbines were built by the Electro Mecanique Company of L'Bourget, Paris. The dimensions are as follows:

Length	11 feet 2 inches.
Diameter	16 feet 1 inch.
Number of furnaces	32
Grate surface	619

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Heating surface ....23,710 square feet.
Working pressure .... 157 pounds.

Two big funnels are used. The lighting throughout the ship is electrical, 900 lamps being provided. The air of all the compartments and the hold is renewed ten times per hour. Steam radiators are supplied throughout which are able to maintain under all conditions a temperature of at least 70 degrees F. Refrigerating apparatus is supplied in order to care for the fruits which are a large part of the cargo from Algeria. Most of the auxiliary apparatus is electric-driven.

Bow-on Collisions.

The result of a bow-on collision with an iceberg is shown by our illustration. The *Columbia* of the Anchor Line ran into an iceberg at a very slow speed during a dense fog, and while no lives were lost several passengers were quite severely injured, being thrown down by the impact. It is not hard to imagine what would have been the fate of the vessel if her speed had been even moderate. In this case the wireless apparatus was in working order, but the operator was unable to pick up for a considerable time either a ship or station. The value of strong bulkheads is most clearly evident here, as without them the accident might have been a catastrophe or even a mystery.

In the English Channel the steamers *Josephine* and *Dobrogea* collided, and we reproduce a photograph of the *Josephine's* bow. The plates on the port and starboard bow seem to have been most symmetrically forced back and the stem maintained its vertical position. The quick bend of the metal on the starboard bow resulted in cracking the material, as can be clearly seen. Neither of these vessels required assistance to make their ports after the accident, and here again the value of the bulkheads is made apparent.

CRUMPLED BOW OF THE COLUMBIA AFTER COLLIDING WITH AN ICEBERG.
(*Photograph by Levick*)

DAMAGE TO A LAKE FREIGHTER AFTER SINKING A STEAMSHIP.

In July the Great Lakes freighter *William Henry Mack* during a dense fog rammed and sank the steamer *John Mitchell* in Lake Superior. The accompanying picture shows the serious damage done to the bow of the *Mack*. She was hauled out for repairs in the yard of the American Shipbuilding Company. These illustrations show the local weakness of steel ships, but they emphasize the value of collision bulkheads when built sufficiently strong and watertight.

BOW OF THE JOSEPHINE AFTER COLLISION, SHOWING CRACKED METAL.

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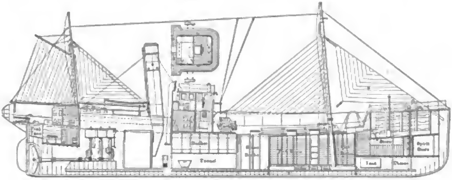
A STEAM TRAWLER FOR THE FRENCH NEWFOUNDLAND FISHERIES.

Steam Trawler Notre Dame des Dunes.

The steam trawler *Notre Dame des Dunes* was built for the French Newfoundland fisheries, and by Messrs. Cochrane & Sons, Selby. Her length is 160 feet; beam, 25 feet, and draft, 14 feet 6 inches. The engine with which she is fitted was built by Messrs. Amos Smith, of Hull. The cylinders are 14, 23 and 38 inches in diameter, the stroke being 27 inches. The boilers are of Scotch marine type, 14 feet 3 inches in diameter by 11 feet long, and carry a working pressure of 180 pounds. The steam trawl winches have great capacity, being able to carry 1,000 fathoms of warp on each drum, and all appliances fitted are of the best for deep-sea fishing. An electric light plant furnishes light for all hands, adding to the comfort of the officers and crew. The arrangement, as shown in the sectional view, is worthy of study. Great care has been taken to obtain an extremely large coal storage, necessitated by the vessel having to keep the sea for a long time. Two spare coal bunkers are provided, whose contents can be reached through a tunnel. The main coal bunkers extend aft on each side of the boiler-room to the engine-room, and forward of the engine-room completely across the ship between frames 31 and 47. The engine-room force is berthed just abaft the engine-room, but not on the same level as the engine-room floor, but above it. These quarters are comfortable and conveniently situated for those in charge of the engine-room. The crew are all berthed forward, while the officers are quartered amidships in the deckhouse.

A steam steering gear is fitted as well as an anchor hoist. It will be perhaps noticed by many that the deckhouse does not rake with the smoke stack and mast, which gives the vessel an odd appearance at first glance. This vessel fishes the Newfoundland water and also the waters near Iceland.



INBOARD PROFILE OF THE NOTRE DAME DES DUNES.

A Speedy Boat.

The motor boat *Tyreless III.*, built by Messrs. J. W. Brooke & Company, Ltd., Lowestoft, for Mr. F. Gordon Pratt, is one of the very interesting boats of the season. After she was launched there were only two days for tuning her up in preparation for the eliminating trials of the B. I. trophy. The boat made a speed of 30 knots, and the accompanying picture was taken when the boat was on her speed trial.

The hull of *Tyreless III.* was designed by Messrs. Cox & King, and was built by Messrs. Brooke & Company of mahogany. She is equipped with two six-cylinder, 150-horsepower Brooke engines, driving independent screws, one screw fitted below the other. That motor boats of this type prove to be most excellent sea boats is an interesting fact when it is considered they are designed for racing in comparatively smooth water.

THE TYRELESS III, CAPABLE OF 30 KNOTS.

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PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

How the Work was Done by "Coupling."

EDITOR INTERNATIONAL MARINE ENGINEERING:

The letters you sent me about how I repaired a broken crankshaft made me feel pretty good. I will do my best to tell how that coupling job was carried out as close as I can remember it.

I notice one letter goes into figuring, but I know enough not to get tangled up with x, y's and z's, and I accept one gentleman's idea that as the repairs stood all right there is nothing more to be said. As some one put it, "If a thing is too strong nobody finds it out."

In West Indian ports, as long ago as I made them, the repair shops were not fitted out for much more than a rough job. When I found the piece of shaft I looked over the shop and found a crank shaper. I think it was called a "Richards" or "Richardson" shaper. It had a long bed with two working rams and knees, but one had been "carried away" and only the knee was left, but this could be raised and lowered and fed along the bed. The knees were about 16 inches wide. The other tool needed was a 11½-inch lath; they call it a 23-inch swing lath in America. I hoisted the 12-inch length of shaft onto the shaper with a great deal of trouble. I managed to cut the shaft half through by using three lengths of parting tools. I then turned it half round and cut down through the other half. I took care in doing this so as to get a good straight face. I cannot remember just how long it took me to do this, but I think it was fourteen hours. I roughed out for the half-round. The most particular part in doing this was to get the sides parallel. The first side was easy enough, but the second half took a lot of care to set just right, as if I didn't get the width and depth in these slots just the same on both sides I would not get a good fit on my "half moons" or have the couplings stand square. The end of the shaft which I cut off I had put in a lathe, and the stub cut off and the flange faced up good and square. I then had a 6-inch hole bored through the couplings, and turned a 12-inch recess ⅜-inch deep in it. This was for the thickness of the metal I left between the end of the couplings and the slots. I could not go any further with this part of the work until I had the shaft end planed, as the lathe work only took about ten or twelve hours. I took the coupling out of the lathe and set four pieces of scrap iron ¾ inch the proper distance, and turned them off just so my 12-inch recess would slip over them. This brought the coupling absolutely true without any trouble. I can tell you, Mr. Editor, in doing all this work we just sweat blood.

It took a good deal of care when I got the coupling done to get the holes drilled in it just right, and one of them was off and I had to file it quite a bit. After I parted the coupling I clamped the parts together on an angle plate, and planed them off to a line.

It took about eight hours to fit the two halves of the couplings in place and to drill the holes. "I guess," as they say up in America, "most men would have done this job about as I have did it." I want to say that my "First" was a fine mechanic, and I wish I could remember his name to give him credit for much of the work on the job, and especially when it came to laying out and doing the finer parts. He always went by the name of "Rio," as we picked him up at that port.

COUPLING.

Repairing a Broken Shaft.

EDITOR INTERNATIONAL MARINE ENGINEERING:

It seems to me that the repair of the broken shaft on the *Clara Belle* by "coupling" was an admirable trick. The incident is one of thousands which go to prove that the marine engineers are the ones who know how to do things. I believe that the repair is practically as strong as the 11-inch shaft; at least the mathematical treatment of the case confirms this belief, and nothing short of the actual test will ever prove which part of the layout is stronger than the rest.

The fundamental formula for torsion is $\dfrac{S\,J}{C} = Pr$,

where S is the greatest stress per square inch, C is the distance from the center of the shaft to the center of gravity of the element farthest out, and J is a term called the *polar moment of inertia.* Without going into a mathematical demonstration of the origin of J, it can be taken by the reader simply to stand for that part of the resisting moment of the shaft that is the sum of the products of each little area or element of the shaft multiplied by the square of its distance from the center. Each square inch of the shaft offers a certain amount of resistance to torsion, and the value credited to each square inch will depend upon its location in relation to the center of the shaft. The letter J stands for a summation covering the entire area of the shaft, and the values of J for all standard forms are given in tables in engineering handbooks. For a solid circle $J = 1/32 \times 3.1416 \times d^4$, and for a rectangle $J = 1/6\, b \times d\, (b^2 + d^2)$.

By applying the principles explained above to our problem, we have

$$\frac{S\ 1/32 \times 3.1416 \times 11^4}{5\tfrac{1}{2}}$$

for the resisting moment of the 11-inch shaft, and

$$\frac{S_1 \times 1/6 \times 10 \times 6\ (10^2 + 6^2)}{\sqrt{5^2 + 3^2}\text{, or } 6}$$

for that of the tang on the 12-inch shaft. Forming the ratio or proportion of maximum stresses in each part, we have

$$\frac{S}{S^1} = \frac{1/6 \times 10 \times 6\ (10^2 + 6^2) \times 5\tfrac{1}{2}}{6 \times 1/32 \times 3.1416 \times 11^4}$$

concentrating and reducing

$$\frac{S}{S^1} = \frac{2,720}{3,038}\text{, or } \frac{S}{S^1} = \frac{27}{30},$$

approximately. This result shows that the stress in the 6 by 10 tang is slightly greater than the maximum stress per square inch in the 11-inch shaft. But it must be remembered that we have figured on only the 6 by 10 section, whereas there are some 7.7 square inches additional in the two segments at the ends of this rectangle. By taking the segments into account the value of J will be changed for the better; hence it is very likely that the tang on the end of the 12-inch shaft is as strong, or stronger, than the 11-inch shaft.

F. WEBSTER.

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Some Boiler Experiences at Sea.

Editor International Marine Engineering:

There is a little anecdote knocking around, but only partially believed, of a philosopher skipper of a coasting vessel who met with a nasty accident to his boilers. He broke it gently to his owners by telegraphing, "Cannot put to sea. Boiler gone out." His owners thought it was a case for the lunacy commissioners, but wired back, "Light the fires again." The reply was, "Cannot light fires. Boiler gone out through deck." While the experiences to be related are by no means so harrowing as this, they may contain points of interest to other engineers that will make them worth printing.

First of all, however, it may be said that looking after a boiler while at sea is by no means the same proposition as attending to the comforts of a steam installation on land. In the latter case there are usually plenty of tools of all sorts available, if not on the works at least within telephone call, and in case of serious trouble the makers of the boiler can be got hold of and renewal parts dispatched without much difficulty. On board a vessel it is different. Often the supply of tools is not excessive; the materials for repair beyond the ordinary joint rings, etc., have to be sought for, and often trouble occurs just when it ought not to, as heavy weather always finds out the weak places. Even if a vessel can be got to port it is as likely as not a few thousand miles from anywhere where engineering supplies can be bought cheaply, and where, probably, there is nothing to speak of in the way of an engineering shop in the whole place. For this reason the marine engineer is thrown very much on his own resources. Some of the jobs he makes of repair work are crude if effective, until one takes account of the materials and opportunities at his disposal. Then they are oftentimes marvelous.

In one case the top of the boiler round about the main stop valve had become badly corroded and very thin. The cause of this in the first place was due to allowing the gland of the stop valve to leak. This had caused the covering to be worn off the boiler near the valve and corrosion had set in. Ultimately the boiler gave out while steam was being raised. On examination it was found that a considerable area had been affected by corrosion, so that a piece was cut out of the bad plate measuring about 2 feet by 1½ feet. A piece of steel plate about ½ inch thick was found on board, and this was cut down to about 2½ feet by 2 feet. It was then heated and hammered until it was brought as near to the curve of the boiler shell as possible, and holes were then drilled through the boiler shell ¾ inch diameter by about 2½ inches apart. The plate was then put through into the inside of the boiler, and the holes marked off on it while it was in place. After drilling it was bolted and hammered up into its place, afterwards being riveted with rivets made of the best Swedish iron. These rivets, by the way, had to be made on board from bar-iron, as no rivets were procurable. When the riveting was complete, the plate was securely calked, the valve was replaced, and the part where the patch was being lower than the boiler shell, owing to the plate being on the inside of the boiler, was filled up with cement and smoothed over in order to prevent any water lying on the boiler. It was not, perhaps, a pretty repair, but it served its purpose.

Very nasty occurrences can happen owing to improper treatment of boilers. They may stand it for some time, but eventually there is the devil to pay. Some engineers, for example, when giving orders to light the main boiler fires, light the middle ones only, and leave the wing fires until the next morning. They then wonder why the boiler begins to leak at the seams on the bottom. A little consideration will show that the top will be hot, under such circumstances, long before the bottom is heated up, and therefore unequal expansion will follow, with the inevitable result of leaky seams. The proper way to treat a boiler is to light all the fires at once and to keep on circulating until the steam is fully up. A marked difference in the state of the seams will be found with careful treatment of this kind.

Another thing in the treatment of a boiler which requires careful watching is the use of mysterious compounds known as boiler fluids. Some of these are good, others are not; even with the best of them they ought to be treated as physic and given to the boiler in measured doses. Reckless use of such materials may easily lead to serious trouble. On one occasion a Fox tube, forming the center furnace of a boiler having three furnaces, collapsed suddenly, and the cause of the collapse was found to be owing to the reckless use of such a boiler fluid. This liquid was supposed to bring the scale off the water-side of the heating surfaces, and the chief engineer used the fluid in unduly large quantities. The result was that so far as the small tubes and the tube plates were concerned, the scale was brought off most effectively, and the same action occurred on the tube crowns of the wing furnaces. The unfortunate part about it was, however, that all the scale ran down upon the crown of the center furnace tube, with the result that it became overheated and laid down for a rest upon the fire-bars. As soon as the occurrence was discovered the dampers of the faulty boiler were at once closed, and steam was taken off the boiler by opening the engines full out, putting the cold-water feed upon the other boiler and running the ballast donkey pump. As soon as it was safe to do so the boiler with the damaged furnace was shut off until the collapsed furnace tube had been built up hard and solid with fire-bars, firebricks, scrap iron and anything else safe and handy. Then the other two fires were set away in the boiler, which was then only worked with the wing furnaces. The voyage was completed by using steam at a reduced pressure, and the danger of too much boiler fluid was amply demonstrated.

One rather lively experience in connection with a boiler furnace tube shows the inadvisability of thinking that they will work forever and a day. In one old steamer a piece of metal about 1½ inches wide and 2½ inches long blew out of the center furnace tube, which was plain, slightly above the line

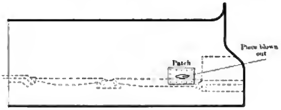

Fig. 1.

of the fire-bars and a little in front of the bridge, as shown in Fig. 1. The engineer on watch when the occurrence happened, on hearing the noise (which was considerable), went to the stokehold, but could see nothing but steam. He could, however, hear plenty of water flying about. He therefore went back to the engine room and had a look at the gage glasses. He found that the water was rapidly going down in the port boiler, and therefore put the extra feed full on, shut the other check down in the remaining boiler, opened the engines out, shut the main damper, and got the donkey feed pump under way as well. By this time the chief engineer had got to the scene of action, and together they made an attempt to get into the stokehold, but they had to come out again in a hurry. Of course, they knew that the trouble was located in the port boiler, and as soon as the steam got right back they shut this boiler off. They eased the safety valve and blew all the steam off, the vessel stopping. As soon as this was done they succeeded in getting into the stokehold, from which the firemen had escaped, one with a very bad scalding. The place presented a rather disorganized appearance, as the furnace had no fire-bars in and everything loose had been distributed round the stokehold. Steam was got up again in the starboard boiler, and the ship proceeded again at half speed on one boiler, while the hole in the port boiler was repaired by putting a patch on the inside of the furnace tube, as shown in the first sketch. The patch was secured by ¾-inch bolts, and to stop the fire from burning the double thickness of plate which was now on the furnace tube, due to the patch, the bridge was built further out so as to come over the bolt heads and so protect the weak part. Steam was then got up again, and the repair carried the vessel safely to port. The cause which led up to this piece blowing out was that pitting had gone on to a very considerable extent at this point and trouble was expected, though not to such an alarming extent. It should be said, by the way, that the joint between the patch and the furnace tube was made with Portland cement and gauze wire. The way the repair was effected may not recommend itself very much to the aristocrats with unlimited engineering means at their disposal. The "classy" way of effecting a repair on a furnace tube would be to bevel the hole, and then bevel the plate which forms the patch. Then the patch should lie on the fire side, and thus, theoretically, there would only be one thickness of metal. But the practical marine engineer who attempts to make the repair in this way while the vessel is at sea is either an extraordinarily clever fellow or else he has bitten off more than he can chew.

Another instance of first-class trouble in a boiler due to apparently insignificant causes can be related. In this case the wrapper plate of the combustion chamber of a boiler became

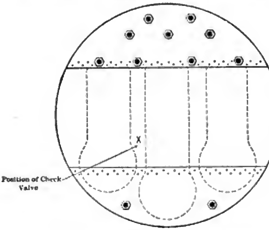

Fig. 2.

holed owing to the way the feed-water impinged upon it. Fig. 2 shows generally the way in which the boiler was arranged with the position of the check valve on the end of the boiler. Fig 3 shows more clearly the shape and general arrangement of the internal pipe leading from the check valve into the boiler. It will be seen that this internal pipe was screwed on to an extended spigot which passed through the hole in the boiler plate back of the check valve flange. This internal pipe, as originally fixed in the boiler, was arranged to stand in an upright position, but in course of time it became loose on the screwed spigot and turned round till it hung downwards. This caused the water to be discharged into the boiler in a stream, which impinged onto the wrapper plate of the combustion chamber. The result was that the local action of the cold feed water upon the hot plate soon weakened the latter, and ultimately this weak part was blown out. The repair of this failure necessitated the blowing down of the boiler and waiting till it was cool enough to enter. The hole was then patched with a plate on the fire-side, the bolts being put through from the water side and the nuts being therefore on the fire-side of the plate. The task of getting this plate bolted up into place will be seen to have been no easy one, when it is considered how all the small stays of the boiler got in the way of the engineers while at work. When the job was done the internal pipe was secured

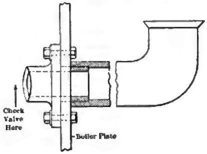

Fig. 3.

in its proper position so that it would not turn round again. This pipe was about 18 inches long, and stood in between the two combustion chambers, the back plates of the combustion chambers being about 7 inches off the back of the boiler. The wrapper plate was holed in the plain part a little distance from the cover seam.

A little negligence goes a long way towards causing trouble in connection with a boiler, and the firemen need to be carefully watched in this respect. A word may be said regarding the habit of leaving the hot ashes on the footplates near the boiler. This is a very bad practice indeed and should not be allowed on any account. Apart from the danger to boiler doors the front plates of the boilers in time become burnt, necessitating expensive repairs. Moreover, if the ashes are cooled by throwing sea-water over them, and the ashes allowed to lie there in this wet state, one of the best ways of starting external corrosion of the boiler plates will have been indulged in, and this practice will sooner or later involve disaster if it is not noticed in time. An instance where a repair, which, although of a minor character, is sufficiently typical, occurred through the firemen allowing the clinkers to remain on the footplates after cleaning the fires, is illustrated in Fig. 4.

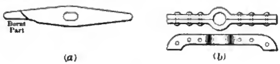

Fig. 4.

In this case the trouble was located in the dog of a boiler man-hole door. This was on the bottom boiler door, and in the stokehold, and the firemen allowed the clinkers to remain, covering the door. The result was that the dog got burnt to the shape shown in the sketch (*a*) and the engineer of the vessel rightly considered it unsafe, in its weakened state, should there be a vacuum formed in one of the boilers when the steam was off. It, therefore, became necessary to extemporize a new dog as shown in plan and elevation in (*b*) by bending two pieces of iron to the shape indicated, drilling 1-inch holes through them, and then riveting the two pieces together. This made a good strong dog.

Trouble does not always occur in the main portions of the boiler. The smallest details have to be watched as well. This was shown in a happily little experience which occurred

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with a salinometer cock. The engineer one day went to open the cock in one of the boilers to draw some of the water in order to take its density, and to his surprise the cock flew out of the shell as soon as it was turned, as the thread in the gland nut had stripped. The engineer found the cock again and, at the expense of being scalded to some extent, he managed to get it into place again by holding it over the shell and giving it a sharp tap with a hand hammer. He then hung on to it and held it down in its place until one of the other engineers arrived and bound it down with some copper wire. In order to make a permanent job of the matter, two small plates were cut, as shown in Fig. 5, and these were arranged with two ⅝-inch bolts and nuts so that they braced the parts

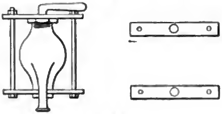


FIG. 5.

of the cock together, as shown in the illustration. This arrangement left the cock so that it could be worked in the ordinary manner without danger.

Every engineer with sea-going experience will know the great difficulty which is experienced with the packing of boiler fittings, so far as the material used is concerned. It is oftentimes a most tedious and difficult matter to deal with a refractory stuffing box, so far as the trouble of getting the old stuffing out is concerned. The packing has often to be cut and chipped out with a hammer and chisel, as it becomes, in contact with water, hard with encrusted salt and in addition is baked solid with the heat of the boiler and stokehold. The amount of time taken up by chipping and picking the old packing out is enormous, and it is to be feared, if one may go by the unpleasant appearance in some stokeholds of leaky glands with great lumps of salt sticking to them, that the job of repacking is sometimes shirked when it ought to be attended to without delay. One engineer, impressed with the trouble and annoyance in connection with the use of ordinary packings, made the experiment of trying lead as packing for some of the stuffing boxes of his boiler mountings, and he found that the idea worked splendidly. In order to pack a stuffing box, he first cleaned it out thoroughly and then carefully rubbed the valve spindle and stuffing box over with some black-lead powder on every part which would be covered by the lead. He then ran the stuffing box up to a certain distance with molten lead, leaving sufficient room, say a quarter of an inch, for the gland to enter. When the gland was put on and tightened down, it was packed in a way which lasted for years without any further trouble. The only thing necessary when opening or shutting the valves was to slack the gland back a little before beginning the operation, and to tighten it up again after the valve had been turned. With the heat of the boiler the lead was kept somewhat soft, but, of course, never obtained its melting point, which is between 400 degrees F. and 500 degrees F., as the boiler water did not reach that temperature. This method of packing is not to be advocated indiscriminately for every gland to be found on a boiler, as some valves, such as the main check valves, are constantly being worked, and such a packing would not be suitable. Where, however, valves are only used intermittently, say once or twice a week, such as, for example, the scum valves, blow down valves, etc., this form of packing gives excellent results, and may be recommended to sea-going engineers with confidence.

In conclusion, it need hardly be said that these notes do not pretend to cover or even hint at the range of possible breakdowns which may occur on a marine boiler. Unfortunately, the variety of trouble which can happen with a boiler is almost endless, and a book could be written on this subject alone. The above remarks are, however, typical of some of the things which a marine engineer has to look out for, and if they stimulate other engineers to contribute their experiences on parallel lines they will have served their purpose.

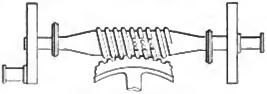
An Old Contributor.

Broken Worm of Steering Gear Engine Shaft.

Editor International Marine Engineering:

An old friend of the writer once told him that if he wanted to form an opinion as to the way an engineer on board of a vessel looked after his machinery he did not go first to the main engines, but to the auxiliaries. He argued that the main set was the show piece, and anyone worthy of his salt would keep that right; but the small details of the auxiliary gear were what tested a man's capacity for thoroughness and strict attention to every item that might lead to trouble. There is more in this view than some people suppose, and very frequently most harassing difficulties arise out of apparently unimportant parts of a ship's machinery. The moral of this is, that the fourth engineer, who is usually told off to look after the auxiliaries, requires just as careful watching as the second and third.

In addition to this, owners of vessels very frequently fall into the mistake of trying to economize on the auxiliaries. They will buy a set of main engines with due regard to their performance, but any old thing will do for the donkey pump if it is cheap enough. It would hardly be thought that this would apply to such an important part of a vessel's equipment as the steering gear, but it sometimes does. For example, it is the writer's opinion that, as a general rule, the worms and the worm wheels of steering gears do not receive as much oil as they should. Some makers take care of this point, but others do not. The result is far too rapid wearing on the worms, and eventually considerable trouble.


BROKEN WORM STEERING GEAR.

If the worm wheel is a vertical one a very good plan to avoid a lot of bother due to this cause is to make up a small oil bath out of galvanized iron sheet of a suitable shape to encase the lower portion of the worm wheel. By keeping this supplied with oil, the oil is carried up to the worm with the revolution of the wheel and an immense amount of wear is saved. It will be found that the worms always wear much more quickly than the worm wheels, and for this reason due regard should be paid to the class of oil used. It is advisable to use a good thick, heavy oil, as light oil is of no use. A very good plan to give good results is to take ordinary marine engine oil and make it properly thick by melting white lead and mixing this with the oil.

The sketch shown herewith gives a rough idea of what happened to the worm of a steam gear engine shaft. Owing to the worm having worn thin it got broken, due to the back-lash which occurred on the worm wheel attached to the chain drum. This back-lash was caused by the rudder lashing about from side to side in heavy weather, and, therefore, the accident

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occurred at a most inconvenient time, as most accidents do. Incidentally it may be remarked that the heavy strains thrown on the chains, drum and worm wheel are often not appreciated. When the rudder is put hard over these are tremendous, so that proper supervision should be given to them. In this case, when the worm broke, the engine jammed itself and stopped. As repair was urgent, a series of ¾-inch tapping holes was drilled in the shaft with the holes close to each other, and in such a manner as to run in line with the worm. These holes were then tapped and ¾-inch studs were screwed tightly in. They were then chipped down to the same dimensions or profile as the rest of the worm. The repair fortunately held good throughout the voyage, although heavy seas were encountered, and got the vessel home without further difficulty.

At Sea. The Fourth Engineer.

Mending a Cracked Shaft.

Editor International Marine Engineering:

When I first read about a turbine boat I was oiling on a tramp. Now I am the chief of a tramp. Just after I got this position I made a certain English port, and heard the steamship ——— was there, which was fitted with this new style of engine, and I made a straight line for it. I had the good fortune to find a man aboard who had been shipmate with me on two voyages, so I got into the engine room without much trouble, and met another old friend (a shopmate) who was doing some repairs. I took a look around, but those round, barrel-shaped affairs with everything inside of them "looked good to me," as the boys say, and I had about made up my mind that all the troubles of an engineer were at an end, and all that we would have to do in the future would be to turn on steam and "let her buzz." I told Jake, that was my old shopmate, my idea. Now, Jake was a Scotchman with the English name of Lynn. He hand only one eye, and he took a look at me out of that one eye and drawled out, "When you ken a turribinne," and that is as near as I can write down how he pronounced it, "you'll bide in the ship where you are." I got a taste of that later; but I didn't start out to tell about turbines but the repairs to a shaft.

No matter whether you've got a turbine or any other kind of an engine, I suppose we'll always have to have shafts. I show a repaired shaft in the drawing herewith, and I want to tell you, Mr. Editor, that the drawing looks a good deal better than the job, and it's a good deal easier to make the drawing than it was to do the job.

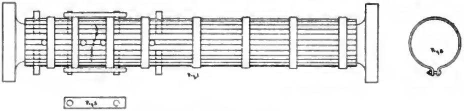
A short time after this visit to the turbine ship I picked up my old shopmate, the Scotchman, pretty drunk, up in Montreal, and for old acquaintance' sake took him aboard my ship as an oiler, and after one trip I took him into the engine room. On my next trip South the first length of the shaft just abaft the thrust cracked, and we discovered it just in time to shut down for inspection and consideration. I knew we had a lot of bar steel on board, and I sent Lynn down to break it out so we could see what we had. He reported there was a lot of 1½-inch square steel about 16 feet long. Now the diameter of my shaft was 12½ inches, so I figured it out that our area of shaft was 122.7. Of course, I could not patch up that shaft so that it would be just as strong as a solid one; but if I put in sixteen 2-inch pins, each with an area of 3.14, I would have about 50 square inches. I started some of the oilers with hack-saws cutting off the 1½-inch bars, so that I could get them in between the couplings and not have them right on the fillets, and I started Lynn and some other men with ratchets drilling 2-inch holes about as shown on the drawing. We drilled them about 4 inches deep, and by shifting the men often we finished these holes in a little over fourteen hours.

I had a small lathe on board, and I cut off from some round stock which was 2¼ inches, and roughed them down to 2 1/32 inches, and as soon as I could caliper the drilled holes I turned the pins down so they fitted good, leaving them sticking out about 3½ inches. I drove these pins in with a light sledge; then I laid the 1½-inch square steel around the shaft, holding them in place temporarily with some small chain we had on board, and it was quite a job to get them in place. Of course, the 1½-inch stuff didn't run perfectly straight or even, and when we came to the last length next the pin I had to do some filing, so as to let the length come in nice and snug.

Before I drilled the holes I got some 4-inch stuff by 1½ inches which we had on board, and cut off two lengths, as shown in Fig. 3. I drilled the two end holes. After I got one of the holes next the crank drilled and the pin in, I put one of these pieces over the pin and used the other end as a jig to drill the second hole. I did this with the second piece, with the idea that this would hold the shaft together; that is, if it gave away it would not back off, and I found this held all right.

Among the firemen I had a man who was a pretty good smith, and he turned up out of some stuff, which was 2¼ by about ⅝ inch, some clamps, shown in Fig. 2. These we drilled in the lathe, and after we got all the 1½-inch stuff nicely set round the shaft we started to spring these clamps around them, and this we found a good deal of a job; in fact, it took a whole lot of time; but we managed to get them on, and passed a bolt through them. I think we put in two, but I do not remember that, and we had the job done, and old man Lynn, when he looked at it, said it put him in mind of one of those old-fashioned things the Romans used to carry about with an axe stuck in the top. But bad as the job looked we thought it was pretty solid, but as we had some ¼-inch wire cable we wound some of this around the bundle to make sure, and we started up very slow, and made our West Indian port about a day and a half late. Of course, there is small chance of getting anything done in the way of a new shaft down there, and as the job seemed to be holding we started in ballast for an American port and made it all right. But the success of this was too much for Lynn, and he, finding a Scotch friend by the name of Whiskey, the first time he went ashore, landed in the lockup, and I guess he is there yet.

Kingston, Jamaica. H. S. G.



METHOD OF REPAIRING A CRACKED SHAFT.

Mr. William Rowland, for many years connected with shipbuilding in New York waters, died July 21 at Spring Lake, N. J., his summer home. His death marks the passing of a type of man to whom the shipbuilding world owes much.

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Whether a community of people are in a ship afloat or in a house ashore, their nature remains the same and the condition in which they have been brought up naturally affects their action. Afloat there exist conditions which bring men closer to each other than those ashore. It is clear that at sea one must do for all and all for one. A very little thought will explain this reason of closer relationship.

Before steam was known there was absolutely no possibility of a division of responsibility throughout a ship. Every order came from the captain; it was carried out by a man trained in exactly the same condition as he. What one said was in a language that had developed from the sea. When, however, steam came this condition changed. Here was suddenly introduced a set of men who did not have the same line of thought or training. Their language differed. "Valves and cylinders" meant nothing to the captain; "port and starboard," "luff and fill" meant nothing to the engineer. It was, therefore, natural that this condition produced friction. The captain saw his skill, obtained by long years of training, becoming less and less valuable, and the self-reliant feeling bred of thorough knowledge grew less and less until the ship seemed to be under the control of another.

The knowledge required to guide a ship from port to port and to handle her under the conditions of storm is of no mean order. The sailorman had to go through a severe and long apprenticeship, and he has always commanded the admiration of the world. What is the outlook to-day? What is to be done? Are all seafaring men to become engineers, or are all engineers to become seafaring men? Or, again, are we to reach such a state of mechanical perfection that there will be no further need of any great intelligence in handling machinery on board a ship? Do not some of the later engineering developments point rather strongly to leaving the high-grade mechanical brains on shore? We have the turbine, which when it goes out of business at sea is apt to stay so. Makeshift repairs seem to be out of the question. From the bridge of a new collier the geared turbines are to be controlled without the intervention of any engineer. The gyroscopic compass may hold a ship on its course more steadily than the best quartermaster to be found. Liquid fuel is changing the fire-room from a glowing seething mass of light and sweating humanity to a room in which are easy chairs. To-day if you buy a cheap watch it is guaranteed for a year, and if you take it back to-morrow on account of some trouble you are handed out a brand-new one and the watch is returned to the factory for repairs. Is it not possible that there will be no repairs whatever at sea? With twin screws every vessel can limp into port, and it can easily be imagined that mechanical things can be so perfected that what might be called a fool-proof system will be worked out, and that every possible condition can be anticipated. The captain of the future ship will be more and more of a mechanician and the mechanician of future ships will be more and more of a sailorman.

The action of the State of Connecticut in respect to the port of New London is important and ought to be far-reaching as to its influence. It is the first movement of comprehensive harbor marine engineering in America. It provides not merely for expert engineering construction, but that which is of greater interest—intelligent operation.

For years INTERNATIONAL MARINE ENGINEERING has urged more scientific development of harbor and dock work, which is so carefully studied and practiced in Liverpool, Antwerp, Hamburg and elsewhere. But for some reason American steamship agents and owners have clung to old methods and have ignored tangible and substantial evidences of up-to-date methods which we have again and again shaken in their faces, as it were. The port of New London has the opportunity to place itself far ahead of New York, Boston and every other American port as the proper place for steamships from all parts of the world to discharge their cargoes expeditiously and economically and reload correspondingly.

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LEGAL DECISIONS REGARDING MARINE WORK.

Injuries from Bursting of Boiler Tube—Necessary Inspection.

A suit in admiralty was brought by the fireman of a steam schooner against the owner for damages for personal injuries sustained by him by the bursting of a water tube in one of the schooner's boilers, resulting in the almost total destruction of one of his hands. The ground of recovery of damages was the alleged neglect of the owner and officers of the boat to keep its watertubes in proper condition. The evidence showed that the tube was overheated, and the trial court found that this was caused by the accumulation of scale or some similar substance in the pipe, whereby the circulation of the water was impeded, resulting in the reducing of its thickness by burning to the bursting point, and that the officers of the schooner were negligent, either in failing to make such inspection as would disclose the existence of the deposit or to take proper steps to remove it if discovered. On behalf of the schooner it was urged that the injuries were caused by a latent defect in the pipe. There were two boilers in the schooner, each of which contained sixteen 4-inch and more than three hundred 2-inch tubes. Expert evidence was given by a government boiler inspector and a marine engineer in the employ of the makers of the boiler in question, tending to show that the bursting was caused by a latent defect in the iron. On behalf of the libelant the exploded tube was put in evidence as an exhibit. It showed that it had been overheated and burned from some cause, and there was testimony tending to show that the cause was neglect on the part of those in charge of the schooner to keep the tubes properly cleaned out. Upon such evidence the court considered it would not be justified in interfering with the conclusion reached by the trial court, and affirmed a judgment for the libelant.—*Maritime Inv. Co. v. Hanos, Circuit Court of Appeals, Ninth Circuit.*

Damage to Cargo from Leaking Pipe.

In a suit in admiralty for damages sustained by a cargo of grain delivered in damaged condition through contact with water while in the hold, it appeared that the water dripped through a crack in the main feed pipe, which extended about 9 feet through the cargo space between the engine and the boiler. The vessel was built eleven years before the accident, which happened in 1905, and had been repaired in 1904. The position of the feed pipe was not unusual in vessels constructed for service on the Great Lakes. She was rated A-1, but after this controversy arose her rating was reduced. The pipe was covered with asbestos. It was inclosed in a wooden box. The pipe was of wrought iron ¼ inch thick and 2½ inches in diameter. Although such pipe comes in lengths long enough to bridge the distance which it ran through the cargo space, two lengths were coupled, not quite midway, but nearer the boiler-room bulkhead. Each length was threaded and screwed into the coupling. After the damage was discovered the pipe was stripped. It was found to be cracked at the bottom of one thread at the edge of the coupling. The crack went just through the pipe, probably three-quarters of an inch long; but the pipe was not broken off. A thorough inspection of the pipe could not be made while the asbestos and the boxing remained on. The last inspection with the covers removed was in 1904, when the vessel was being repaired. The weather encountered was rough, but not unusual at the season of the year (October). It was held that the vessel had not sustained the burden of proving that the leak resulted from a "danger of navigation" within the exception of the bill of lading. Whether the leak resulted because a seaworthy pipe was exposed to some extraordinary strain, or because pipe, weakened by age and by some incipient crack which had developed since its last thorough inspection over a year before, gave way under strains which were to be anticipated, and which would not have broken a seaworthy pipe, could not be said upon the proof. The decree for the shipper in the district court was therefore reversed and the case remanded for further action.—*The Rappahannock, Circuit Court of Appeals, Second Circuit.*

Construction of "Inchmaree Clause" in Marine Insurance Policy.

The owners of a steamship claimed to recover for an average loss under a policy of marine insurance on the hull and machinery of the vessel. The policy was for twelve months against the ordinary Lloyd's perils; and it also contained the clause known as the "Inchmaree Clause." For the purposes of the present case the directly relevant words of this clause are: "This insurance also specially to cover * * * loss of or damage to hull * * * through any latent defects in the * * * hull * * * provided such loss or damage has not resulted from want of due diligence by the owners of the ship, or any of them or by the manager." There was a defect in the ship's stern frame. This defect was covered up by the makers. During the currency of the policy the defect became visible owing to the ordinary tear and wear, and the stern frame was condemned. The assured claimed to recover under the policy the cost of replacing the condemned stern frame. It was held that there had been no loss or damage to the hull, and therefore that the assured could not recover.

The introduction of the "Inchmaree Clause" into marine insurance policies followed an explosion which damaged the machinery of the *Inchmaree*, either through a valve becoming salted up or by the valves being closed by negligence of the engineers. The House of Lords in Thames and Mersey Marine Insurance Co. v. Hamilton, Fraser & Co. (3 Times L. R. 764; 12 App. Cas. 484), held that such a damage was not recoverable either as a peril of the sea or under the general words in a Lloyd's policy. "Inchmaree Clause" was introduced to give the protection denied by this decision. It covers the negligence of servants, explosion and bursting of boilers, and it covers loss or damage through latent defects.

In the court's view what is recoverable under the quoted part of the "Inchmaree Clause" is: (1) Actual total loss of a part of the hull or machinery, through a latent defect coming into existence and causing the loss during the period of the policy. This was the kind of latent defect alleged in the *Inchmaree* case. (2) Constructive total loss under the same circumstances as where, though the part of the hull survives, it is by reason of the latent defect of no value, and cannot be profitably repaired. (3) Damage to other parts of the hull happening during the currency of the policy, through a latent defect, even if the latter came into existence before the period of the policy. The pre-existing latent defect itself is not damage, indemnity for which is recoverable, even if by wear and tear it becomes visible during the policy.—*Hutchins Bros. v. Royal Exchange Assurance, 27 Times L. R., 217 (K. B. Div.)*

Construction of Steamer for Government a "Public Work."

An action was brought under the act of August 13, 1894, Chap. 280, 27 Stat. at L. 278, as amended by the act of Feb. 24, 1905, Chap. 778, 33 Stat. at L. 811, U. S. Comp. Stat., Supp. 1909, p. 948, upon a bond given to the United States, as required by the act, to secure a contract by an engine works to build and deliver a single-screw wooden steamer for the United States. The main question in the case was whether the

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statute applied to a contract for a steamer, or, in other words, whether a steamer is a "public work" within the meaning of the statute, which gives any person who has furnished labor or materials used in the construction or repair of any public work, which have not been paid for, the right to intervene in a suit upon the bond, and is intended, besides securing the United States, to protect persons furnishing materials or labor for the construction of public works. The court held that a steamer is within the statute. By article 3 of the contract in question, partial payments were provided for "as the labor and materials furnished" equaled certain percentages of the total. By article 4, "the portion of the vessel completed and paid for under said method of partial payments shall become the property of the United States," although the contractor remained responsible for the care of the portion paid for. By article 2 there was to be a final test of the vessel when completed. The vessel had been built and accepted, and was then in possession of the United States. Notwithstanding this it was argued that the statute did not apply to the contract, because the laborers and furnishers of materials had a lien by the State law; and that, even if the statute applied, they had lost their rights by not asserting them before the delivery of the vessel, as before that, it was said, the title did not pass to the United States. But the recent decision in United States v. Ansonia Brass & Copper Company, 218 U. S., 452, establishes that the title to the completed portion of the vessel passed, as provided in article 4, and that the laborers and material men could not have asserted the lien supposed to exist. The court did not consider itself bound to read the words "any public work" as confined to work on land. The fact that the bond was not executed until ten days after the contract was signed did not make it without consideration, as the transactions were practically simultaneous. And the assignment of some of the claims did not affect the remedy.—*Title, Guaranty & Trust Co. of Scranton v. Crane Co., United States Supreme Court.*

TECHNICAL PUBLICATIONS.

Engines and Boilers. By W. McQuade. Size, 5½ by 8½. Pages, 87. Illustrations, 62. London: G. Bell & Sons, Ltd. Price, 3/6.

When it is remembered that Mr. McQuade uses but 87 pages to outline boilers, engines, internal-combustion engines and steam turbines, it can be easily seen that but a mere skeleton of the subjects has been presented, but this skeleton is one on which the flesh of further knowledge can be indeed well applied. The author does not pretend to furnish a book the reading of which will result in one becoming an engineer, but he most admirably starts a student in that direction. The illustrations used are admirable. Not a single superfluous line is to be found in any of them, and they really look like drawings such as are made by competent draftsmen and engineers. We regret that at times there is a misuse of names of articles, and this should be corrected in the next issue, as, for instance, on page 5 there is an assertion that the "junk ring is held in place by set screws." Now, set screws are not used for any such purpose, and this is misleading to the student, as is the statement that the starting valve on a locomotive is called a "regulator;" this is found on page 60. We have never heard this appliance called anything but a throttle valve. We do not think the author has been personally and practically in charge of engines or he would never say as he does on page 9 that "the wear at the crosshead pin (connecting rod) is slight." For the student we recommend the book, and we consider it to be extremely interesting to many people who merely take a passing interest in mechanics, as many things in engineering which now seem blind to them will be made clear.

Railway Shop Kinks. By Roy V. Right. Size, 9 by 11¾ inches. Pages, 290. Illustrations, 803. *Railway Age Gazette*, New York-London. Price, $2.00.

No matter who bought this book of Mr. Right's they could not turn a page without learning something. Many might say that the "kinks" shown are old. That may be true, but we do not all know them, and there are a lot of these "kinks" that seem new, at least to us. The International Railway General Foreman's Association, in solemn conclave assembled, passed resolutions in due form to have this book published, and we are all going to be better off for it. We would, therefore, offer in return the following resolutions: That whereas "Railway Shop Kinks" is a valuable book, full of practical information, and whereas knowledge is money in its most valuable form, be it resolved, that the readers of this notice order a copy at once.

Fighting Ships. By Jane. Size, 7¾ by 13 inches. Pages, 548. Illustrations, endless. London, 1911: Sampson Low, Marston & Company, Ltd. Price, 21/ net.

To those who have had any experience in collecting data this publication will awake their admiration. The work is admirably well done. It must be remembered that in making up such a remarkable volume it is with infinite difficulty that certain details, and even generalities, concerning vessels of war are obtained, and absolute accuracy cannot be hoped for, but we are fair when we judge a work by what we personally know, and in turning to fighting vessels which are well known to us we find the detail strictly correct. It is a source of wonder to us, however, that the work can be made to pay, as the cost must be very large and its sale somewhat limited, but there is hardly a publication that has ever come to our knowledge which is more thoroughly interesting from end to end than is this one. A treaty of peace between Great Britain, France and the United States has been debated, and yet the guarantee of such peace must be found in the power to enforce the agreement, and that power lies almost exclusively in the fighting ships of the various nations. To be able to turn to any vessel and find out dimensions, speeds and other valuable information is not only of great interest but of the very greatest convenience, and every naval architect with military inclinations certainly should have this work.

Valve Gears. By H. W. Spangler. Size, 6 by 9¼ inches. Pages, 179. Illustrations, 109. New York: John Wiley & Son. Price, $2.50.

Mr. Spangler asserts that the designing of valve gears is entirely a drawing board process. In all but radial gear, and even in them, this is true to a great extent. He has adopted the admirable system of taking the data of engines that have been actually constructed to illustrate and expatiate on. It does not seem as if there is anything new on the interesting subject of valve gearing, and yet here is put forth in a much more concise way than is usual the results of the labor of many who have given the study of valve gear the closest attention and who have become so thoroughly allied with the subject that their names are synonymous with its study. If the readers have no book on valve gear we know of none which it would be so wise to purchase as this, and if he does buy it and reads it, "marks, learns and inwardly digests" it, he will thoroughly understand valve gear.

Marine Gas Engines and Their Construction and Management. By Carl H. Clark, S. B. Size, 5¾ by 8 inches. Pages, 115. Illustrations, 102. New York: D. Van Nostrand Company. Price, $1.50.

This particular field seems to be pretty well supplied already with books of this character, and in reading it over we do not find any new presentation either in construction or management. Primarily, we should judge the author's idea is to help those who are running engines rather than those who are con-

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structing them, and in this it ought to be successful and a help in many cases.

Answers on Refrigeration and Ice Making. Two volumes. By Gideon Harris. Size, 6 by 8½ inches. Pages, 1,059. Numerous illustrations and tables. New York and London, Theo. Audel & Company. Price, $2 each.

A book of this kind is most convenient for the man who has actual charge of refrigerating machinery, and is also most admirable for all refrigerating engineers to have at hand to turn to. The most insignificant details are carefully noted and explained and illustrated. In many cases the information is given so that the man who is in a great hurry to know just what to do and how to do it can immediately obtain it. The advantages and disadvantages of various systems of refrigeration are made plain, and the temperature at which various products should be kept is clearly set forth. It is self-evident that the writer of the book, Mr. Gideon Harris, is fortunate in his selection of assistants who aided him in making up the book, and the refrigerating world is much better off for their work. If there is one thing to criticise it is the index; but it is a grave question whether it is possible to index a book of this kind so that it could be used to the best advantage until one is thoroughly familiar with it. This is largely accounted for by the line of thought of those who will use the book, but after a very short time we believe that almost anything connected with cold storage and refrigeration can be sought for and found within the covers of the book. It certainly, at times, does not waste words, and this is a very decided advantage; for instance, the question is asked, how much ceiling space is needed? the answer is, "½ inch." Here is a gem.

An excellent table or log is laid out for use with refrigerating appliances, so that what is done can be carefully recorded with a view to bettering conditions from week to week. In short, the work is an addition, and a valuable one, to the literature of refrigeration.

Lloyd's Register of American Yachts. Size, 9½ by 7¼ inches. Pages, 468. Forty-five colored prints and supplement. New York: Lloyd's Register of American Yachts, 17 Battery Place. Price, single copies, $8.50 and $7.

This is the ninth edition of the *Lloyd's Register of American Yachts*, and in it is shown the increased predominance of power over sail boats, the proportion of power craft being even greater than last year. Many important additions to the yacht world were made last year, among them the schooners *Enchantress*, *Elena* and *Karina*. The first, designed by Cary Smith & Ferris, is Class 100 A-1, and is the latest advance in yacht construction. The *Karina*, designed by Theodore D. Wells, is designed for off-shore cruising. The *Elena* is a racing schooner. The *Enchantress* and *Karina* are sailing yachts, but fitted for the ultimate installation of gas engines. One of the most notable additions to the list of yachts is the *Sovereign*, designed by Charles L. Seabury. *La Belle II*. is a steel yacht fitted with triple screws and designed by Cox & Stevens. In the smaller divisions of sailing yachts the additions are limited to 31 feet and smaller classes. The power division, however, includes many new cruising yachts of all sizes from 100 feet down, practically all equipped with gas engines. The *Register* has been slightly enlarged in the last year and thoroughly revised and all the old yachts dropped out. The list includes over 3,500 vessels, 472 yacht clubs and 31 associations within the limits of the United States, Dominion of Canada and the West Indies. The burgees of 456 clubs and associations are given. Estimating closely, there seem to be at least 600 yacht clubs within the territory mentioned. There are the names of 3,300 owners of yachts, with their full address whenever it could be obtained, together with the clubs to which they belong. Yacht builders and yacht designers, also engine builders, builders of yacht equipment, are listed most completely, as well as the manufacturers of miscellaneous fittings for yachts.

Marine Engine Design. By Edward M. Bragg, S. B. Size, 6½ by 8 inches. Pages, 172. Numerous illustrations. New York: D. Van Nostrand Company. Price, $2.

There is much concerning the design of engines in this book which is put in a clearer form than usual. It is evident that the book is the result of a want felt by an instructor. The details of construction are shown, and there are to be found tables which are most convenient to have for ready or quick reference. In commenting on the turning and reversing engines, and giving data for their design, we think the author would find that there is a wider diversity in this respect than anywhere else arising from a fact he did not mention; *i. e.*, that such engines are made usually with very small bearings, as time of operation is never long—in fact, rarely more than a few minutes; consequently small bearings are admissible, and, as a matter of fact, a good many engine builders in making these turning engines are apt to take any design that they happen to have and cobble it up so as to make something which will do the work with comparatively little attention to refinements. We recommend the book to all interested in marine engine design. It is a reprint of the excellent articles which appeared in our columns.

Praktischer Schiffbau Bootsbau. Size, 7 by 9½ inches. Pages, 327. Illustrations, 328. Issued by the Akademischen Verein Hütte, E. V. Berlin: Wilhelm Ernst & Sohn.

This work goes into the construction of small boats in a very practical way. It also devotes a part of its pages to the description of motors and various kinds of propellers and boat appliances. It also touches on racing shells. The usual painstaking German characteristic is clearly shown in the minuteness of the details given, and many of the drawings are most interesting of the sail boats as well as the motor boats.

Cold Storage, Heating and Ventilating on Board Ship. By Sydney F. Walker, R. N. Size, 5½ by 8 inches. Pages, 269. Illustrations, 70. New York: D. Van Nostrand & Company. Price, $2.00.

In this book, which was reprinted from previous issues of International Marine Engineering, there is no attempt to go into the details of the mechanical apparatus used for refrigeration on board ship. It wisely devotes its pages to the use and application of the various systems now generally employed for refrigeration, and these are most clearly described. The most commendable feature of the book is that of discussing the "faults," as the author calls them, commonly known as "troubles," and giving solutions which will rectify them. The method of operating each system is not perfunctorily entered, but all the explanations are practical. It must be remembered that refrigeration at sea is a comparatively new development, and the value to seafaring men and their personal comfort and the great value to the world at large have not been really thoroughly appreciated.

Blue Book of American Shipping. Sixteenth edition. Size, 7½ by 10 inches. Pages, 408. Numerous illustrations and tables. Price, $5.00.

The Blue Book of American Shipping has reached its sixteenth annual edition. It contains its usual list of vessels, drydocks, shipbuilding concerns, as well as the names of the heads of the various government bureaus, and this list of names is most valuable for those who are bidding or are carrying on business with the government in its various departments. The additions of vessels during the past year are entered, and we note that hereafter the publication will be issued biennially, which will enable the list to be corrected to a closer date than heretofore.

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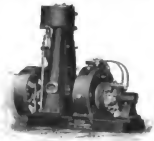
ENGINEERING SPECIALTIES.

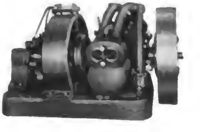
Compact Electric Lighting Sets.

While undoubtedly the controversy concerning isolated plants will continue for some time, the Engberg Electric & Mechanical Works, St. Joseph, Mich., seem to have settled the question concerning a compact, reliable and neat electric light plant, and they do not confine themselves to making these plants for steam only, but for internal-combustion drive as well. They make them from 2½ kilowatts, running at the moderate speed of 625 revolutions per minute, up to 10 kilowatts, running only 350 revolutions; in internal-combustion engines they make, not only a vertical outfit, but one with cylinders set directly opposite each other, thereby saving head room. These plants are made as small as 1½ kilowatts, running at 625 revolutions per minute, and weighing but 525



pounds. The generator which is fitted to these prime movers is made by the company, and is most compact and yet rugged. In the smaller electric sets, run by gas engines, a revolving field is used which does away with the fly-wheel, reducing weight and making a very compact outfit. The steam engines are entirely self-lubricated, and the governing is right up to the requirements of the present day. The internal-combustion engines are fitted with the splash oiling system throughout.

In connection with these generating sets the Engberg people make a line of searchlights in three sizes, or rather two sizes, 8 inches and 10 inches; but the 10-inch is made for marine work as well as land work, and, consequently, has certain features which are only valuable for this class of work.



An automatic cut-off is provided in these lamps, so that no damage will be done if the operator neglects to pull the switch when the carbons are consumed. This is a feature, we understand, possessed by no other searchlight, and certainly is a most valuable one.

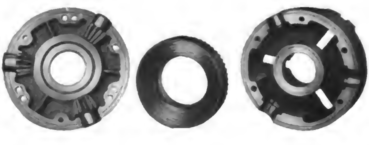
Dermatine Valves.

The quality of material used in the mechanical part of a machine is of importance, but it is by no means all of it, as, if the material is not properly applied or used trouble results. "Dermatine" is a substance which is made by the Dermatine Company, Ltd., 93 Neate street, London, S. E., and is used for valves of all kinds. The nature of this substance is not explained in the catalogue, but its value is clearly shown, and most useful hints are given therein as to how valves of both

the rigid and flexible type can be best applied. Numerous illustrations are given of practical forms of valve guards and grids, and their improved anchor bushing for valves, which we illustrate, is described, and by their use leaks in air pumps are greatly decreased.

The "Columbia" High-Speed Universal Chuck.

The universal chuck, manufactured by Messrs. Schuchardt & Schutte, 90 West street, New York, grew out of the demand created by the heavy cuts which can be taken with high-speed steel. Let us say right here that the designation of chucks is very apt to lead to confusion. The universal chuck, such as shown in the illustration, has jaws which work to and from the center simultaneously, and this word "universal" is often misunderstood and ordered where the combination chuck is wanted, the combination chuck being one in which the jaws can be made independent of each other in action or can be set



in any position from the center and then worked simultaneously in combination, while the third style of chuck is called "independent" where each jaw is actuated by a screw so they cannot be worked simultaneously.

The peculiarity of the "Columbia" is that the jaws slide on an incline, which gives a much larger wearing surface for the scroll, and a finer pitch of scroll can be used, which, of course, gives additional holding power and far greater wearing surface, so that the chuck can be used on a single diameter for a great length of time without the jaws becoming loose in that particular position. This chuck is not adapted for holding rings or any article which should be held from the inside by

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expanding the jaws. They are made from an outside diameter of 3⅛ inches holding a 4-inch piece up to 16 15/16 inches, holding a 16-inch piece. This is an unusual range for a chuck, and yet the maximum size of work can be held absolutely firmly.

Queen Portable Testing Set.

The principal applications of the portable testing set aboard ship as made by Messrs. Queen & Company, of Philadelphia, are the checking of conductor resistances in dynamos, motors, starting boxes, etc., the measurement of moderate insulation resistances, the location of crosses, grounds and opens, the checking of ammeters and voltmeters, measurements of capacity and inductances and other determinations dependent upon the electrician's knowledge of the fundamental principles involved and his skill in applying them.

The installation of this instrument aboard ship evidences the advances made in electrical apparatus equipment. The outfit becomes a standardizing laboratory, capable of manipulation and accuracy by those who may not be skilled in the use of measuring instruments, and makes it possible for the ship's electrician to carry out those tests essential for maximum efficiency.

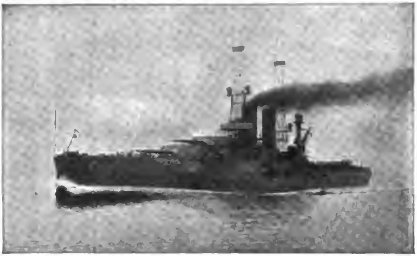
The instrument illustrated is the Queen Dial Decade Portable Testing Set. The dial, a switch pattern, provides a somewhat quicker method of manipulation than a plug. The construction of the switch is such to insure permanency of contact, and provision is made so that it can be taken apart for inspection. The galvanometer is of the D'Arsonval type, uninfluenced by proximity to dynamos, and is balanced to minimize the effect produced by the rocking of the ship. The battery consists of ten cells placed in a block; each individual cell can be placed in circuit. Provision is made for connecting an external battery, so that the instrument is never useless by reason of its cells becoming exhausted.

The lid is provided with a special gasket and hasps, so as to prevent the salt air from getting into the interior of the set. All interior steel and iron parts are heavy nickel-plated, and the resistances specially treated to prevent deleterious action of the sea air.

Battleship and Yacht Blowing Outfits.

The United States battleship *Utah* and the seagoing yacht *Aloha* are fitted with "Sirocco" fans. In the case of the *Utah* twelve forced draft sets are used, four in each of three blower rooms, each equipment consisting of 30 inches diameter by 30 inches wide "Sirocco" wheels, driven by 31-horsepower electric motors, and each capable of delivering 22,000 cubic feet of air per minute. We are informed that these fans, displacing the above volume of air with a total of 264,000 cubic feet of air per minute, have rotors the combined volume of which is but 147 cubic feet, the fans thus handling a volume of air in cubic feet per minute equivalent to 1,800 times their own volume.

In the yacht *Aloha* one small fan 15 inches in diameter, driven by a direct-connected motor, is ample to produce sufficient draft for all needs, with ample margin against necessity, producing 6,000 cubic feet of air per minute total, or 8,000 times the volume of the wheel.



The *Utah* on her trial trip made over 21 knots with but nine fans in operation. On the four-hour trial run she easily maintained her speed. The entire twelve fans were run at below their maximum rated speed for coal only.

Some Rope.

The accompanying picture is a coil of rope made by the Columbian Rope Company, Auburn, N. Y. The coil stands 8 feet high and is 8 feet across. It contains 1,200 feet of continuous rope. In the coil are thirty-two bales of the best manila hemp. The rope is made in three strands of 510 threads each. The great weight of this coil and its exceedingly

large size made it necessary to charter a special freight car in order to ship it. The rope is 15 inches in circumference, and the full coil is 200 fathoms. It was made on order for the United Fruit Company.

Reversing Motor Drive.

There is little doubt but what the planer has pretty nearly reached its maximum size if driven with belts. The difficulty arises from the fact that in order to get the enormous power required for the quick return of a very heavy platen, high speed of belt drive is not alone necessary, but width of belt is also demanded, and this gets so cumbersome that to shift a wide belt became practically uncommercial. Four belts were resorted to, which helped matters some, but when the introduction of the electric motor began, and finally was selected as the means of an individual drive for various machines, it was not to be wondered at that the motor drive was first used in connection with belts, but of late, both abroad and in the United States, a great deal of money has been expended and a tremendous amount of experimenting done with the reversing motor drive.

The illustration which we give is a slab which was worked up on a 76-inch "Pond" planer driven by a 30-horsepower reversing motor. The load on the table was 17,000 pounds.

The illustration does not clearly show just the conditions of the work. The 12-inch scale, which lies on the piece, gives a fair idea of the dimensions of the piece planed. The extreme left portion, which is shown as being smooth up, with a very wide cross feed, is in a higher plane than any of the other parts, numbered 1, 2, 3, 4 and 5. It is, therefore, to be noticed that in planing No. 5 the tool dropped into the clearance space and planed up to an absolute stop, which is the point at which part No. 4 started. It is to be noticed that this line is practically straight. The next step, No. 4, was taken with a different feed, and it in turn brought up against a shoulder which formed the right-hand edge of No. 3, and so on. The part marked No. 6, of course, had ample room to the right for the tool to start in its work, and it ran out in the clearance space at the end of the cut, but it is to be noted that the feed of this plane portion, No. 6, varied. This was done while the planer was in motion. The square part, marked No. 7, is a depression, the tool digging in at one end and running up against a shoulder at the other. This, of course, is not an operation that would often be required and would hardly be looked upon as commercial, but it is extremely illustrative of the wonderful control which this reversing motor drive places in the hands of the operator.

The whole secret of the matter is that at the instant of reversal, when the leading or pilot switch comes in contact with the shifting dogs on the table, the controller short circuits the armature, creating therefore considerable resistance, which causes the motor to become a generator, consequently a most powerful electric brake. The cutting speed is shifted at any time the operator desires by merely moving a little contact button, while the feed can be varied in the same way and under the same conditions, and the control of the motor is such that there is practically no overload and no wide fluctuation of the amount of current to be supplied from the line. This is a most interesting point. The Niles-Bement-Pond Company, New York, handles these tools in its own shop.

COMMUNICATIONS.

Terminal Improvements at the Port of New London.

Editor International Marine Engineering:

The State of Connecticut has appropriated $1,000,000 (£200,000) to improve the terminal facilities at the port of New London. The act provides that the State Commissioners "shall have full power on behalf of the State to acquire, own, construct, maintain and operate docks, wharves, piers, quays and dykes, canals, slips and basins, or any other appropriate harbor facilities, sheds, warehouses of all kinds, vaults, railroad tracks, yards, terminals and equipments and all other land and water transportation facilities in the city of New London necessary to expedite the interchange of rail and water traffic."

The cost of handling miscellaneous cargo freight between vessel and shore is one of the most important factors in influencing cargoes to go to any particular city. A differential of 2 cents (1d.) per ton in favor of a city on a large cargo of bulk freight would influence its going to that city, other conditions being equal. By installing the latest and most improved mechanism, under expert advice, so that miscellaneous freight can be properly handled, there will be effected a saving of at least 15 cents (7½d.) per ton, or including both the loading and discharging, total saving of more than 30 cents (15d.) per ton. On a 5,000-ton cargo, this would be $1,500 (£300) in favor of the city having the modern equipment. Besides the reduction in the cost of transference, rapidity is necessary.

The charter value of a freight steamer of medium size is about $400 (£80) per day. For every day saved, by rapidity in loading or discharging, there is over other cities not equally well equipped also a differential in favor of that particular city. If two days can be saved, $800 (£160) would be to the credit of New London to attract commerce.

To show to what extent machinery has been used at foreign ports, at the Kuhwaeder dock alone at Hamburg there are installed around this dock 134 traveling elevated gantry cranes costing over $500,000 (£100,000). Under the control of the harbor authorities at Hamburg there are about 1,000 cargo-handling cranes, and every active port in Europe is equipped with similar machinery.

The development of the city of Antwerp is highly corroborative of my statements that as well-equipped terminals are provided the traffic of the city and State expands. In 1870 the tonnage was only 200,000 tons. In 1909 it was 11,940,332 tons from sea navigation and 8,169,754 tons of interior vessels. Antwerp was visited by 6,135 vessels in 1908. The increase of the population of Antwerp has been equally remarkable with the commercial increase.

Most of the large ports in Europe have been equipped with machinery for ten or twenty years, and some are even now installing hydraulic machinery instead of the far superior electric. Reference is not made to them as examples to be

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exactly copied, but as illustrating the great necessity of not neglecting mechanical methods. The cost of lifting package cargoes from the ship's hold upon the edge of the pier may be 6 cents (3d.) per ton, but to assort and distribute throughout the transference shed, or to the cars, would be at least 28 cents (14d.) additional. Machinery can now perform these movements at a cost of 14 cents (7d.) per ton. Provision should also be made for economically transferring bulk cargoes.

Take the two cities Liverpool and Bristol, between which there was a struggle for supremacy. Bristol did not expend the money for improvement, although it had equal natural advantages. Liverpool did, and to-day Liverpool is one of three great ports of the world. The Liverpool docks compose a large part of the city front and cost $200,000,000 (£40,000,000). Twenty-six thousand vessels in one year visited Liverpool, with a registered tonnage of 17,000,000, and the total tonnage, inward and outward, was 35,201,767 tons. These vessels pay dock, harbor and tonnage rates. The revenue for the year ending June, 1911, was $6,899,000 (£1,379,800). London is another interesting example of the danger of neglecting terminal facilities. It neglected to keep abreast with the demands of commerce, and within a few years awoke to the fact that Liverpool, Hamburg, Antwerp, Amsterdam, Rotterdam and other ports had wrested from it a large amount of its foreign commerce. It has now commenced the expenditure of $83,000,000 (£16,600,000) to recover, if possible, its former position.

New London is splendidly situated to become one of the great ports of the United States. On account of its close proximity to the sea, easy approach and a rich hinterland, largely interested in manufacturing, with excellent railway connections, even to Canada, there is every reason to expect a great increase, if there is an open gate terminal through New London to the markets of the world. The Thames River is tidal for several miles. In 1900 there was a traffic movement of 464,283 tons. In 1907 reports show: Coal, 190,304 tons; lumber, 5,177 tons; steamboat freight, 486,566 tons; miscellaneous freight, 150,921. Total, 697,139 tons. Among the transportation companies which do business in New London are: New England Navigation Company, the Thames Transportation Company, the American Lighter Company, McWilliams Bros. Montauk Company (L. I. R. R.), Fishers' Island Navigation Company.

On the 4 or 5 miles of frontage on the Thames River at New London the city at present owns practically nothing. It maintains merely a right to a ferry slip and one or two small dock privileges at the ends of streets. Practically all the water front is owned by private parties and corporations. The wharves and the most desirable front belong to the railway and steamship lines. Arrangements should be made that there should be berthings open to all the world. The present depth of the harbor is 23 feet. Loading and discharging bulk cargoes, such as coal, is done by means of cranes and derricks, but for the rapid and economical transference, which is most to be desired for New London, there are no facilities. It is of the greatest importance that the piers, wharves, transshipment sheds and warehouses and railroad tracks be laid out with proper reference to each other, and also that they be connected with the railroads.

There are a number of principle factors essential to a good water terminal. First, ample pier, quay and wharf capacity and basins; vessels must not be delayed awaiting a berthing. Second, commodious and high transshipment sheds. Third, as distinct from the transshipment sheds, warehouses and warehouse yard space. Fourth, modern transshipment machinery. Fifth, mechanical connections between the piers, sheds and warehouses. Sixth, rail or water connections between the terminals and the cities of the hinterland.

These water terminals should not be under long lease, but the terminals and piers should be the public servants of the whole port. There should also be private warehouses, as now proposed for New York, but subject to the control of the State as to rates.

There will be ample depth of water, and the wharves should be of sufficient length to accommodate the longest ocean steamers. To secure the best results at a complete terminal there should be included every factor necessary to secure easy freight movements, but all installed under expert advice, and co-ordinated in such a way as to secure the greatest possible rapidity and economy of operation.

The city should do everything in its power to provide paved roads to the terminals, and to reserve wharves which can be occupied by other vessels and freighters besides the regular lines, and everything should be done to make the city of New London an open port where steamships of every nationality can easily and quickly load and discharge. Provided that this is done under engineering direction, and modern improvements added from time to time, it is absolutely safe to predict that the growth of the city will be phenomenal. There have been published valuable figures showing that for every ton of freight which passes through a city a certain amount of money is left in the city. Terminals under proper management can be made self-supporting. In the city of New York it is stated that the terminal charges have not only paid all port expenses but also have produced a handsome surplus of over $100,000,000 (£20,000,000), which it has invested in wharves, piers and dock properties. H. McL. Harding.

New York.

A Correction.

Editor International Marine Engineering:

Regarding the reference to my work by Mr. Barnaby in your August issue, in which he states that I have made the statement that thrusts as high as 16 pounds per square inch of projecting surface have been recorded in turbine propellers giving a fair amount of efficiency, I wish to make a correction.

Mr. Barnaby has taken a wrong meaning from what I intended. My statement was as follows:

"In case of the turbine ships with propellers of low pitch and high speed of rotation, a maximum value of meter thrust to hold 50 percent propulsive efficiency on bare hull appears to be reached at about 16 pounds per square inch of projected area."

I had previously explained in the article, from which this quotation is taken, that by meter thrusts was meant the shaft-horsepower multiplied by 33,000, divided by pitch, times the revolutions, times the projected area of the propeller in square inches, while Mr. Barnaby assumes that the 16 pounds referred to was given as effective thrusts.

Washington, D. C. C. W. Dyson, U. S. N.

In the article on "Electrification of Marine Engineering Work" in our July issue, by an oversight the name of the Shields Engineering & Dry Dock Company, Ltd., was left out.

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SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

993,440. ICE-BREAKER. ELOUILD DUPLESSIS, OF SOREL, QUEBEC, CANADA.

Claim.—An ice-breaking boat provided with a projecting prow adapted to extend under the ice and lift and break the same said prow also having laterally extending parts (4) for scraping the ice from wharves and the said ice-breaking boat being further provided with a keel (3), which is deeper in the water than the body of the boat and is located only under said prow and has its bottom line inclined forward, its greatest depth being under the tip of the prow. One claim.

993,402. LIFE PRESERVER. JACOB ELFORREST PRESCOTT, OF PORTLAND, ME.

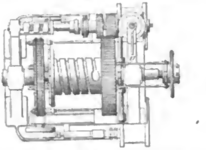
Claim 1.—A life preserver comprising a flexible base, two series of parallel horizontally positioned buoyant elements attached thereto, one series at each side of the base, the two series being parallel and being separated laterally from each other by a wide uncovered portion of the base, a head receiving opening in the base positioned between the two series of buoyant elements, and means for securing the life preserver to the body. Six claims.

994,552. SUBMARINE BOAT. GEORGE B. YERTON, OF NEW YORK, N. Y.

Claim 1.—A life boat for submarine craft, comprising a shell provided with a manhole in the floor of the shell, said shell being adapted to be removably secured to the submarine provided with a manhole in the upper part of the same, a removable and replaceable cover for the said manhole, to enter the said shell from the said submarine, a safety cover adapted to removably close the manhole in the said shell, an annular chamber in the said submarine encircling the manhole of the submarine, and inter-connected gears in the said shell engaging the said chamber for disconnecting the said shell from the said submarine. Three claims.

994,576. COMBINED STEAM AND HAND STEERING ENGINE. FREDERICK C. SCHOEN, OF NEW YORK, N. Y., ASSIGNOR TO LIDGERWOOD MANUFACTURING COMPANY, A CORPORATION OF NEW YORK.

Claim 2.—In combination a drum, a gear on the drum, a hand-power shaft, a gear pinion threaded on said shaft and meshing with the drum



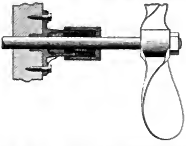
gear, a second pinion on said shaft, and means for placing said drum gear in mesh with said first and second gears simultaneously. Fifteen claims.

994,874. POWER-TRANSMISSION MECHANISM. THEODOR RICHARD RYSZKA, OF KANSAS CITY, KAN.

Claim 1.—In power transmission mechanism, a friction wheel having an annular concentric flange, a smaller friction wheel concentric and rotatable with the other wheel, two laterally flexible rotary shafts, two intermediate friction wheels respectively secured to and rotatable with said shafts and disposed at diametrically opposite sides of the smaller friction wheel between said wheel and said flange, and means for simultaneously laterally shifting said shafts in opposite directions, whereby both intermediate wheels may alternately be brought into driving contact with the other two wheels. Six claims.

994,709. PROPELLER SHAFT STUFFING-BOX. CHARLES B. ADAMS, OF CHARLESTON, S. C., ASSIGNOR OF ONE-HALF TO E. E. WEHMANN, OF CHARLESTON, S. C.

Claim.—In a stuffing box for propeller shafts, the combination with the cylindrical externally threaded packing box for the reception of a

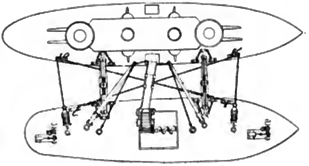


fibrous packing and having a base flange integral therewith for attachment to the stern post of a boat, an integral nipple projecting from said flange opposite to the stuffing box and forming an elongated shaft supporting bearing, and an internally threaded relatively long cap fitting on said box and having a propeller shaft aperture therein of greater diameter than said bearing, of a follower mounted to move longitudinally within the box for compressing the packing therein and fitting the box and shaft with sufficient accuracy to prevent the packing from slipping past the same, an anti-friction thrust bearing co-operating with the outer side of said follower, a bearing ring for the shaft located in the cap whereby entry of dirt into the cap is prevented, an anti-friction thrust bearing co-operating with said ring, and a coil spring interposed between said thrust bearings for compressing the packing, the compression being in the same direction in which the water pressure acts upon the packing.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

16,430. APPARATUS FOR TRANSFERRING CARGOES TO SHIPS WHILE UNDER WEIGH. C. M. ASKEGREN, PENSACOLA, FLA.

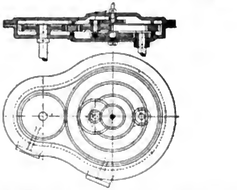
In the lowest part of the hold are spiral conveyers, each receiving motion from a vertical shaft and bevel gear. About midway the length of the vessel is an upright shaft, in which is an endless hand conveyer, to which motion is imparted by pulleys on the ends of the spiral conveyers. A chute hinged to the upper end of the shaft can be raised or lowered to deposit the cargo into the hold of an adjacent ship by



means of booms raised and lowered by pulley blocks and cables. During the operation the vessels are connected by cables, the ends of which are attached by spring devices on the deck of the vessel containing the conveyers; the cords passing around belaying pins or pulley blocks on the adjacent vessel, and then back to the other vessel to which it is attached either directly or to a coiled spring on to the deck as a further resiliency to prevent breakage of the cable. Resilient struts keep the vessels the right distance apart.

17,812. SPEED INDICATORS. CHADBURN'S (SHIP) TELEGRAPH COMPANY, LTD., AND A. J. GRANT, BOOTLE.

Has reference to telegraphic apparatus in which the relative speeds of two or more revolving shafts is indicated, say the two (or more) driven propeller shafts where it is desirable to keep the relative speeds of the two shafts the same, or at any fixed ratio, or where the mean speed should be indicated and ascertained, or that the same total number of revolutions of the shaft should be made in any given period of time. In this speed indicator the train of wheels between the shafts



which transmit motion to the apparatus, and the indicating spindle, or axis, are of the spur type and arranged in parallel planes; and the two motions are transmitted from the two shafts to a large wheel, which is toothed externally to be geared up directly with the one shaft, and toothed internally to mesh with a "floating" wheel which is carried on an axis adapted to be rotated relatively to or about the center of the large wheel; and the rotation of this wheel about its revolving axis or spindle is transmitted through gearing to the indicator spindle or axis.

3,397. NETS FOR PROTECTION AGAINST TORPEDOES, ETC. VOLTOHMSEIL- UND KABELWERKE AKT. GES., FRANKFURT a/M. GERMANY.

This is a net of wire cords in which each grommet is wound in the shape of a cable from a round wire cord consisting of thin straight wires wound round a central core.

23,266. SHIPS' BERTHS. A. N. CHAMBERLAIN, BIRMINGHAM.

The berth comprises an angle-iron framework in two parts pivoted together, and when these are extended the flexible mattress will accommodate, say, two persons, but when folded so that one part lies upon another it forms a berth suitable for, say, one person. In the latter case a stretcher is turned outward to form a support and stretcher for the outer side of the mattress.

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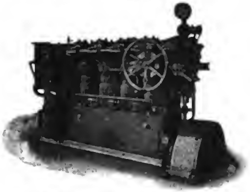

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TRADE PUBLICATIONS.

AMERICA

"American Vanadium Facts," published monthly by the American Vanadium Company, 318 Frick building, Pittsburg, Pa., is the only regular publication in the world on the industrial application of ferro-vanadium and vanadium alloys. This publication will be sent free every month to any of our readers mentioning this magazine. "Buyers of metals are specifying vanadium in compositions because vanadium increases the strength, toughness and life of all metals. Makers of steel and iron castings, forgings and miscellaneous parts must get ready for the specifications."

"The Marine Transfer for Broadside Coaling in Harbor" is the subject of Bulletin No. 27, published by the Lidgerwood Manufacturing Company, 96 Liberty street, New York. This bulletin describes the Lidgerwood marine transfers as installed on the United States colliers *Mars*, *Vulcan* and *Hector*, and the bulletin states that two well-drilled winchmen on the collier *Hector* discharged 190 tons of coal in one hour from one hatch to a barge alongside. "Each collier has ten hatches Each hatch has one marine transfer. A collier alongside a warship can usually arrange at least five of the marine transfers to deliver coal to convenient points on board the warship. The clam-shell bucket digs the coal, hoists vertically and swings horizontally in a straight line, and will deliver coal at the same spot at each time. The booms are fixed. The coal may dump directly over a coal chute. When bunkers are empty the coal may pour into them at the full capacity of the marine transfer. Coal can be dumped on the deck, shoveled into bags or baskets and carried to coal chutes on the opposite side of a ship. Two battleships can coal at once, the collier being in the center. Or two colliers can coal one battleship, the battleship being in the center. The employment of this invention means the emancipation of the sailor from the arduous work of shoveling coal into bags in the hold of a collier. Coaling warships results in more desertions from the navy than any other cause. The marine transfer will increase the speed of coaling and reduce the fatigue of the men performing the service."

Tools for Boiler Makers' Work.—In boiler shops we have two conditions. First, that of doing new work, and, second, repairs; and it is hard to say which requires the greater ability. But in either case the mechanic has constantly to get into the most cramped spaces where even a fraction of an inch makes it almost impossible to do work quickly and well, if at all. The Pratt & Whitney Company, Hartford, Conn., shows in a catalogue of small tools, those used by boiler makers, which are of more than usual handiness, and the quality is assured by being made by that company. Their ratchets are most compact, and permit use between plates where most ratchets could not be employed at all. They are made to receive either taper or square-shank drills, and the company provide standard pipe tubes made to fit the ratchets, and also a most handy combination of drill and pipe tap, which, while old, sometimes saves an endless amount of time by its use. The stay-bolt tap made by this company is constructed so that the lead of the external and internal threads are sure to coincide, which insures a continuous thread in the two boiler sheets when set apart, as, for instance, where staybolts are to be used. They, of course, make the regular spindle stay-bolt taps with its shank threaded to obtain the same results. The question of cost of home-made tools is always a vexed one in every shop, and the accurate production of such things as taps, dies, punches, etc., it must be admitted, is far more easily arrived at by those who make a business of producing these articles and are not intermittently engaged in their production. It is an art to make lasting punches and dies, and long experience has taught the Pratt & Whitney Company just what selection of steel is best for the work, and its treatment is not any haphazard method but a systematic hardening and drawing which results in lasting qualities. The reduction coupling for punches made by this company saves a large number of stock couplings, as it can be used for many lengths and sizes of punches. A flue beader for locomotive boiler tubes forms an inside bead most satisfactorily, and the tool can be made for any thickness of steel. This, of course, is not a stock article, but usually can be obtained on short notice. Reamers, both straight and tapered, solid or with inserted blades, are always kept in stock, as are the dies for various sizes of stay-bolts and standard bolts. The company's catalogue is beautifully printed and thoroughly well illustrated.

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Bulletin No. 201 describes the "Power" water cooler, made by the Power Specialty Company, 111 Broadway, New York. "The machine consists of a horizontal cylindrical chamber or casing, through which air is passed, a rotor within the chamber forming moving cooling surface, a fan for circulating air and a pump—when needed—for circulating water. The casing is of sheet iron, cast iron, or concrete, according to the size of the machine. The lower part of the casing forms a trough in which water circulates. The rotor, which completely fills the casing, is made up of thin annular plates, nested concentrically. The plates are supported from a central shaft which revolves slowly in outside bearings. The fan is mounted at the end of the casing and blows air between the plates. The pump for circulating the water, and is not always required. The machines are very compact, occupy small space, moderate head room and require no storage tanks."

Hydraulic Testing Apparatus.—In engineering to-day it is essential that we be sure. Materials are tested chemically and physically as far as possible, but even then we must go further and test the entire made article. In boilers, tanks, pipes, etc., this is especially true, and it is rather strange that the idea is so prevalent that testing apparatus for hydraulic work is so very expensive. This is not so, and it is worth while to write the Watson-Stillman Company, 188 Fulton street, New York, and find out from them not only the cost of testing apparatus but to get their catalogue No. 81-A, and read about their products. In boiler work most of us have seen time running up into hours, wasted, trying to pump up a pressure with a poorly designed and made pump, and often the gage itself is a "used-to-be" affair, and reliance on it often causes no end of annoyance to the manufacturer, friction with the customer and financial loss all around. While the hydraulic testing apparatus is not expensive, even a dollar spent on one not thoroughly reliable and of first quality is an absolute waste. Reputation takes years to be worthy of, and when a test is to be made on which a reputation rests it is mere folly to use an apparatus which can be in any way questioned, and which, after a test is made, you still have to do guessing. The Watson-Stillman people do not make toys or do business in an old-fashioned way. Every article they make is worked out to be of value to the purchaser, and, should a part of it get lost or any repairs be needed, their system of code number prevents any possibility of error in ordering. One thing which we commend is the fact that the catalogues of this company are of standard 6 by 9 size, and any one of the many they issue is well worth keeping, and generally has information concerning their specialties which is of great value.

"Power in the Air" is the title of the leading article in the latest number of *American Vanadium Facts*, published by the American Vanadium Company, 318 Frick building, Pittsburg, Pa. "Who would have imagined that 50 horsepower could be transmitted through a tubular shell of chrome vanadium steel ⅛ inch in thickness, with a factor of safety ample to meet the constant hazards of flying through the air? This is not an imaginary problem but an accomplishment firmly fixed in the realm of facts. The Bourne-Fuller Company, Cleveland, Ohio, furnished to the Roberts Motor Company, Sandusky, Ohio, some chrome vanadium material known as Scott's unique alloy steel. This material was forged into a solid shaft under a steam hammer, rough turned and heat-treated in the regular way. The forgings were then sent to the Roberts Motor Company, who finished them and bored out the center. They were tested and developed a margin of safety 38 percent greater than is necessary for a 50-horsepower engine with an explosion on the head of the piston of 1,100 pounds to the square inch. This accomplishment is extraordinarily good from two standpoints: First, because no other material with which we are acquainted is sufficiently uniform and free from imperfections to flow evenly in the forging operations and come out without segregations or hard and soft spots. Nickel steel has been shown to be very unsatisfactory for such operations owing to the pasty or gummy nature of the product; forging people report considerable trouble with nickel steel on account of the liability of this material to stick to the dies. In the second place, nickel chrome steel, we believe, could not be machined and bored with satisfactory results. Three shafts, one of which is illustrated on this page, were made from forgings which in the rough state weighed 82 pounds each; after being completely finished they weighed 18 pounds each, and were used in three four-cylinder Roberts motors to furnish the power for three Hadley & Blood Farnam type biplanes which are now in successful service. The other photograph on page 2 represents one of these biplanes in actual flight at Mineola, L. I."

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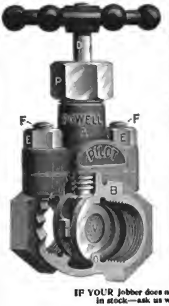
The Powell PILOT
Brass-Mounted Gate Valve



A Double Disk Iron body Gate Valve for medium pressures. The body is strong and compact with heavy lugs carrying stud bolts E. The stud holes, in lugs of bonnet cap A, being accurately drilled to template, permit the valve to be assembled any old way. No matter how you handle it after taking apart, it always fits.

The Double Brass Disks, made adjustable by ball and socket back, are hung in recesses to the collar on the lower end of the stem. Stem is cut to a true Acme thread, the best for wear.

The Powell Pilot Gate Valve is also made all iron. For the control of cyanide solutions, acids, ammonia and other fluids that attack brass it has no equal. Send for special circular.

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Sample 75-C Free.

JOSEPH DIXON CRUCIBLE CO.
JERSEY CITY, N. J.

"Bearings" is the title of a booklet published by J. A. Nelson, 11 John street, New York. It consists of a series of questions on the subject of "Anti-Friction Bearings" and the answers given thereto "by an experienced and impartial engineer." A copy will be sent free to any of our readers upon request.

"Economic Lubrication" is the title of a booklet published by the Albany Lubricating Company, 708 Washington street, New York, manufacturers of "Albany" grease. In this book is a practical talk on lubrication, the purpose of which is to assist in the selection of lubricants which will give the most satisfactory results when all conditions are considered.

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The "Providence" steam towing machine is described in circulars issued by the American Ship Windlass Company, Providence, R. I. The claim is made in the catalogue that this towing machine prevents the parting of hawsers, no matter how sudden the shocks. It tows with a steel hawser, and the drum stows all the line, leaving the deck always clear.

Ball bearing hangers are described in a catalogue issued by the Hess-Bright Manufacturing Company, Twenty-first street and Fairmount avenue, Philadelphia, Pa. "In the purchase of the equipment of a new factory, or in the remodeling of an existing plant, often very little consideration is given to the selection of the hangers to hold and support the line and countershafting. To many a shop owner a hanger is simply a 'hanger,' no thought being given to the saving that can be effected through the elimination of friction and the consequent increased efficiency of the power plant. The following pages contain information that will prove of interest to every power owner or user, and we offer the services of our engineers without charge to those desirous of reducing their factory cost."

Grooved ball and thrust bearings are described and illustrated by the Standard Roller Bearing Company, Philadelphia, Pa., manufacturer of ball bearings for all purposes. "The grooved ball end thrust bearings illustrated, described and listed in this pamphlet generally consist of three elements, two being grooved steel discs, the third being a bronze cage in which the balls of the bearings are self-contained. The discs or races are manufactured from high-grade selected steels, carefully heat treated, tempered and accurately ground, one face of each race being grooved, the form of the groove being circular, its radius being slightly larger than the radius of the balls to be used therewith. The cages are made of high-grade bronze, carefully machined, the pockets in which balls are confined being located with special tools to secure accuracy as to the diameter of pitch circle and the spacing of the balls in cage. The balls used in these bearings are of the highest grade, our 'Standard Alloy' steel balls being used in all of these bearings. These bearings are made also of the self-contained type. In this latter type the bearing is of one unit, the two discs or races and the balls interposed between the races being bound together with a retaining band encircling either the outer or inner diameter, as is found desirable by the user. These latter bearings are not kept in stock, and are manufactured to order only. The material used and methods of manufacture of the races for the self-contained type are the same as those for the standard type. With the self-contained type, however, no bronze cage is used, balls being loosely laid between the discs or races in the grooves provided."

"The Automatic Smokeless Furnace" is the subject of an illustrated 48-page catalogue, published by the Model Stoker Company, Dayton, Ohio. "The model automatic smokeless furnace has now been in use seven years. We have not hesitated to make installations alongside of any of the other makes of stoker furnaces, and have tested it out alongside in the same boiler room with each of the other two makes of the same type as well as all other types, and its superior utility is fully demonstrated and established. The model automatic is the only furnace in use that fully and efficiently keeps the fire clean. Numerous installations have been made covering a wide range of territory. It uses with marked success any soft coal of feedable size mined between the Atlantic coast and the Pacific, readily adapting itself to the various coals of differing characteristics. Its superior adjustability enables the attendant to promptly meet all the requirements, whether due to difference in quality or character of coal or to variations of load. Its superior self-cleaning produces better economy, larger sustained capacity, quicker response to sudden increased demands, and also provides better protection to the grates and all parts exposed to the heat of the fire, and thereby insures greater durability, and by reason of its superior mechanical design and construction, when repairs are required they can be more readily made and with less cost than repairs can be made on any other stoker furnace. We do not hesitate to place the Model automatic alongside of any other, and guarantee superior utility and smokeless combustion. We wish to express our appreciation of the kindly interest shown by the many purchasers, managers, engineers and firemen who have used, explained, shown or recommended the Model automatic. We have within the past two years made some improvements which add to the utility value of the Model automatic, and we shall maintain its pre-eminent utility and increasing prestige by leading all others in smokeless combustion, economy, capacity, adaptability, durability and utility in general for all kinds of conditions and service."

When writing to advertisers, please mention International Marine Engineering.

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Sturtevant multi-vane fans for marine work are described in a booklet published by the B. F. Sturtevant Company, Hyde Park, Mass. These fans are compact, requiring small space, and may be suspended from the ceiling or mounted on the platform. They are durable, being rigidly constructed for high-speed work. They are efficient, furnishing a large volume of air at small expenditure of power.

Air pumps, air pumps and jet condensers and surface condensers, which have been furnished during recent years by the Dean Bros. Steam Pump Works, Indianapolis, Ind., are described in Catalogue No. 75, which the company has just printed. Twenty pages of this list are devoted to the names of steamships which have been equipped with this company's product.

Racing sails, marine accessories, etc., are described in a 500-page marine supply catalogue published by George B. Carpenter & Company, 202 South Water street, Chicago, Ill. We understand that a copy of this catalogue will be sent free to any of our readers who will mention this magazine. The catalogue is a splendid book of reference for any one interested in marine matters, as it contains an up-to-date treatise on the installation and operation of marine gasoline engines, and also a chapter on the care and handling of sail craft, both written by men who know.

Booklet No. 77, published by the Derome Standard Pulley Block & Crane Manufacturing Company, 78 Southwark street, London, S. E., describes this company's pulley blocks and overhead traveling cranes. "Our lifting appliances of standard types are built in large quantities, and we can therefore offer them at very reasonable prices and effect prompt deliveries. You will find that our manufactures are of an unquestionably superior value and always give complete satisfaction. In fact, their equal is not yet on the market. The D. S. pulley blocks and D. S. overhead traveling cranes are used in all parts of the globe by the most important engineering establishments, and we have the custom of the principal governments and railway companies. We are always pleased to forward on trial, entirely at our risk and free of all charges, any pulley block with the required length of chain. Do not hesitate to apply for particulars and appliances on trial."

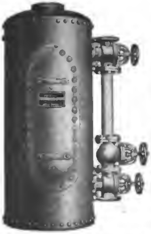
TRADE PUBLICATIONS

GREAT BRITAIN

A catalogue published by John Gibbs & Son, of Liverpool, deals with the construction and application of electric motor and belt-driven fans for ventilating purposes. The concluding portion of the catalogue is devoted to the ventilation of ships.

A circular recently sent out by the Machine Tool & Engineering Association from its new offices at 104 High Holborn, W. C., states that the association has been registered as a limited company, as it was thought that this would be the best and most business-like form of organization. Its primary object is to exercise control over the organization and frequency of exhibitions, and its policy is to promote one in London every three years, and possibly one in the provinces alternately with those in London. The show which is to be held next year under the direct control of a committee of the association promises to be most successful, and at the present date just over £5,000 worth of space has been applied for and allotted to members of the association, exclusive of space applied for by non-members. From negotiations that have been conducted with the Exhibitions Branch of the Board of Trade, it is stated to be probable that in the matter of exhibitions abroad the association will be asked by the Board of Trade to trade to take a very important and responsible position in connection with the engineering sections. Now that the preliminary work has been completed it is intended to initiate a progressive policy which will be of advantage to the trade generally, and information will be supplied to members from time to time dealing with trade openings abroad, with proposed legislation affecting the trade, and with other appropriate matters. The directors are: Mr. J. T. Peddie, of Vickers (chairman); Mr. W. Deakin, of H. W. Ward & Company (vice-chairman); Mr. J. W. S. Asquith, of William Asquith; Mr. A. Drummond, of Drummond Bros.; Mr. E. M. Griffiths, of C. W. Burton, Griffiths & Company; Mr. A. Herbert, of Alfred Herbert; Mr. W. D. Ford Smith, of Smith & Coventry, and Mr. Charles Wicksteed, of Charles Wicksteed & Co., the secretary being Mr. Herbert G. Williams.

Reilly Multicoil Heaters



and **Evaporators** are **in stock** at the shops, Pier B, Jersey City, awaiting your rush orders. Coiled, flexible copper tubes, ground union joints (no expanded ends), and the Reilly manhole door, giving access to all interior parts, give the marine engineer an auxiliary which **saves coal, increases Condenser capacity,** and needs **no repairs.**

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International Marine Engineering

OCTOBER, 1911.

PROGRESS OF THE DIESEL ENGINE IN MARITIME WORK.

BY J. RENDELL WILSON.

Lord Furness, the head of Furness, Withy & Company, Ltd., when he publicly gave out that his firm had placed an order for a 3,000-ton vessel to be driven by oil engines of the Diesel type, stated that to-day we are face to face with a development that will revolutionize the methods of propulsion in shipping. Of this there can be little doubt, so rapid has been the development of the crude oil-consuming marine internal-combustion engine. What were considered merely wild dreams five years ago are now solid facts, and many oceangoing craft are already in active service, and by the end of the year these will be joined by small transatlantic liners, which are now in course of construction in Continental yards.

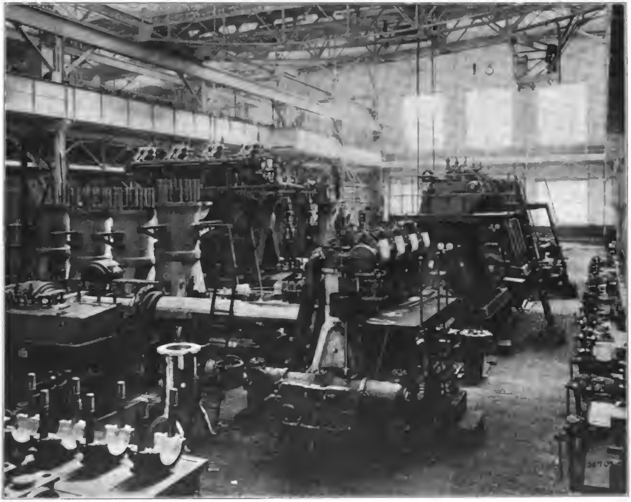

FIG. 1.—MARINE DIESEL ENGINES UNDER CONSTRUCTION AT THE WINTERTHUR WORKS OF MESSRS. SULZER BROS.

ADVANTAGES.

One of the principal claims of the Diesel-type engine is, of course, the great saving on fuel costs. Against this it has been argued that, after a certain number of such vessels are on the water, the price of oil will increase to the extent of rendering them more expensive to run than their

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steam-engined sisters. This is a fallacy, or misstatement, to which no shipowner should give heed, as oil is distributed over a very wide area, probably over a wider area than coal. When the demand comes there will be a short disturbance in the market, and hundreds of new oil companies, good and bad, will be formed, and more oil fields opened up, as was the case with rubber recently. At present the flow of oil at the various great oil fields is far in excess of the demand, despite the enormous quantity of refined oil consumed.

FUEL.

Even were the price of oil fuel to increase, fuel charges are but a small item in the advantages of the heavy oil in ships. Oil being carried in the double bottom of vessels, the coal bunker space, and the boiler and condenser space saved enables the same amount of cargo to be carried with a great reduction of tonnage. This means smaller harbor dues. Again, stokers are not required, a considerable saving in the wages and food bills, and their quarters can be given over to cargo space, again increasing the earning powers of the vessel on the same tonnage. When the ship is in harbor, "oiling" is accomplished by simply running flexible piping aboard, and the fuel tanks filled in a short space of time. Here, again, much manual labor, time, and consequently expense, are saved; also no time is wasted in cleaning up ship, as is the case after coaling operations.

A few years ago the large passenger vessel *Uto*, in service on Lake Zurich, had her steam machinery replaced with a 150-horsepower Sulzer-Diesel motor. Originally she carried 150 passengers; but since the alteration she has been licensed for 200 passengers, so great was the saving of space. Naturally this made an enormous difference in her earning powers, and tends to show at least one advantage of oil engines, not to mention the many others.

So it will be seen that there are more points in favor of the internal-combustion engine than against.

PROGRESS ON THE CONTINENT.

Continental engineers realized these facts long before other nations, consequently they are far ahead, and the experimental stage with them is past. Already the Diesel-type motors in the Russian navy and mercantile marine aggregate 23,000 horsepower, composed of about fifty engines. Among the more notable firms engaged in large marine heavy oil-engine construction must be mentioned Fried Krupp, of Kiel-Gaarden, Germany; Sulzer Bros., of Winterthur, Switzerland; Carel Frères, of Ghent; Aktiebolaget Diesels Motorer, of Stockholm; Maschinenfabrik Augsburg, Nurnburg, Germany; Schnieder et Cie., of Paris; Société des Moteurs Sabathé, of St. Etienne, Paris; Société des Ateliers de La Loire, France; Nederlandsche Fabriek van Werktuigen en Spoorweg Materieel, of Amsterdam; Société Anon. John Cockerill, of Seraing, and Hoboken, near Antwerp; Burmeister & Wain, of Copenhagen; Chantiers & Ateliers Augustin Normand, of Havre, and the F. I. A. T. Company, of Turin. All these firms have already constructed marine oil engines up to 1,000 horsepower, and several have engines of 12,000 horsepower going through the shops, notably the F. I. A. T. Company, M. A. N. and Krupps.

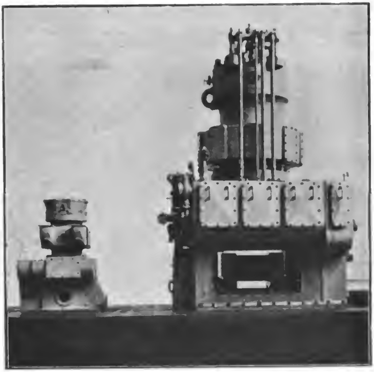

FIG. 2.—15,000-HORSEPOWER, SINGLE-CYLINDER CAREL-DIESEL MARINE OIL ENGINE.

DEVELOPMENT IN GREAT BRITAIN.

The launching of several large ships of this class right under their very noses awakened British engineers to serious consideration, and about thirty firms are now deep into the problem. On the other hand American marine engineers are only beginning to show signs of progress in this direction. It is time the United States government gave the necessary impulse by fitting a small warship with Diesel motors. The British Admiralty have already moved in the matter, and have publicly placed an order for an internal-combustion engined torpedo boat destroyer with Messrs. John I. Thornycroft & Company; while there can be little doubt that Messrs. Vickers, Ltd., is (in secret and at its own risk) building an eight-cylinder engine of 12,000 horsepower to be fitted, in conjunc-

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tion with steam engines, in a battleship. Vickers is, it is understood, benefiting by the experiences of Carel Frères, on whose license it is working, and the illustration, Fig. 2, shows the single-cylinder 1,500-horsepower engine on which the design was based. This engine stands about 17 feet high, and has a bore of about 40 inches. It is of the four-cycle type with overhead valves. The high and low-pressure compressors are arranged by the side of the cylinder, but are not shown in the photograph for obvious reasons. The makers are bound by agreement with their licensees not to divulge any information, therefore further details cannot be given. The smaller engines to the left of the illustration are partly finished castings of a 250-horsepower set.

Among other British firms actively taking up the new industry are: Richardson, Westgarth & Company, of Hartlepool; Barclay Curle & Company, of Whiteinch, Glasgow; Brazil Straker & Company, of Bristol; J. White & Company, of Cowes; Gardners, of Manchester; Swan, Hunter & Wigham Richardson, Ltd., of Newcastle-on-Tyne; Beardmore Bros., of Dalmuir; Palmer Bros., of Jarrow; Babcock & Wilcox, of boiler fame; Mirrless, Bickerton & Day, of Stockport; Westinghouse Brake Company, and Willans, Robinson & Co. Messrs. Barclay, Curle & Company is building a 7,000-ton motor vessel for the East Asiatic Petroleum Company, and Richardson, Westgarth is constructing an engine of 1,000 horsepower for the 3,200-ton ship under construction by Sir Raylton Dixon & Company for Furness, Withy & Company, referred to by Lord Furness; while Messrs. Swan, Hunter & Wigham Richardson, Ltd., is building a 400-horsepower marine motor based on the experience gained with the Polar-Diesel engines of *Toiler*.

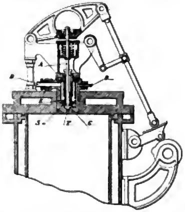

FIG. 3.—FUEL IGNITION ARRANGEMENT OF A 500-HORSEPOWER SABATHÉ MOTOR.

CONSTRUCTIONAL PROBLEMS.

Many are the problems and difficulties that face builders of large marine heavy oil engines, the conditions at sea being vastly different from the requirements of land installations, especially in connection with the government arrangements. Perfect castings of a fine grain iron are required for the cylinders and pistons, in addition to very careful machining. It has been found that mechanics accustomed to constructing steam locomotives make the best fitters and turners for Diesel work, as being used to working to a very delicate gage. Regarding the cylinder castings, the chief problem is that, while the necessity for cooling the walls demands thinness, strength demands thickness, as the casting has to stand internal pressures that may be anything from 400 pounds to 1,000 pounds per square inch. This pressure is, of course, not applied gradually, but in quick succession, about 100 to 200 times per minute. Strains of this nature demand all the designer's care, and a compromise has to be effected. Water-cooling the pistons is another difficulty, but in one or two cases this trouble has been ingeniously overcome; with one engine this has been avoided by cooling the pistons with lubricating oil. Of course, cooling is partially effected by the scavenging air, which with all two-cycle engines is blown through the cylinders at the bottom of every stroke. With the double-acting class of engine greater difficulties arise, as stuffing-boxes to stand enormous pressures under heat of over 500 degrees C. have to be made, and a suitable packing found; also the piston rod must be hollow and water-cooled by swivel-jointed water pipes or telescopic tubing. Propeller racing in rough weather can be guarded against by efficient governing, or by fitting a heavy fly-wheel; also the very high pressure is a factor against the engine suddenly picking up excessive speed. However, most of these worries have now been satisfactorily overcome by Continental engineers, and I am enabled to give short descriptions and illustrations of the principal marine engines.

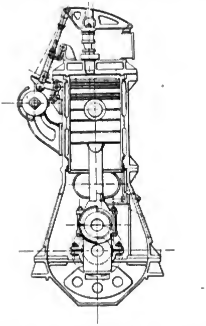

FIG. 4.—SECTIONAL DRAWING OF A 500-HORSEPOWER SABATHÉ MOTOR.

TYPES OF ENGINES. THE SABATHÉ.

A serious rival to the Diesel engine is to be found in the Sabathé crude oil engine, which has several distinctive features. Of the four-cycle type it is essentially a marine job, and the center of gravity is lower than is the case with the majority of engines of the Diesel variety. This, by the way, also seems to be a feature of Krupp engines. There are six cylinders, cast in pairs, each 13¾ inches diameter by 13¾ inches stroke, and 500 horsepower is developed at 400 revolutions per minute; but when required the revolutions can be reduced to 100 with excellent results. The cylinders are lined with steel, and the pistons, which are not water-cooled, are each fitted with four broad, white metal rings in addition to the ordinary cast iron rings, which obviates any frictional trouble likely to arise from the steel walls. The top of the piston is concave, giving a large, efficient combustion area.

Air for starting and fuel injection is provided by a three-stage compressor, which delivers the air at 800 pounds per square inch, and which is driven off the forward end of the solid machined six-throw crankshaft, as are the water circulating and lubricating pumps. The fuel pumps, of which there are six, are driven by eccentrics off the horizontal shaft,

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which can be seen about 18 inches above the crank case doors, and a link motion gear alters the position of the fulcrum of the driving arms for varying the speed or shutting off the fuel feed. Regarding the fuel injection arrangements, there is a double valve in the center of the cylinder head, allowing the fuel to be sprayed directly onto the piston (Fig. 3). The needle valve (*G*) and the poppet valve (*S*) are kept on their

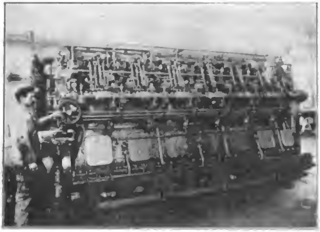

FIG. 5.—A 500-HORSEPOWER SABATHÉ CRUDE OIL ENGINE, BUILT FOR A FRENCH YACHT.

seats by springs, the valve (*G*) being lifted by a rocking lever and a cam, while the valve (*S*) is raised by a collar (*T*), which is secured to the needle valve, so that as the latter opens to a certain extent the valve (*S*) is lifted. This system allows of a small quantity of fuel only being injected into the combustion chamber at low speeds. Fuel consumption, I may say, has been brought as low as 0.4 pound per horsepower-hour of residual oil, the consumption of any engines of the Diesel type being not lower than 0.42 pound. The above engine was built for a French yacht.

THE POLAR-DIESEL.

It is not generally known that the Aktiebolaget Diesels Motorer, of Stockholm, makers of the Polar-Diesel motor as fitted aboard the *Toiler*, are one of the pioneers of marine Diesel work. This firm, by the way, recently removed the steam machinery from Dr. Nansen's Arctic exploration ship *Fram* and installed a 150-horsepower Polar-Diesel motor for the Amundsen Antarctic expedition. Their engines are of the two-cycle type, and usually have six cylinders, four working and two maneuvering. The forward of the latter contains a compressor, which contains a big storage cylinder charged to about 150 pounds per square inch, and this is utilized for starting purposes, supplying air through a reducing valve to both the maneuvering cylinders. As the working cylinders do not take up the load until the engine has made several turns, they pick up very easily. The maneuvering cylinders are, of course, double acting, and they also supply scavenging air at 5 pounds per square inch. Each of the working cylinders is equipped with a separate adjustable fuel pump. The exhaust and air scavenging ports, on opposite sides of the cylinder, are uncovered by the piston towards the bottom of the stroke, the piston head being so shaped as to ensure complete scavenging. In the cylinder head is the fuel injection valve, which is operated by a rocking lever, actuated by an overhead cam shaft driven off the crankshaft, by a perpendicular shaft and skew gearing, at engine speed. An interesting and noteworthy feature is that each cylinder is fitted with a hand-controlled relief valve for use if the engine has stopped with a working piston at the top of the stroke, as the admission of high-pressure air at such a moment would put heavy strains on the big ends and main bearings and also prevent the engine from turning. It is interesting to note that Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Newcastle-on-Tyne, is constructing a 400-horsepower marine engine of similar design.

The following is a report, hitherto unpublished, of a test made by Mr. G. Bremberg, surveyor to the British Corporation Registry, of a 200-horsepower Polar-Diesel marine engine for the Southern Whaling and Sealing Company, of North Shields: This shipping firm is having the four-masted barque *Sound of Jura*, which was built of steel in 1906, installed with

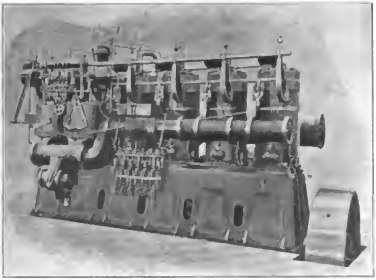

FIG. 6.—A 260-HORSEPOWER POLAR-DIESEL ENGINE. SPEED, 250 REVOLUTIONS PER MINUTE.

a 260-horsepower Polar-Diesel engine developing its rated horsepower at 250 revolutions per minute. She is 210.3 feet long by 35.6 feet beam and 19.5 feet draft. The firm is also having built, by Messrs. Smith Docks Company, two motor whalers, each 92 feet by 18 feet by 6 feet 10 inches, which will be fitted with Polar-Diesel motors of 200 horsepower at 280 revolutions per minute. The engine of which I give extracts of the tests is for one of the latter. After several hours' con-

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tinuous run a consumption test of thirty minutes was taken with the engine at full load, the mean net load being 313 pounds. The engine averaged 282 revolutions per minute and developed 200 brake-horsepower, the fuel consumption being 42 pounds for the thirty minutes, and the consumption per brake-horsepower per hour was .42 pound. Another short test was made to obtain maximum power. With a net load of 225 pounds, and with the engine turning at 292 revolutions per minute, the effective brake-horsepower was 222; the exhaust gases were quite colorless, and no sign of warmth was noted in the bearings. Very satisfactory trials were also made of stopping, starting and reversing. Solar residue oil was used throughout the tests. The Aktiebolaget Diesel Motorer have supplied this type of engine to many firms, including the 320-horsepower tug *Jakut*, owned by Messrs. Nobel Bros. Naphtha Company, of St. Petersburg. But their first marine job was the 60-horsepower Polar-Diesel engine fitted in the 120-foot schooner *Orion*, owned by the Cassiopeja Shipping Company, of Stockholm. This was installed in the autumn of 1907. Among other vessels so fitted may be mentioned the 110-horsepower Polar-Diesel engines in the cargo vessels *Rapp* and *Snapp*, owned by the Alvar Shipping Company, of Stockholm.

With Polar-Diesel motors, which are of the two-cycle type, very nearly the same consumption of fuel as with four-stroke engines has been obtained, results quite unparalleled.

THE SULZER-DIESEL.

Another firm which has had much experience in this direction is Messrs. Sulzer Bros, of Winterhur, Switzerland, which is constructing the two 1,500-horsepower motors for the 6,000-ton liner now building at the Howaldt yard for the Hamburg-South America Company. This notable Swiss firm numbers among its achievements the equipping of the 1,000-ton passenger vessel *Romagna* with two 400-horsepower Sulzer-Diesel oil engines, which is now in service between Trieste and Ravenna, Austria. In the Sulzer engine, using oil fuel having a thermal value of 18,000 British thermal units per pound, the consumption at normal load varies from 0.40 to 0.55 pound per brake-horsepower hour, according to the size of the engine. This makes the running costs about 0.2 to 0.25 cent (0.1 to 0.15 pence) per brake-horsepower hour, basing the price of oil at $12.50 (50/-) per ton. This is, of course apart from lubricating oil; but the Diesel requires less lubrication than any other type of engine. Sulzer Bros. do not direct their energies to one particular type, but build both the two and four-stroke variety.

Fig. 7 shows the sectional drawings of a 400-horsepower Sulzer engine, which is of the four-cycle class. There are four working cylinders, the two others being the high and low-pressure compressors. Very great care has been taken in the construction, and the cylinders and piston rings are made of a special cast iron of fine grain, possessing exceptional wear-resisting qualities, the rings being turned with mathematical precision by a method ensuring equal radial tension, and are placed on the piston with polished faces. The connecting rod, crankshafts and pins are of very tough forged steel, while the bearing bushes follow the usual marine practice, being of white-metal lined gunmetal. Balance weights are fitted to the crankshafts. It will be noticed that the cylinders are water-cooled their entire length, and that the trunk-type pistons are exceptionally long, no crossheads and guides being fitted.

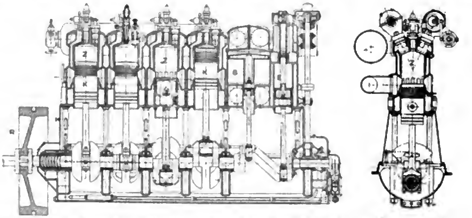

FIG. 7.—SECTION OF ONE OF THE 400-HORSEPOWER SULZER-DIESEL ENGINES FITTED IN THE 960-TON PASSENGER VESSEL ROMAGNA.

WERKSPOOR-DIESEL ENGINES.

These engines came into prominence in connection with the 1,900-ton motor tankship owned by the Anglo-Saxon Petroleum Company, of London, this vessel being propelled by a six-cylinder Werkspoor-Diesel engine of 500 horsepower, constructed by the Nederlandsche Fabriek Van Werktuigen en Spoorweg-Materieel, of Amsterdam. This boat has given such excellent results that her owners have already placed an order with the same engineers for an engine of 1,000 horsepower. *Vulcanus* is 196 feet long by 37 feet 9 inches beam and 10 feet 2 inches draft. She is built of steel, and her speed is over 8½ knots. Her engine is on the four-cycle principle, with six cylinders 15¾ inches diameter by 23 9/16 inches stroke, and 500 horsepower is developed at 180 revolutions per minute. As far as possible it has been built to conform with marine steam engine practice, and accessibility of working parts has been made one of the principal features of the design. The length is about 25 feet, and the height from the center of the crankshaft to the cylinder tops is 12 feet, while the weight is 42 tons without the piping, compressors, etc., the whole weighing some 85 tons. On Taraken residue oil at $9.50 (38/-) per ton the full speed consumption of fuel is .42 pound per brake-horsepower hour and .5 pound when at half speed.

This engine differs from those previously described in this article, in that the compressors do not form part of the actual engine; but the engine is started by a two-cylinder, 50-horsepower auxiliary motor of the Diesel type, also a very heavy fly-wheel is fitted to prevent racing of the engine when the propeller lifts from the water in rough weather. The connecting rods are fitted with cross-heads and guides, allowing fairly short pistons. The 50-horsepower auxiliary drives a two-stage compressor for filling the air tanks, used for starting purposes and for maneuvering the main engine; but it also drives a centrifugal pump for discharging the liquid cargo, *Vulcanus* being an oil carrier. The compressed air tanks, of

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which there are four, hold air at 300 pounds per square inch. On the starboard side of the main engine are the three-stage compressors used for fuel injection, the fuel being injected at 900 pounds pressure through a valve operated off the cam-shaft. The first-stage compressor is a single water-jacketed cylinder driven by links and a rocker off one of the cross-heads, while the second and third-stage compressors are in one casting, and are driven off another cross-head. The water-cooling pumps are also arranged on the starboard side between the compressors. Lubrication is by a Belliss & Morcom oscillating valveless pump actuated by an eccentric off the crankshaft, all oil, of course, passing through a filter before reaching the working parts.

The cylinders are cast in threes, and are fitted with cast iron liners. Unlike the Sulzer engines, which have exceptionally lengthy trunk-type pistons, the Werkspoor pistons, as before mentioned, are short, but are fitted with ten rings a

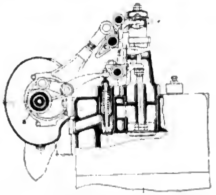

FIG. 8.—VALVE-GEAR ARRANGEMENT IN THE CYLINDER HEAD OF A 600-HORSEPOWER F. I. A. T. MARINE DIESEL ENGINE.

piece to prevent the compression escaping to the crankpit. As cross-heads and guides are fitted there is no side thrust to worry about; but the pistons are hollow and are cooled by a fan driven by friction off the fly-wheel, the current of air being admitted into the body of the piston by telescopic tubing —a noteworthy feature. There is no crankcase, but the cylinders are supported on I columns, the crank pit being covered in by large iron doors. By this arrangement the pistons and crankshaft can be taken out without disturbing the cylinders or valve gear.

Regarding the valve gear, this is arranged in the cylinder heads, and there are four valves to each cylinder—the inlet, exhaust, fuel and compressed air for starting, respectively. Each is operated by a cast steel rocker off an overhead cam shaft running the entire length of the engine. Being about 25 feet long it is, of course, well supported by ample bearings. The engine is reversible, but space prevents describing the valve mechanism in detail, and I have already dwelt at length upon other parts. Briefly, however, reversing is carried out by bodily moving the cam-shaft, bringing another set of cams into action for the opposite motion. I must refer, however, to a recent voyage made by *Vulcanus* from Rotterdam to Hamburg and back. The distance between the two ports named is 735 nautical miles, the outward run from Rotterdam occupying just 100 hours. Her cargo for this voyage was 1,000 tons of benzine; the maximum speed for twenty-four hours was 8.5 knots, and the total fuel consumption 8¼ tons. The return run with 475 tons of water ballast was accomplished in 98 hours, maximum speed 8.9 knots. The cost of her fuel was about $10 (£2) per ton (although residue oil is obtainable at a lower figure), and her engines consume 1 ton of oil fuel for every 100 nautical miles that *Vulcanus* runs. Thus she can carry 1,000 tons of cargo 100 nautical miles with a fuel bill of $10, a saving of more than 50 percent over a steam vessel of similar cargo capacity, which is but one of the many advantages that steamship owners must eventually realize.

THE COCKERILL.

The system adopted by Messrs. Cockerill, of Seraing, and Hoboken, near Antwerp, for the engines under construction for the King of the Belgians' passenger vessel is entirely novel, and will give the ship excellent maneuvering qualities and economical slow-running powers; it is a practice likely to be generally adopted should it prove successful. The engine is divided by a clutch into two units or three or more cylinders, the forward half also being connected by another clutch at the fore end to a compressor, while the after half of the engine is coupled direct to the propeller. When slow speed is required by the navigator the forward half is disconnected and the compressor clutch thrown into gear, and the after part of the engine is run entirely on compressed air. This may seem complicated, but in reality is simple, and should prove to be very efficient.

M. A. N.

In International Marine Engineering of May last, the 3,000-ton auxiliary ship *Quevilly* was described and the two 300-horsepower M. A. N. (Maschinenfabrik Augsburg-Nurnburg) engines with which she is fitted were illustrated. Each engine has seven cylinders, six working and one air-compressing cylinder—not four working cylinders, as was stated in the May issue. This air-compressing cylinder is the high-pressure compressor for the fuel injection. A separate scavenging pump is attached to each cylinder at the lower half, virtually forming a cross-head guide for the connecting rod of the working cylinder pistons. All the lubrication and water-cooling pumps and the controls are mounted at the forward end of the engines. At the after end of each is a powerful clutch, used for disconnecting the propeller shafts when the vessel is under sail, allowing free rotation of the propellers. For starting purposes there are several air storage bottles, which are supplied by a compressor driven off an auxiliary engine, which also drives the electric light dynamo. On the test bed each engine developed 320 horsepower at 305 revolutions per minute on a fuel consumption of .462 pound of residual oil per horsepower per hour.

F. I. A. T.

The Fabrica Italiana Automobili Torino (F. I. A. T.), of Turin, is very busy with marine engines of the Diesel type, the largest being of 12,000 horsepower for the Italian navy, of which, of course, they are unable to divulge details. But their six-cylinder, 600-horsepower marine engine is of interest. It is of the two-cycle class, single-acting, and the rated horsepower is developed at 600 revolutions per minute. There are several decidedly novel features, one of these being that no separate pumps are fitted for air-scavenging the cylinder. This is arranged by double diameter pistons, the upper part being the working piston, and the lower portion acts as an air pump, while the air is retained in a reservoir formed in the crank-case casting, and supplied to the cylinders at the bottom of the stroke through two valves on the cylinder heads. These valves are actuated by cams on the cam-shaft that work the fuel injection valve and starting air valve, also on the cylinder head. The exhaust discharge is through ports uncovered at the bottom of the stroke.

For supplying the air for fuel injection and air for starting purposes there is a two-stage compressor at the forward end, driven off the crankshaft. The pumps for water-cooling and lubrication are grouped at the forward end, where they are driven off the crankshaft extension through a reduction gear. It is interesting to note that with F. I. A. T. engines difficulties arising from water-cooling the pistons have been avoided by oil-cooling the piston tops, which is found to be more successful than expected. The engine is, of course, reversible, and in the official trials by Italian naval officials the

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reversing from full speed ahead to full speed astern was carried out with ease in five seconds.

GERMANIA MARINE ENGINE.

Messrs. Fried Krupp, the famous engineers of Kiel, Germany, have devoted considerable attention to the marine Diesel-type engine, and are the manufacturers of the Germania oil motor. This firm are building four 1,000-horsepower oil engines for the two 7,900-ton ships building for the German-American Petroleum Company. Through their courtesy I am enabled to illustrate a direct reversible, six-cylinder engine of 1,000 horsepower, which was lately built by them for the German government. It is of the two-cycle type, although Messrs. Krupp also make the four-cycle variety. The cylinders are divided into two units of three by the high-pressure compressor, while at each end is a low-pressure compressor, the former being used for fuel injection and reversing, and the two latter for air scavenging of the cylinders. Thus it will be gleaned that should one section of the engine break down the crankshaft can be uncoupled at the center and the vessel driven by the other half. The air and fuel injection valves, which are arranged in the cylinder heads, are driven off a horizontal overhead cam-shaft, actuated by a central perpendicular shaft and gearing, driven in its turn off the crankshaft. Nine large inspection doors are provided to the crankcase. As in the case of the Sabathé engine, the center of gravity is very low, there being no cross-heads, such as in the Werkspoor motor, trunk pistons being fitted. This engine is, of course, for naval work. The firm has just built an interesting motor vessel for the German government, which has been named *Mentor*. At present they are unable to divulge details, but from other information received she is of 75 tons, fitted with motors of 600 horsepower. Personally, however, I believe she is a much larger vessel, and equipped with oil engines of several thousand horsepower.

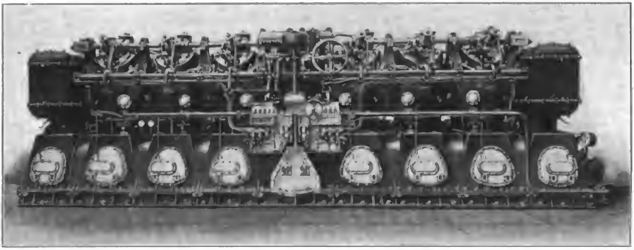

FIG. 9.—A SIX-CYLINDER, DIRECT-REVERSIBLE GERMANIA MARINE OIL ENGINE OF 1,000 HORSEPOWER, BUILT BY FRIED KRUPP OF KIEL.

SHIPS NOW IN SERVICE.

It is not generally known that there are already more than fifty large Diesel-engine ships actually in service. On the river Volga, Russia, the horsepowers of the various Diesel craft aggregate 23,000; two of these are gunboats—the *Kars* and *Ardagan*—each of 620 tons, which are equipped with motors of 1,000 horsepower. Messrs. Nobel Bros. Naphtha Company, St. Petersburg, owns half a dozen large motor ships, each of several thousand tons, while Messrs. Merkuljiff Bros. owns a vessel of 4,000 tons capacity, named *Djalo*, driven by two Diesel engines of 500 horsepower, and fitted with an auxiliary motor of 150 horsepower. Regarding other big motor vessels, *Vulcanus, Toiler, Quevilly* and *Cornelius* are already known to my readers.

VESSELS UNDER CONSTRUCTION.

Big motor ships known to be now building are too numerous to deal fully with here, and probably as many are building secretly or quietly, especially when one considers the fact that the Maschinenfabrik Augsburg-Nurnburg has nearly 100 large marine engines of this type on order, including a six-cylinder engine to develop 2,000 horsepower per cylinder, for German naval purposes—most probably for the center shaft of a battleship—but authentic information is unobtainable. However, I must make brief reference to the two 6,500-ton liners building for the Hamburg-American Line by Blohm & Voss and Burmeister & Wain, while the Hamburg-South America Company is having a 6,000-ton liner built at the Howald yard, Kiel, with engines by Sulzer Bros., Winterthur; Messrs. Burmeister & Wain is also building an 8,000-ton motor vessel of 2,000 horsepower for the East Asiatic Company, of Copenhagen, for service between Antwerp and Bangkok, Siam.

Again, the German-American Petroleum Company is having the 2,300-ton tank ship *Excelsior* fitted with two 900-horsepower Carel-Diesel type motors by the Reshertig Schiffsbau A. G. Of course, this paragraph is not given as *news*, but merely to draw attention to work in progress. Other craft may be mentioned. There is the 3,200-ton cargo vessel ordered by Messrs. Furness, Withy & Company from Sir Raylton Dixon & Company. Again, there is the 6,000-ton boat building on the Clyde by Barclay, Curle & Company, of Whiteinch; also the 1,000-horsepower tank ship for the Anglo-Saxon Petroleum Company, owners of *Vulcanus*. Also, there is the 600-ton revenue cruiser to be fitted with motors of 1,000 horsepower building for the Russian government by the Société Anon. Chantiers Navals Atelier et Founders de Nicolieff, and the Thornycroft oil-engined destroyer for the British Admiralty. Last, but not least, is the 1,000-horsepower Cockerill passenger vessel for the Congo, building to the order of the King of the Belgians. I could continue this list, but space forbids; however, the above will suffice to show that the future outlook is most promising, and shows strong indications that the Diesel type of oil engine will take a prominent place in the propulsion of ocean-going ships in the near future.

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THE SUBMARINE VESSEL.

BY K. DIETZ.

(Concluded from page 360.)

In the determination of the value Q of the ballast water (see also page 358) it is to be observed that the amount Q_1, belonging to the external tanks, completely fills these in the under-water condition, and thus prevents the outer skin enclosing them from being bulged in by water pressure exerted from one side only. Similarly, also, the external oil fuel tanks must be kept full by pumping in water as the oil is consumed. During submerged runs it is desirable that the outer flooding valves be kept entirely open, in order that the hydrostatic pressures within and without the tanks may be kept as far as possible alike. For the determination of the amount of the rest of the ballast water Q_2, which is still maintained within the inner hull, it must in the first place be remembered that a variation of the percentage of salt contained in the water is accompanied by an increase of buoyancy. Should, for instance, during a blockade, a boat be submerged at low tide in the brackish water at the mouth of a river; that is to say, should the ballast tanks be filled with such brackish water (γ_2 = min. 1.0), a rapid equalization of the latter will not easily be effected even with the valves open, and the increase of the buoyancy $(D + d)$ $(\gamma_1 - \gamma_2)$ = max. .026 $(D + d)$, due to the greater specific gravity of the water at a distance from the shore (γ_1 = max. 1.026 tons* per cub. m.), will have to be overcome by the taking in of additional ballast. Further, in the case of external fuel tanks with volume V, attention must be given to the circumstance that the oil, the specific gravity γ_0 of which is less than that of the ballast water γ_1, will, under water with tanks nearly full, continue to provide a maximum amount, $v(\gamma_1 - \gamma_0)$, of buoyancy, which must likewise be overcome by an increase of the ballast water. Now, since γ_0 = about 0.85 and γ_1 max. = 1.026 tons per cub. m., Q must amount at least to .026 $(D + d)$ + .176 v. There must also be a further amount of ballast sufficient to overcome any trim the vessel may have in the awash condition. It is, of course, incumbent upon the designer to arrange the ballast tanks in such a manner that, taken together, they trim the vessel horizontal when she is awash; but in spite of all care inclinations will always take place which will have to be adjusted. In the dimensioning of the ballast tanks it must further be borne in mind that all the structural parts of these and of the open erections, as well as all cavities in pipes passing through these latter, air storage flasks, exhaust pipes, cement, etc., also have a certain displacement which must be exactly determined by calculation and compensated by ballast water.

* Of 1,000 kilogrammes.

The pumping out of the ballast tanks after an under-water run is effected in the awash condition by ordinary centrifugal pumps, the air thereby flowing in of itself. In case of necessity, however, it must be possible, in the submerged condition, or in that of sinking as a result of damage, to pump out ballast when the slipping of detachable lead ballast has proved unavailing. For this purpose most of the pure submarine boats are provided with special high-pressure centrifugal pumps, which must be capable of overcoming the greatest hydrostatic pressure that will in practice be encountered. The air then flows from the inside of the boat into these tanks. In the case of submersible vessels, on the other hand, the emptying of the external tanks can be effected only by compressed air, and is not resorted to until the pumping out of the internal tanks has proved insufficient. For this purpose, indeed, large quantities of highly compressed air are necessary, the storage and constant replenishing of which within the vessel requires the presence there of new appliances. Special high-pressure air pumps are, as a rule, carried (output per minute = about .353 cubic feet of air at a pressure of 2,426 pounds per square inch). In case of necessity the compressor of the Diesel motor may also be pressed into the service. The use of compressed air for the emptying of the external tanks becomes necessary, because the outer skin is not strong enough to withstand great pressure, for water cannot be expelled till the air pressure within the tanks to be emptied is at least equal to the hydrostatic pressure without, so that the walls themselves (the outer skin) are actually not under one-sided pressure. Care must be taken, however, that when the boat rises on the emptying of the external tanks, the compressed internal air is able to expand and escape through the flooding valves.

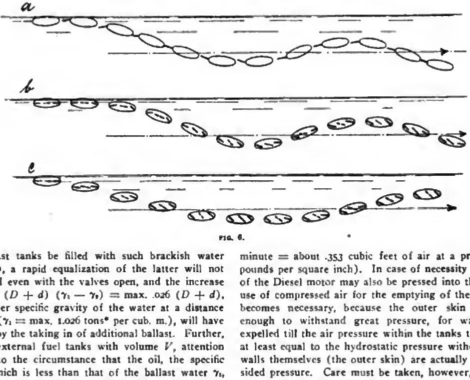

FIG. 6.

After the ballast water has all been taken in the transition from the "awash" to the "submerged" condition may proceed somewhat as follows: 1. By alteration of the trim (Figs. 6a and 6b). 2. By the sinking of the boat bodily downwards, the position of her axis remaining parallel with that in the awash condition (Fig. 6c). Boats with single pairs of horizontal rudders at their after ends can dive only in this way (Fig. 6a); but when a boat is fitted with several pairs of diving rudders it is possible for her to dive in either way. For a dive by means of alteration of trim the foremost pair of rudders are so adjusted as to press the fore body down beneath the surface of the water. The aftermost pair are meanwhile adjusted for "raising," so that the boat under the influence of the thrust of the propeller and of the rudder

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moments, $T_a \times a$ and $T_b \times b$ (Fig. 3), both acting in the same sense, describes a gentle curve in the vertical diving plane. As soon as the desired depth has been reached the horizontal submerged condition is attained by the adjustment of the after-diving rudders to the downward pressing position as well as the fore ones. This method of diving is a very rapid one, because the speed of the boat is made use of to

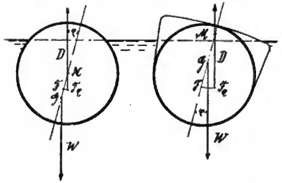

FIG. 7.

bring her down. It is also, however, the most hazardous, since, with the slightest inattention, dangerous depths may very quickly be reached. Greater angles of inclination with the horizontal than 10 degrees are accordingly carefully avoided. In the case of a dive with the axis of the boat kept at the "awash" inclination to the horizontal, which is often called a "dive on even keel," all the diving rudders are at the outset adjusted so as to produce downward pressure, and so handled that the vessel sinks with a fair degree of evenness. A dive in this manner takes rather longer than one made as above described, but it may be accomplished with greater safety, and, with a relatively inexperienced and unreliable crew, should always be preferred. If the rate of the reduction of the speed which accompanies the transition to the submerged condition were known, a simple theoretical analysis (Figs. 2 and 3) of this latter method of diving might be made, since the condition of equilibrium at any moment existing between the vertical components of the pressures on the diving rudders and the part of the surplus of buoyancy already overcome is of a purely static nature. In view, however, of the unknown deflection of the particles of water, due to the shape of the vessel, all existing theories relating to rudder pressures break down; here, again, we are thrown back on the results of experiments with models which, on account of the separation of the resistance of the vessel from that of the rudder blades required for calculation purposes, become very expensive.

After the intended depth of immersion below the surface and the "even-keel" position have been attained, the aftermost of several pairs of rudders, when so many are adopted, are fixed at the angle for diving, and the finer adjustment of the vertical steering is effected entirely by the help of the foremost pair. We have already seen that a state of suspension of a submarine boat is an impossibility, and in consequence every excess of rudder pressure causes an acceleration and a turning of the boat downwards, and every deficiency of pressure a like motion in the upward direction. It follows from this that during under-water runs the regulating diving rudders will be constantly in action; to enable her to maintain the intended depth of immersion the boat must constantly perform oscillations and stamping movements of more or less considerable amplitude. This tendency will be the more pronounced in boats fitted only with single pairs of diving rudders. In order to minimize these oscillations—that is to say, to give a better stability, of course, at the depth of immersion desired—hydroplanes are fitted abaft the diving rudders, but the large proportion of length to depth (max. $L : B :: 12 : 1$) is in particular design to give a certain steadiness in this direction. Further, the already-mentioned effect of the broad after-body on the course-stability also shows to advantage here. The center of mean distances of the greatest superficial extension of the boat in the horizontal plane, correspond-

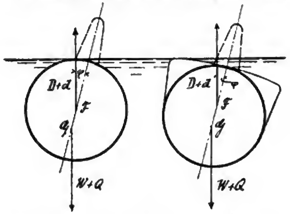

FIG. 8.

ing approximately with that of the waterline of greatest area, is thereby kept unusually far aft and unusually far behind the center of gravity of the vessel when this point assumes its ordinary position. On the assumptions that with a given trim under water the turning of the boat takes place about a horizontal athwartship axis through her center of gravity, and that

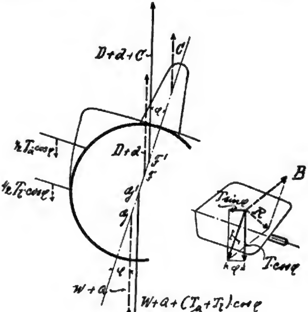

FIG. 9.

the resistance of the water to such turning acts approximately in the center of mean distances above mentioned, a moment tending to bring her back to her old course must be set up with every vertical deviation from the latter. If this center of mean distances lay at a point forward of the center of gravity, the tendency of the boat to turn a somersault would, under certain circumstances, be directly promoted thereby. The

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influence exerted by the broad after part of the vessel towards the prevention of vertical oscillations is therefore to be ranked in importance with that of trim by the stern of a vessel steaming at the surface to prevent her from falling off sideways from her course.

When submerged, a submarine represents a system which approximates very nearly to a condition of equilibrium between forces acting in the vertical plane. Sudden disturbances, such as the firing of a torpedo, inclinations caused by the putting over of the vertical rudder, etc., may, with careless manipulation of the diving rudders, cause incalculable course-deviations in every direction, and this may suffice to show the difficulties of submarine navigation, impeded as it already is by the difficulties of obtaining bearings.

In the case of the large boats, at all events, the action of the increased inertia towards the prevention of alterations of trim

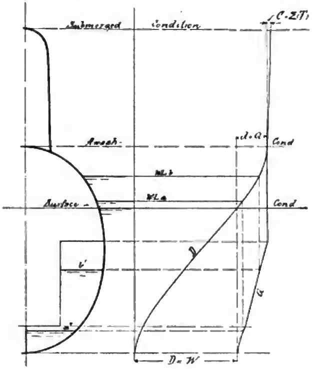

FIG. 10.

is agreeably in evidence. This was probably one of the reasons for the increase of the displacement of these boats beyond that formerly ruling. In view of the considerable cost for the construction and maintenance of the first experimental boats, the dimensions of these were, of course, kept very small; for dependence had in the main to be placed on the expensive purely electrical accumulator system for propulsion, even for surface runs. Since the systematic development and actual application of the submarine boat as a weapon of warfare, however, its displacement has increased. To this growth a limit of about 800 tons of surface displacement has now been set, chiefly because oil motors for the powers, which would, beyond this, be required, have not yet been built, and the necessary reliability in working with them would be missing, but also for the further reason that the deadweight of the storage battery, which always has to be carried, reaches quite unmanageable proportions. Here, also, however, experience has in general shown that increase of displacement brings advantages in almost every direction. In addition to the improvement of the course-stability and the action of the inertia in counteracting changes of trim, this lies in the considerable enhancement of the fighting value (speed, radius of action, necessary comfort and safety for the crew and increase of the store of spare ammunition) in the improved sea qualities accompanying the increase of reserve buoyancy and in the improvement of the stability.

The advantages of greater displacement are especially prominent in the submersible, which in itself already represents an important step in advance. For the magnitude of the reserve buoyancy of the submersible there is, properly speaking, no upper limit so long as the duration of the maneuver of submergence does not come in question. A lower limit, determined in relation to the resulting freeboard exists, however, and this is set by the extension of the stability conditions of a modern submersible as contrasted with those of a pure submarine boat In general, these are very simple. During surface runs they do not differ in any way from those of an ordinary vessel. The stability of a vessel floating at the surface of the water is, as is well known, made up of a weight stability and a surface stability, the former depending on the height of the center of gravity G and the latter depending on the height of the center of buoyancy and on the alteration of form of the displacing body at inclinations from the upright (waterline stability); that is to say, on the lateral movement of the center of buoyancy F, occasioned by such deformation. As may be seen from Fig. 7 the older submarine boats, which swam on their circular-sectioned hulls even on surface runs, have, by reason of the arching up of their upper surfaces, very little water-plane stability, so that dependence must in the main be placed on the weight stability. It is advisable, therefore, in these boats to keep the center of gravity below the center of buoyancy, already in surface condition, so that a moment tending to careen the vessel does not at any inclination occur. In the submersible the case is different. Here the broad upper works give very considerable water-plane stability, and in order to attain reasonable stability conditions a position of the center of gravity above the center of buoyancy must, especially for surface runs, then be aimed at.

If J_s be the lateral moment of inertia of a waterline we obtain for the initial stability $M\,F = \frac{J_s}{v}$. Let us now consider the awash condition. If the surplus buoyancy be represented by the volume of the tower, the hull proper will already be below water. If the slight influence exerted by the tower, which is still above water, be neglected, we may set $J_s = O$, and also $M\,F = O$; that is to say, in the awash condition the metacenter coincides with the center of buoyancy. The waterline stability is herewith destroyed, and only the weight stability remains; that is to say, it is imperative that the center of gravity G lie below the center of buoyancy F ($F\,G = 250$ to 500 mm.). The same holds for runs in the submerged condition with both types of boat, but on account of the tower, *i. e.*, of the surplus buoyancy, the general center of buoyancy F' will rise somewhat higher, and, according to the vertical position given to the horizontal rudders and the varying vertical pressures on these, the general center G' of gravity resulting from $Q + W' + (T_s + T_b) \cos \Phi$ (Fig. 9) will be subject to slight oscillations.

Such is the stability in the final conditions. In the intermediate state between the surface and awash conditions, however, it becomes complicated by the circumstance that the free surface of the water in the gradually-filling tanks, with its stability-reducing properties, has to be taken into account. In a pure submarine boat this is of small consequence, for, provided the center of gravity be not unduly raised by the water in the tanks, she is in a condition of absolute stability, with G below F. As a check upon the reduction of the stability, due to the free surface of the tank water, the method shown in Fig. 10 may be applied, the only assumption in which is that all the tanks are run up simultaneously. The surfaces of the water in the tanks will then be at about the same height at each instance. By means of the displacement scale D and the filling scale of the tanks Q, it becomes possible for each external waterline a or b readily to determine the heights and breadths of the internal water surfaces (a' b') and the influence these exercise on the initial stability.

Exactly the same holds good for a submersible, on the assumption that the center of gravity is already below the center of buoyancy in the surface condition. Prominence is here assumed by the phenomenon that, after a certain point of time represented by the waterline c in Fig. 11 is reached, that dangerous if the waterline stability were insufficient. It is absolutely necessary, therefore, and the height of the freeboard must be so arranged that the deck of the boat does not become submerged till a later instant of the awash period, so that a sufficient degree of waterplane stability is available at this critical time. It is also good practice to bring about the coincidence of the two points before the extreme waterline c (Fig. 11) is reached, so that there is then only one tank waterplane exercising a reducing influence on the stability. Fig. 11 gives, at its right-hand side, the suitable alteration of level of the two centers for the case assumed. F is the locus of the center of buoyancy above top of keel (to the external

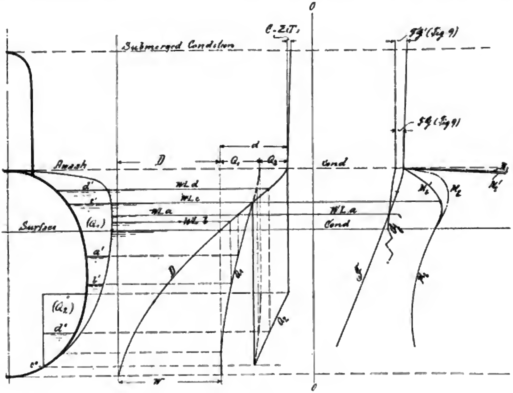

FIG. 11.

two free water surfaces in the tanks have to be reckoned with—that of the outer ballast water Q_1 and that of the inner ballast water Q_2—which may, for any external waterline, be obtained from Fig. 11 in exactly the same manner as for a submarine boat from Fig. 10. The stability-reducing influence of the ballast water between the surface and awash conditions is given for the transverse and longitudinal metacenters in the right-hand diagram of Fig. 11. The curves M_b and M_t give the metacenters regardless of, and M_b' and M_t' these as affected by, the water surfaces of the tanks. For the longitudinal stability is also affected by these, and the longitudinal metacenter in the submerged condition again coincides with the center of buoyancy, so that below the water the longitudinal and transverse stabilities become exactly alike. It therefore is necessary to care for a sufficient degree of subdivision of the tanks in the longitudinal direction and the necessary wash-plates must in every case be provided.

Of special interest again are the stability conditions of a submersible in which the center of gravity is above the center of buoyancy in surface trim. In the submerged condition G must lie *below* F; during the running up of the tanks, then, the critical condition must at one particular instant occur in which the two centers coincide (W' L a). This might be waterlines, set off from the vertical line O-O). G is the locus of the center of gravity. Waterline a is the critical one for the stability. It may at the same time be seen from the figure that the longitudinal and transverse stability are at their minimum in the awash condition; for the influence of the vertical diving rudder pressures T_a and T_b on the vertical position of the general center of gravity is, for the most part, less than that of the surplus buoyancy on the general center of buoyancy.

Hitherto the assumption has been made that the surfaces of the water in the tanks are "free." This is not, however, in accordance with the actual conditions. In regard to the stability, indeed, these are still less favorable, since they include a certain leakage through the valves, which have to stand open during the awash period. The ingress of the water is here greater at the side which is becoming submerged on account of the increase of the hydrostatic pressure. The leakage, however, can only be looked on as exercising a limited influence; for the flow through the valves will always be throttled to a considerable degree, so that for small inclinations the condition of free water planes above mentioned may practically be reckoned with. Of interest, also, is the circumstance that when the diving rudders are turned during an inclination of the vessel the vertical pressures are $T_a \cos \Phi <$

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T_a and $T_b \cos \Phi < T_b$ (Fig. 9); that is to say, the rudders must then be turned to a greater angle. If the inclination of the boat were 90 degrees, no further diving could take place, and the boat would certainly come to the surface.

There is no difficulty in providing the necessary local and general strength required by a submarine boat. As was to be expected, the experiences obtained in the construction of ordinary vessels were, in the first designs, made use of. The early methods have latterly, however, been entirely discarded. The ordinary transverse and longtudinal structural arrangements are applied only to the erections outside of the hull proper, while the latter, when of circular section, has no inner framework except what is necessary for the seatings and brackets for the machinery and other equipment. The strong shell plating which is necessitated by the external hydrostatic pressure is, thanks to its circular form, itself so well able to resist longitudinal bending moments that nothing further is required. It results from this that the internal space is no longer cramped by projecting structural parts, and that the hull itself is evenly stressed; for, when frames were fitted, the resistance to external pressure, although very great in way of these, was, owing to the reduction in the thickness of the plating, considerably lessened between them. The great advantage possessed by the frameless hull, however, is that it can be built in sections, each of which in itself forms a completely welded-up length of tube. By this means the dangers of leakage at riveted connections are completely removed, and the circular form of the hull can best be kept true. The further experience appears here to have been obtained that, even when frames were fitted, no considerable amount of weight was saved, in spite of reductions that could be made on the shell plating. The only objections to the welding of the hull are that the process itself is very expensive, and that it is difficult, if not impossible, to check the quality of the work.

The stresses due to external pressure, which are applied only to the inner hull, the tower and the hatch casings, are accompanied by the ordinary longitudinal ones which are present in every vessel, and which are here subject to slight alteration only in connection with the diving-rudder pressures and the surplus buoyancy in the submerged condition. The first-named stresses reach their maximum in way of the largest diameter of the inner hull, and the others in general at a section at another point in the length. It is the affair of the designer to determine the section between these two which is actually subject to the action of their greatest resultant. The greater the depth of immersion assumed in the preparation of the strength-diagram the smaller will be the influence of the longitudinal stress, unvarying as the latter is for all depths. It must here not be lost sight of that the longitudinal bending moment also affects the more lightly built erections and the walls of the external tanks; in view of the riveted connections of these their strength conditions must receive special attention.

For the determination of the stress to which the hull proper is subjected by the external pressures, one of the many available empirical formulæ may be applied. The approximation to the actual conditions hereby obtained is sufficiently accurate, because the variation of the contour of the inner hull of a submersible, in particular, from that of a spindle-shaped body, to which these formulæ in general apply, cannot yet be taken into account. If, however, the sections of the inner hull are not circular, as in the case of the Italian *Laurenti* design, the method of determining the stresses adopted by Hurlbrink (Schiffbau, Annual No. IX.) may be recommended. In this the local stresses are also taken into account, but, above all, the point in each section of the inner hull under investigation at which the greatest transverse bending moment occurs, and which must therefore be most strongly stayed, is indicated.

The transverse strength of the inner hull receives considerable support from the presence of bulkheads in the hold. Formerly much uncertainty prevailed as to whether it was desirable to fit bulkheads into a submarine boat, because they prevented a good survey of the interior. As the displacement gradually increased this reason ceased to be in itself conclusive. The next step, therefore, was the fitting of light watertight bulkheads, the sole object of which was the localization of explosions or of gases which might be unpleasant to the crew. The tacit hope seems, however, to have been entertained that at shallow depths they would, in case of leakage, be able to withstand one-sided water pressure. In some recent boats, bulkheads would appear to have been fitted that are specially designed to resist one-sided pressure even at considerable depths of immersion.

The foregoing may serve as a general survey of the many theorems which come in question in the design of a submarine boat. The clearing up of the many doubtful points which still await complete theroetical and practical solution must be left to the future. These, however, are mostly of a minor description; the general problem of the submarine boat may be regarded as completely mastered.

Recent Development in Sea Transportation of Swedish Ore.*

BY J. JOHNSON.

The vessels employed in this trade (ore carrying) are nearly all tramp steamers, of which those which are especially built for the trade have a distinguishing feature—a special outfit of a large number of ordinary steam-hoisting winches. In the best-planned vessel of this kind the arrangement of hatches has enabled the cargo to be better distributed in order to reduce the straining effect on the ship. The discharge of ore is still done chiefly by manual labor, it being shoveled into ore bags, which are hoisted in the usual way and emptied in the chutes. Shoveling iron ore by hand is extremely laborious and not in keeping with the best-equipped loading ports. Naturally one's attention is turned to the latest system of discharging ores in the United States, but the condition of the American ore trade differs from that of Europe.

Iron miners in Sweden decided to try the Johnson-Welin system, which proved very satisfactory, and in the following year a vessel of about 8,000 tons dead weight was fitted with the same. The system is to sub-divide a steamer by means of transverse bulkheads, forming alternately bins for the cargo and discharging shafts. The vertical bulkheads do not extend to the bottom of the hull, but terminate about 7 feet from the tank top and are connected to the sloping bottom of the bins, the slope being about 42 degrees from the horizontal. The design further embodies wing tanks for carrying water ballast, and the tops of these tanks are sloping in order to convey the ore to the wing outlet chutes. This system dispenses entirely with all the hands on deck except the crane driver, the hoisting, slewing and tipping being done by one man on a platform on the crane, and the electric transmission of power lends itself admirably to the smooth and effective working of these cranes. Steam-heating pipes are fitted in the holds under the bottom of the ore bins, which prevent them from freezing when the ore is received covered with snow. The vessels so far built on this system are the *Vollrath Tham*, 8,000 tons; the *Sir Ernest Castle*, 10,800 tons. They were built by R. & W. Hawthorn, Leslie & Company, of Hebburn-on-Tyne. These two vessels during continued service have fulfilled all expectations of their owners, designers and builders.

* Abstract of paper read at the Jubilee Meeting of the Institution of Naval Architects.

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FOR HEAVIER ARMOR.

BY SIDNEY G. KOON, M. M. E.

In connection with the re-designing, last year, of a dreadnought for a South American power, a curious result was obtained upon an investigation as to the best means to utilize increased displacement in adding to the armor of the ship. The vessel, as originally designed, carried a powerful battery associated with high speed, but the armor protection was the target for a great deal of criticism. For this reason it was decided to allow the designers an extra 1,000 tons of displacement, to be utilized, so far as possible, in strengthening the protective elements of the ship. And right here is where the difference of opinion set in; for one faction wanted to completely overhaul the design, expanding the vessel in every direction to accommodate the increase in displacement from 21,000 to 22,000 tons. The other side wanted to hold the design as it was, so far as possible, and to obtain the extra displacement by deeper immersion (a matter of 12¾ inches). As the controversy showed no signs of clearing away, the case was made the subject of an investigation, of which the following is a brief account:

The original design showed a waterline length of 510 feet, a beam of 87 feet and a normal draft of 28 feet (uniform), the block coefficient being 0.5916. The designed speed was 22 knots. The shaft horsepower of the propelling turbines was to be 33,000, based on an Admiralty coefficient (K) of 245½, in the well-known horsepower formula

$$H = \frac{D^{2/3}\, V^3}{K},\ D^{2/3}\text{ being 761 and } V^3 \text{ being 10,648.}$$

The battery included eight 14-inch guns mounted in pairs in four turrets, after the manner of the 12-inch guns on the United States battleship *Michigan;* twenty-four 5-inch guns in the battery; fourteen 3-inch semi-automatic guns on the superstructure, under the bridges and on the upper turrets, and four submerged tubes for discharging 21-inch torpedoes. The main items of weight are shown in the table, in the column headed A, that marked B being for the expanded ship, while C shows the weights for the ship more deeply immersed.

The armor protection, about which the whole controversy raged, included a belt amidships, 300 feet long and 12 feet wide, of which one-half was above and one-half below the normal water plane. This belt had a uniform thickness of 9 inches. It was continued to the bow and stern by a 12-foot end belt 5 inches thick. Diagonal armor, starting at the ends of the heavy belt and sweeping around the bases of the endmost turrets, was 12 feet deep and 6 inches thick. Above the main belt and diagonal was a citadel 11 feet high and 6 inches thick. The 5-inch guns were so located as to train over the upper edge of this citadel, and were further protected by 5-inch battery armor rising 5 feet above the citadel. The axial height of these 5-inch guns above the normal water plane was 18 feet. Barbettes for the heavy guns, 33 feet in diameter, were protected by 9½ inches of armor wherever exposed, and by 4 inches where behind other armor. The turrets had 11-inch face plates and 8-inch backs. The one conning tower was 12 inches thick.

The expanded design had a length of 519 feet, a beam of 88 feet and a draft of 28½ feet, the block coefficient of fineness being 0.5916, as before. With $D^{2/3}$ raised to 785, the new shaft-horsepower becomes 34,000 on the same Admiralty coefficient. The battery was identically the same. With the added weight allowable for armor it was found possible to increase the thickness of the main armor belt to 10 inches; of the diagonal and citadel armor to 7 inches; of the battery to 5½ inches, and of the exposed portions of the barbettes to 10½ inches.

In the design C the draft becomes 29 feet ¾ inch, and the block coefficient 0.5971. This was considered a little more difficult to propel than design B, and the Admiralty coefficient was accordingly reduced to 242¼, at which the shaft-horsepower figures out as 34,500. The battery is as before. The additional armor weight permits an increase in the main belt to 11 inches; in the ends to 5½ inches; in the battery to 7 inches, and in the barbettes to 11 inches. The diagonal and citadel armor are 7 inches, as in design B. Splinter protection in the battery, to the amount of 45 tons, was also added. The deeper immersion required the raising of the entire armor belt about 1 foot, but stability was ample to permit this.

Distribution of Weights.	A.	B.	C.	D.
Hull and fittings	8,400	8,800	8,450	8,428
Equipment and stores	1,065	1,100	1,070	1,070
Machinery and water	2,310	2,380	2,415	2,380
Normal fuel supply	1,650	1,700	1,725	1,700
Battery and ammunition	2,500	2,500	2,500	2,500
Armor, complete	5,075	5,520	5,840	5,492
Total	21,000	22,000	22,000	21,570

Details of Armor Weights.	A.	B.	C.	D.
Main belt	1,182	1,313	1,444	1,313
Belt at ends	464	483	507	484
Diagonal armor	315	371	371	368
Citadel, complete	1,012	1,181	1,178	1,178
Battery armor	301	332	421	331
Splinter shields	....	....	45	....
Barbettes	696	715	734	715
Turrets	780	780	780	780
Conning tower	80	80	80	80
Total armor	4,830	5,255	5,560	5,229
Backing and bolts	245	265	280	263
Totals	5,075	5,520	5,840	5,492

In the general distribution of weights it will be seen that the expanded ship B requires 400 tons additional for hull weights, where the deepened ship C takes an increase of only 50 tons. The weights allotted to equipment and stores show only moderate changes, due in part to the additional horsepower and in part to increased general size. The weight of machinery and water (for steaming purposes, including condensing water actually in the condensers and pipes) follows the horsepower directly, so also does the fuel supply (equal steaming radii being required). The battery was not changed at all.

In the expanded ship the turrets are all located in the same position, relative to the center of length, as are those in the other two designs. This means that the length of main armor belt remains constant, and the only required additions to armor weights, as a direct consequence of augmented size, come from the "end belt" 9 feet longer than in A and the diagonal armor on water plane and citadel, due to an addition of 1 foot to the ship's beam (16 inches added to length of diagonal armor at each end of vessel). From these three sources the necessary weight increments amount to about 28 tons, which would have increased the armor weight of B, on the schedule of thicknesses adopted for A, to 5,103 tons. We have thus obtained from the additional 1,000 tons of displacement in B a gain in armor of $5{,}520 - 5{,}103 = 417$ tons, or 41.7 percent of our added displacement. In C, on the other hand, no changes in dimensions call for additional armor weight, and the full difference, $5{,}840 - 5{,}075 = 765$ tons, or 76.5 percent of the added displacement, becomes available for increased armor protection.

Had the armor schedule in B been expanded from that of A on the same ratio of expansion as the dimensions, but without increasing the thickness, the required armor weight on B would have been $5{,}075 \times 785 \div 761 = 5{,}235$ tons, which would have permitted us a gain of only $5{,}520 - 5{,}235 = 285$ tons, or 28.5 percent of our added displacement. This would, of course, have presupposed a slightly wider and longer heavy armor belt, and other dimensions accordingly. Such an arrangement would have deprived us of 132 tons, or nearly one-third of our actual 417-ton gain.

One interesting point brought out at the discussion on these

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several designs, which, after all, were not used, but were later abandoned in favor of a heavier and somewhat different one, was that a ship with all the advantages of *B* could be designed after the manner of *C*, but with a considerably smaller displacement addition than the 1,000 tons allotted. This vessel, called *D*, is also shown in the table. The estimated difference in cost between *B* and *D*, which is about $175,000 (£36,000), would cover the cost of a small submarine.

FREIGHT TRANSFERRING MACHINERY AT ANTWERP.

BY MCL. HARDING.*

Terminal engineering, especially that branch which pertains to the installation and operation of freight-handling machinery, has now become a most important branch of engineering. It is history that two cities may start with equally natural advantages but the one which furnished the best terminals and approaches will soon outstrip the other. There are many examples that the city which neglects its terminals endangers its commercial existence. A port may be said to be built up through convenient, quick and low-cost transference of freight between vessel and shore. A difference of one penny per ton in freight transportation will often change the destination of a ship's cargo.

Antwerp, one of the four greatest ports in the world in reference to foreign commerce, realizing this, is now making most extensive improvements and planning for a still greater enlargement of its commodious harbor. The city is located on the river Scheldt, about 53 miles from the North Sea. Antwerp forms the port of entry and exit for the trade of Belgium, and a portion of Southern Germany, of France and Switzerland. In order that there may be no limitations as to the length and depth of the vessels which here are to be accommodated, the Belgium government is arranging to cut an entirely new bed for the river and diverting its course. In general, there are two ways of increasing port facilities so as to give the greatest lineal frontage for the berthing of vessels. Where there is plenty of water area, as in a bay or harbor, the piers should be extended either at right angles or diagonally to the shore line. Another method is to build the quays parallel to the shore front and also to cut into the shore and form docks or basins. Antwerp, located upon a river, has built massive masonry and wide quays in length about 3 miles, and has constructed a number of docks or basins in addition. There are at present ten inner docks in the north of the city, three barge docks on the south, and an outlet to the Campine Canal for the use of inland shipping. There are six drydocks, 4,500,000 square feet of sheds and many large buildings, such as warehouses and storehouses.

Freight Transshipping.—Among the freight-handling machinery may be mentioned one sheer of 120 tons, two 40-ton cranes, one 50-ton crane, one 10-ton crane, one 5-ton crane and nearly 400 power cranes of smaller capacity. An apparatus for lifting and dumping trucks containing 25 tons of coal, a barge with movable appliances for the transshipment of ore and sixty powerful capstans were installed.

GOVERNMENT WAREHOUSES AT ANTWERP.

Transference of Freight Between Vessels and Cars.—For this movement of freight there are ninety-one power cranes of 1½ tons and 2 tons capacity. These cranes are similar and move on a 4-meter gage line, allowing the cars to pass between the arches of the cranes. The cars are transferred from one track to another by sliding transfer platforms. By an agreement between the general government of Belgium and the town of Antwerp the latter supplies the power for the capstans placed along the quays, also for moving the transfer platforms and the railway trucks along the quay frontage. Many of the cranes have been installed for a number of years and should not be considered as representing the best practice. There are other quays and docks located a distance from the city to avoid the danger of fires, where petroleum, benzine and other heavy oils are loaded and discharged. The installation for this oil handling covers 74 acres. The main system of inner docks is at the north end of the city and covers 220 acres, and there is 46,200 running feet of quays and wharves. There are 262 acres on the quays for storing merchandise, where docks can accommodate about 350 vessels of moderate tonnage. At right angles to these two docks and parallel with the river bank is the Kaltendyk Basin, which is in the center of the port

* Terminal Engineer, 20 Broad street, New York.

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section of the city, and about it are grouped warehouses of large dimensions. There are six drydocks, as mentioned above, and the length of the new drydock, which has been commenced, will be 726 feet. Although Antwerp has the above facilities, yet for some time it has become apparent that the commerce of Antwerp must soon outgrow its docking accommodations.

About ten years ago engineers were put to work to prepare plans that would make the port equal to any demands that are likely to be made on it for many years to come. These plans have received the sanction of the royal government, and will make the port of Antwerp a larger one than any in existence, and three times its present size. The new docks will consist of a canal in the shape of a quarter circle, 815 feet wide and nearly 40 feet deep, extending from the Kattendyk dock for a distance of about 5 miles to the northwest, and there entering the river Scheldt. With this canal will be connected a large turning basin, a system of drydocks for loading and unloading, each 660 feet wide with an average length of 3,960 feet, and complete handling equipment of the latest and most improved character. In the cutting of an entirely new bed for the river there will be removed several bad curves.

Antwerp up to date has spent more than $45,000,000 (£9,000,000) in improving her harbor, and the improvements above outlined are estimated to cost more than $55,000,000 (£11,000,000) in addition, making a total cost of about $100,000,000 (£20,000,000). It is the chief commercial city of Belgium, and has a population of above 300,000. All matters pertaining to the harbor and port are administered by the city.

Sea-going vessels pay 10 cents (5 pence) per ton for two months and 1 cent per ton per month afterwards. Warehouses are rented by the month for 2 cents (1 penny) per square foot on ground floor and four-tenths of this amount per square foot on top floor. In 1907 by sea-going boats there were 11,200,000 tons. There is a charge of 10 cents (5 pence) per month per linear meter (3.28 feet) to merchants outside of the city; 14 cents (7 pence) per month per square meter (10/75 feet), and one-third of this amount for storage in yards. Cranes, 10 tons capacity, 39 cents (20 pence) per hour. Small cranes, 3,350 pounds capacity, 19 cents (10 pence) per hour.

The crane shown in the illustration deserves special study, both from its massive construction and the way it is supported, there being only one leg, the other end being supported upon the girder at the edge of the shed. There are many of these cranes. It will be noticed that the freight is transferred from the hold of the steamship either directly upon drays, cars or elevated platforms. These cranes are adjustable, so that they can be placed directly opposite the hatchways of vessels. For moving the freight between the vessels and the shore this crane does excellent work, but is limited to an in-reach of about 40 feet. If the freight is to be taken into the sheds there is the necessity of rehandling, and much of the advantage of the crane is lost. The freight, when loaded into the steamship, is generally stowed in the vessel without regard to consignments. It may, therefore, happen that the freight taken from the hatch may not be routed for a car directly opposite the hatchway, but for one of the train of cars located at a considerable distance to right or left of the car opposite the hatchway. This means rehandling by manual labor, which is expensive, and even more expensive than the rest of the movements. In similar cases elsewhere where the expense was 6 cents (3 pence) per ton to place on the pier to handle in and place upon cars within the shed, there was an additional cost of 26 cents (1 shilling). Other types of crane along the river and on the Campine Lock have two legs instead of one. These cranes are elevated so that cars and locomotives can pass beneath. There are open sheds back of the river quays for the temporary storing of freight, and elsewhere convenient to the water front are great government warehouses for storage purposes. These warehouses are of very pleasing architecture and fitted with all freight-handling appliances.

HALF-ARCH CRANES FOR HANDLING FREIGHT ON ANTWERP PIERS.

A replica of the first steamboat to navigate the Ohio and Mississippi Rivers has been constructed to aid in commemorating the centenary of steam navigation on the inland waters of the United States by steaming from Pittsburg to New Orleans.

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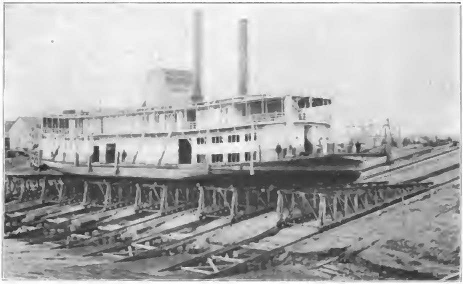
SIDE-HAUL RAILWAY DRY-DOCK FOR THE UNITED STATES GOVERNMENT.

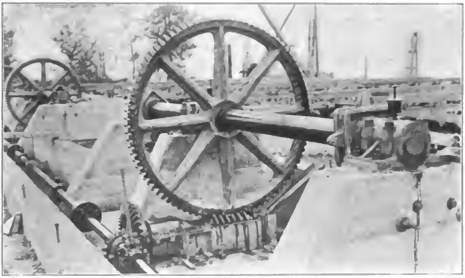
Some months ago there was completed for the Mississippi River Commission a side-haul railway drydock of 1,500 tons capacity, which contains some unusual features, and which in all probability represents the most highly developed form of this kind of drydock. The question of the type of drydock which would meet the requirements to the best advantage was carefully considered, with the result that the side-haul was chosen in preference to the end-haul or the floating dock, as better adapted for the handling of the flat-bottom, shallow draft boats predominant on the Mississippi River.



NEW 1,500-TON, SIDE-HAUL RAILWAY DRY-DOCK ON THE MISSISSIPPI RIVER.

The site selected for building is at West Memphis, Ark., which is the headquarters of the Mississippi River Commission's fleet of dredges, steamboats and other floating craft, and where the repair shops are located. To prepare this site for the foundations, and to bring it to grade, some 13,000 cubic yards of earth were removed from the bank, the deepest part of the cut being about 19 feet. The material was dug and handled by heavy scoops of one cubic yard capacity, which were operated by engine power. A small amount of dredging for the underwater portion was also required.

The dock in general consists of twelve lines of tracks, laid in pairs, of total length 315 feet. The upper portion of 150 feet is composed of reinforced concrete, connected to the lower portion of 165 feet, which is built of timber and thoroughly braced. The upper portion rests on reinforced concrete piles, spaced 7 feet 6 inches centers, while the lower is secured to timber piles. The distance between each pair of tracks is 19 feet, while the individual pairs measure 15 feet



WORM-GEAR MECHANISM USED IN OPERATING THE SIDE-HAUL DRY-DOCK.

centers; the total width from outside to outside being 185 feet. The grade is 1:6. Upon the tracks travel six fabricated steel cradles, which measure 52 feet long horizontally. To the under chord are attached the truck wheels, which are of cast iron, double flanged, chilled tread, 12 inches diameter.

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and run in enclosed bearings, which contain grease reservoirs. On the top chord is placed a patented device for releasing the cradles from under the bottom of the vessel, and which is operated by releasing and tripping mechanisms, handled from the outside of the cradles. By this means the cradles can be conveniently and quickly released, leaving the vessel, if so desired, resting upon blocking laid upon the ground in the 19-foot space between the cradles and independent of them. Any extensive repairs may, therefore, be done on the vessel, while the drydock may be used for further docking.

The cradles are hauled on the endless chain system, the chains passing over sprocket-wheels, which are operated through worm-gear mechanisms. These are of the special M. R. side-welded, long-link type, and of the highest quality of material and workmanship.

The hoisting machinery consists of six separate units, which are operated by a line shaft extending from one end of the foundation to the other, and which is made to revolve by double-cylinder reversing engine placed in mid position. Each unit may be operated independently of the other, or the whole lot may be run in unison by simply throwing in or out the shifting clutches. The foundations are composed of concrete, bedded solidly in the ground, and braced to the heads of the tracks. The time of hauling full-rated load the total length of the track is 45 minutes.

This dock was built by the well-known firm of drydock builders, H. I. Crandall & Son Co., of East Boston, Mass. The chains were manufactured by Bradlee & Co., of Philadelphia, Pa.

Mr. Oscar R. Cauchois, assistant general agent of the Compagnie Générale Transatlantique at New York, has been decorated Chevalier de la Legion d'Honneur, in recognition of his many years of valuable service in promoting and furthering commercial relations between France and the United States.

Mr. Omar N. Steele, manager of the Cleveland yards of the American Shipbuilding Company, died Aug. 17, aged 68 years. He was an engineer on the Great Lakes for twenty years, and brought out the first iron boat built on the Lakes.

PROGRESS OF DISSOLVED ACETYLENE FOR MARINE SIGNALS.

The adoption of acetylene for lighted aids to navigation dates back less than one decade. Beginning with the cumbersome carbide generator beacon (such as are still in use to-day in Mobile Bay), the acetylene aid has developed through the various types of apparatus which generate their own gas on the light stations up to the modern and scientific system where the illuminant is compressed into portable steel cylinders charged at large generating plants on shore. The process of safely storing large quantities of gas in small cylinders suitable for marine work is known as the "acetone process," and is a European invention. Pure acetylene alone cannot explode, but when combined with air in certain proportions it becomes highly explosive, therefore it is dangerous to compress neat acetylene in store holders; but with the acetone system the gas can be highly compressed with just as great safety as you would compress ordinary air.

Acetone is a liquid somewhat resembling alcohol, and has the property of absorbing or dissolving twenty-five times its own volume of acetylene per atmosphere of pressure. Before introducing the acetylene, the cylinders or accumulators (which are of heavy solid drawn steel) are filled with a porous mass composed of infusorial earth, charcoal, asbestos and certain metal oxides. This mixture is poured into the cylinders as a semi-liquid and, after being carefully shaken down so that every space is completely filled, allowed to harden. This hardening process is assisted by baking in a special oven. In this mass, which is 80 percent porous, there is no space large enough for an explosion to occur, and in no case can an explosive wave travel through the porous mass. An amount of acetone equivalent to 40 percent of the internal volume of the cylinder is next poured in, and the cylinder is then ready to receive the acetylene. The initial supply of acetone is sufficient (with very little replenishing) to last for the complete lifetime of the cylinder. A cylinder prepared in this manner will contain 100 times its own volume of acetylene at ten atmospheres pressure (150 pounds per square inch).

No surer guarantee of the absolute safety of dissolved acetylene prepared in this manner exists than its present

NORTHEAST END LIGHTSHIP NO. 44, OFF CAPE ANN, EQUIPPED WITH ACETYLENE FLASHING LIGHT.

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extensive employment by the Light House Bureau of the United States Department of Commerce and Labor for lightships, beacons and buoys.

Accumulators are made in various sizes to suit all varieties of lighthouse work. The large cylinders are used in connection with buoys, one of these containing sufficient to maintain a buoy in operation for from one to two years. The type usually employed for beacons and light vessels weighs, when fully charged, about 200 pounds, and contains at ten atmospheres pressure 180 cubic feet of available gas.

The next most important part of this lighting system is the mechanism for reducing the pressure of the gas to suit the burner and for producing distinctive light characteristics, *i. e.*, alternate light and dark intervals. The flashing mechanism is provided with accessible adjusting screws by which it is possible to adjust it accurately to any desired characteristic.

Occulting light as a peculiarly distinctive signal is well known to mariners. The pilot burners used with this system consume about 1/75 of a cubic foot of gas an hour, which is about one-third of a cubic foot of gas a day.

The powerful light produced by acetylene, together with the wide possibilities provided by this flasher in producing any desired light characteristic, has introduced to lighthouse work an opportunity for improving all minor lights. Hitherto only relatively large light periods (five seconds or more) in combination with dark intervals of about the same length have been used; partly owing to the adherent limitations in the design and structure of the flashing mechanism, but chiefly on account of the feeble lighting power of the illuminants used. In large lighthouses short flashes have been in use for years, and are considered by all lighthouse experts more effective than long flashes. The characteristic most used with this new system is .3 second followed by 2.7 seconds eclipse. With the multiple flashers used with this system a great variety of light characters are readily obtained such as hitherto have been possible only in large lighthouses provided with revolving lenses or screens operated by machinery.

Another interesting feature of this system is the device known as the sun valve, which automatically performs the functions of a light keeper. The sun valve is a combination of metal rods which, by the action of light, control the flow of gas to the burner, closing off the gas in the morning and thus extinguishing the light, and opening the chamber for the gas to flow again at night when the light is again required. Fifty percent of the gas supply is saved by this mechanism. The sun valve will operate equally well in cold or tropical climates.

Last summer Cornfield light vessel, Long Island Sound, was equipped with an acetylene flashing light. This is the first lightship in which an acetylene flashing light apparatus has been installed in America. This year light vessel No. 44, off Cape May, was similarly equipped. Four other light vessels are being fitted out at present, and will be installed at important light stations on the Atlantic coast.

The accumulators, six of which are generally employed, are installed below the main deck; the piping is carried from the accumulator through a manifold to the pressure regulator, which is fastened underneath the deck, thence to a valve also underneath the deck, and then up the mast to the lantern.

The pilot light operates continuously, but the main light is cut off in the morning by the valve just mentioned and allowed to light up again when required at night. The lantern containing the flasher is suspended on gimbels at the masthead, so that in the heaviest sea it remains perfectly vertical, and thus throws the light beams in a horizontal plane at all times. These acetylene lights are visible at 15 miles in clear weather. This system is replacing the old oil lamps, and eventually will be used on all light vessels, with the exception of those using very powerful electric arc lights.

The dissolved acetylene light system is now in use all over the world. In America the following important channels and light stations have been equipped: Ambrose Channel, in which eight buoys are now employed; Point Judith, Montauk Point, and various minor light stations along Long Island Sound; Great Round Shoal (near Nantucket Shoal), also off Atlantic City, Fenwick Island Shoal, Winter Quarter Shoal, Hetzel Shoal, Tampa Bay, Savannah harbor, Charleston harbor, etc.

Acetylene beacons are installed in Alaska (thirty or more); also off the coast of Oregon, Washington and Maine, and forty or more from Maine to Florida. They are also used in the Hawaiian Islands, on the Great Lakes, and the Livingstone Channel in the Detroit river will be lighted throughout with beacons and buoys using dissolved acetylene.

Contracts for U. S. Torpedo Boat Destroyers 43 to 50.

Bids were opened at the Navy Department, Washington, on Aug. 7, 1911, for the construction of eight torpedo boat destroyers. The award of contracts was made on Aug. 27 to the following successful bidders, at price of construction and under guarantees as given below:

ACCEPTED BIDS FOR UNITED STATES TORPEDO BOAT DESTROYERS NOS. 43-50.

		Bath Iron Works.	New York Shipbuilding Co	Fore River Shipbuilding Co.	Cramps Shipbuilding Co.
A	Number of vessels	2	1	1	4
B	Price of construction, each vessel	$761,800 (£156,000)	$781,800 (£160,000)	$779,450 (£164,000)	From $761,000 (£156,000) to $766,500 (£157,000)
C	Time to complete, months	24	24	24	Ranging from 22½ to 24
D	Speed in knots	29	29	29	29½
F	Maximum consumption of fuel oil per knot run at 29 knots	710 lbs.	700 lbs.	686 lbs.	706 lbs.
G	Maximum consumption of fuel oil per knot run at 12 knots	175 lbs.	175 lbs.	110 lbs.	170 lbs.
H	Mean trial displacement	1,010 tons	1,078 tons	1,010 tons	1,046 tons
K	Length of vessel	300 feet	300 feet	300 feet	300 feet
L	Shaft horsepower	16,000	18,000	15,350	16,500
M	Type of machinery	Parsons turbines, 3 shafts with 1 reciprocating engine on each wing shaft.	Curtis turbines, 2 shafts with 1 reciprocating engine on each shaft for cruising purposes.	Curtis turbines, 2 shafts with 1 reciprocating engine on each shaft for cruising purposes.	Cramp-Zoelly turbines, 2 shafts with 1 reciprocating engine on each shaft for cruising purposes.
N	Type of boilers	Normand	Thornycroft	Yarrow	Express

From the price of construction given for New York S. B. Co. and The William Cramp & Sons S. & E. B. Co. $1,000 and $4,000 may be deducted respectively if vessels are tried on Delaware Breakwater course.

Monthly Shipbuilding Returns.

The Bureau of Navigation reports 115 sail and steam vessels of 17,409 gross tons were built in the United States and officially numbered during the month of August, 1911. Two steel steam vessels of 4,897 gross tons were built on the Atlantic coast and two steel steamships of 7,372 gross tons were built on the Great Lakes.

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THE LOCATION AND DISPOSAL OF DERELICTS.

BY STANLEY V. PARKER.

Derelicts always have had a fascination for those who are interested in the sea and its mysteries, but a practical consideration of them has seldom appealed to other than those whose profession made them aware of their danger and interest. A few years after the meeting of the International Marine Conference at Washington, which came to the conclusion that a division of the sea among the nations of the world for the purpose of keeping the pathways of commerce clear of dangers was impracticable, the activity of the United States hydrographic office in the interest of shipping resulted in the publication of a paper of statistics about derelicts. As a result of this, the British maritime interests took up the question of the removal of derelicts under the impression that the British government had never taken any steps in the matter. A board, consisting of members from the Board of Trade and the Admiralty, after a careful and exhaustive taking of testimony, placed as they were on the defensive by the demands of the maritime interests, concluded that as the number of derelicts afloat was so small and the *known* collisions with them so few, no action in the matter further than had already been taken by those responsible for the removal of wrecks in British home waters was justified. However, the United States government, being more afflicted with these menaces of the ocean, employed the vessels of the United States navy at times for their location and removal and, finally, Congress authorized the construction of the derelict destroyer *Seneca*, the first vessel built for this express purpose.

Except those whose duties connect them with the location and removal of derelicts, few mariners realize the difficulties that beset the path of those engaged in the work. It is no rash statement that the location without some method is as difficult as the proverbial attempt to find a needle in a hay stack. However, methods have been developed for this work that have proved successful and others are hoped to prove successful, and it is with some of these and of the methods of disposal that this paper will deal.

CRUISING SUSPECTED AREAS.

The methods of cruising to cover a given area in which a derelict is suspected to be are several. In one, a series of concentric squares or rectangles is cruised about the origin,

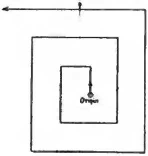

FIG. 1.

the last reported position of the derelict, as a center (Fig. 1). This does not appear to be a very satisfactory method, for, if we have any information in regard to winds and currents that have prevailed, we are simply wasting time on a great part of the area. This would seem to be equally true of the method in which a spiral is cruised about the origin. The more we can restrict our cruising area, the less the distance we have to cover and the longer our coal will last. Both of the methods just mentioned may be used to good purpose in searching for stranded wrecks whose position is uncertainly located, but their use would seem to be a waste of time in locating drifting objects when we can forecast at all the direction of drift of the derelict.

Another method consists in cruising a series of partial rectangles along a line which we assume lies in the direction that the derelict has drifted (Fig. 2). This should prove to be a very efficient method, provided we have an efficient scheme for estimating the derelict's drift. As the uncertainty of the derelict's direction of drift varies as the square of its distance

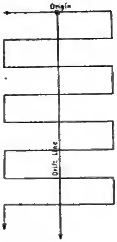

FIG. 2.

from the origin, it would seem to be wise to lengthen the rectangles laterally as we recede from the origin. This constitutes another method of covering cruising ground. If we can estimate the proper length of the sides of these rectangles at a certain distance from the origin, we can thereby determine a sector to which we can confine our cruising. The angular magnitude of these sectors will depend on the exactness of our knowledge of the winds and currents that have prevailed. To cover a linear distance of 100 miles along the bisector of a

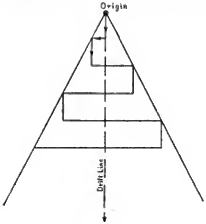

FIG. 3.

90-degree sector would require us to cruise a distance of about 640 nautical miles. This would require, supposing we confined our cruising to daylight, cruising for 12 hours a day at ten knots, about five days, and it would seem to give a very discouraging outlook. But we must notice that, although we may not be drifting at the same rate as the derelict, nevertheless we are generally drifting in the same direction and the derelict is not drifting away from us as fast as at first glance might appear. We will consider this in more detail later.

In the case of a 45-degree sector (Fig. 3) we will have to cruise a distance of 290 for every 100 miles along the bisector.

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This would require a little over two days' cruising at the speed above mentioned. In all the diagrams illustrating the sector method, the lines for cruising over are at a distance apart equal to twice the range of vision at a height of 60 feet, and it was on the assumption that the crow's nest would be at this height that the distance and times above noted were computed. This height of 60 feet was assumed because if we work with a less height, our distances to be cruised are greatly increased, and a height of 60 feet can be attained on almost any seagoing vessel. It will also be noted that we cruise directly along the bisector until the sides of the sector separate a distance equal to twice the range of vision, and that then the method of cruising becomes that of the varying rectangle. In many cases it will be necessary to lessen the distances between cruising tracks on account of the thick weather, etc., or the search may have to be, for the time being, discontinued, but it is not advisable to reduce them if we can see distinctly.

DETERMINING THE DERELICT'S DRIFT.

In considering the time elapsing between the sighting of a derelict and the arrival of the destroyer at the point at which the search is to begin, it will be of value to consider their general location in the North Atlantic. Issuing from the Gulf of Mexico through the straits of Florida, the gulf stream flows to the northward along the coast, tending always more to the eastward. South of Nova Scotia its course is almost due east, but after clearing Cape Race its course is more to the northeastward. It is not always well defined, being influenced by the winds, but its maximum and minimum rates of drift are fairly well known in most positions. Abandoned vessels along our coast are, in the majority of cases, found in this stream and, carried along in it, they sometimes cruise thousands of miles. In any part of the stream they are a menace, but in that part of it south of Newfoundland they are directly in the path of the fast transatlantic liners They are at times found in the counter and branch currents of the gulf stream, such as the Arctic current that rounds Cape Race, in the counter current along our coast, or in the branch current flowing from a position approximately latitude 41 degrees, longitude 50 degrees to the southeastward and southward to the great calm belt in the middle of the ocean, commonly called the Sargasso Sea. An examination of a current chart of the North Atlantic Ocean would seem to indicate that under certain circumstances a derelict vessel might make a complete circuit of the ocean, and that this is possible is shown by the cruise of the derelict schooner *Fannie E. Wolston*. Abandoned off Cape Hatteras, Dec. 15, 1891, she was carried very nearly due east, was drifted about in the calm belt, reaching a position as far east as longitude 38 degrees 30 minutes or about 1,770 miles east of Hatteras, was then carried to the southward, thence to the westward and on Feb. 29, 1894, was seen about 240 miles S. S. E. of Cape Hatteras. She had then been a derelict 830 days and had cruised 7,025 miles.

The information concerning derelicts in the North Atlantic Ocean is ordinarily transmitted to the United States hydrographic office and is published in its bulletins and represented graphically on its pilot charts. The New York *Herald* also publishes daily such similar information as may be reported to it. Generally it is not submitted until the reporting vessel's arrival in port, and this, from the general position of derelicts, results in a delay of the report of from perhaps 24 to 72 hours. Add to this the time it takes the destroyer to reach the point for commencing the search, say 18 to 60 hours, and the arrival at the point is delayed some 42 to 132 hours. This might be avoided if the masters of reporting vessels equipped with wireless would send in report at the time of sighting the obstruction. Between the time of the sighting of the derelict and the arrival of the destroyer, the derelict has had an opportunity to drift, and, as their rate of drift may be as great as 2½ knots, in fact derelicts have been known to drift that fast, her position may be at a distance of some 300 miles from the origin. An accurate estimate of the vessel's drift would be difficult to make, given our present knowledge of the subject, and some method of approximation is all that we can now hope to use.

The consideration of the relative effect of wind and current on the derelict's drift is of considerable interest. It will be found that where a current of any strength prevails, the ultimate position of the derelict depends upon the current. This is particularly true of the gulf stream. However, the position within the current or the predilection of the derelict for branches of it will depend upon the wind. Thus, as the current may be hundreds of miles in width, the derelict's position within the current is of as much importance to us as its ultimate destination, if it is not more important. The reason for the great difference in the effect of these two elements is that the current is practically always in motion, while the wind may be light or there may be calms at times. Again, the tophamper of a vessel is oftentimes carried away after a time, and the wind has little surface exposed to it. In the horse latitudes the jumble of tracks of a single derelict shows the uncertainty of purpose due to the absence of current and the prevalence of variable winds or calms. This uncertainty is seldom seen in the tracks of derelicts in the gulf stream. The effect of wind as determining the derelict's predilection for a part of the current or for branches of it, is well shown in the tracks of the two derelict vessels, the *Anna R. Bishop* and the *Elvira Ball*. Both abandoned on the American side of the Atlantic; they both passed very close to the point in the stream above mentioned where the branch of the current flowing to the southeastward branches off. The *Bishop*, evidently meeting southerly winds at this point, was driven to the northward into the branch flowing toward Greenland, then met northerly and westerly winds and was driven toward the British Isles. The *Ball*, meeting northerly winds at the point above mentioned, was taken in charge by the southeasterly branch, then encountered westerly winds after arriving in the area of little current, and was finally picked up not far from Fayal in the Azores. The final positions of these vessels were hundreds of miles apart.

A very few derelicts have drifted counter to the gulf stream, but they are but a few out of hundreds; and if such a one was sighted more than once, the reported positions would be a guide to that fact.

A vessel's speed before the wind would depend on the ratio of the areas exposed to the wind and exposed to the water resistance respectively, and we have no accurate information as to their behavior under the various circumstances. A method of determining a derelict's position when acted upon by the wind alone, which has suggested itself, might be of considerable value, as the knowledge of the actual rate of drift does not enter. We assume that the speed of the derelict varies directly as velocity of the wind. Suppose we assume that a wind of Beaufort scale force 5, having a velocity of 24.3 nautical miles per hour, causes a drift of one nautical mile per hour. Then the drift that any other wind will cause will be proportional to its velocity with respect to 24.3. We can now prepare a table giving the ratios of the various winds of the Beaufort scale to the standard breeze No. 5. Suppose we have a record of the wind's force and direction since the sighting of the derelict. We multiply the number of hours' duration of the first wind by its force multiplier in the table and lay down in nautical miles from the origin the resulting number in the direction in which the wind has blown. Now proceeding with the next wind that has blown as before, lay down its length from the last point reached. So continue until we have completed the plotting up to the time of

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TABLE OF MULTIPLIERS.

Beaufort No.	Velocity.	Multiplier.
1	6.9	.284
2	11.3	.465
3	15.6	.642
4	20.0	.823
5	24.3	1.000
6	29.5	1.214
7	34.7	1.428
8	41.6	1.712
9	48.6	2.000
10	56.4	2.321
11	65.1	2.679
12	78.1	3.214

[NOTE:—It will be noticed by reference to the Beaufort scale that the values of the velocities in the above table are, with the exception of the No. 12 wind, the maximum values. It would seem to be advisable to use instead the mean values, but inasmuch as we are simply using the values of the velocity to obtain *ratios*, it is not essential that we use the mean values, as the proportions would be practically the same.]

arrival of the destroyer at the point of commencement of the search. Now let us assume that a 5 breeze causes a drift of two knots. Our values in the table will be doubled and, plotting the tracks again, using the same data as before, but using the new table values, we reach another point which, it will be discovered, is on the extension of the line drawn from the origin through the first point reached. It is probable that, no matter what assumption we make as to the actual rate of drift, provided we assume that the drift is proportional to the velocity of the wind, all the points reached will be on this line. And that this is true is easy of demonstration. The determination of this line, then, simply requires the determination of one final point as above, and our line will be that joining the origin with it. We can not determine the exact position of the derelict along this line, but we now have some means of restricting our cruising area.

The average quartermaster can judge the Beaufort force of the wind to at least the first scale number on each side of the actual force. This would mean, in the case of a five breeze, an error of about five knots, or proportionally of about one-fifth. It is evident that if the errors are all plus or if they are all minus, no error will result in the direction of the line, but that if the estimates are one-half plus in error and one-half minus in error the error in the trend of the line will be a maximum, for in the first case the quartermaster has practically used a table with larger or smaller multipliers, while in the other case the error is always onesided. The errors will effect a maximum error in the trend of the line when the track lines are nearly perpendicular to the locus obtained, and will be a minimum when the lines nearly parallel the locus, being in intermediate positions proportional to the sine of the angle of the tracks of the locus. The practical application of this point (Fig. 4) would consist in laying off on each side of the locus at the final point a distance perpendicular to the locus equal to one-fifth of the total departures, as the projection of the various tracks on a line perpendicular to the locus might be called, thus forming a sector. This would result, in case of tracks near the origin which were generally perpendicular to the locus, in the sector formed by the lines from the origin to the two correction points being of great angular extent. Practical considerations of distances to be cruised would generally limit the sector to 90 degrees, as it is simply a provision against error that may or may not exist.

It is evident that to correct our line of current it will be necessary to shift it in the direction of the set a distance equal to the drift per hour times the number of hours since the last report of the derelict. This, of course, refers to a current constant in drift during that time. If the current is not constant the line becomes a curve, difficult of determination. These observations are true, because no matter what the position of the derelict along our locus, provided the current is constant, it will be set an equal distance in an equal length of time. On the other hand, not knowing the exact position of the derelict on the locus, if there are different currents along it, we can not determine when it entered a particular current, nor how long it remained in that current, so that the shift of the locus becomes variable, according to the length of time spent in each part.

The question now occurs: "How are we to obtain the drift of a current at sea so as to correct our line for current?" An examination of a current chart of the North Atlantic (hydro-

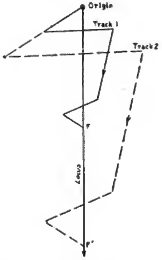

FIG. 4.

graphic office No. 1,308) will show that the currents with their drift per day (24 hours) are noted on the chart. It will also be noticed that in most cases two values of the drift are given. This means that under certain circumstances at certain parts of the year the drift is greater or less than at others, although during a period of several days or weeks it may remain the same. This fact, then, adds a complication to the shifting of the locus for current, and it will be necessary to apply both drifts unless we have more accurate information. So that to shift our line we will run it up according to both values of the current given, thus obtaining two lines parallel to each other, so that the probable position of the derelict is somewhere between them (Fig. 5). These lines will be, of course, at a distance apart equal to the product of the days and the difference between the two rates of drift. In the stream to the eastward of Cape Henry the two values appearing on the chart are 24 and 95, about the greatest difference in drift that we find. Supposing five days to have elapsed since the sighting of the derelict, the lines will be 355 nautical miles apart. If we were to use these lines as the sides of a parallelogram approaching a rectangle, the other sides being 100 miles apart, for defining a probable area, it would be necessary to cruise an area of 35,500 square miles in the search. This, if we used the rectangular method of cruising, would necessitate the cruising of a distance of 2,000 nautical miles, which, at the rate of cruising noted above, would require about 14 days. A greater number of days between the sighting of the derelict and the arrival of the destroyer at the point of search, in this part of the ocean, would require a correspondingly greater time of cruising. We see from this the need of the utmost speed in reaching the area to be searched.

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With a familiar knowledge of the effects of the seasons and weather on the gulf stream, derived from experience and what has been published on the subject, it may be possible to restrict the probable current values to still closer limits, and thereby reduce the area to be searched. Off Cape Hatteras, it will be noticed that a multiplicity of current sets and drifts prevail; it would be necessary in a case of this kind to apply the very maximum and minimum limits of the assortment of current sets and drifts if we cannot say accurately which current the derelict may be in. This would relieve us of the necessity of determining the curve for the variable set and drift of the current above mentioned, although it would undoubtedly increase the area to be covered. Sometimes the currents in a neighborhood will be so contrary in set and so variably in drift that we will have great difficulty in making any estimate at all. A guide as to which current the derelict is in might be sure that the derelict's drift will be that which would be caused by the prevailing wind.

The locus should be corrected for wind and current up to the time of the arrival at the point selected for the commencement of the search. It will be remembered that with our locus method we obtained a line that the object of our search would be on if the wind alone had affected her; again, we saw that in order to correct this line for current it would be necessary to shift it. Using the maximum and minimum values of the drift, the line when shifted would be represented by two lines, one for each rate of drift and, evidently, to cruise the area between the lines will consume considerable time. If we can further restrict the area to be cruised we will be much better off. The use of tables with various drift assumptions for the standard breeze will be of value when we have had enough experience to be able to assume a fairly

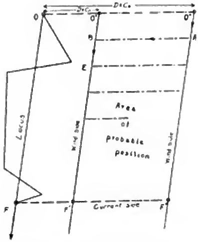

FIG. 5.—SHIFTING OF LOCUS FOR CURRENT.

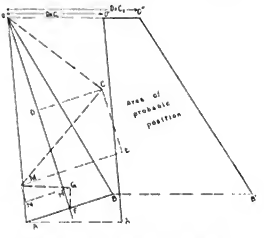

FIG. 6.—CORRECTED SECTOR, SHIFTED FOR CURRENT.

the temperature of the water at the origin, but too implicit faith should not be placed in such a test, and it would at least require us to proceed to the origin. We see then that we have some method for determining the area to be searched, although this area may be considerable.

To show the application of these theories, let us suppose we are ordered to search for a reported derelict. The navigator should obtain from the vessel which reported it, if possible, an abstract of her weather log for a few days preceding and following the sighting of the derelict, together with the approximate positions at the times of the entries. He should also attain the position of the derelict anew, as an error of hundreds of miles might result from a telegraphic or typographical error. With this information and any other weather information of the position on hand, the wind locus should be determined and corrected for current approximately. When the vessel leaves port she should obtain from the lightship nearest the position of the derelict, and vessels in that neighborhood and which have been in that neighborhood, abstracts of their weather logs, and the locus should be corrected so as to represent that obtained from the most accurate information. The approximation of these winds obtained from the pilot charts, the use of which has been suggested, would be of little value unless no other information were available. The data on the pilot charts represent average conditions, and in places other than the trade belts a deviation from the average would very probably exist for days at a time. It is only necessary to glance at a pilot chart to see that a derelict will for days run counter to the longest wind lines. Neglecting current, they may follow these average winds in the long run, but as our search is limited to days or weeks, we can not be accurate drift of the derelict from her build, rig, etc., as obtained from Lloyd's Register and the description of her condition received from the vessel that sighted her. Having made that assumption we can then use the table that has that rate of drift for the standard breeze. However, until that is done, we must do the best we can with the present table.

Having shifted locus, origin and second point so that we now have two loci, two origins and two second points, we, by them, determine a parallelogram that represents in its area the area of the probable position of the derelict (Fig 6). Upon reaching the minimum drift origin position (or the maximum if that be closer) the searching vessel would be put on a course along the current side until she reached the opposite wind side of the parallelogram, when her course would be changed to follow the far side until she had gone along that side a distance equal to twice the range of vision at the crow's nest, when she would parallel the first course back, continuing this as in the rectangular cruising method, although the partial figures may not be right figures. After we had finished cruising the parallelogram, if we had not found the object of our search, we should continue over an extension of it until we were compelled to return for coal. By so continuing this cruising we would nullify any effect of the error of the assumption that the drift before the wind was 1 to 0 for the standard breeze. If our wind locus had been corrected for possible error in judgment of the wind and, therefore, is a sector, our shifted figure would be an irregular one, resembling somewhat a trapezoid.

It will be noticed that the closer the knowledge of the current drift and the more nearly the maximum and minimum values approach each other the nearer our loci lines approach

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each other, and the less the area to be searched, until, if the current is accurately known and has but one value, the locus will be shifted as one line or figure. In this case it would be advisable to make the locus the bisector of a cruising sector and follow the sector cruising method.

Each day we should continue the search until dusk, when cruising should be discontinued and the vessel simply kept under control until daylight, being kept near her position when she stopped searching by cruising in a restricted area, and at daybreak searching should be resumed. We can assume with accuracy that the destroyer is drifted by the current at the same rate as the derelict. The assumption that she has been drifted at the same rate as the derelict by the wind would not be accurate. This rate of drift depends, as was said before, upon the relative area submerged and exposed to the wind, and these will not be necessarily the same for any two vessels. But the difference would only be material with winds of considerable force. Therefore, under average conditions, it would be proper not to correct the position of the ship on the diagram as the result of sights taken, but we would consider that the destroyer, derelict and diagram had all been drifted an equal amount, and our dead reckoning would be used as far as our cruising for the derelict is considered. Of course, I do not mean to say that an accurate record of the ship's position should not be kept, but it would not be used to correct the ship's position on the diagram.

If on account of the great length of time spent on the search, the knowledge that the derelict is light and will therefore drift faster than the ship, or that she is waterlogged and will not drift so fast, during all of which time a considerable wind were blowing, there would be doubt of the advisability of acting as above noted. It would be better to use the ship's observed position and correct the diagram for the force and direction of wind and current that has prevailed since the beginning of the search, and then maneuver to get back to the diagram where we left it.

There is no doubt that the information given commanding officers ordered to search for derelicts is far from satisfactory. A sample report taken at random from the New York *Herald*:

> "Boston, March 21. Steamer *Nanna* (Nor), from Macoris, reports March 16, latitude 36—17, longitude 70—41, passed a vessel, bottom up, about 200 feet long, evidently a recent wreck."

Here we have no information whatever concerning the winds prevailing at the time, nor the apparent current experienced, and we must rely on information obtained subsequently either from the nearest lightship or from the pilot chart and current chart, or on the chance of getting some information from vessels that have been in that vicinity, and this information we may or may not be able to obtain. This is a typical report, and I have never seen one that really contained any valuable information from the standpoint of the searcher.

To remedy this I would suggest a form of report somewhat like the following:

REPORT OF DERELICT SIGHTED.*

	Latitude	bearing
1. Position		or
	Longitude	dist.

2. Date and hour of sighting.
3. When and where last seen (if as above, so state).
4. Name of derelict.
5. Rig.
6. Condition (Bottom up or otherwise).
7. Masts (Standing?)
8. Condition of hull (Breaking up? etc.).
9. Wind's force and direction at time.
10. Wind's force and direction every 2 hours for 12 hours, before and after. (True force, magnetic direction.)

Before	After
2	2
4	4
6	6
8	8
10	10
12	12

11. Current experienced at time and for 2 days before and after.
12. Where bound at time of sighting.
13. Temperature of water at time of sighting.

This form would call attention to the essentials of the information required. The forms could be printed with plenty of room on them for remarks, and in sending information by wireless, which should be encouraged, it would only be necessary to affix the information desired to a number representing the particular item in the table. It will be noted that all numerals are to be written out in the position; this to avoid error.

(To be concluded.)

* Write out in words.

The New Transatlantique Steamer Rochambeau.

In May last we published a view of the steamer *Rochambeau*, which was built for the Compagnie Générale Transatlantique at the Atlantic Works at St. Nazaire. She is second in size to the steamer *France* and *La Provence*. The general dimensions of the *Rochambeau* are as follows:

Length over all	597 feet 9 inches.
Length between perpendiculars	538 feet 6 inches.
Beam	63.8 feet.
Depth at the spar deck	43 feet 4 inches.
Displacement	70,300
Indicated horsepower	12,500
Designed speed	17 knots.

Mild steel is used in the construction of this vessel, and she is divided into thirteen watertight compartments. The double bottom, extends from end to end of the ship. The hull is divided by five steel decks, worked from stem to stern. Above the spar deck are the promenade and the boat decks.

She was designed to carry first and third class passengers, as well as steerage, totaling 1,450 souls. She will run between Havre and New York.

A peculiarity of this ship is that she will be propelled by a combination of reciprocating and turbine engines, and this is the first time that such a combination has been tried in the French liners. She has two triple-expansion main engines of the three-cylinder type of the following dimensions: High, 33½ inches; intermediate, 49 inches; low, 56 inches; stroke, 29 inches. The revolutions per minute are 115. The turbines will be run at 350 revolutions per minute. The diameter of the turbine rotors is 68 inches. The reciprocating engines will drive the center shafts and the turbines the outside propellers. The main engines, when going astern, will exhaust directly into the condensers. Steam is supplied to both main and auxiliaries by a set of nine marine cylindrical boilers, 16 feet 9 inches in diameter and 11 feet 2 inches in length, carrying a normal pressure of 200 pounds. The grate surface will total 690 square feet and the heating surface 26,820 square feet. It is expected with this combination that the maximum efficiency will be obtained.

When they attempted to launch this vessel tallow was frozen on the ways and she could not be started, and the next spring tide had to be waited for.

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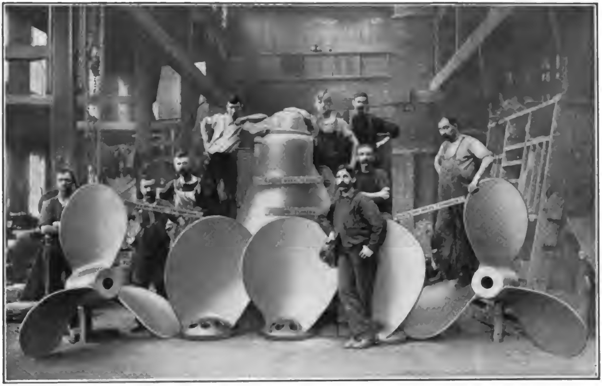

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THE SPERRY GYRO-COMPASS.

As ships are constructed more and more of steel, wood being replaced, and especially as they have become larger, it has been found that the magnetic compass becomes more and more of a problem. In earlier times the earth's magnetism, upon which the magnetic compass depends, had no difficulty in finding its way directly to the compass needle, but now, with steel ships, the ship itself becomes strongly charged or magnetized from the earth's magnetism, and thus steps in as a powerful factor and tends to control the needle. The ship itself thus becomes a great magnet, and it is with much difficulty that the needle is brought to be influenced even to a small extent by the earth's magnetism, as the needle naturally tends to point to the induced magnetic poles upon the ship which are comparatively close by, and thus move with the ship rather than point to the earth's magnetic pole.

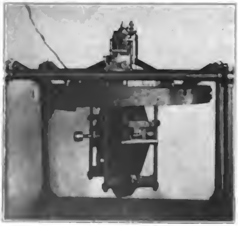

FIG. 1.

Again, the magnetic pole is nearly 1,000 miles removed from the North Pole, so that a compass needle in Iceland points westwardly. The compass is 32 degrees out on the northern steamship course between England and America. There is only one place out of ten thousand different positions upon the earth's surface where the needle can point north. These spots, together with all magnetic meridians, are constantly moving and changing locus. The object of the non-magnetic yacht *Carnegie* is to explore in attempts to relocate many of these meridians which are known to have shifted.

On warships the uncertainty of the compass is still further aggravated by the fact that gunfire, moving of turrets, or shifting of any gun or other piece of machinery on board are found to greatly disturb the compasses, rendering them unreliable. The starting up of the forward bank of boilers, and consequent heating of the funnel, has been known to throw the magnetic compass out 15 degrees.

Marine insurance reports show losses to the extent of many millions annually, traceable directly to compass failures and deviations which occur without the knowledge of navigation officers, especially in cloudy weather, when the navigator is without means of checking. Many attempts have been made to find some phenomenon outside of the earth's magnetism which may be employed to develop true direction or terrestrial position. In 1852 Foucault discovered that a rapidly spinning mass would detect the earth's rotation, and named the instrument the gyroscope (gyro to move, scope to measure). Great excitement was caused at the time in scientific circles, especially in the Royal Society of Great Britain, by Foucault's demonstration of this wonderful property of his gyroscope, but it has been left to an American engineer to devise simple and practical means whereby this wonderful instrument, known as the gyroscope, shall seek and persistently hold exact geographical north, indicating the exact position of the North Pole of the earth, and this regardless of where it stands upon the earth's surface or to what position it is transported; and what has been very much more difficult to accomplish, the machine is so constructed that it successfully withstands other forces, such as acceleration and decelaration pressures, jar and shock of gunfire, having recently withstood all of the salvos of the ten great 12-inch guns upon the Coronation battleship *Delaware* when they were all fired simultanously.

The practical machine develops a directive power which holds true geographically. Instead of pointing to the magnetic pole it points absolutely true to the North Pole of the earth.

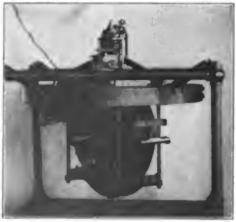

FIG. 2.

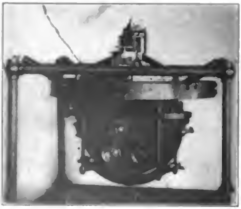

FIG. 4.

To add another chapter to the wonders of this instrument it may be stated that it derives its directive power by actually reaching down some 4,000 miles and "laying hold," as it were, of the exact axis of the earth a noumenon, this imaginary line passing through the earth's center of gravity about which the earth revolves, and even though it is compelled to act at this great distance, yet in protracted sea trials, which we are informed have been of the most searching character, through which the United States navy has recently carried this compass, it was found to have a directive power of about 7,000 times the directive power at the Equator, and no force was found that could tear it away from its dead north indicating direction, no matter how many times the ship was swung entirely around the circle or back, or how great a storm the ship was in, or how much motion or jarring the ship had or

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tremendous vibration through gunfire. No force was discovered which could turn it aside from its wonderful tenacity of purpose.

The gyro navigation equipment consists of a master gyroscopic compass which is located below decks. It is about 1½ feet in diameter and about the same in height. It contains a small spinning-wheel, which is electrically driven, and requires about the same current as would operate two or three ordinary incandescent lamps. The little wheel operates on two small ball bearings, which require practically no attention and maintain a life of many months in constant use. The wheel is enclosed and can be seen depending from a large horizontal compass card below the cardian or suspension ring in Figs. 1, 2 and 3. These figures are of added interest, owing to the fact that this group of photographs constitutes a moving picture, indicating the exact motion one sees the gyro-compass make when the ship is turning around in a circle or through 90 degrees.

In Fig. 1 the casing containing the gyro-wheel, or gyroscope, is seen edgewise to the observer; in Fig. 2 the forward edge has swung around somewhat to the right, and in Fig. 3 still further to the right, nearly 90 degrees from the first position. Although the wheel and casing are seen to move, this is only apparent. The facts are: the spinning-wheel and the casing are standing absolutely still in space, pointing to the North Pole, while the walls of the room and the ship as a whole move about it. Although this master compass down in the hold of the ship is possessed of a compass card and is directly used for navigating purposes, yet it need not be so used, because the little mechanism seen on top

FIG. 4.—GYROSCOPIC REPEATING COMPASS ON THE BRIDGE OF THE DESTROYER DRAYTON

of the compass, in Figs. 1-3, constitutes a transmitting device whereby all of the directive movements, even to the most minute, are instantly transmitted to a number of repeating compasses located on the bridge, in the wheel-house, or in the chart room, and, in fact, wherever else desired throughout the ship, a simple electric wire connecting them for transmission of the directive forces. Fig. 4 shows the position of the gyroscopic repeating compass in its own binnacle, the one to the left arranged close to a magnetic compass, on the bridge of the United States destroyer *Drayton*, one of the fleetest ships in the United States navy, which was designated to make the initial sea trials.

These photographs were taken in New York harbor, where the magnetic variation is about 9 degrees. There was also a magnetic ship deviation at this particular heading of several degrees, and their sum is exactly the difference that can be seen between these two compass cards, the gyro-compass holding to the geographical meridian—dead north—whereas the compass card is pointing 12 to 15 degrees away from true north. It was found at the end of the trials and after the repeating compasses had changed their positions a great many hundred thousand times that there still remained no difference between the readings of the master and repeating compass.

In the case of the *Drayton* the demands of the United States Navy Department were unusually rigid, and the master compass was required to perform its full function when placed

FIG. 5.—SPERRY GYRO-COMPASS ON THE STEAMSHIP PRINCESS ANNE.

away down in the hold of the ship; in fact, in the lowest part, just on top of the keel in the powder magazine, surrounded on every side by solid steel walls, where the earth's magnetism could not penetrate nor have ever been available to the slightest degree, and where no mariner would ever think of placing or atempting to operate a magnetic compass.

SEA TRIALS ON NAVAL VESSELS.

The series of sea trials referred to above has resulted in establishing many points of interest regarding gyro-navigation, some of which are noted below.

All readings of all azimuth circles or indicators, whether master compasses or repeating compasses, are held dead upon the meridian, thus avoiding all necessity of calculation or reference to charts in translating the observations; especially is this emphasized when it is remembered that prior to Mr. Sperry's work, with the reading of the gyro-compass indication, at least three other simultaneous observations had to be made, namely: The ship's speed or headway; the ship's course, and especially the meridional component of the course; the latitude, and then calculations made, or charts or tables consulted before the proper correction is ascertained and position of the meridian found, this being hitherto the universal practice with gyro compasses.

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The amount of correction, and whether it is positive or negative, which is being at all times automatically introduced by virtue of the peculiar structure of the compass itself, is given on a special scale which can be read whenever desired.

Directive power of at least 200,000 dyne centimeters, about 7,000 times the magnetic, in the east and west position at the Equator is available with less than 9,000 revolutions per minute. The comparatively low speed of the Sperry gyro-compass is advantageous on a number of important accounts, among which are integrity of bearings and rendering the machine low in point of maintenance and attention required, as well as low in power absorption during operation, and also important on account of quick starting.

Gyroscope compasses have a very long period of swing or oscillation. This period is in direct proportion to the gyroscopic moment or the directive power of the compass, and one great difficulty in developing a compass with as high a directive factor as that of the Sperry compass has been to devise means whereby this period of oscillation can be brought down within practical limits. It is just here that engineering skill is displayed in introducing an entirely new phenomenon into the art of gyro-compasses, viz.: positive orientation, whereby the period has been reduced by about 800 percent and becomes a perfectly practicable operative quantity. All Sperry gyro-compasses have this feature.

All azimuth indicators, scales or pointers, either master, repeating or recording, including those for navigational purposes, and also those for ordnance, are positively driven and possessed of a large and positive torque factor, whereby all sensitiveness of indication is removed and the instruments freed from disturbance from gunfire, etc.

Definite provision is made for simultaneous connection and operation of other special automatic instruments, including the automatic pelorus azimuth indicator, recording and other various navigation and ordnance instruments now in operation on the battleships of the United States navy. These function properly by virtue of the non-lag mentioned in the previous paragraph.

The entire circle in azimuth is turned in less than one minute instead of six minutes heretofore required; not that some ships will turn an entire circle in this time, but many motions requiring accurate indication without lag are made at least at this rate, and are thus made instantly available for accurate steering, and especially for other important purposes in which their use has been established.

All repeater scales or cards hold to their positions instead of being constantly on the move. A method has been discovered and adopted giving the time of rest, very large as compared with the time of taking up the new position, nearly five to one, thus greatly facilitating taking of observations.

Artificial orientation is possible and conveniently arranged. The combination with the azimuth-moving element of the Instrument of an indicator mounted upon the freely-moving wheel frame, combined with handles by means of which the instrument can be almost instantly set upon the meridian, and whereby even the most ordinary attendant can instantly discern that the apparatus is in condition of permanency during the operation of setting, and will maintain its indication for an indefinite period if the setting be correct.

As correlative to the last feature is the fact that these particular features of the equipment constitute an apparatus by means of which the position of the meridian can be quickly found or determined when its position is not known without waiting for the instrument to come to the north and settle itself, by means of which this setting operation can be very materially hastened. On the battleship *Delaware* the meridian was located on test by Engineer Ford in about twelve minutes while the boat was maneuvering constantly, and where, the gyro-compasses being down very low in the ship, the location of the north was entirely unknown to Mr. Ford.

Provision is made for running the spinning-wheel in vacuum, whereby a material saving of electrical energy is effected, especially when the compass is operated on submarines where this energy must be furnished from storage batteries. It is found that a saving of fully four-fifths of the energy is in this way effected.

The advantage of vacuum operation was furthermore demonstrated on both the earlier sea trials where the current was off for periods up to three-quarters of an hour, and in that time the speed had not diminished materially, and the directive power had kept up so that the meridian was held throughout; under atmospheric pressure the gyro-wheels would have run down much more rapidly, fully five times as rapidly for top speeds, especially when this wheel is used to generate an air blast.

Electrical energy is saved in not being employed to develop an air blast or any other extraneous forces, and a point of the greatest importance is secured, namely, accumulations of grit, dirt and foreign matter are thus prevented from reaching the interior of the most important part of the equipment, including the main journals, which by the Sperry arrangement remain hermetically sealed and are found not to require attention and cleaning nor even oiling except about once monthly.

The suspension system is purely mechanical, consisting of a short, stout torsion suspension of pianoforte wire; it is possessed of very great sensitiveness—this factor being such that the wheel when at rest will make upwards of thirty vibrations across the hair line in coming to rest when pulled aside only one degree and released. All mercury or other volatile liquids or fluids are eliminated, and the supports are reduced to a few simple and purely mechanical factors. The elimination of mercury is considered by those experienced in its use to be a positive and important step in advance. In operating without mercury the drawing around of the compass from the true north through the well-known drag or reaction of the swirling of the mercury bath upon the float is entirely avoided. Certain compound motions of the boat are very likely to set up these swirls, especially where the mercury is present in the form of a ring or annulus and when the float supplying the card is also annular, thus introducing serious errors without giving the slightest warning or alarm. Deflections as high as 10 degrees have been noticed due to this cause.

Integrity of circuit is obtained because the electric circuits within all the repeaters are permanently closed, and there are no traveling or moving contacts, commutators or the like. All wiring and parts are soldered and permanent and cannot get out of order nor require attention. The azimuth controllers or actuators are all in duplicate and separately removable and replaceable, and may be removed, inspected or adjusted at will without in the slightest interfering with the operation of the instrument. The master compass occupies comparatively small space, and requires no adjustment, addition and removal of weights with changes in latitude or in changing from north to south latitude, this difficulty being entirely overcome by functions which are automatically introduced.

The master compass is entirely independent of position in the ship with reference to the ship's axis of oscillation, and reports show that it works equally well and with equal precision in any position. The oil equalization system, connected with the main gyro bearings, does away with inequalities and out-of-balance conditions arising through unequal oil consumption. Perfect equilibrium is at all times automatically maintained, both oil receptacles being also automatically refilled through a single opening, and this only at very infrequent intervals, the whole rotor system requiring very little attention.

The repeating-compass operating mechanism is made light and small, with a view to its being placed when required in an

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extremely light and small "portable," and is supplied with a light flexible cable of some length for use in submarines in connection with the different positions and stations requiring the presence of the commanding officer. Wherever the commanding officer is he is thus supplied with a precision instrument operating with an accuracy of a small fraction of one degree, aiding greatly in the accuracy of his aim and in determining the exact moment for the discharge of his torpedoes, to say nothing of the advantages in navigation as such, especially in connection with accurate maneuvering.

SEA TRIALS OF THE SPERRY GYRO-COMPASS ON THE PRINCESS ANNE.

A five-day test of the Sperry gyro-compass was made recently on the steamship *Princess Anne*, a vessel of about 2,200 tons, belonging to the fleet of the Old Dominion Line, plying between the ports of New York and Norfolk, Newport News and Old Point, Va. The tests were conducted in the presence of Mr. John Bliss, of John Bliss & Company, New York City, compass adjusters of the port of New York, whose sun instrument and chronometers were used. The master compass was set with its motor generator in the steering engine room of the vessel, two decks below the bridge. The repeating compass was placed in a tripod, furnished by John Bliss & Company, a few feet astern of the ship's standard compass on the bridge. These were connected by wire cable, ordinary lamp cord, No. 18, being employed. The gyroscopic compass persists with great rigidity in the meridian, showing the very minutest deviation of the boat. The repeating compass follows these deviations with every change of one-third degree. A great many comparisons were made, and it was always found that the repeating compass retained permanently its original "set" and never varied therefrom. At the finish the correspondence was found to be perfect between the two compasses, although it is estimated that there were over a half million changes in azimuth made by the repeating compass. No supplies were used on these trials except about two tablespoonfuls of oil in the compass supplied to the motors-bearing equalizer pipe. The only adjustment found necessary was the original adjustment of the lubber line to bring it in correspondence with the ship's axis. On one occasion the current was turned off by accident while operating the headlight. After it had been off about twenty minutes it was discovered and turned on again, but the speed of the gyroscope had not come down very much and the directive power had not been sufficiently impaired to be discernible. It was immediately compared with the other compass and checked exactly with the proper difference. The compass required practically no attention.

During these trials the ship rolled considerably. Its period seemed to be between ten and twelve seconds. Some rolls were about 40 degrees total arc, a great many 32 degrees, and one was measured to the leeward 22 degrees from the vertical. These motions of the boat seem to have no effect upon the operation of the compass. While swinging in the harbor of Newport News with a hawser at the bow of the ship and the propeller reversed, there were various resonant points in the period of the spring of the boat when the boat shook very vigorously. Upon this occasion, Commander A. M. Cook, of the Ordnance Bureau, was present, and reported that this vigorous shaking, which seemed at times of the magnitude of 8 inches up and down and in period with the engine vibrations, was very much more severe on the compass than heavy gunfire would have been on a warship with the compass in, or about, the engine-room. These motions seemed to have not the slightest effect upon the instrument or its accuracy.

During the trip a speed of only 6,000 revolutions per minute of the little gyro-wheel was maintained, developing all the directive power that was necessary, holding both the master compass and the repeating compass practically absolutely upon the meridian. The course laid between magnetic variations of about 9 on the north to 4 7/10 on the south end of the course. During the voyage South the magnetic compass was seen to gradually close in, bringing the needle more nearly in line with the readings of the gyro-compass, and on the return course the magnetic compass gradually pulled away from the readings of the gyro-compass. This observation was of considerable interest to many.

THE U. S. COLLIER NEPTUNE.

The above-named ship was built by the Maryland Steel Company, Sparrow's Point, Md. The contract was awarded Sept. 23, 1909, the price of construction being $889,600 (£182,000), and time of completion 20 months. Standardization trials were performed July 26 last and the 48-hours' full-speed trial on July 27, 28 and 29.

The *Neptune* is a sister ship of the *Cyclops*, completed on Oct. 28, 1910, by the William Cramp & Sons Ship & Engine Company of Philadelphia. Both of these colliers were authorized by the Naval Appropriation Act approved May 13, 1908. The principal contract requirements stipulated were: An average speed of the vessels on a continuous 48-hours' trial of 14 knots when carrying a full load of 12,500 tons of coal, inclusive of bunkers; 100 tons of reserve feed water, 20 tons of drinking water, 130 tons of stores, and with equipment complete. Besides the foregoing it was stipulated that the coal consumption for all purposes should not exceed 1.8 pounds per indicated horsepower per hour, figured on the power developed by the main engines. Both of these vessels were built in conformity with the rules and regulations of the American Bureau of Shipping and the United States Steamboat Inspection Service.

The essential data of hull and machinery, with especial reference to the *Neptune*, are incorporated below:

Length between perpendiculars..	520 feet
Length, over all................	542 feet 10 inches
Length on load waterline.......	529 feet 10 inches
Beam, extreme.................	65 feet 3 inches
Beam on load waterline.........	65 feet
Mean draft, load...............	27 feet 7⅝ inches
Displacement on load draft.....	19,440 tons
Block coefficient................	.734
Material	Mild steel

The machinery installation of the *Cyclops*, partly described in a previous issue of International Marine Engineering, consists of twin-screw, three-cylinder, vertical triple-expansion engines, 48 inches stroke, cranks at 120 degrees, and piston valves on all cylinders. The machinery installation of the *Neptune* consists of twin-screw Westinghouse turbines, connecting to the line and propeller shafting by Melville-Macalpine reduction gears. The main boilers, as in the *Cyclops*, are three double-ended, cylindrical return fire tube, with one single-end Scotch donkey boiler.

Condensing surface in the *Neptune*, distributed in two main cylindrical surface condensers and one auxiliary condenser, totals 11,700 and 1,000 square feet respectively. The main airpumps are of the Le Blanc-Westinghouse type. Dynamos, centrifugal pumps and fans are all engine driven. The following table gives speed in knots, revolutions per minute, horsepower, etc., on trials:

CYCLOPS.

Speed in knots	14.61
Revolutions per minute	92.26
Average steam pressure at boilers.............	192.00
Vacuum, inches	27.1
Collective indicated horsepower of main engines	6,705

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Pounds of coal per indicated horsepower per hour (main engines only)	1.48
Displacement at middle of trial	19,095 tons.
NEPTUNE.	
Speed in knots	12.926
Revolutions per minute	119.5
Average steam pressure at boilers	173.00
Vacuum, inches	28.30
Collective brake-horsepower of turbines	5,409
Equivalent indicated horsepower of turbines	5,879
Pounds of coal per indicated horsepower per hour	1.791
Average displacement	19,531 tons.

In commenting on the preliminary contract trials of the *Neptune* the following citation is made from the August number of the *Journal* of the American Society of Naval Engineers: "On the 48-hour full-speed and endurance trial the contract speed of 14 knots was not maintained, due to the use of very inefficient screws. * * *. The reduction gear worked very satisfactorily on the trials with but little noise and no appreciable vibration."

While the Navy Department has decided to take over the *Neptune* temporarily and place her in service at once, so as to lose no time in gaining valuable experience in the operation of the reduction gear, it is at the same time understood that the contractors have made arrangements to replace the present turbines with others expected to fulfill all requirements. New screw-propellers are also now being made and will be finished shortly. Six months at least, however, will be necessary for the manufacture and installation of the new turbines.

It will be of interest to the readers of INTERNATIONAL MARINE ENGINEERING to learn that the *Jupiter*, a third collier of identical dimensions and requirements as those which refer to the *Cyclops* and the *Neptune*, now building at the Mare Island Navy Yard, California, will be equipped with an electric system of propulsion. The contract for the installation in question has been given to the General Electric Company of Schenectady, N. Y., and will be along lines described by Mr. W. L. R. Emmet, in a paper read before the American Institute of Electrical Engineers, the contents of which were given in an abridged form in the July number of this magazine.

Much instructive and interesting data will be afforded the engineering profession when the comparative results of the three vessels here referred to become available, but the liberal policy pursued by the Government in this regard will be valuable not only to the engineer, but will at the same time be commercially useful.

SINGLE SCREW STEEL COLLIER SUFFOLK.

The New York Shipbuilding Company, Camden, N. J., has recently completed and delivered to the Coastwise Transportation Company, Boston, Mass., a steel screw collier of the following dimensions:

Length between perpendiculars	373 feet.
Beam, molded	50 feet.
Depth, molded	32 feet.
Draft, loaded	25 feet.
Cargo carried at this draft	7,200 tons.
Gross tonnage	4,718 tons.
Speed at sea, loaded	10 knots.

The vessel is of the same type as the *Coastwise* and *Transportation*, built by the New York Shipbuilding Company for the same owners last year; the dimensions and deadweight, however, have been increased. The construction is in accordance with the requirements of the American Bureau of Shipping.

The vessel has a single deck of steel, with poop 80 feet, bridge 17 feet, and forecastle 34 feet long, seven steel watertight bulkheads, two pole masts, straight stem and semi-elliptical stern. A deep double bottom is fitted all fore and aft for the carriage of water ballast, and particular attention has been paid to the construction of this part of the vessel; the plating being of extra strength and fitted flush; no wood ceiling is fitted. The five cargo holds are entirely clear of beams and pillars, the deck being supported by deep arched beams and web-frames placed midway between the watertight bulkheads; a continuous trunk, 24 inches deep by 30 feet wide, is carried on the upper deck for the full length of the cargo spaces. Large steel cargo hatches are in the top of this trunk, eleven in all. Six steam winches are fitted in connection with five pairs of king posts for raising the hatch covers and securing them in place when open. A cargo boom is located on the fore mast for handling stores, etc. The coal bunkers are at the sides of the vessel in the boiler room and in the poop 'tween decks, with hatches on the poop deck and pockets leading to the fire-room. The peaks are both arranged as water-ballast tanks. The accommodations consist of a midship deck-house on the bridge deck for the captain's stateroom and spare room, with a pilothouse over; the saloon officers' and petty officers' berths, pantry, toilet, etc., are in the bridge; the engineers, cooks, steward, messrooms, refrigerator, toilets, galley, etc., are in the houses on the poop deck, and the oilers, seamen and firemen are berthed in the poop abreast the engine casing.

The steam windlass is fitted with warping ends and located on the forecastle deck, with the engine below in forecastle.

COASTWISE TRANSPORTATION COMPANY'S NEW COLLIER SUFFOLK.

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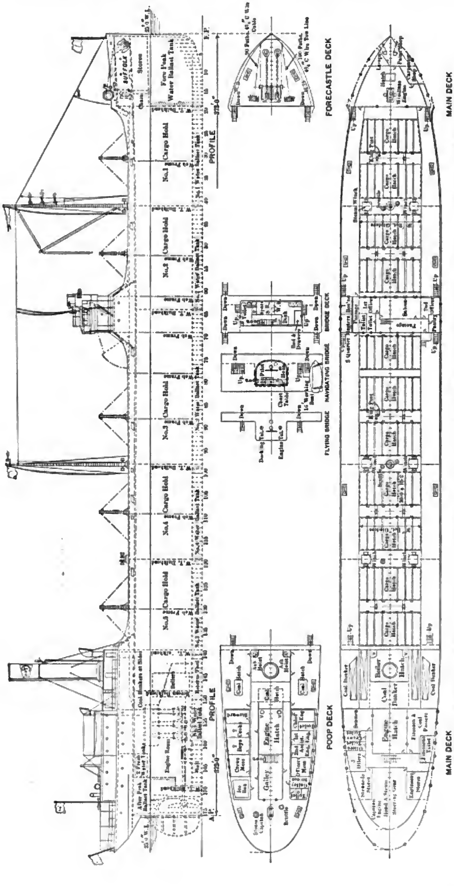

OUTBOARD PROFILE AND DECK PLANS OF COLLIER SUFFOLK, BUILT BY THE NEW YORK SHIPBUILDING COMPANY OF CAMDEN, N. J., FOR THE COASTWISE TRANSPORTATION COMPANY, OF BOSTON, MASS.

The steam capstan is on the after end of the poop deck, with the engine below. The steam steering gear is on the upper deck abaft the engine casing, with connection to the steering stations in pilothouse and on navigating bridge; auxiliary hand-steering wheels are also provided. The propelling machinery is placed aft, and consists of one triple-expansion, inverted reciprocating engine of about 2,100 indicated horsepower, and two single-ended Scotch boilers having a working pressure of 175 pounds. The vessel is intended for the coastwise coal-carrying trade between Baltimore and Boston. Loading and discharging gear is not fitted on board, the two terminal points being arranged with these facilities.

GAS ENGINES; THEIR DESIGN AND APPLICATION.

BY E. W. PERCY.

(Continued from page 352.)

The effect of compression is threefold, first upon horsepower, second upon economy and third upon design. High compression increases the horsepower because in order to have high compression it is necessary to have a proportionally small clearance, which permits the egress of a large portion of the burnt charge and the intake of a large fresh charge, obviously resulting in more horsepower.

To find the limit of velocity, we know that pressure varies inversely as volume with gases. When these gases are suddenly compressed work is done, which is converted into heat which is expressed by rise in the temperature of these gases. A correction is necessary, as it is obvious that with temperature there would be increased pressure, hence some modifying factor must be introduced into the well-known formula: $P V = C$. This has been established with very fair accuracy with theoretical conditions, such as isothermo compression, or compression with a rising temperature and adiabatic compression, or compression at a constant temperature, the heat being abstracted at the same rate as added. This formula may be employed with fair accuracy for air compressors working under known conditions, but the constants for gas engines are impossible to derive theoretically except by assuming certain conditions which cannot be proved to exist in the gas engine.

The acknowledged proper form for an equation for compression is $P V^n = C$. From an enormous number of experiments the value of n is found to vary from 1.3 to 1.5; 1.4 being accurate enough for all practical purposes and normal designs. The most practical way to handle this formula is obviously by the aid of logarithms, it being somewhat awkward on the slide rule.

PRACTICAL METHODS OF FINDING COMPRESSION.

The true compression of an engine can only be found approximately, and then only for given conditions. Careful calculations for given conditions will indicate the compression more closely than it can be found by any instrument, providing the conditions in the engine and in the calculations coincide. The indicator card, when taken with the proper instruments, shows not only the amount of compression but also its instantaneous character and the extremely instantaneous character of the maximum pressure about it, being in most cases a sharp point far above the rest of the diagram; at the same time an engine having a throttle governor or a governor which in any way alters the charge will so change this compression at any variation of load that it is entirely a matter of judgment as to what is the true compression of the engine, it being usual to assume the maximum compression as the true compression. But this is seldom the case so far as averages are concerned.

No method could be more unsatisfactory than that of putting a gage on the cylinder to learn the compression, as when such a gage is used and the engine turned by hand the compression indicated is barely two-thirds of the true compression. On the other hand, if a gage with check valve and receiver be used, and the engine operated at full speed by an outside source of power, the compression is still incorrect because the cylinder valves and piston are not so highly heated as in the case of an engine under full operation.

In a 6¼-inch by 7½-inch single-cylinder engine running at 400 revolutions and under normal conditions a compression of 75 pounds was shown both on the indicator cards and by careful computation. The steam gage test carefully applied for tests extending over an entire day with two gages, check valves, and so forth, operating the engine from outside power, also turning slowly by hand, show the compression to vary from 50 to 57 pounds.

In general, as a rough average, it may be stated that for a given relation the compression in a gas engine under operative conditions is anywhere from 5 to 20 percent more than a carefully cooled air compressor. Hence to determine compression for particular conditions one is dependent upon either one of two methods, calculation or the indicator card.

The effect of compression on economy is best shown by actual test, as summed up in Table 4. This table quotes from tests of Prof. Burstall, all on the same engine at Birmingham, with gas, as given in the proceedings of the Institute of Mechanical Engineers, 1898.

It will be noted from this table that the heat efficiencies and the total efficiency increases with the compression, also that the clearance volume approximated the compression amount when calculated $P^{1.4} = C$.

By referring to Table 5, in which four particular compressions have been experimented with, each with a different volume of air to volume of gas, the effect of each upon the heat efficiency and the other factors may be noted.

Practically, compression should be as high as possible for the sake of technical economy. The combustion chamber should be as nearly globular as possible. The means of ignition should be as near to the center of this globe as possible, so that explosion might be provided on all sides. The piston speed should be as high as possible in order that the loss, due to radiation, be reduced to a minimum, and the stroke should be long enough to allow complete combustion.

Opposed to these theoretical requirements and their relations to combustion are the requirements or reliability and durability representing commercial efficiency. These requirements call for ample bearings, slow speeds, moderate compression, ample cooling surface and great capacity for governing, regardless of economy. Thus any design which goes to radical ends to attain technical economy is apt to depart from the requirements of commercial economy and its field of usefulness ceases to exist. Among the more or less radical steps to obtain all the advantages of high compression without infringing upon these immovable commercial requirements are the injection of water, off-set cranks, the absence of fuel until after compression and slow-burning mixtures.

The water injection engine has been used in many forms, some engines using it in the form of steam after evaporation in the engine jacket. These engines have, in addition, a very high thermal efficiency, but for reasons doubtless practical and founded on experience do not compress above 60 or 70 pounds and are designed to burn oil exclusively. Off-set cranks, while not practically allowing a very high compression, diminish or eliminate the shock incident to greatly advanced spark or rather high compression. Of the many engines which compress pure air and afterwards igniting the fuel, the Diesel seems to be the only one aggregating more than 100 pounds compression; hence it cannot be stated that the fuel value of compression is utilized by carburetors of the ordinary engines.

(To be continued.)

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TABLE 4.

Test No. in Order of Merit.	Revolutions per Minute, Mean.	Power. I. H. P.	Power. B. H. P.	Heating Value of Gas Thermal Units per Cubic Foot.	Gas Consumed per Hour Including Ignition. I. H. P. Cubic Feet.	Gas Consumed per Hour Including Ignition. B. H. P. Cubic Feet.	Thermal Units Consumed per Minute. I. H. P. T. U.	Thermal Units Consumed per Minute. B. H. P. T. U.	Compression in Pounds per Square Inch, Absolute Pounds.	Volume Air to Volume Gas.	Initial Pressure in Cylinder Absolute Pounds per Square Inch.	Exhaust Gases Analysis by Volume Percent. CO_2.	Exhaust Gases Analysis by Volume Percent. O	Clearance Volume to Total Cylinder Volume Percent.	Temperature Jacket Water Out. Degrees F.	Original Test No.	Heat Efficiency Percent Taking. I. H. P.	Heat Efficiency Percent Taking. B. H. P
1	107 min.	5 10 max	4 13 max	598	20.3 min.	25 1 min.	202 min.	250 min.	103	8 6	201	6 8	8 6	25 min.	144°	15	21 0 max.	17 0 max.
2	156	2 87	2 32	608	23.3	26 8	236	291	72	9 5	171	6 0	9 6	41	145°	7	18 0	14 6
3	149	2.58	2 07	595	23 8	29 4	236	292	105	10 8 max.	135	3 6 min.	11 6 max.	25 min.	152°	17	18 0	14 5
4	155	2 61	2 11	605	24.0	29 6	242	298	80	10 1	161	5.2	10 8	36	160°	10	17 6	14.2
5	154	2 50	2 01	586 min.	26.5	32 7	259	320	83	8 7	203	6 5	7 0	37	134° min.	11	16 4	13 3
6	161	2 65	2 15	617	25 6	31 6	263	325	62	8 0	211	7 6	6 4	49	144°	2	16 2	13 1
7	204 max.	3.79	3 07	610	26.9	33 2	273	338	65	8 3	167	7.2	7 6	46	144°	5	15 6	12.6
8	158	2 69	2 18	635 max.	25.9	32 0	274	339	64	8 4	171	7.2	7 4	49	148°	3	15.5	12.5
9	164	2 79	2 26	607	27 3	33 7	276	341	64	7 1	203	8 0	5 2	49	146°	4	15 4	12 4
10	158	2 61	2 11	606	27.7	34.2	280	346	76	7 1	230	8 2	5 8	36	149°	9	15 2	12 3
11	117	1.84	1 49	603	28 2	34 8	284	350	96	10 4	179	6 2	9 4	37	140°	15	15 0	12.1
12	158	2 44	1 97	600	29 7	36.7	296	367	71	7.2	237	8 2	6 6	41	151°	8	11 4	11 6
13	118	1 60 min.	1.30 min.	606	31 1	38 4	313	388	102	9 2	210	5 4	10 6	25	141°	14	13 6	11 0
14	157	2 48	2 01	625	30 3	37.4	316	390	105 max.	7 2	278	7 4	6 6	25	138°	16	13 4	10 9
15	118	1.72	1 39	614	33 0	40 8	337	418	52 min.	9 1	118 min	6.0	10 0	57 max.	142°	1	12 6	10.4
16	155	2.52	2 04	621	35.1 max	43 3 max	363 max.	449 max.	83	5.3 min.	286 max.	9 3 max	0 4 min.	37	168° max.	12	11.7	9 5
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

TABLE 5.

Test No. in Order of Merit.	Revolutions per Minute, Mean.	Power. I. H. P.	Power. B. H. P.	Heating Value of Gas Thermal Units per Cubic Foot	Gas Consumed per Hour. I. H. P. Cubic Feet.	Gas Consumed per Hour. B. H. P. Cubic Feet.	Thermal Units Consumed per Minute. I. H. P. T. U.	Thermal Units Consumed per Minute. B. H. P. T. U.	Compression (Absolute) Pounds per Square Inch	Volume Air to Volume Gas.	Maximum Pressure in Cylinder, Pounds per Square Inch (Absolute).	Exhaust Gases Analysis by Volume Percent. CO_2.	Exhaust Gases Analysis by Volume Percent. O.	Clearance Volume to Total Cylinder Volume Percent.	Temperature Jacket Water Out. Degrees F.	Original Test No.	Heat Efficiency Percent. Taking. I. H. P.	Heat Efficiency Percent. Taking. B. H. P
A. 1	201 5	4 41	3 29	547	24 9	30 9	227 0	281.7	55	7.8	131 2	7.28	8.57	0.57	151	A 4	18.7	15.0
2	207 5 max.	3 95	2 98	547	24 8	32 8	226 0	299 0	55	8 2	125 0	6 54	9.70	0.57	140	A 5	18.7	14 2
3	197 1	4 24	2 88	561	24 8	36 5	232 0	341 0	55	8 1	130 0	5.71	10 07	0.57	137 min.	A 6	18.2	12.4
4	201 3	3 75	2 55	561	25 6	37 6	239 3	351 5	55	8.0	122 0 min.	4.94	11.64	0.57	147	A 8	17.7	12 0
B. 1	199 8	1 72	4 07 max.	540	24 3	28 2	218 7	254 0 min.	71	6 8	177 0	8 00	6.25	0.45	153	B 3	19 4	16.7 max.
2	200 5	4 38	3 20	547	22 6	30 9	206 0	281 7	71	8 7	151 4	6 28	9.98	0 45	149	B 7	20 5	15 0
3	197 0	4 33	2 90	540	22 8	34 0	205 0	306 0	71	8 1	172 6	6 44	9.19	0 45	142	B 6	20 7	13 8
4	196 3	5 44 max	3 91	540	24 8	34.4	223 0	309 6	71	5.4	224 5	10 55	1.05	0 45	146	B 1	19 0	13.7
C. 1	198 8	4 65	3 66	562	22 6	28 6	211.7	268 0	93	7 9	166 6	6 94	8.12	0.34	144	C 5	20 0	15 8
2	194 4 min	4 21	3 17	562	22 8	30 3	213 5	283 8	93	8.5	167 0	6.44	9 20	0 34	149	C 6	19 9	14 9
3	198 7	5 27	4 04	562	26 3 max.	34 3	246 3 max	321 2	93	5.0 min.	209 7	10.78 max.	0 82 min.	0 34	147	C 1	17 7 min.	13 2
4	202 2	3 43 min	2 05 min.	562	22 7	38 0 max.	212 6	356 0 max.	93	10 3	130 8	4.72	12.46	0 34	155 max.	C 8	19.9	11 9 min.
D. 1	202 0	4 88	3 51	559	20 0 min.	27 9 min.	186 3 min.	260 0	124	8 4	200 0	6 93	9.09	0 25	151	D 5	22 7 max	16 3
2	200 3	5 08	3 71	559	20 5	28 1	191 0	261 8	124	8 0	205 0	7 99	7.42	0 25	147	D 4	22 2	16 2
3	202 0	3 71	2 37	559	20 2	31 6	188 2	294 4	124	11.7 max.	170 6	4 59 min.	12.90 max.	0 25	147	D 10	22 5	14 4
4	196 7	4 57	3 41	547	24 4	32.7	222 4	298 0	124	6 8	260 0 max.	9 02	5.52	0 25	144	D 2	19.0	14.2
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

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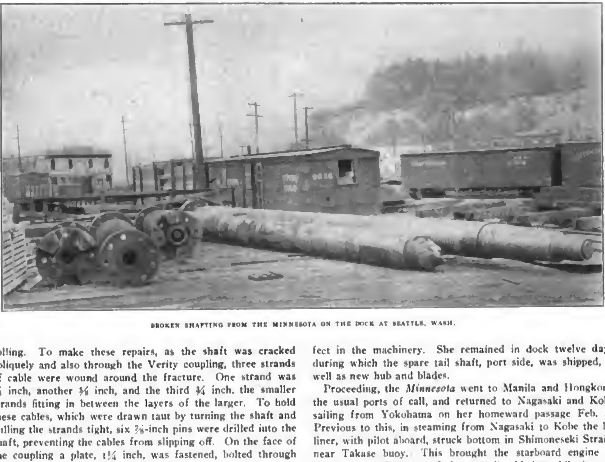
A Remarkable Series of Breakdowns.

Editor International Marine Engineering:

While on a recent voyage to the Orient, the Great Northern Steamship Company's 28,000-ton liner *Minnesota* had an extraordinarily bad run of luck, breaking both tail shafts, thrust shafts and short section line shafts in addition to losing her port propeller, and Chief Engineer George Allan and his assistants had an opportunity to perform some exceedingly skillful repair work, considering the conditions under which this was done. While the engineering force did several noteworthy repair jobs at sea, probably the most commendable was that to the port thrust shaft. It was accomplished under most severe difficulties, as the sea was very heavy and the ship was rolling. To make these repairs, as the shaft was cracked obliquely and also through the Verity coupling, three strands of cable were wound around the fracture. One strand was ⅜ inch, another ⅝ inch, and the third ¾ inch, the smaller strands fitting in between the layers of the larger. To hold these cables, which were drawn taut by turning the shaft and pulling the strands tight, six ⅞-inch pins were drilled into the shaft, preventing the cables from slipping off. On the face of the coupling a plate, 1¼ inch, was fastened, bolted through two couplings. Then a band was shrunk on the circumference of the coupling, with bolts 6 inches in length by 1½ inches diameter. This work took about two days, and is considered a noteworthy engineering accomplishment. That this repair job was thoroughly done is evident, as with it the steamer returned to Japan under the port engines alone, steaming probably 1,500 miles with this thrust shaft thus temporarily repaired.

The *Minnesota* was again in the Orient after having spent two months in Seattle, her home port, awaiting spare parts for her disabled shafting. While here the starboard fractured thrust shaft was replaced. A spare thrust shaft, two spare tail shafts and two spare short section line shafts were placed aboard before she departed again. These were furnished by the Midvale Steel Company, of Philadelphia.

On last New Year's day, while crossing the Pacific from Puget Sound to Japan, the Minnesota sustained the first of this remarkable series of mishaps. The port tail shaft broke about 5 feet from the end, the propeller dropping into the sea. Heavy head weather prevailed at the time, but the remaining 790 miles to Yokohama were steamed under the starboard engine alone. Thence she proceeded to Nagasaki under starboard engine, and at the latter port she entered drydock. The broken port tail shaft was withdrawn, and a survey disclosed no weakness or injury at the inboard end nor any other defect in the machinery. She remained in dock twelve days, during which the spare tail shaft, port side, was shipped, as well as new hub and blades.

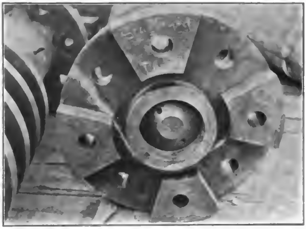


BROKEN SHAFTING FROM THE MINNESOTA ON THE DOCK AT SEATTLE, WASH.

Proceeding, the *Minnesota* went to Manila and Hongkong, the usual ports of call, and returned to Nagasaki and Kobe, sailing from Yokohama on her homeward passage Feb. 24. Previous to this, in steaming from Nagasaki to Kobe the big liner, with pilot aboard, struck bottom in Shimoneseki Straits, near Takase buoy. This brought the starboard engine up standing, bending two of the propeller blades while in contact with some hard substance. After grounding, the vessel slipped over the bottom into deep water, and continued to Kobe and Yokohama, no damage apparently having been done to the machinery. After leaving Yokohama, homeward bound, the steamer's machinery worked satisfactorily until, when she was 900 miles out, the engineers discovered a fracture in the port thrust shaft's Verity coupling. They began temporary repairs, as already described, the vessel meanwhile steaming on her course under starboard engine. About March 1 the temporary repairs were finished, and the port engines again placed in service at 50 revolutions per minute.

It was just two hours and thirty minutes later that it was noticed that the starboard thrust shaft had given way, and examination proved that it was fractured through the Verity coupling. As the engineering force had no means or material by which they could shrink a band on this coupling, it was necessary to turn back to Yokohama, it being deemed unwise to attempt to make the remaining distance across the Pacific under port engine alone, the thrust shaft of which was temporarily repaired. She arrived at Yokohama nine days after the port side and temporary repairs made to the starboard thrust shaft and short section line shaft on the same side. On the starboard thrust repairs were made by shrinking a band 4½ inches by 4 inches thick on the Verity coupling. This worked satisfactorily during the remainder of the voyage across the Pacific. From Yokohama the liner returned to Nagasaki, where, for the second time on this voyage, she entered drydock to ship the spare starboard tail shaft, which was fractured at the inboard end but otherwise intact. From Nagasaki the vessel returned direct to Puget Sound, where it was necessary to install only a new thrust shaft on star-

FRACTURED PART OF THRUST SHAFT, SHOWING BOLTS FOR TEMPORARY REPAIRS.



FRACTURED STARBOARD THRUST SHAFT.

PORT TAIL SHAFT BROKEN 8 FEET FROM OUTBOARD END, LOSING PROPELLER.

FRACTURED STARBOARD TAIL SHAFT, INBOARD END.

repairs had been finished to the port thrust shaft, steaming under port engine for 1,500 miles, during which the repairs to the port thrust shaft held out well. A thorough examination at Yokohama was made of both engines, and it was discovered that in addition to a fracture in the starboard thrust shaft the starboard tail shaft was cracked at the inboard end. There was also a fracture in the Verity coupling of the starboard short section line shaft. At this time it was concluded that the injury to the starboard shafting was due to the stranding in the Inland Sea. It was also surmised that the first mishap, when the port tail shaft broke, was the cause of the injury to the other shafting on that side. It was evident that after the port tail shaft broke the engines raced considerably before the governor took effect, undoubtedly causing the fracture to the port thrust shaft and injury to the short section line shaft on the same side.

While at Yokohama the spare thrust shaft was placed on board side, replacing that one which had done service under temporary repairs for more than 5,000 miles.

On the company's docks in Seattle are lying about 60 tons of steel shafting, this including two tail, two thrust and two short section line shafts. With the exception of the port tailshaft, which wrenched off at the outer end, each shaft contains one or more fractures, some very slight. To the expert these cracks present the peculiarity of not having passed through the weak points in the couplings. One of the short section line shafts contains two fractures, one along the lug and the other through the coupling, it being believed that the latter developed first. The *Minnesota's* shafts are hollow, each having an 8-inch bore throughout. The tail shafts are each 37 feet long, 19 inches diameter through the steel and 21⅜ inches over the lines. Each weighs 36,603 pounds. The thrust shafts measure 14 feet in length and 18 inches diameter, each weighing 13,325 pounds. The short section line shafts are 7 feet

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10 inches long by 17¼ inches diameter, and each weighs 6,295 pounds.

While returning to Yokohama on both occasions, the first time under starboard engine alone and the second time under port engine, the *Minnesota* was in exceedingly heavy weather. The second time she steamed 1,500 miles against unusually high seas. On her return from sea the second time she was in company with the Japanese liner *Sadom Maru*, which stood by until the *Minnesota's* passengers, mail and fast freight were transferred for the American side. This was no easy task, as the weather was bad and the *Minnesota* was hard to maneuver under one engine alone. This is stated to have been the first time that mails have been transferred from one liner to another in mid-Pacific.

By wireless and cable the *Minnesota's* plight was soon known to her agents in Seattle and St. Paul. When she sustained her first mishap the wireless carried the news ashore 800 miles, and it was immediately cabled to her agents on this side. On the occasion of the second accident the news was quickly known; for although she was 900 miles out from the Japanese side, within nine hours news of the mishap was known here. The *Minnesota* has been an unfortunate vessel, having had several bad breaks in her machinery. But for the fact that she has twin screws it is possible that she might have been lost before this, or at least would have cost her owners a large sum in salvage. Two years ago she broke one of her tail shafts when about 600 miles off this coast. Under the engine still intact she made the remaining distance, and at that time was docked in the Puget Sound navy drydock.

Seattle, Wash. R. C. HILL.

Another Method of Repairing a Fractured Shaft.

EDITOR INTERNATIONAL MARINE ENGINEERING:

Quite an interesting letter that of H. S. G., page 377 of the September issue of the journal. As stated by F. Webster, in the same issue, marine engineers are the ones who know how to do things. In fact, they *must* know, for very often it is a case of sink or swim with them, and at such a time their inventive faculties are very much alive. Too bad that H. S. G. did not have a friction coupling such as I am about to describe, for with it he could have done the job much quicker and with less labor; and, I believe, a better all-round job. Not that I discount the job as it was done, as he evidently did the best he could with the facilities at hand.

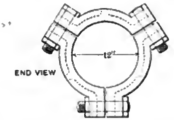

FIG. 1.

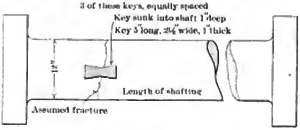

FIG. 2.

Probably the accompanying illustrations—Figs. 1 and 2—will tell the story pictorially as well as words would do. But, on second thought, a brief word explanation will not be superfluous. Fig. 1 shows a three-piece clamp or friction coupling, as it is sometimes called. It is made of cast steel, ribbed at the back, and is usually made from two and one-half to three times as long as the diameter of its bore, which is made to suit the shaft for which, in any case, it is intended. Many ships carry clamps like the one referred to, as it has proved its worth.

The clamp is placed over the fracture, which fracture is shown in Fig. 2. The three parts must be drawn up with the bolts equally, so as to have an even stress on all parts. When the clamp is properly tightened there is not much danger of the shaft slipping, especially when it is considered that a fracture seldom if ever occurs exactly at right angles to the center line of the shaft, and therefore an irregular break will assist the coupling to turn the outboard broken piece. Of course, it would be better to put in two, or preferably three sunken keys, as shown in Fig. 2. The dimensions of such keys will suggest themselves to the engineers about to use them. I merely assume a case in the illustrations and dimension the keys to suit. The keys should be slightly tapered toward the center of lengths, so as to insure the broken pieces of shaft not pulling apart.

With ratchet and drills and chisels, which all ships carry in their engineer's storerooms, the key-seats can be cut in a few hours; in the meanwhile the keys can be made by those not engaged in making the key-seats. The keys do not have to be as neatly fitted as though the job were to be permanent, for when once in place and secured by the cast steel friction clamp there is no danger of either slippage or failure of the keys to remain in their places. This kind of repair has stood the test and will, I am sure, commend itself to those who may some day require it. CHARLES J. MASON.

Scranton, Pa.

Cut-Off for Mid-Gear Position.

EDITOR INTERNATIONAL MARINE ENGINEERING:

The Stephenson link motion, which is one of the most common reversing gears, serves the double purpose of reversing the direction of rotation of the engine and of varying the point of cut-off. The point of cut-off may be changed by changing the link to some intermediate position, the effect being to hasten the cut-off and the compression and, consequently, increase the number of expansions. When the link is placed in its mid-position the engine usually stops, for the reason that the amount of steam admitted is not sufficient to overcome the resistance of the engine. The steam ports are not entirely closed, as some are inclined to think, but they may be opened an amount equal to the lead; that is, the maximum port opening for mid-position of the link is equal to the lead. The displacement of the valve, that is, the distance that the valve moves in either direction from its mid-position, is equal to the lap plus the lead. The total travel of the valve is, therefore, equal to twice the lap plus twice the lead.

With the foregoing information and the use of a diagram the point of cut-off for mid-gear position may be found. Draw a horizontal line, *a b*, to some convenient scale to represent the stroke of the engine. The circle *a c b d* then represents the crank circle. At a distance equal to the lead above the stroke line *a b*, and parallel to it, draw the line *e f*, which will be known as the lead line. Now, with a radius equal to the lead, and with the center *O* of the crank circle as a center, draw the circle *g h*, which will represent the port opening

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circle, since the maximum port opening is equal to the lead. The lead line *e f* will be tangent to this circle, as shown. From the point *O*, which is the center of the crank circle, erect a perpendicular, *o c*, to the stroke line *a b*. From the lead line *e f* lay off a distance, *g j*, on this vertical line equal to the lap of the valve. Then, with the point *j* as a center, and with the lead *g j* as a radius, describe the circle *g i k* tangent to the lead line *e f*. The distance *O j* then represents the displacement of the valve for mid-gear position, since the displacement of the valve is equal to the lap plus the lead. The center *j* of the lap circle must be vertically above the center

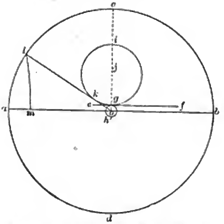

DIAGRAM FOR CUT-OFF FOR MID-GEAR POSITION.

O for mid-gear position, because if the center of the lap circle is taken either to the right or left of the vertical through *O*, and the lap circle is drawn tangent to the lead line *e f*, the displacement of the valve *O j* will be greater than the lap plus the lead.

Having located the lap circle as shown, then from the center *O* draw a radial line tangent to the lap circle at *k*, cutting the stroke circle at *l*. Then, with a radius equal to the length of the connecting rod, and with a center on the stroke line produced, draw an arc of a circle from the point *l*, and cutting the stroke line at some point as shown. The distance *a m* measured to the same scale as *a b* will be the portion of the stroke completed when cut-off takes place. The principal employed in the above diagram is the same as that employed in the Bilgram valve diagram, which is probably familiar to many of the readers of this paper. T. W. HOLLOWAY.

Scanton, Pa.

Trouble with a Capstan Motor.

EDITOR INTERNATIONAL MARINE ENGINEERING:

On a vessel in which electricity was employed for auxiliary purposes the anchor winch was operated electrically. In such winches and capstans there is, or should be, always some form of safety device whereby, in the event of the chain fouling, or the load becoming excessive, the motor and capstan are protected from too heavy strains. In the case considered the motor was arranged with a friction clutch, so that this would slip when the motor was subjected to an excessive load. Of course, it did not at any time allow the motor to run free, as it always maintained a certain amount of strain on the winch.

One time, when the winch was hauling the anchor the latter suddenly got caught and the motor was at once heavily loaded. Probably the clutch was dirty; at any rate it did not do its duty in slipping under the excess load, with the result that the motor was suddenly brought to a standstill and the rush of current through it damaged it very severely. The motor was probably over-fused at the time; there is a tendency on board ship, if an electric fuse blows, to strengthen it, so that it will not give any more trouble, and this sort of thing will always occur so long as all and sundry can get at the fuses. Another thing which might have been done to avoid trouble of this sort would have been to put a compounding winding on the field of the motor, which would have stiffened the field (and therefore the back electro-motive force of the motor while running) against the strain. This would, however, have made the motor more expensive, and shipowners usually do not spend too much on their electrical equipments. Yet another way to protect a motor of this sort would have been to have had a resistance, which, when the motor was overloaded, could be inserted in series with the armature by automatic switches, thus bringing the current down to limits which would not damage the armature. For this arrangement a series motor would have been required.

Probably the best cure of all, however, is the simplest; this is attention to details. However small and insignificant a part of the ship's machinery may be, it should have its turn of attention and repair. If the clutch had been systematically cleaned, and if the surfaces, when worn so that the clutch was "fierce," had been renewed, the trouble would probably not have occurred and the expense of a new armature would have been avoided. S. A. BOOTH.

Fracture of a Feed Pump Barrel.

EDITOR INTERNATIONAL MARINE ENGINEERING:

The steamship "B——" was on a voyage from Valencia, in Spain, to Liverpool. We were two days out from Valencia, and during this time the engineers experienced great difficulty in keeping a proper quantity of water in the boilers, although the feed pumps were working properly and the evaporator was going all it knew how all day. We made an external examination, but failed to discover any leakage. The evaporator was blamed for the whole trouble. The evaporator was really a very good one, and the loss of water seemed likely to continue, when, fortunately, one of the engineers grasped the bilge discharge pipe to prevent himself from falling during a heavy roll of the ship. Finding the pipe extremely hot he immediately suspected where the lost feed water was going, especially as the feed and bilge pumps were all in one casting.

The chief at once ordered the feed donkey to be started and the pump opened out, and when this was done we found a hole between the feed and bilge pumps, which we afterwards found out was due to a faulty casting. We then made a lead templet, from which we made a brass patch to cover the hole. This was bedded on and jointed up, and we then started the pump up again; but, I am sorry to say, the repair gave way after working for two days, due to it being impossible to secure the patch properly against boiler pressure. We then tried working with one pump, but failed to supply the necessary quantity of water, so we decided to attempt another form of repair. The ram was taken out of the bilge pump and a blank flange was fitted over the stuffing box. The bilge suction valve box was uncoupled and a blank flange fitted, and wood plugs were inserted in the bilge suction, and the discharge pipes were uncoupled.

As will be seen, the bilge pump was then shut off and connected to the feed pump, the leak being effectually stopped.

The after well and bilges were alternately pumped out by the after bilge pump. Upon arriving in a home port, a new feed and bilge pump casting was supplied and fitted.

Camden, N. J. F. J. S. N.

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Shipbuilding Revival in the United States.

The completion of the Panama Canal in 1913 will open a new field for sea transportation in the United States which has not been paralleled in history before. Preliminary preparations to take advantage of some of the opportunities offered by this new method of carrying on commerce between the Atlantic and Pacific coasts and between the United States and Central and South American countries have resulted in the tentative calling for bids from American shipbuilders for about forty new passenger and freight steamships of large tonnage and speeds corresponding to the services required. This prospective activity in building large steamships will be accompanied by the construction of a great number of barges, tugs, lighters and shallow-draft boats for service on both the Atlantic and Pacific coasts, and particularly in Central America, where a vast amount of trade awaits the connecting link of sea transportation through the Isthmus.

The most important development of the coast-to-coast traffic by sea through the Panama Canal is the call for bids on the ocean mail service advertised by the Postmaster-General between New York and Colon, New Orleans and Colon, San Francisco and Panama, and Seattle and Panama, with calls at intermediate ports. This coast-to-coast mail service is to be maintained weekly, and will call for about fifteen ships capable of sixteen knots. The principal company, which has been incorporated for bidding on this work, considers that such a service will form but the nucleus of a rapidly-growing and most important transportation service by opening up direct connection with thousands of miles of navigable inland waters in the Mississippi Valley and in the Central American countries, together with transshipments at the canal terminals to and from the steamship lines from all other nations in the world. This sort of traffic has already been provided for by the Government by beginning the construction of piers and warehouses equipped with the necessary freight-handling appliances at the canal entrances. In this direction much can be done at the ports which are to benefit by the coast-to-coast service. Improving terminal facilities in American ports has always lagged far behind the progress made in foreign ports where the improvement of terminals has kept pace with, and more frequently preceded, the domestic development in shipbuilding and ocean transportation. This state of affairs, in view of the coming impetus in the American merchant marine, should be given prompt and careful consideration in order to make the most of opportunities.

Although shipbuilding in the seacoast yards of the United States gives promise of a substantial increase during the next few years, with equally good opportunities to follow, the outlook for the shipyards on the Great Lakes, where such large amounts of tonnage have been produced in the last decade, is not so good. The production of freighters has apparently been overdone, but there is still some indication that orders will be placed for ships of special classes, and that the lull is temporary.

Development of the Oil Engine.

Propulsion of ships is a subject prolific of countless changes and innovations in the various means available for generating, transmitting and applying power to overcome the resistance of ships. Fuels, generators, prime movers, transmission devices and the vast hoard of auxiliaries all receive due attention, and often the changing of one involves the entire readjustment of the others. It is only the result of years of experiment, trial and development that any definite type of power plant attains the state of perfection which insures increased efficiency and the desired economy in operation. The internal-combustion engine using heavy oil as fuel, or, as it is usually called, the oil engine, is no novelty, and has long held a minor place in marine work as a prime mover. Its possibilities have been widely proclaimed, and many of its features which tend toward simplicity in the whole

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plant by doing away with much of the machinery and manual labor required in operating a steam plant cannot be ignored. The savings in weight and space on board ship, the thermal efficiency of the engine and the ease in handling the fuel apparently indicate a valuable saving in running expenses and an increased capacity in the ship, which mean added returns from the earning power of the vessel. It cannot be assumed, however, that such alluring possibilities of a comparatively new form of propulsion can supply a demand for it by themselves. The problems concerning the available supply and cost of the fuel, the reliability and actual efficiency of the engine as shown by practical results, and the practical construction, operation and repairs of the engines designed in large sizes for various uses need careful consideration. Fortunately much progress has been made in this direction in the last two years, particularly in Europe and Great Britain, and the reader can form some idea of its magnitude and the results to be expected from our leading article this month.

Success in the propulsion of ocean-going ships by oil engines, whether of the Diesel or similar types, will depend largely upon the knowledge and practical experience gained from the volume of this work now going through the shops of prominent builders of marine machinery. Constructional problems cannot be solved at a glance, nor can the difficulties at sea be eliminated by preliminary experiments on shore. Oil engines, if successful, require a high grade of material and the most careful workmanship by skilled mechanics who are accustomed to delicate work. Operation, upkeep and repairs at sea will require the same intelligent work, with a full knowledge of the principles and practical operation of such engines. With the rapid progress in the development of oil engines now in sight it is advisable for marine engineers to give the subject a careful study. What the engine builders and naval architect put before you in this way is not merely a matter of passing interest, but food for thought.

Improving Terminal Facilities.

The port of Antwerp is one of the most progressive European ports, and the description of some of its terminal features, which is published elsewhere in this issue, is worthy of examination by those connected with shipping interests in large American ports where very little progress has been made to increase the transshipping facilities for handling freight from the railroads to the steamship lines. Not all of the Antwerp equipment is modern, but its usefulness has been proved, and the application of the same principles to the old-fashioned docks where freight transferring is done principally by manual labor could be adopted with profit. The harbor arrangements and dock facilities at Antwerp have been steadily improved, and in connection with them government warehouses of ample capacity and convenient location have been installed. Freight is easily transferred by mechanical means from the hold of a steamship upon trucks or railroad cars, or placed on platforms where consignments can be sorted and the re-handling reduced to a minimum. The cranes are movable, so that they may be placed directly opposite the hatches on the steamship and swing the freight to the cars, which can be driven directly under the frames. Also, the government warehouses are fitted with freight-handling appliances, so that the time and cost of handling freight are both reduced.

To secure the best efficiency in handling freight mechanically at terminals, both speed and immunity from damage are necessary. Whatever gain is made by quick transference of the freight from the ship to the pier may be lost if much rehandling and transference by hand labor are necessary. Special forms of dock cranes and transporters are needed in most cases, depending upon the conditions to be met. Perhaps the worst obstacle in the improvement of American ports is the control of water frontage by private interests, where little help can be expected from municipal or State action. Whoever owns the water frontage in a harbor will, naturally, develop it for his own exclusive interests, and many things which would benefit the port as a whole are disregarded. There are some ports where government control is possible, and it is here that the more important improvements can be made which will benefit all of the corporations who use the harbor as a terminal. With the rapid increase in the American merchant marine which is expected, it is undoubtedly true that there will be more direct and progressive action on the improvement of ports, bringing about the same facility and economy that are secured at Antwerp.

While many arrangements for transporting freight must conform, in a measure, to the requirements imposed by the kind of construction used in existing freight steamships, yet, as has been brought out before by the discussion in these columns, there is much to be gained by co-operative work between naval architects, shipbuilders and the designers of mechanical appliances for handling freight at steamship terminals, so that improvements can be embodied in the design of vessels which will simplify the adaptation of the cargo-transferring devices and permit a ship to be loaded or unloaded in a shorter period of time and with less damage to the cargo. Of course, any change in ship design is but one feature in the question of transporting freight at terminals, for there are many other local conditions which affect the delivery of cargo from ships to its destination; but the design of a freight steamship is of much more importance, and much can be made of it to secure better results even in the best equipped terminals, such as Hamburg, Liverpool and Antwerp.

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ENGINEERING SPECIALTIES.

Acme Steam Engines.

The Acme engine, formerly manufactured by the Rochester Machine Tool Works of Rochester, N. Y., and now by the Sterling Machine Company of Norwich, Conn., has been on the market for the past twenty years and has been improved, from time to time, to meet the demands of the day for a rugged, simple and economical unit. These engines are of the vertical, two-cylinder, single-acting enclosed type, with a balance rocking valve, and are splash lubricated. They are built in three series of sizes. This range of sizes covers all the applications to which these engines are especially adapted. Because of the extreme simplicity of construction, the type of valve which adjusts itself to wear, the large bearing surfaces which are thoroughly well lubricated at all times by a splash of oil, they are especially well suited in marine service for

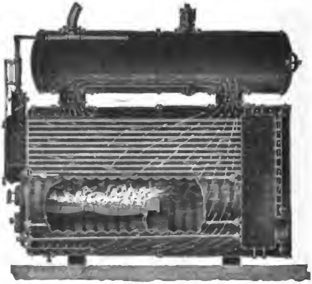
driving lighting sets, ammonia compressors, ventilating fans, etc.

The character of internal construction shows the influence of automobile engine practice in many of the details. For example, the crank shafts are drop-forged and ground to very accurate size, the connecting hods are of the popular I-beam section, bushed with bronze at both ends; the bearing cap on the crank end being held in place by castle nuts and cotter pins, as is common in automobile work; the piston rings are of the diagonal cut type, two being placed above the wrist pin and one below. These rings are re-turned after cutting and ground to accurate size. The valve is a simple one-piece casting, which is ground on the outside to fit a very accurately bored chamber, and is fastened to the extended valve stem with a cross key in just the same way that the ordinary Corliss valve is fastened. A further point of considerable interest is the matter of automatic cylinder relief valves, which are built into the cylinder heads to relieve any water that might otherwise cause damage. The governor is of a very simple type, consisting of four main pieces, the action of the weights being modified by means of a hardened roller which travels in a milled arc. The entire governing mechanism is contained in an oil pocket, only the pin to which the lower end of the valve rod is connected being extended through; and, further, inasmuch as this mechanism is on the outside of the fly wheel it is readily accessible. There are but two grease cups requiring attention, all other surfaces being amply lubricated by the internal splash. Provision is also made in the base of the engine for the elimination of the condensation which may collect, and the leakage from the valve stem stuffing box falls down into the engine base through the vent pipe at the end of the engine. The entire series of engines is built with new and accurate jigs on the interchangeable plan.

Robb-Brady Boiler.

The Robb Engineering Company, of South Framingham, Mass., and Amherst, Nova Scotia, is marketing the Robb-Brady Scotch marine boiler.

The boiler has two drums, which are connected by two necks—the lower being entirely filled with water, while the upper drum is for steam space. The lower drum is filled with tubes. The combustion chamber is cylindrical and of a



diameter nearly equal to that of the larger shell. The tubes take the place of through staybolts. The main point claimed is that the arrangement results in better circulation than is obtained in the usual Scotch boiler. This is obtained by compelling the hot water from the steam drum to flow down the front neck and around the shell through the annular space, the water from this space emptying below the furnaces and replacing the hot water and steam which take the shortest path to the top, passing to the steam drum through the rear neck, thus increasing the economy of the boiler, as this rapid circulation keeps all heating surfaces clear, resulting in a more uniform expansion and eliminating the necessity of a special pump to increase the circulation. This boiler is made in sizes from 50 horsepower up to 300, and for pressure up to 225 pounds.

Maxim Boiler with Allison Economizer and Arch Drum.

The Maxim boiler is a watertube boiler which has no flat surfaces, stayed parts, headers or hand doors, a construction which, it is claimed, insures entire freedom for expansion and contraction, and makes the boiler suitable for high-pressure requiring minimum floor space. Three manholes give access to all drums and both ends of every tube. The alleys are wider than the tubes, so that any tube can be replaced without disturbing the others. The lower main drum and blow-off pipes are thoroughly protected from the action of

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the fire. Wrought steel construction supports the boiler independent of the brickwork. Both the furnace and combustion chambers are of brick, and they are of ample size to insure good combustion.

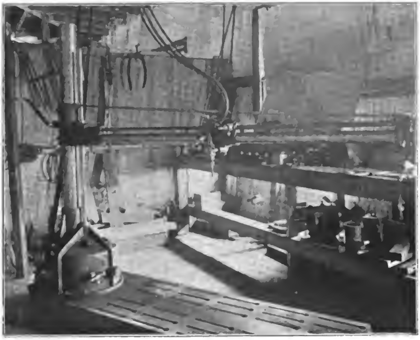
In the Allison patent economizer or fourth pass the gases pass down while the water rises. A partition in the lower main drum opposite the baffle prevents the feed water from getting into the boiler circulation until it has been heated and purified in the economizer tubes. This, it is claimed, insures low stack temperature and a clean boiler. On test it was demonstrated that with steam at a temperature of 357 degrees F. the temperature of the escaping gases was only 312 degrees F. This boiler is sold by Allen Stirling, Drexel building, Philadelphia, Pa.

Acetylene Welding and Cutting Machine.

A machine for welding and cutting material by means of an acetylene torch has recently been brought out by the Davis-Bournonville Company, of 90 West street, New York City.

The illustration which we give shows the tool set up in a shop. It is in appearance, in a general way, very much like a radial drill of light construction.

By means of a friction drive in the column and gears on the driving shafts, the screw seen above the extended arm is made to actuate the sliding saddle which travels on the arm, and which carries the torch to which the oxygen and acetylene are brought by flexible tubes, which are of the ordinary form. The torch can, of course, be replaced by a cutting jet. The feed of the torch can be varied from 3 to 24 feet per minute,

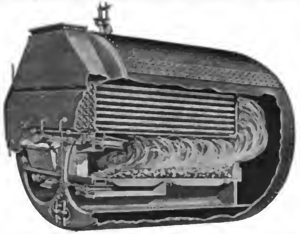


and work 6 feet long can be welded. The work is clamped on the table. The arm can be raised or lowered by means of a rack and pinion. A tight and loose pulley is used in connection with an ordinary countershaft for driving.

The Gregory Patent Coal-Oil Apparatus.

A device for preventing smoke, accomplishing the complete combustion of inferior grades of coal, anthracite, bituminous and lignites, as well as peat, etc., and increasing the economy of boilers has been placed on the market by the Direct Gas Fuel, Ltd., 17 Victoria street, London, S. W., and in America by the Davis Volatile Fuels, Ltd., Land Title building, Philadelphia, Pa.

The apparatus consists essentially of means for admitting air and gasified oil, both above and below the grate, in quanti-



ties which can be regulated to give complete combustion of the fuel in the furnace. When applied to Scotch marine boilers the portion of each furnace nearest the furnace door is fitted with a cast iron air-heating chamber resting on the dead plate, with an opening through the same corresponding with the size and shape of the furnace opening. Air is admitted directly into this chamber through two air holes, 3 inches in diameter, on each side of the furnace door in the furnace front. Underneath each fire grate and extending for half the length of the furnace another chamber is fitted, forming an air duct to that portion of the grate where the draft is least effective. The draft is admitted to this chamber through a delivery pipe, on the inner end of which is attached a nozzle of special form fitted with a small steam jet to assist the draft to the front half of the grate. Either compressed air or steam can be used. The admission of air through the delivery pipe is regulated by a small valve, so that the proper quantity can be admitted to insure the combustion

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of whatever kind of fuel is being used. Inside the air-heating chamber, immediately over the furnace door, is a specially constructed nozzle pointing into a discharge pipe fitted close to the top of the furnace, the mouth pointing slightly down towards the fire. Radial pipes 2 inches in diameter branch from each side of the nozzle in the upper heating chamber, and pass around the furnace opening, forming a connection to the air chamber below the grate. A steam pipe of small bore is fitted through the furnace front into the nozzle, so that a small jet of steam or compressed air may be introduced when desired.

The discharge of steam through the nozzle produces a partial vacuum in the nozzle, so that air is drawn from the air chamber below the grate through the branch pipes, and in passing through the air chamber at the top of the furnace becomes heated. The steam mixing with the heated air forms a gas, and the gas thus produced is projected from the nozzle through the deflected discharge pipe into the furnace, and combining with the other gases as it passes over the fire it ignites and assists in the combustion of the fuel. In addition to the steam or compressed air jet, a small pipe is fitted for the supply of oil, and a quantity of oil may be introduced into the nozzle with the steam. This action gasifies the oil and assists materially in consuming the gases from the fire, which would otherwise pour out of the stack in the form of smoke. The oil supply can be regulated as desired, but it has been found that the average proportion of oil should be about 2 or 3 percent of the coal used.

A number of steam vessels have been fitted with this device, and under test on a vessel which used coal at the rate of 10 tons per day a saving of about 2 tons of coal per twenty-four hours' steaming was shown to have been obtained by the use of the Gregory apparatus.

TECHNICAL PUBLICATIONS.

Annual Report of the Mercantile Marine Bureau for the Year 1909-1910. Department of Communications, Tokyo, Japan.

This compilation is most instructive and seems thorough to the last degree. It takes up tonnage, shipbuilding, inspecting, casualties and many other sub-divisions of marine work, also the matter of subsidies granted various lines, giving their earnings and expenses, which show a profit in most cases. The dimensions of vessels, together with the horsepower, are given, and, taken altogether, the issue is well worth studying.

Essential Factors in the Formation of Producer Gas, Bulletin No. 7, Bureau of Mines. By J. K. Clement, L. H. Adams and C. N. Haskins.

The Bulletin is of a scientific character, and will be of interest to engineers engaged in gas-producer and gas-engine work. Copies may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

Self-Taught Mechanical Drawing in Elementary Machine Design. By F. L. Sylvester, M. E. Size, 5¼ by 7¼ inches. Pages, 325. Illustrations, 218. The Norman W. Henley Publishing Company, New York.

All through this work the author has stuck closely to the highly practical. The mathematics needn't frighten anyone. They are extremely simple, clear and can be understood by anybody that can multiply, divide and subtract. It is much more than a book just on learning to draw and design, as it goes into the fundamentals of physics clearly and concisely. It gives excellent examples of various accepted styles of mechanical contrivances, and it would seem to us that the apprentice should welcome the book most heartily. The only thing that we criticise is the author's idea of making self-study easy. We are not of the opinion that anything that is easily obtained sticks well. A little hard digging is good. The ambitious boy that wants to know something can learn, but there is a never-ending lot who are mentally ambitious and thoroughly lazy. This class want their study in capsules to swallow at a single gulp, and we hardly think that the class is worthy of consideration, but any determined young man in the mechanical trade can read Mr. Sylvester's book with advantage.

The Naval Pocket Book. By Rollo Laird Clowes. Size, 3¾ by 5 inches. Pages, 1,029. Illustrations, numerous. N. Thacker & Company, 2 Creed Lane, London, E. C. Price, $2.00.

It is quite impossible for the man who is interested in marine matters to be without this book. Every newspaper in the world should have it, and, in fact, the information contained therein is of general interest, as even with the peace movements of late the power to make people be good is needed, and every country takes interest in its navy, and from *The Naval Pocket Book* the important facts concerning it can be learned.

Practical Applied Electricity. By David Penn Moreton. Size, 5 by 7¼ inches. Pages, 414. Illustrations, 323. Numerous tables. The Reilly & Britton Company, Chicago, Ill. Price, $2.50.

There is no place where training is better obtained for those who desire to impart information than through the evening schools. Here the pupil is anxious not merely to get through but to learn, and he is a sponge in absorbing knowledge. Mr. Moreton, who is the author of *Practical Applied Electricity*, has had this training, and certainly he is to be congratulated on what he has turned out, and while he says he may not be considered "at all times logical," he must be considered, we think, at all times highly practical, and that is the object of his work. The use of something visible in explaining electricity is most happily chosen, as, for instance, the hydraulic analogy of electrical currents helps the beginner to understand, through his eyes, which are, in fact, our greatest teachers, and Mr. Moreton has most admirably used this idea in his explanation.

The Slide Rule—A Practical Manual. By Charles N. Pickworth. Size, 5 by 7½ inches. Pages, 118. Illustrations, 34. New York: D. Van Nostrand & Company. Price, $1.00.

The value of this little book on the slide rule is largely proved by the fact that it has passed through eleven editions, and in the present issue it has been revised and extended. There is not much to be said on the subject that is new. The significance of various gage points is commented upon, and some new styles of slide rules are described. It seems from our observation that a person once started on the study of the slide rule very soon "gets the habit," and its practical use is really endless, and to the busy engineer or draftsman it is of the very greatest help.

COMMUNICATION.

Notes on the Strength of Ship Columns.

Editor International Marine Engineering:

The following notes may have interest in view of the recent addition of comprehensive column tables to the general specifications for building ships of the United States navy. The explanation in which Mr. R. E. Anderson, in the October and December, 1910, issues of International Marine Engineering, foreshadowed their appearance, is also alluded to.

CLASSES OF COLUMNS.

Warship columns may be divided into two classes—structural and local.

Structural columns are those which support the main

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structure of the ship, and which are as much a part of that structure as the frames and beams.

The scantlings of structural columns are not worked out in detail, but are a matter of judgment and experience, as the maximum load they may have to carry is unknown. So far attempts to find these loads by Dr. Bruhn's method of least work has not furnished quantitative results.

Local columns, which form the second class, are those which support local loads, such as capstan, gun and other foundations.

It is here that formulæ can, in general, be applied, but the thick deck plating and heavy overhead girders now obtaining in warships form such rigid abutments that to neglect end fixing is absurd.

COMPARISON WITH BEAMS.

Putting on one side the direct stress in columns and shear in beams, we have for the same form of elastic surface a perfect analogy. Take, however, actual loadings—simple compression for the column and uniform loading for the beam—and consider the ends fixed.

Assuming a high value of L/r we may apply Euler's method. Let W be the equilibrating load for a column of length l, and M_o, M_c, M_x the bending moments at ends, middle of length, and a section distant x from one end, respectively the deflection at the x section being y, we have

$$M_x = E I \frac{d^2 y}{dx^2} = -Wy + M_o$$

The solution is $y = \frac{M_o}{W} + A\ Cos. \sqrt{\frac{W}{E I}}\,x + B\ Sin. \sqrt{\frac{W}{E I}} \cdot x$

$$\left.\begin{array}{r}\text{When } x = o\\ y = o\end{array}\right\} \therefore A = -\frac{M_o}{W} \qquad \left.\begin{array}{r}\text{When } x = o\\ \frac{dy}{dx} = o\end{array}\right\} \therefore B = o$$

$$\left.\begin{array}{r}\text{When } x = \rho\\ y = o\\ \& \\ \frac{dy}{dx} = o\end{array}\right\} \therefore \left\{\begin{array}{c} Cos. \sqrt{\frac{W}{E I}}\,\rho = 1 \\ A\ Sin \sqrt{\frac{W}{E I}}\,\rho = o\end{array}\right\}$$

$$\text{Solving } \sqrt{\frac{W}{E I}}\,\rho = 2\pi, \text{ or } W = \frac{4\pi^2 E I}{\rho^2}.$$

Again, by substituting, we have:

$$M_x = Cos. \sqrt{\frac{W}{E I}}\,x\,M_o.$$

$$\therefore \text{When } x = o, \text{ or } \rho.\quad M_x = M_o$$

$$\& \text{ When } x = \frac{\rho}{2}.\quad M_x = -M_o = M_c.$$

We thus see that fixing the ends reduces the bending moment at middle to one-fourth of that for free ends, and that the bending moments at the ends are equal to that at middle.

For beams, we know that fixing the ends reduces the bending moment at middle to one-third of that for free ends, while the bending moment at ends are twice that at middle.

END FIXING.

Watertight-bulkhead testing affords a good criterion as to end fixing where the stiffeners are regarded as beams.

A large number of tests were analyzed by the writer, the results of which were given in a paper read before the North East Coast Institute of Engineers and Shipbuilders, and it was there shown that for watertight bulkheads having good, solid abutments the degree of constraint of the stiffeners was 60 percent.

Taking into account the above comparison of distribution of bending moment, it seems reasonable to expect for local columns a good degree of constraint. In general, experiment supports this conclusion.

THE GOVERNMENT COLUMN TABLES.

Consider these two excerpts from the instructions for proportioning compressive members:

1. "In determining the safe loads no distinction is to be made between fixed, flat, pin hinged and round ends." * * *

2. "For pin-end compressive members * * * the radius of gyration used should be that corresponding to the probable plane of failure, provided this radius of gyration be not greater than twice the least radius of gyration of the cross section."

In actual practice we find that structural columns, not being "figured out," are not affected—a divergence of 1 : 2 for similarly placed columns existing in recent warships.

The Navy Department tables, taken as self-explanatory, do not meet the case of local columns, inasmuch as they entirely neglect end fixing, and in consequence demand scantlings two to four times heavier than necessary.

Mr. Anderson's justification for his neglect of end fixing seems to rest partly upon the supposed incompetence of draftsmen in shipyards aspiring to government work, and partly upon one or two opinions which are really not applicable.

For instance, Mr. C. C. Schneider (Quebec Bridge Report), when speaking of the "elastic deformation of the truss," was not referring to a 60-pound N. S. deck to which a column was firmly bolted, nor did Moncrieff, in speaking of the difficulties of estimating the restraint, infer that it should be neglected.

The second excerpt may be written thus: Pinning the ends of a column may be regarded as fixing them in a plane parallel to the center line of the pins to any extent up to 100 percent.

Here Mr. Anderson errs on the other side, for a single pin, unless a very vicious affair, would hardly produce absolute constraint.

The innovation of using nominal ultimate loads—loads which are purely hypothetical, and tax the imagination to conceive—is apt to lead to some confusion.

The upper limit of the range of nominal factors given is 9, which corresponds to a true factor of 5.4, and which would barely cover the case of a column likely to be much fatigued.

THE ROOT FORMULA.

Mr. Anderson eschews the Rankine-Gordon formula, and considers it the "least accurate of all." This is most interesting, as only last year Dr. Lilly, one of the highest authorities, gave as his opinion that it was the most satisfactory of all column formulæ. Between the limits usually taken —namely, $L/r = 20$ and $L/r = 200$—the Rankine-Gordon formula is the most reliable.

For mild steel, rounded ends, the formula is

$$\frac{W}{A} = \frac{21.4}{1 + 1/_{7100}\left(\frac{\rho}{r}\right)^2} \text{ (tons per square inch).}$$

Between the limits stated the writer finds a close agreement with the tables, excepting that the loads there given are less for the lower values of L/r. Now, the Rankine-Gordon formula is on the safe side for short columns, so the Moncrieff curve droops too much. It would seem that the eccentricity factor of Mr. Anderson does not take into account the fact that eccentricity is more marked the shorter the column.

As regards rationality, there is nothing to choose between either of the above formulæ.

Mr. Anderson is to be complimented on having made a determined onslaught on the rather nebulus data pertaining to strength of columns; but even while admiring the result, one wonders if system, like fire, though a "good servant," may not prove a "bad master." A. J. MURRAY.

Quincy, Mass.

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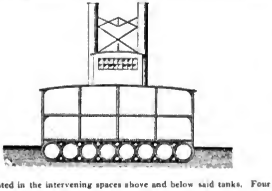
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

996,867. FREIGHT VESSEL. AUGUST J. PEEBLES, OF MOLSON, WASH.

Claim 1.—A freight vessel having a plurality of storage tanks extending side by side lengthwise thereof, and buoyant tubes associated with



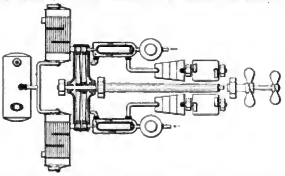
and located in the intervening spaces above and below said tanks. Four claims.

995,562. PROPELLING-WHEEL. JOHN PLEWES, OF KIMBERLY, ONT., CANADA.

Claim 1.—A propelling wheel comprising a hub, four blades each having a straight front edge radiating from the center of the hub, a peripheral edge concentric with the axis of rotation and the back edge cut away or hollowed in compound curve form in proximity to the hub and with a straight edge from the end of the curve to the concentric outer edge, and each blade increasing in width from the hub to the concentric outer edge, so that a line drawn at any point across the width of the blade is equal in length to the radial distance to such line and the pitch of each blade being so arranged as to have an even graduated decrease from the hub to the outer edge. Two claims.

996,324. PROPULSION APPARATUS FOR SHIPS, BOATS AND THE LIKE. SEBASTIAN ZIANI de FERRANTI, OF HAMPSTEAD, LONDON, ENGLAND.

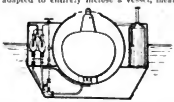
Claim 1.—In combination, a turbine having one or more bladed members, a plurality of guides coacting with the blades of said members to



form a plurality of paths for the working fluid of varying operative lengths, together with means for supplying working fluid to any of said paths at will. Eight claims.

998,970. FLOATING DOCK. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO SOCIETA ANONIMA FIAT-SAN GIORGIO, OF SPEZIA, ITALY.

Claim 1.—In a floating dry dock, the combination of a cylindrical watertight receptacle adapted to entirely inclose a vessel, means for admitting



a vessel to said receptacle, and caissons supporting said receptacle. Thirteen claims.

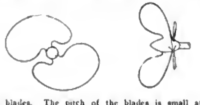
999,795. FOLDING ANCHOR. DANIEL A. JONES, OF OSHKOSH, WIS.

Claim 1.—A folding anchor, comprising a shank having arms and stock members pivotally connected thereto, and means operatively connected to the arms and to the stock members to cause the said arms and the said stock members to move to folded or unfolded position and said means also extending through the upper end of said shank for connection with a cable. Eleven claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

19,396. PROPELLERS. F. H. TREWEEK, FALMOUTH.

By this invention the maximum thrust per horsepower is obtained. In shape the blades are nearly semi-circular, but radially shorter at the front than at the rear edge, and they are joined to the boss with the smallest connection consistent with strength to allow free access of the



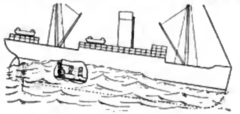
water to the blades. The pitch of the blades is small at the front edge and gradually increases towards the rear edge, thus gradually imparting velocity to the water as it passes through it. An axial section gives a curve inclining, and its concave side facing backwards and both the inclination and the concavity gradually increase from the front to the rear edge to minimise the effect of centrifugal force which tends to throw the water off the blades.

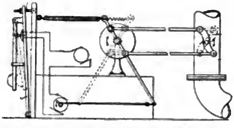
20,667. INDICATING THE POSITION OF SUNKEN VESSELS. J. B. BLAINE, S. R. EAST AND J. G. STEVENS, NEW ZEALAND.

When the vessel sinks, a buoy, contained in a stand on deck, floats to the surface and indicates its position in daylight by means of a bell, and at night by means of a pilot light in the chamber. There is a compartment for documents, etc. The chain is made in, say, fathom lengths connected by swivels to prevent twisting and to indicate the depth at which the vessel is submerged.

23,443. PREVENTING THE RACING OF MARINE ENGINES. F. TANNER, H. J. HARRIS, AND H. BURT, NEW ZEALAND.

A throttle valve in the main steam pipe has a lever upon its spindle, which is actuated by a spring so that the valve is normally kept open to its full extent. A weighted pendulum, which is adjustable to suit the

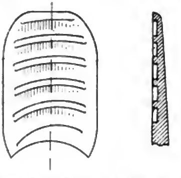




loading of the ship, is arranged to close contact in an electric circuit when the stern of the ship rises in the air. A motor in this circuit is thus brought directly into operation, and by actuating suitable gearing closes the throttle valve. A buffer may be used in connection with the pendulum to prevent shock.

17,935. SCREW PROPELLERS. J. HALLIDAY, LIVERPOOL.

This refers to the type of propeller blade provided on its thrusting surface with a series of projecting ribs. The invention consists in eliminating the helical twist of the thrusting faces of propeller blades



and in providing the plane thrusting faces with transverse grooves sunk below the normal surface. The face view of the blade is approximately rectangular with rounded corners as distinct from the usual elongated oval.

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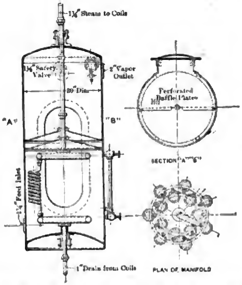

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TRADE PUBLICATIONS.

AMERICA

International Acheson Graphite Company, Niagara Falls, N. Y., has established a marine department to assist in the introduction of the Acheson lubricants—Oildag, Aquadag and Gredag—to the marine trade. Mr. J. J. Lynn, Port Huron, Mich., is in charge of this department. These lubricants are described in booklets, which will be sent free to our readers upon request. "Oildag is deflocculated graphite diffused in oil. The graphite will make 1 gallon of Oildag do the work of 3 gallons of oil. It is put up in condensed form for charging 1, 5, 10 or 50 gallons of oil. Aquadag is deflocculated graphite diffused in water. It is an ideal lubricant and coolant, valuable as an aid in all kinds of metal cutting. It is put up in condensed form for charging 1, 5, 10 or 40 gallons of water. Deflocculated graphite is graphite reduced to the molecular state, in which form it is easy to diffuse it in oil or water. This graphite is not obtainable in powder form, nor in any lubricants but Oildag and Aquadag. Gredag is a ready-to-use lubricant that is far superior to plain grease." It is the only grease that contains pure, gritless Acheson graphite."

The McKim gasket, made by the McCord Manufacturing Company, 2587 East Grand Boulevard, Detroit, Mich., is described in a catalogue the manufacturer has just issued. "The McKim gasket comprises a proper combination of soft, ductile metals and a variety of elastic packings, resulting in a gasket capable of resisting heat, pressure and chemical action of any circulation, at a minimum tension of bolts and unions, and at a price that defies competition, even when compared with the cost of cheap and inferior gaskets. The McKim patent gasket combines all the attributes of a perfect packing, forms a natural expansion joint, will not spread, is impossible to blow out, can be used again and again, is a factor of safety, and is as good as an insurance policy. Above will be noted sections showing construction of various styles. Figs. 1 and four illustrate double copper jacket asbestos gaskets, which are used on flanges for superheat and extreme service; Fig. 2, a single copper asbestos gasket for high-pressure and ordinary steam service; Fig. 3, a single copper rubber gasket for low-pressure and cold water, etc., service; Fig. 5, a double copper asbestos gasket as used in handhole plates on watertube boilers."

"Comparative Tests of Large Engine and Turbine-Driven Centrifugal Pumps" is the title of an article by Mr. Francis Head, member American Society Marine Engineers, which recently appeared in one of the technical journals, and has been reprinted by the De Laval Steam Turbine Company, of Trenton, N. J. "The tests were made at the Torresdale Filter Plant of Philadelphia, where there are installed seven compound-engine-driven centrifugal pumps, each having a capacity of 45,000,000 gallons per day against a head of about 45 feet, and one steam turbine-driven centrifugal pump of a capacity of 50,000,000 gallons per day against the same head. During the past year six of the engine-driven pumps and the turbine-driven pump have been carefully tested for economy, according to the specifications, by representatives of the contractors and of the city. The pamphlet before us gives the detailed results of the test, which show that the turbine-driven pump developed a duty of over 21 percent in excess of the duty shown by the compound-engine-driven pump, and required less attention and seemed to be more easily maintained. The economy developed by the turbine pump was 104,000,000 foot-pounds of work per thousand pounds of steam, not crediting the pump with the head lost in the condenser and power consumed by condenser. While this may appear low in comparison with the duty shown by vertical triple-expansion, crank-and-fly-wheel pumping engines, it should be borne in mind that the annual charges against turbine-driven pumps are very small alongside of those upon expensive high-duty pumping engines, and that the total cost of pumping per year with coal at $5 per ton and less will, in most cases, come out decidedly in favor of the turbine-driven pump. In tenders recently made to one of the large cities in this country, for instance, it was found that the total operating cost with coal at $3 per ton would be $43,372 per year for the triple-expansion engine having a duty of 170,000,000, as against only $27,846 for the turbine-driven centrifugal pump having a duty of 120,000,000 foot-pounds per thousand pounds of steam. As a matter of fact, the actual cost of coal was only $1.50 per ton, and further computation shows that in order to bring the cost of pumping by the turbine-driven centrifugal pumps up to the cost of pumping by the vertical triple-expansion reciprocating pump, the price of coal would have to be in excess of $13 per ton." Copies of the booklet mentioned will be sent to interested persons upon request.

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The turbo-blower, a machine designed to produce the proper draft in a boiler, that is necessary to burn all grades of fuel in such manner as to effect complete and economical combustion, is described in a catalogue published by Turbo-Blower Company, 30 Church street, New York. "In most cases where natural draft is used conditions are such that the amount of steam obtained from the fuel in use is inadequate to the requirements of the plant; of if sufficient steam is produced more fuel is consumed, and in addition more labor is expended than would be necessary if a proper system of mechanical draft were employed. It is well known that from 25 percent to 40 percent of the heat generated in the boiler furnace passes away through the chimney and escapes into the atmosphere. Only a small portion of this heat is actually necessary to create the draft needed for combustion of the fuel. The remainder is dead loss. Stacks require to be heated to a high temperature in order to draw, and the greater part of the enormous amount of fuel used to produce this heat is saved by the use of the turbo-blower."

The Bristol Company, Waterbury, Conn., has just issued condensed Catalogue No. 160, describing recording instruments for pressure, temperature, electricity, speed, time, etc. "This is a condensed general catalogue and price list of Bristol recording instruments for pressure, temperature and electricity, including a few indicating forms, such as the thermometer-thermostat and indicating pyrometer. Since the first Bristol instruments were put on the market more than twenty years ago hundreds of different applications have been found where recording instruments would pay for themselves in service, and to meet the continuously-increasing requirements a great variety of Bristol instruments have been developed. More than a thousand charts of various sizes, covering hundreds of different ranges of pressure, temperature and electricity, have been specially engraved for use with Bristol instruments, and charts of special ranges will be engraved to order. The individual lines of these instruments are catalogued separately in special bulletins, as noted on page 5, and copies of these special bulletins for any particular line of Bristol instruments will be mailed upon request. Thousands of Bristol recording instruments are now in daily service. The continuous records of pressure, temperature or electricity, made automatically by these instruments, are of great value in helping to maintain uniform operating conditions in manufacturing plants and industrial works. Results obtained have led to their being regarded as an operating necessity in many processes. One of the most important features of Bristol instruments has always been their extreme simplicity of construction and operation. The general principle on which they have been designed is that the most simple equipment that will do the work is the most practical equipment for that work, because it is the easiest to maintain."

Conveying machinery is described in Bulletin No. 110, published by the Conveying Machinery Company, 50 Church street, New York. Among the illustrations in this bulletin is one showing the naval coaling station built for the United States government at Algiers, La. "On the dock there is a pocket having a capacity of about 300 tons which can be discharged by gravity into vessels lying alongside. The coal is discharged from vessels by a grab bucket operated by electric hoist with alternating current, 2,200 volts, 60 cycles, and deposited into the receiving hopper in the movable discharging tower, and is distributed in the dock storage pocket by a gravity bucket conveyor system. From coal storage pocket on the dock the coal is taken to the coal storage building by a main gravity bucket conveyor system, which encircles the building. The same conveyor system takes the coal from the coal storage building to the dock storage when desired. Coal is also received at the building in cars, and put into storage with the same conveyor system. The distribution of coal from the coal storage building to the various points in the naval station is done by delivery to wagons or cars through gravity chutes. There are weighing devices located at the dock and coal storage, suitably arranged to accurately record all coal received and disbursed from the station, whether by wagon, vessel or cars. The entire structure being fireproof steel concrete construction, and all handling of coal to or from the station at least possible expense, make it the most complete and economical coal storage plant in the world. This conveyor system is built with 24-inch by 24-inch malleable iron buckets and drop-forged links, having a capacity of over 100 tons of coal per hour. It handles all kinds of coal, principally run-of-mine. There is over 14 feet of conveyor with a vertical rise of 56 feet, and operates with less than 16 horsepower."

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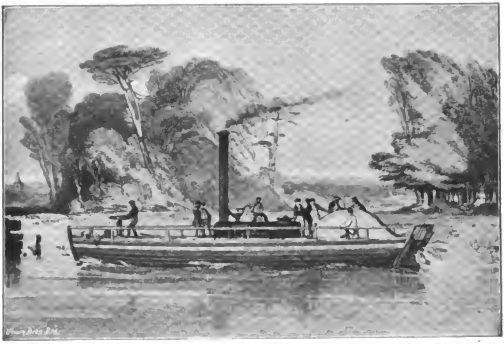
International Marine Engineering

NOVEMBER, 1911.

A FEW NOTES REGARDING THE HISTORY OF SHALLOW RIVER NAVIGATION.

In reference to the descriptions given in this issue of the very latest types of vessels built for the purpose of shallow river navigation, it may not be uninteresting to go back to the history of steam navigation specially adapted for shallow rivers.

In the year 1737, Jonathan Hull invented and built a remarkable vessel, which he called "A machine for carrying ships in and out of harbor against wind and tide." This consisted of a wooden hull and a paddle wheel without any rims, the supports for which projected from the stern of the vessel. We believe it may be said that this stern-wheel vessel is the prototype of all steam vessels.



THE CHARLOTTE DUNDAS.

In 1803, Symington produced what was termed at the time "The first practical steamboat," which was named the *Charlotte Dundas*. This vessel, which was also a stern-wheel boat, had a paddle box embodied in the after part of the hull.

Four years later the *Clermont* was built by Fulton. This boat was a side-paddle boat, a type which is now so much more familiar to the general public than that of the older stern-wheel boats.

In 1817, Henry Bell, whose name is almost as familiar as that of Watt, built a vessel called the *Comet*, which is also a side-wheel boat; and it is very familiar to all those who have visited the Scottish Historical Exhibition, there being two models exhibited there, one in the Kelvin Hall, and the other afloat in the river Kelvin.

These two methods of propulsion gradually developed until a side-wheel vessel, called the *Scotia*, was built, which crossed the Atlantic in about twelve days; but, with the exception of vessels built for short passages, such as from Dover to Calais or from England to the Channel Islands, the screw propeller has now practically ousted this form of propulsion.

In 1856, John Buchanan introduced a device by means of which a screw propeller could be used with advantage for vessels of very shallow draft. The propeller revolves in an arched tunnel, built up from the bottom of the hull, the bottom of the tunnel being open to the water. The tunnel on cross section has vertical sides and semi-circular top.

This method of a propeller working in a tunnel had an advantage because a fast-running engine could be used, being very much lighter than the slow-running machinery used in the case of either the stern-wheel or side-wheel boat. A certain number of vessels were built from time to time on this method, but the objection to it was that, when the vessel was loaded below its light draft, the after part of the tunnel produced a very serious resistance to the speed of the vessel, and for this reason the system fell out of use. It was again introduced by Messrs. Yarrow in 1892, and a good many fairly

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THE CLERMONT.

successful boats up to 100 feet by 20 feet were constructed. In the case of pleasure boats and gunboats, in which the draft of water was scarcely varied, these boats were very successful, but when it came to boats of varying draft the resistance of the after portion of the tunnel had to be considered. This trouble arose only when the vessel was deeply laden. This difficulty was overcome by the builders in a very simple manner by making the after part of the tunnel work on a hinge, so that the rear portion of it could be adjusted to touch the surface of the water, without being immersed in it, on whatever draft the vessel might be running, a device which has proved very successful. Not only does this adaptability of the after part of the tunnel to various drafts increase the speed when the vessel is laden without necessitating extra power, but even on a light draft it is a great advantage, because, when the propeller is at work, it raises a mound of water behind it, and the tunnel can be adjusted to touch the top of this mound, which is often a good many inches above the level of the water outside.

Many gunboats have been built on this system for the

THE COMET.

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British and other governments. Besides *Macau*, built for the Portuguese government, and the *Widgeon*, the last of eleven gunboats built on this system for the British Admiralty, a similar boat was built for the Japanese government and sent in pieces to be riveted together in Japan. This boat left the country just before the declaration of war between Russia and Japan, and every effort was made by the Russians to have it stopped. During the voyage out of the freight steamer through the Red Sea the latter was overhauled by the Russian gunboat, whose captain had been informed that a Japanese gunboat was on board. The officers searched the freight vessel, but seeing nothing but wooden cases returned with the report that no gunboat was on board. The freight steamer's destination was Hongkong, and there the British authorities had orders to stop her and take out the gunboat. The captain of the freight vessel, however, had secret orders to proceed direct to Japan, without calling at Hongkong, and so the shipment safely arrived at its destination and was riveted together by the Japanese.

The importance of shallow-draft vessels can hardly be overestimated. In geography books the rivers in various countries are described as being navigable up to a certain point, and the function of the shallow-draft boats is to carry this point further to the source. We may state that these vessels have been sent on expeditions among the primeval forests of Africa, where dwell the dwarf races. They have been sent into the mountains of Peru, where white men have never been before and where the natives are in the Stone Age. These people wear no clothes and know no weapons but stone axes and poisoned arrows, and are shot at sight like wild beasts by the half-civilized natives of the surrounding regions. They have also advanced along the shallow tributaries of the Amazon, which are practically unknown to civilization, and where the natives are scarcely superior to those mentioned above. The natives of these regions are very fierce and disfigure their faces in every kind of grotesque manner.

If a history could be written, giving the combined experience of those who have accompanied these boats, it would be a very interesting one, as illustrating the very first introduction of civilization to the naked savage.

American River Steamer Saguenay.

The Richelieu & Ontario Navigation Company's new steamer *Saguenay* was constructed at the Fairfield Shipyard, Glasgow. The *Saguenay* is 275 feet in length, 56 feet 6 inches in breadth, and 40 feet in depth to hurricane deck. She is fitted with two direct-acting, triple-expansion surface-condensing engines, each having four inverted cylinders, with cranks on the Yarrow-Schlick-Tweedy system of balancing. One of the low-pressure cylinders is at the forward end, and next to it is the high-pressure, then comes the intermediate-pressure cylinder, with the second low-pressure at the aft end. The engines are designed to develop a total of 2,300 indicated horsepower when driving the ship at 15 knots sea speed on a draft of 10 feet.

As is usual in American river passenger steamers the starting platform is situated at the level of the main deck within the engine-room casing, and the gear is so arranged that both sets of machinery can be conveniently operated by the engineer in charge.

The steam generating plant consists of three single-ended boilers of the multi-tubular type, each designed for a working pressure of 180 pounds per square inch. All the furnaces are of the suspension bulb type, working under Howden's system of forced draft.

The electric generating plant consists of two sets, manufactured by Allen, of Bedford. Each set is constructed for a continuous output of 75 kilowatts at 100 volts when running at a speed of 500 revolutions per minute.

CHAIN AND ROPE TOWAGE ON GERMAN RIVERS.

BY K. DIETZE.*

It is about forty years since the needs of the high-running tide of German commerce began to direct renewed attention to the possibility of making use of the inland waters as traffic ways. The want of suitable means of transport, especially for cargo, made itself the more felt because the railways had not then developed to their present high state of efficiency. Even in the face of this powerful rivalry a large share of the transport of goods still falls to the cargo vessels on the rivers and canals, and will probably continue to do so for all time, in Germany as well as in other countries, because, on account of their low original purchase, maintenance and working costs, and therefore of the small amount of the interest on and amortization of their working plant, they can work at much cheaper rates of freight than the railways. In the case of bulk goods, for which rapidity of transport is less required, this latter circumstance is of great importance.

By reason of the low state of the water occasionally experienced in most of the rivers of Germany, the conditions there are, it is true, no longer so favorable for inland shipping as they formerly were, so that the competition of the railways has gradually become very formidable. Moreover, this occasional shallowness of the German rivers admits only of a partial use of cargo steamers, a peculiarity of which is that, apart from their high original purchase and maintenance costs, a considerable part of their otherwise available space and carrying capacity has to be surrendered to the accommodation of engines, boilers and bunkers. Also, in view of the in part very considerable fall of the rivers, and of the consequent speeds of the currents during high stages of the water, power would have to be amply apportioned to such vessels to enable them to make fair headway in the up-stream direction. The result of this state of things was the retention of the old-fashioned engineless cargo barges fitted, for occasional use only, with from one to three large sprit sails. It now, however, became urgently necessary to provide for their up-stream journeys special tugs, which should be capable of propelling themselves and the barges on these shallow waters even against a strong current. Thanks to the very extensive regulation of the courses of the rivers, shallow-going side or stern-wheel paddle steamers, which, with draft of about 2 feet, can carry engines of as much as 350 indicated horsepower, are generally made use of with advantage. Not many decades ago, however, when jutting promontories of the banks or narrow bridges severely throttled the current, and rapids rendered up-stream voyages difficult, the so-called Tauerei, or mechanical towage, was in full bloom on the German rivers. The term Tauer, or towing vessel, was applied to all river steam tugs which by means of mechanically-operated drum or wheel appliances wound themselves and their trains of barges along a rope or chain that was permanently anchored in the river.

It will at once be apparent that the advantage of this method of towage over that with paddle or screw lies in the avoidance of the slip. The slip of the paddle or of the screw must, in view of the opposing speeds of current and small depths of the water, make itself specially unpleasantly felt when, in addition, the propeller is burdened with the considerable resistance of the train. This consideration will at once show that, where the last-named influences (fast-flowing currents and small depths of water) are especially operative, paddle or screw steamers will work very uneconomically, whereas the Tauer will move forward with the speed due to the revolutions of its machinery uninfluenced by the speed and depth of the current. The propulsive efficiency of the Tauer is here

*Charlottenburg-Berlin.

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TABLE 1.

		Paddle Tugs.			Rope-Towing Vessels.		
1	Name of vessel	Cöln I.	Cöln II.	Mannheim.	No. I.	No. III.	No. V. (Tauer).
2	Towed Vessels: Wooden barges ... number	4	5	2	6	5	5
3	Towed Vessels: Iron barges ... number	1	0	1	0	0	0
4	Towed Vessels: Cargo-carrying capacity ... centner*	25,170	24,456	0	25,271	26,445	25,197
5	Towed Vessels: Cargo ... centner*	25,170	23,593	19,600	19,060	25,723	22,552
6	Length of the chain-towing stretch ... km.	82.98	82.98	91.5	57.78	22.24	13.65
7	Net time of running ... hrs. m.	18 h. 4 m.	16 h. 59 m.	21 h. 10 m.	13 h. 57½ m.	4 h. 29 m.	3 h. 5 m.
8	Speed over the ground ... m. sec.	1.248	1.357	1.20	1.15	1.378	1.23
9	Speed over the ground ... km. hr.	4.493	4.884	4.33	4.14	4.96	4.43
10	Engine power ... I.H.P.	803	753	450	131	145.1	133
11	Consumption of coal per I.H.P. per hour ... kg.	1.142	1.105	1.82	1.45	1.42	1.46
12	Speed of current ... km. hr.	1.65	1.40	1.65	1.50	1.40	1.47
18	Speed against the current ... m. sec.	2.898	2.757	2.85	2.65	2.776	2.70
19	Average resistance of the towed train ... kg.	7,309	6,713	4,699	5,981	5,528	5,677

* 1 centner equals 50 kilogrammes.

affected only by the ordinary resistances in the engine itself, and by losses in connection with the gearing and drums (given by Arntzen at 23 to 25 percent for ropes); further, there is a certain loss of efficiency due to the raising and stretching of rope or chain or to slipping (about 3 percent for ropes according to Arntzen, about 10 percent according to Bellingrath). For chains the latter assumes a total efficiency of $.7 \times .87$ (these being inclined from 8 to 10 degrees from the horizontal with an engine of 120 indicated horsepower, a speed of vessel over the ground of 5 feet per second, and a weight of chain of 10 pounds per foot of length). On the other hand, in addition to the ordinary losses in the engine, screws and paddles are further subject to vertical thrust and water-raising losses and to their frictional, form and eddy resistances, so that a towing vessel of this class may be credited with an efficiency hardly exceeding about 30 percent. For the institution of a comparison between the working capabilities or rope Tauers and paddle tugs, Prof. Teichmann (1880) gives the figures in Table 1.

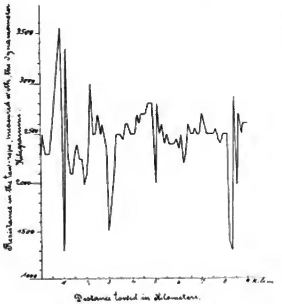

FIG. 1.—TOW-ROPE RESISTANCE OF A RHINE BARGE (OF 1,670 TONS CARGO CARRYING CAPACITY AT A DRAFT OF 8.85 FEET) LOADED WITH 1,030 TONS OF CARGO AT A DRAFT OF 6.3 FEET, TOWED UPSTREAM BY A PADDLE TUG ON THE SIX-MILE REACH BETWEEN LEINERSHEIM AND WÖRTH.

The resistances of the barge train that here come in question vary very considerably with the attendant circumstances. It is in such cases advisable first to institute on the special experimental trials for the type of barge found on a particular river in question on the reach on which it is intended to ply. Account must here be taken of the experience that, in contrast to the conditions with a Tauer, a barge behind a paddle or screw-steamer has its resistance increased on the average by 10 percent. It is, moreover, a well-known fact that the bargemen much prefer to have their vessels drawn along behind a Tauer than behind a paddle or screw-vessel which churns and tosses the water about, quite apart from the consideration that the section of the river may be damaged by the waves raised by a tug-steamer of one of these types.

The following illustration (Fig. 1) shows within what wide limits the resistance of the barge trains may vary. It must not here be forgotten that the resistance of wooden cargo barges is about 50 to 75 percent greater than that of iron ones of the same size. The fitting of a wooden bottom in an iron vessel alone suffices (according to Haack and Engels) to increase the resistance by an average of 33 percent. On the other hand, it is not advantageous to reduce the resistance of the tug itself too much by reducing her coefficient of displacement or by other means of this kind. Blümcke (see the papers of the Permanent International Association of Navigation Congresses) very appropriately compares the required minimum displacement with the minimum weight which a locomotive must have in order to give the necessary rail friction for heavy work. The degree of efficiency found by experience to be necessary for a chain-towing vessel may be obtained from the following considerations:

If W = the total resistance of the tug with its train,
n = the number of towed vessels, not including the tug,
K = about .3 = coefficient of resistance, and
F = area of 'midship section of one of the towed vessels in square meters,
K_1 = about .4 = coefficient of resistance, and F_1 = area of 'midship section of the tug in square meters,
v = the speed of the tug over the ground in meters per second,
c = the speed of the current in meters per second,
N_t = the total efficiency of the installation,
g = the acceleration of gravity in $^m/_{sec^2}$,

then $\dfrac{W v}{75} = N_t \times I.\ H.\ P.$

$$W = \left(\frac{n+1}{2} \times K \times F + K_1 \times F_1 \right) \frac{1{,}000}{2g} (v + c)^2,$$

and therefore $\left(\dfrac{n+1}{2} \times K \times F + K_1 \times F_1 \right)$

$$\times \frac{1{,}000}{2g} \times (v+c)^2 \times v = N_t \times I.\ H.\ P. \times 75.$$

Thanks to the very economical use of the horsepower just set forth the costs of working are relatively small. For instance, the coal consumption of a chain tug on the Elbe is only one-third that of a paddle tug, and that of a rope tug on the Rhine only $\frac{1}{3.6667}$ of the latter for the up-stream journey. On the down-stream journey the difference, of course, becomes less. An additional advantage is to be found in the reduced number and wages of crew required and in the relatively small expenses of maintenance and repairs.

Bellingrath, the staunch upholder of the German chain-tug traffic, writes off 6 percent of the first cost of the chain vessels (exclusive of equipment) and 7 percent for the chains. He assumes the annual cost of the repairs of a chain vessel of about 130 feet in length with engines of 130 indicated horsepower to be about $1,200 (£240). Judging by the balance sheets of the chain traffic companies, these figures would appear to be somewhat too low. In 1880, for instance, we find 12½ percent written off by a lower Elbe company for the chain and about twice as much for repairs to a chain tug approximately corresponding with the above in size.

It is true the chain and rope towage systems also have many disadvantages. The heavy first cost will only admit of the use of a single line of chain or rope for up-stream and down-stream work, so that when two vessels meet their passage becomes a difficult and complicated matter. This operation has been somewhat simplified by the fitting of a special propelling plant for the down-stream journey. But during work the small degree of mobility and the constant dependence on the length and position of the chain or rope form a not inconsiderable impediment to the rest of the river traffic. This is, moreover, especially the case when the chain or rope breaks, so that a whole train of barges lies helpless in the channel. Further, the permanent installation of such a valuable object as the chain or rope on the bed of the river, where it is exposed to the action of drifting ice and to decay in various ways, and where it is also difficult to look after, has its objections. It once happened on the Elbe that a trunk of a tree was caught by the chain in such a way that one of its ends stuck in the ground and the other penetrated the skin of the vessel, which then sank. Again, on the down-stream journey, screw and paddle tugs give greater security in the towage of barges so that they can take the same number of these as on the up journey. Moreover, a screw or paddle steamer may be applied to other purposes, or may be sold, whereas this would be very difficult in the case of a chain or rope vessel. Finally, the introduction of the chain and rope systems meets with difficulties on rivers the courses of which are interrupted at frequent intervals by dams or locks.

The question whether the chain or the rope system is the more advantageous was the subject of somewhat extensive discussion about forty years ago in Germany. A fact it is, that in view of the considerable practical success attained with the chains, which were the first to be introduced into Germany, they for a considerable time held their ground. Towards the close of the seventies, however, a powerful competitor arose in the flexible steel wire rope. The deciding factor in the question whether rope or chain shall be resorted to is the available depth of water on the reach in which the vessels are to ply. Thus on the Rhine, with its ample supply of water, we find the rope system (average depth of water on the reach in question equals 3.28 feet), while on the shallower tributaries of the same river and on the Elbe (average depth of water 1.6 to 2.6 feet) the chain system is the one in use. The point of importance in shallow waters is not so much the strength as the weight of the appliance. In shallow water a rope would, by reason of its small weight, have to be raised from the ground for too great a distance, and this would be especially awkward at sharp bends of the river or in cases of meeting with other vessels. On the other hand, however, a chain may in such case be sufficiently depended upon to afford the necessary friction on the river bed against the pull of the vessel and against lateral shifting. The chain also, when raised by the vessel, drops into the water again more easily than the rope, on account of its much greater mobility; for the same reason its application admits of the use of comparatively smaller and lighter wheels, rollers and drums. The chain is also less easily affected by local stresses, so that, even at the lowest state of the water and with moderate ice drift, the service can be maintained. Further, the breaking of a chain can, by the interposition of a shackle, be more easily repaired, and shortening or lengthening may be more readily effected than in the case of a wire rope. The winding drum for a chain is also to a certain extent simpler in itself and in its fittings, the chief advantages being the leading of the chain along the center line of the vessel with the attendant symmetrical arrangement of the weights on board and the considerably improved steering.

On account of the readiness with which disconnecting can be effected the tug can use the same chain also on the down-stream journey. The parting of the chain to enable an approaching train of vessels to pass, which will be described later, renders the provision of a separate propulsive arrangement for the down-stream journey unnecessary.

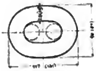

FIG. 2.

FIG. 3.

FIG. 4.

According to information kindly supplied by the "Vereinigte Elbe-Schiffahrts-Gesellschaft, Dresden," which still carries on the chain towing service on the upper Elbe and Saale, the links of the chains used in these rivers have the dimensions given in Fig. 2, the figures in parenthesis applying to the Bohemian reach of the Elbe, which has a somewhat greater fall than the others. The chain is manufactured in lengths of from 1,640 to 3,280 feet, and the connections are made by means of chain locks, or double shackles, which take the form shown in Fig. 3. Similar chain locks are kept in readiness on the steamers, and, if the chain happens to break, are used for reconnecting. The diameter of link of the chain that is still in use on the Neckar towing service is 1 inch, and its first cost, including laying, on the 79-mile towing reach are stated to have amounted to $120,000 (£24,000).

The life of a good chain of about 1 inch in diameter of link on a difficult river reach ranges from about four to at most six years when used from three to five times a day by tugs. After this, however, it can still be used for several years on reaches on which the general conditions and the stresses are less severe. The chain on the Elbe is anchored at each end.

In spite of the undoubtedly great advantages of the chain, it also has serious disadvantages. Its great weight limits the steering capabilities of the tug and of its train, and the ability of these to deviate from the line of advance to a considerably greater degree than in rope towage. By reason of its great weight and of its structure, the chain also wears away much more rapidly than the rope, and also wears out the drums and wheels, this action being further increased by the sand and dirt from the river bed which adheres to it, and by its twisting and frequent entanglement. In addition the chain causes severe vibration of the whole structure of the vessel and makes a good deal of noise in passing over the drums and

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wheels. The first cost of a wire rope, moreover, is only about one-fifth of that of a chain, and therefore is associated with relatively smaller interest and amortization. The chain, then, when separate lines are provided for the up-stream and down-stream journeys, will be economical only in case of very great traffic. High stages of the water will oblige the chain vessels to cease work sooner than the rope vessels. For the considerably increased weight of the lifted chain acts very unfavorably on the stability of the tug, especially when the pull is partly lateral. A case actually occurred on the Neckar during a somewhat high state of the water, in which, probably from the cause referred to, a chain-tug was blown out of her course by a lateral gust of wind and caused to capsize. Then, again, a wire rope, by reason of the uniform stressing of all its strands, gives greater security against breaking, and a broken chain always causes unpleasant disturbance of work, loss of time and expense, not to mention direct danger, to the crew and to the rest of the traffic. This advantage of the rope is unquestionably to be attributed also to its smoothness of working and to the possibilities it gives of exact manufacture and testing, all this at the same time considerably reducing the annual outlay for repairs.

The wire ropes for the tug-steamers on the Rhine are made up of seven strands of seven wires each of Siemens-Martin steel; the whole rope has a diameter of 1.7 inches and a weight per foot of 5 pounds. The center strand is enclosed in a waterproof covering, and the splicing of the ends is performed with especial care. The life of a rope is found by experience to be from five to six years.

The structure of another rope, which has been supplied for a wire-rope towing vessel on the very dangerous Iron Gate reach of the Danube, may be seen from Fig. 4. This rope has been armored by a covering of special Z-shaped external wires to protect it from the very sharp rocks and stones, with the incidental effect that wear and tear has been reduced, and that any catching of the rope on projecting points and corners is prevented. Within the armoring come two layers of flat-sided ring-segment-shaped wire, and the necessary flexibility is obtained by the 12 + 6 round inner wires. As a result of its structure, every rope has the tendency, in a greater degree than a chain, to twist about its longitudinal axis. In view of this a swivel arrangement was in the first instance attached to a block of stone in the river bed, to which in the above-mentioned case the rope was anchored, ball bearings being used in order to still further reduce the resistance to twisting.

After the foregoing observations on the principal members of the towing installation we may return to the vessels. The first chain was experimentally installed on a reach of the Elbe between Magdeburg-Neustadt and Buckau (about 3.4 miles in length) in 1866, and a chain-tug was set to work to tow laden and unladen vessels cheaply and safely up-stream through the Magdeburg bridges, where a strong current runs. The favorable results thereby achieved encouraged the promoters of the undertaking to extend the chain towage service from Magdeburg to Hamburg on the lower Elbe in the one direction and to the boundary between Saxony and Bohemia on the other; it was subsequently continued onwards far into the latter country. On other rivers also the system was taken up. In 1891 we find it introduced on the following reaches:

		Miles.
1. On the Elbe—Melnik in Bohemia to German frontier.		68
Frontier to Magdeburg	(about)	200
Magdeburg to Hamburg	"	185
2. On the Saale—Barby to Halle	"	65
3. On the Brahe—Mouth to Bromberg	"	10
4. On the Neckar—Mannheim to Lauffen	"	80
5. On the Main—Offenbach to Aschaffenburg	"	56
Aschaffenburg to Kitzingen	"	125
6. On the Havel and Spree—Round Berlin	"	12

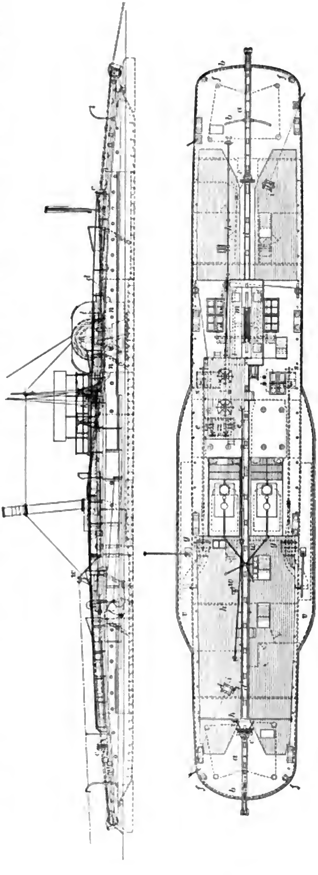

FIG. 5.—THE CHAIN-TOWING STEAMER.

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On account of the year-by-year advancing regulation and canalization of the rivers and the accompanying reduction of the speeds of the currents, the chain steamers were, however, obliged one after another to give way to the superiority of the paddle tugs; at the present time the chain-towing services are retained only on the upper Elbe, the Saale, the Neckar and the Main.

The dimensions of the chain steamers of the "Vereinigte Elbe-Schiffahrts-Gesellschaften, A. G., Dresden," which now carry on the service on the Elbe and Saale are the following:

Length over deck, 125 to 183 feet.
Breadth, molded, 22 to 27 feet.
Depth, molded, amidships, 6.6 to 8.5 feet.
Draft without bunker coal, 2 to 2.9 feet.
Number of boilers, 1 to 2.
Heating surface, 880 to 970 square feet.
Indicated horsepower, 100 to 200.

In view of the circumstance that the steamers in moving up and down stream are connected in the same manner in each case with the chain, their longitudinal section is made symmetrical (Fig. 5), so that the alteration of their direction of motion is effected by the reversing of the engines alone. Following the inclinations of the incoming and outgoing chain, the deck slopes down at each end to about 40 inches below the 'midship height. In order to increase the maneuvering power of the vessel she is provided with a rudder at each end, which can be separately actuated from the bridge by means of shafting, *h-v* (see Fig. 5). The later steamers are built entirely of steel, while some of the older ones have wooden bottoms. The engine and boiler rooms are arranged amidships, the crew space and other rooms being at the ends of the vessels. Forward and aft on the deck of a chain vessel is fitted an outrigger, *a*, the length of which is about one-sixth that of the vessel, and which is hinged in vertical rollers, *c*, and turned on one or more semi-circular racers, *b*. In conjunction with chain troughs, *d*, which, to facilitate the leading of the chain, are provided with vertical and horizontal rollers, the outriggers serve to lead the chain to the drums. The rollers are of cast steel or case-hardened cast iron; the non-movable chain trough, which at the same time serves to take the rollers, is made of plates and angles riveted together. To enable the chain to be brought back to its proper position in the channel in the case of sharp bends of the river the after outriggers are so arranged that they can, by means of special hand winches, be turned to a considerable angle in the lateral direction; spring buffers, *f*, limit the lateral movements of the outriggers. On each of the older vessels two chain drums, *a* (Fig. 6), which are driven by the engines below deck, and each of which is arranged to take three turns of the chain, are installed at about the middle of the vessel. By means of two disconnectable systems of wheel gearing with different reduction ratios, different speeds of drum or of advance of the vessel can be applied for the up-stream and down-stream journeys, respectively, without any alteration of the revolutions of the engine, which it has not been found desirable to vary to the otherwise necessary extent. Each of these chain drums consists of four single wheels with steel tire bands, which are separated by wrought iron disks, which project so as to form flanges. By this means grooves are formed, which take the chain, the latter being prevented from slipping entirely by its friction against the periphery of the drum. The fitting of two drums was necessary because it was impossible with a single one to get the chain to wind itself evenly onto the one side of the drum and from off the other side without lateral slipping. The flexibility of the chain renders possible the use of relatively small wheels and drums, and this again admits of lighter construction of the winch and of the leads along the vessel. The circumference of the drum over the tires is about 11.5 feet, corresponding with a diameter of 3.6 feet. The distance between the axes of the drums is about 8.2 feet, and the reduction ratio of the drum to the engine is about from 2 to 1 to 2.5 to 1.

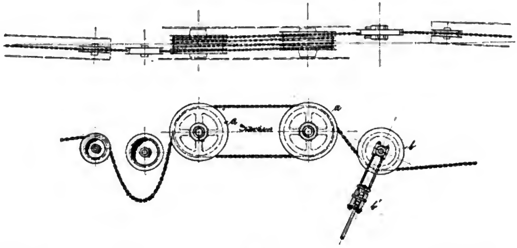

FIG. 6.

Now it is clear that on account of the maximum stresses which there occur the outer grooves of the chain drums are specially subject to wear. The result of this is that their diameter becomes smaller, so that the central grooves have a tendency to wind on more chain than the outer ones. By reason of the lengthening of the chain at this turn on the drum, even when no twists nor kinks have to be reckoned with, stresses of such magnitude have been set up that most of the breaks that have occurred could be clearly traced to their influence. Here, again, our thanks are due to Bellingrath, whose chain-grip wheel (D. R. P., No. 67,813, Fig. 7, and also *m* in Fig. 5) avoids all the disadvantages of the old chain drums. This chain-grip wheel has in consequence lately been applied to all the German chain vessels. The arrangement consists in a single driving wheel, over the upper half of which the chain is led. In other respects the manner of leading the chain to and from the wheel is the same as before. The grooved driving wheel, *a* (see Fig. 7), has flanges, *b*, through which the fingers, *c*, from four to five of which combine to form a hand, *e*, are made to project on each side. The fingers,

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which are provided with springs, *d*, that press them against the links of the chain, are fixed within the hands, *e*. By means of the rollers, *f*, these latter are forced to move in a separate guiding frame, *g*, in such a manner that during the passage of the chain the fingers are successively inserted between its links and prevent these from slipping. At the point where the chain leaves the wheel the hands with their fingers are, by means of guiding frames, *g*, corresponding with those which effect the grasp, set free again (see Fig. 7). The excessive wear which was expected to be set up by reason of the many moving parts has not taken place. The experiences obtained with the appliance are of the best, and the chain itself has suffered much less than by the old method.

With a view to the avoidance of the several turns of the chain round the drum, de Bovet proposed a single wheel, on the upper periphery of which the friction of the chain was to be increased by electro-magnetic adhesion. Experience is said to have shown that a partial turn of 270 degrees is sufficient even in presence of moisture and dirt. Both chain and wheel are undoubtedly saved from wear by this means. It appears doubtful, however, whether it would be equally effective in case of violent twisting of the chain.

The engines used in the older vessels for the driving of the drums or gripping wheels are of the twin-cylinder description, with jet condensation. (Diameter of cylinders about 15.4 inches, stroke 27 inches and revolutions per minute 50.) Recently four-cylinder compound engines with jet or surface condensation have been substituted. The Woolf engine for the winding gear of the steamer *Baensch* (Fig. 5) has cylinders of 9.85 and 17.6 inches in diameter with a stroke of 11.8 inches. The newer vessels have the low-pressure cylinder with its rod at the one side of the winding gear and the high-pressure cylinder at the other. The boilers are of the single-ended marine description, with one or two furnaces on the return-flame or on the direct-flame plan. Their working pressure is 60 to 150 pounds per square inch.

Separate auxiliary engines for paying out and hauling in the towing hawsers, *e*, the windlasses, *i*, and the funnel winches, *k* (Fig. 5), are arranged on deck. A separate towing apparatus, *w*, is provided for the down-stream journey.

On several of the chain tugs the experiment has been tried of fitting each of them with a pair of four-bladed screws with separate compound engine for the down-stream journey; but this principle has not found universal acceptance. On the newer vessels the screws are replaced by Zeuner turbine propellers (*g* in Fig. 5), which are stated to have given satisfactory results.

For those chain tugs, however, which negotiate the up-stream and down-stream journeys with the same chain, special measures are adopted to enable vessels to pass each other. Although it would be possible for a steamer *A* proceeding with her train in the up-stream direction to transfer her barges to a steamer *B* approaching from above, another method which is considered to cause less loss of time is preferred. During the passage of *A*, *B* is disconnected from the chain. To effect this *B* looks for a chain lock and opens it at a point on her deck opposite to the down-stream outrigger. A rope is attached to each of the loose chain ends, and the vessel makes her way slowly down stream. When the rope attached to the up-stream chain end has reached the drum of *B*, it is replaced by an auxiliary chain *C*, which is then attached to the main chain. During a further advance down stream this auxiliary chain is wound over the drum in place of the main towing chain, and drawn along the fore chain trough up to a point in way of the up-stream outrigger. The lower main chain end has meanwhile been lowered onto the river bed by means of the attached rope, and since the vessel has moved down stream it also comes into the vicinity of the up-stream outrigger of *B*. Here the loose end of the main chain is raised by means of the rope and again connected with its other end on tug *B* by means of the original chain lock, after the up-stream end has been taken out of the outrigger, so that the main chain again forms an unbroken whole. The auxiliary chain *C* is now disconnected from the main chain again after the tug *B* has attached

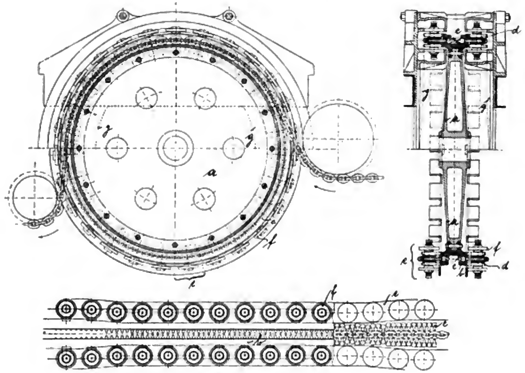

FIG. 7.

herself to the latter by means of another small chain *D*. On a preconcerted signal the up-stream moving tug *A* with her train comes nearer, till she lies alongside the tug *B*, which now attaches herself to the tug *A*. The latter continuing to move up-stream, *B* is taken along till the small auxiliary chain *D* can be detached from the main chain. The two tugs, thus coupled together, continue their advance up-stream until the chain lock already made use of comes out behind the down-stream outrigger of the tug *A*. Here the lock is again opened, and the down-stream chain end, to which a small line has been attached, is taken over to the tug *B*, through her after outrigger, and made fast there by means of a chain catcher. Tug *B* is now cast loose from *A*, and drifts back till her up-stream outrigger is opposite the down-stream outrigger of *A*. The chain *C*, which is still on the drum of *B*, is again passed through the down-stream outrigger rollers of the tug *A* and connected with the main chain end, which is still lying there loose. The two steamers now move one behind the other up-stream. *A* is free to continue her journey up-stream, and *B* follows her until first the chain *C* and then the main chain has passed the drum of *B*. Chain *C* is then removed again, and the loose main chain end, being drawn by means of the attached line through the fore outrigger and through the chain trough, the ends of the main chain are connected together again with the original chain lock. Steamer *B*, also, is now enabled to continue her down-stream journey.

The passing of two steamers in this way occupies a time of from fifteen to thirty minutes, while the transference of the train of barges to the approaching tug *B* would take twice as long.

In case of the breaking of a chain the engines are at once stopped by the shutting off of the steam supply by means of a weight, which, when the engine races, is released by a governor with four fly-balls on the attainment of a certain number of revolutions. The anchors must then be let go to prevent the train from drifting away or the barges from colliding with each other or with the tug. When the chain fracture occurs on the steamer herself the running out of the towing chain is prevented by chain catchers fitted for the purpose. On the insertion of a chain lock (see Fig. 3), which is accomplished in about fifteen minutes, the journey can be continued. If, however, the chain fracture occurs in open water ahead of her, a steamer that is provided with apparatus for self-propulsion will, after anchoring the train of barges, attempt to pick up the lost chain-end by means of a small search-anchor. A steamer not so provided must conduct these operations from her boat. By means of a small auxiliary chain the loose end is then drawn through the outrigger onto the vessel till the two ends meet; they are then connected together by a spare chain lock held in readiness for such occasions.

The up-stream journey on the Elbe with the chain is, on the average, accomplished at a speed of from 2.5 to 3.1 knots, and the down-stream journey at about 5.4 to 6.5 knots. The engine of the steamer develops about 130-180 indicated horsepower, and is so dimensioned that from 1,200 to 1,500 tons of cargo can be carried up-stream in from four to six towed barges.

On the older vessels the coal consumption was about 7.7 pounds of lignite per indicated horsepower, but on the introduction of the compound engine this was reduced to from 4 to 4.5 pounds per indicated horsepower per hour.

For the development of the chain-towing traffic on the rest of the rivers of Germany the experiences obtained on the Elbe have been in general followed. On the Neckar, seven chain tugs belonging to the "A. G. Schleppschiffahrt auf dem Neckar, Heilbronn," carry on the service. The particulars of these vessels are: Length, 147 feet; breadth, 21.3 feet, and displacement 112.5 tons at a draft of 1.75 feet. Their contract price was about $14,000 (£2,800) each, and the material and engine stores used are stated to cost about $400 (£80) a year. With engines of 110 to 130 indicated horsepower their maximum speed up-stream is 2.8 knots, and their maximum speed down-stream about 6.8 knots. The engines are of the high-pressure condensing type with an admission of .3. The average hourly consumption of coal is about 3.5 pounds per horsepower per hour. The working conditions on the Neckar are specially favorable for chain towing, because, owing to the peculiarities of the river, any competition from paddle or screw-tug steamers is impossible. As a result of this the financial result is a very good one. On the other rivers this is not everywhere the case.

(To be continued.)

A SINGLE-SCREW STEEL RIVER TUG.

Among European rivers the Rhine is the one which carries the heaviest traffic, and although some small sea-going ships ascend as far as Cologne, it is interesting to note that the river traffic between the seaport Rotterdam and the different points beyond the German frontier is carried on in a manner quite different from anything to be found elsewhere. The greatest part of the freight handled is iron or coal and other bulk cargo. The goods are trans-shipped in Rotterdam in so-called river lighters, the lighters coming alongside the sea-going ships for the cargo. The capacity of these lighters ranges from 300 to 3,600 tons deadweight, and all of them are towed to their destination by river tugs.

The tugs differ widely in size, construction and efficiency, but for regular long-distance work they run from 150 to 1,500 indicated horsepower. The larger ones, which are mostly paddle steamers, serve on the upper Rhine, principally between Duisburg and Mannheim, and even as far as Strassbourg when the depth of the water permits. The smaller tugs up to 600 indicated horsepower maintain the traffic between Rotterdam and Duisburg, although some of them go as far up the river as the biggest side-wheelers.

The tug illustrated is one of the latter class, which was designed and constructed by Messrs. Arnhemsche Stoomsleephelling Maatschappij in Arnheim, Netherlands. She was designed to draw a load of 1,500 tons in two lighters up stream from Rotterdam to Duisburg in forty-five hours, on a guaranteed coal consumption of 1.7 pounds per indicated horsepower-hour, using slightly superheated steam of about 250 degrees C., with her engines working at normal cut-off, making about 190 revolutions per minute, the firing to take place under natural draft.

The hull, constructed of mild steel, is 83 feet long between perpendiculars, 17 feet 6 inches breadth, molded, 18 feet 6 inches breadth over guards, 8 feet 5 inches depth, molded, 6 feet 3 inches draft with 35 tons of coal in the bunkers. Four watertight bulkheads divide the hull into five watertight compartments, the fore-and-aft peaks serving as water-ballast tanks. The captain's quarters are fitted forward, and the crew is berthed aft.

The machinery consists of a set of diagonal triple-expansion engines, fitted with a jet condenser and horizontal air pump, developing about 275 indicated horsepower with normal cut-off and running at 190 revolutions per minute, using steam at 205 pounds pressure superheated to 250 degrees Centigrade. This construction of engine is a specialty of this firm, which was patented in 1888, and of which a great number have been built, varying from 70 to 600 indicated horsepower, mostly for river work. The engine for this boat has cylinders 11 inches, 18 inches and 29½ inches diameter, with a common stroke of 14 inches. All three connecting rods work on a common crank-pin; all valves receive their motion from one common

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eccentric strap, thus reducing the wearing parts as much as possible. The high-pressure cylinder is fitted with cut-off which can be varied from 56 percent, which is the normal up to 75 percent, which is the maximum. This arrangement is actuated by a small eccentric placed on the crankshaft between the forward main bearing and the eccentric governing the valve motion. It works on an ordinary double-bar link, which can be lifted or lowered, and gives the necessary changes in travel of the valve and cut-off. With this arrangement the engine can be forced to develop about 370 indicated horsepower at about 220 revolutions when working on the maximum cut-off. This is used at places where the current is exceptionally strong on the upper Rhine and in the rapids near Bingen.

The cylinders are of hard, close-grained cast iron cast in one piece, with the valve casings and with the necessary flanges for pipe connections. The high-pressure valve is a piston valve, the intermediate valve an ordinary D valve, and the low-pressure valve a double-ported slide valve.

The bed-plate and framing of the engine are of cast iron, secured to the engine seating in a rigid manner, as can be seen from the illustration. All the shafts, connecting rods, crossheads, eccentric straps and all rods and levers in connection with the air pump gear and valve motion are of the best forged steel.

The jet condenser is cast in one piece with the air pump, and is placed just behind the low-pressure cylinder. The air pump is of the horizontal type, double-acting, the rod being carried through the back cover, acting as the feed pump plunger. The bilge pump, which is of the ordinary single-acting horizontal type, is connected by the air pump eccentric, which is keyed onto the crankshaft just behind the main bearing. All bearings throughout the engine are of hard

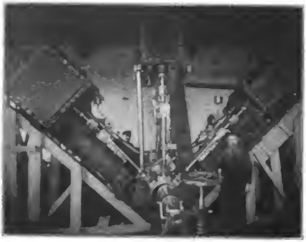
RHINE RIVER TUG.

gunmetal, and when transmitting a rotary movement they are lined with high-grade white metal. The thrust block is situated behind the engine on a rigid foundation.

Just above the air pump and thrust block an exhaust feed-water heater is placed, through which the exhaust is conducted before being condensed. The heating surface of the heater is about 90 square feet, giving a rise of temperature to the feed-water of about 15 degrees C.

Steam is supplied by a Scotch boiler of the river type, 11 feet long, 8 feet 9 inches diameter, with a heating surface of about 930 square feet. The boiler has a dome 16 inches diameter, 20 inches high, and all steam connections are taken from the dome through a heavy gunmetal T-piece. In the smoke-box is a steam superheater with a total heating surface of 330 square feet. The temperature, when working under ordinary circumstances, varies from 240 to 260 degrees C., and although not a high degree of superheat it gives an average of about 7 percent above saturated steam, without the drawbacks which come from superheated steam of very high temperature.

On trial the vessel used forty-three hours in running from



DIAGONAL TRIPLE-EXPANSION ENGINE FOR RIVER TUG.

Rotterdam to Duisburg with a load of nearly 1,700 tons in two lighters, the coal consumption working out at 1.57 pounds per indicated horsepower-hour.

Compound Non-Condensing Machinery for a Light Side-Wheel Steamer.

A set of compound non-condensing machinery for a light side-wheel steamer, the hull of which has been built in Rangoon, but for which the design and working drawings were supplied by the makers of the machinery, has been built by Messrs. W. Sisson & Company, Ltd., Gloucester. The engines are of the makers' standard design, generally similar to the stern-wheel engines described elsewhere in this issue. The cylinders are 9 inches and 13½ inches diameter by 36 inches stroke, driving side paddle-wheels of the makers' specially designed feathering float type, which has an arrangement of grease lubrication to the joints. Since this vessel is to ply in the Rangoon River, the water of which is often sandy or dirty, this plan of grease lubrication, in conjunction with the easily removable and replaceable sleeves and bushes of the feathering gear, is a great advantage. The boiler is of Sisson watertube type, the working pressure being 165 pounds per square inch. A feed heater is provided, through which the exhaust steam from the engine is carried on its way to the blast nozzle in the base of the funnel, and a feed pump on the main engines delivers the water through this feed heater to the boiler. There is also an independent double-acting steam pump arranged with suitable connections for feeding the boiler or delivering water on deck for washing or fire extinguishing purposes. A third means of feeding the boiler in case of emergency consists of an automatic restarting injector. With this machinery a steam capstan of W. Sisson & Company's special design has also been supplied, there being two horizontal steam cylinders driving a vertical capstan head through worm gearing, but with special arrangement for hand working also. This machinery was supplied complete with all necessary accessories, also spare gear and outfit.

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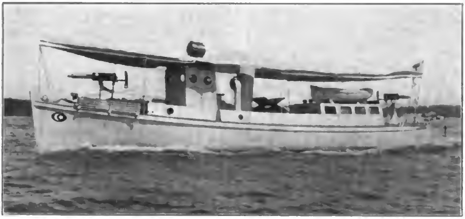
ARMORED MOTOR PATROL LAUNCHES FOR THE TURKISH GOVERNMENT.

No fewer than twenty-two armored motor patrol launches of the type illustrated have quite recently been constructed at the Woolston Works, Southampton, of John I. Thornycroft & Company, Ltd., to the order of the Imperial Ottoman government. These vessels are intended for service in the Red Sea, Persian Gulf and Mediterranean Sea, and will be used for the prevention of smuggling and kindred purposes. They have a length over all of 60 feet, a beam of 11 feet, and a depth of 5 feet 6 inches. The draft of water has been kept dowu to the minimum, being only 2 feet 6 inches, to render them capable of shallow river work. The lines have been designed to give the best results on a shallow draft, the flat stern giving easy running lines and keeping the stern from pulling down when going at full speed. The speed guaranteed as a mean of six runs on a recognized measured mile was 11 knots, and this speed had to be maintained for a further period of two hours.



TURKISH ARMORED MOTOR PATROL LAUNCH.

On official trial a speed of over 11.9 knots has been attained with engines not fully extended. All the boats yet tried have been capable of a knot over the contract speed. The boats have proved to be very handy, and can turn a complete circle of about a length and a half in diameter when running at full speed. Steering is effected by means of a hand-steering gear fitted in the wheel-house, and connected to the tiller on the rudder head by wire rope leads. Protection has been afforded to the steersman by constructing the wheel-house of bullet-proof nickel steel. The hulls are protected against rifle bullets by means of bullet-proof nickel steel fitted inside. This extends from the aft end of after cabin to forward end of the motor room and from the waterline to the deck. The casing sides also have been protected for the same length up to the height of the motor casing. The top of the motor casing is covered with nickel steel bullet proof at 60 degrees.

The arrangement of the boats is compact. The machinery is placed in a separate watertight compartment amidships, and is separated from the cabins, etc., by steel watertight bulkheads. The main fuel tanks are carried at the forward end of motor space in two circular brass tanks, the top one is used as a service tank and supplied to the motors under gravity. Two reserve tanks of brass are placed in the stern compartment, and connected to the forward tanks by means of a semi-rotary pump. The total fuel capacity is about 740 gallons of kerosene (paraffin), giving a range of over 600 knots at full speed. Abaft the machinery space a cabin for officers has been arranged, with a sofa-seat berth having cushion backs on each side of the cabin, and the seat backs arranged to hinge up to form top berths. The underside of the casing top has been lined with "Vanesta" wood in panels with air space to keep the cabin cool. Forward of the machinery space a cabin has been provided for the crew, with locker seats on each side to form lower berths and folding pipe berths with canvas bottom above. The boats are fitted with double canvas awuings, all fore and aft, carried on ridge wires and supported on wrought iron stanchions. Two guns have been fitted, one forward and one aft, of the Vickers Maxim patent 37 mm. quick-firing type, having water-cooled barrels. One thousand rounds of ammunition per boat are carried and stowed in lockers in the crew and officers' spaces.

The construction is practically similar to that adopted by the British Admiralty for their 50-foot and 56-foot pinnaces. The shell consists of two thicknesses of teak, the inner thickness laid diagonally and the outer fore and aft. The hull from keel to about 4 inches above the waterline is covered with 12-ounce copper sheathing. The keel is of oak, with a 1½-inch rubbing strip to take the wear. The boats have been built under the supervision of Lloyd's surveyors, and are equal to Class A in their yacht register for river service. The mild steel armor has been tested under British Admiralty supervision.

The main engines consist of two of the Thornycroft C/6 type, having six cylinders 6 inches bore by 8 inches stroke. At 750 revolutions per minute each engine will develop 70 horsepower, but in these boats the engines are kept back to 670 revolutions per minute by means of a spring-controlled governor. The fuel used is commercial kerosene (paraffin), which is vaporized in a Thornycroft vaporizer heated by the exhaust. Starting is effected on kerosene (paraffin) by heating the vaporizer with a blow-lamp, or if gasoline (petrol) is available by running on gasoline (petrol) for a few minutes. Ignition is by high-tension magneto. Lubrieation is effected by means of the drip method, a pump pumping oil into a pipe over the cylinders, from which it runs through nipples to each main bearing and connecting rod. The pipe is provided with an overflow into the crankcase. This method of lubrication is at once sure, fool-proof and extremely economical in practice. Reversing is effected by means of an epicyclic reversing gear.

There is also an electric lighting set, consisting of a Thornycroft M. I. kerosene (paraffin) engine, having cylinders 4½ inches by 6 inches, connected to a Crompton four-pole direct-current dynamo, giving an output of 60 volts and 41 amperes at 800 revolutions per minute. This dynamo, which can also be driven by a belt off the main engine, is used to light the ship (ten electric lamps being provided), run three electric fans and

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work the searchlight. The latter is of the Crompton type, with automatic and hand control, and has a projector 16 inches in diameter. Four of the boats were built in steel, and three others of the same power and of similar general arrangement, but of a still shallower draft (viz., 22 inches), are also of steel. The hulls were built complete at Messrs. Thornycroft's Woolston Works, Southampton, and as they were put into the water they received their motors, which were made at the Thornycroft Company's Motor Works, Basingstoke.

COMMERICAL MOTOR BOAT FOR CHINA.

The motor boat *Rosette* illustrated herewith is of the shallow-draft, tunnel-stern type, her principal dimensions being 45 feet long, 10 feet beam and 3 feet 6 inches depth. She has been designed by Messrs. R. Wilson & Sons, of South Shields, and built by Messrs. Banker & Company, of Hongkong and Wuchow, to the order of the British-American Tobacco Company in Hongkong.

The boat will be run by a Chinese crew entirely, and in addition there will be two Europeans in charge of and to negotiate the sale of the cargo at the various river side villages, as the boat was designed and built exclusively for the sale of cigarettes at the various wayside villages on the Chinese West River and tributaries, her first run being one of 250 miles, and then 120 to 200 miles to the nearest supply base.

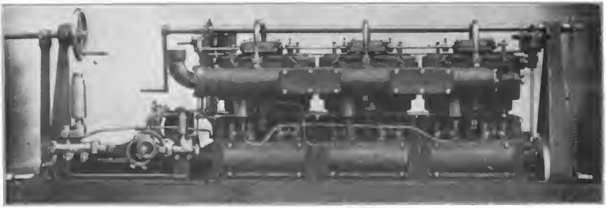
The hull is divided by watertight bulkheads into four compartments, the hold and engine room being amidships, and a large lazerette aft, fuel tanks and chain lockers being forward. The galleys and lavatories are arranged on the main deck aft, and the saloon and sleeping accommodation for the two Europeans on the upper deck. The steering wheel and telegraph are placed well forward on the upper deck and covered by an awning. To obtain all possible deck space a gangway is placed full length of the vessel each side.

operate, but the engine is of the above firm's M. E. type, and runs entirely upon ordinary petroleum.

The engine cylinders are cast in pairs, and the bed-plate is one solid casting, upon which is mounted the whole engine and reversing gear (also the firm's own make), and the cylinders follow the firm's usual practice, being supported on steel columns, which method allows all stress to be taken up by the solid bed-plate. The engine details consist of Bosch high-tension magneto ignition with battery and coil as a standby, with bronze plunger pumps for fuel, circulating, forced lubri-

CHINESE RIVER BOAT ROSETTE.

cation and bilge. The fuel pump delivers to a small reservoir, which feeds the three float chambers, each pair of cylinders having its own vaporizing system. There are no induction pipes, as the fuel on being vaporized passes straight into the cylinders. This system is also noteworthy by virtue of the entire smokelessness of the exhaust. Accessibility is a prominent feature, the connecting rods and pistons being removable through the crankcase doors, while a few minutes are sufficient to remove the cam shaft and valve tappets. The valves, of course, are all on the starboard, so that the port side is free from gear. This is the standard practice on all Djinn engines.



SIX-CYLINDER, 45-HORSEPOWER DJINN PETROLEUM MOTOR INSTALLED ON THE ROSETTE.

The machinery consists of a six-cylinder Djinn petroleum engine, built by Messrs. Brazil, Straker & Company, Ltd., of Bristol, developing 45 brake-horsepower at 800 revolutions per minute, giving a speed of 10 knots to the vessel when going "all out." This engine was built to the order of, and under the special survey of, Messrs. R. Wilson & Sons, and installed in Hongkong by Mr. R. Wilson, Jr., who ran the vessel from Hongkong to Canton (80 miles), making a non-stop run without any engine or navigation troubles. Generally, no gasoline (petrol) is obtainable in the district in which this vessel will

A water-cooled exhaust branch connects the exhaust outlet, and into this the cooling water is discharged, passing thence to the silencer.

The Hamburg-American Liner *Victoria Luise,* which was formerly the *Deutschland,* recently made her first trip to New York. Since remodeling the vessel's speed has been reduced to 17 knots, anti-rolling tanks installed, her passenger accommodations enlarged, and in future she will be used as a cruising steamship for extended cruises.

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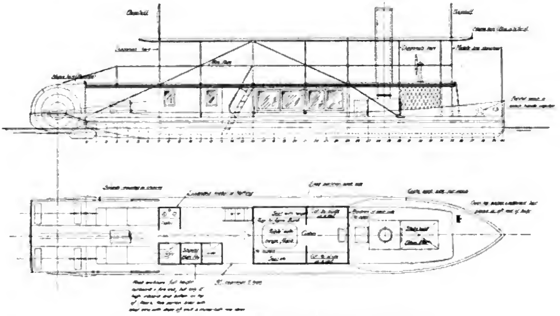
Stern-Wheel Steamer Grenfell for the Congo Mission Service of the Baptist Missionary Society.

This vessel is somewhat similar to the *Endeavor*, built for the Baptist Missionary Society for their Congo Mission service in 1905, and as illustrated in the November, 1910, issue of INTERNATIONAL MARINE ENGINEERING. It is, however, a smaller vessel, since it is to be used for pioneer work in the upper reaches and tributaries of the river, where the *Endeavor* cannot be navigated. The general arrangement is shown in the drawing. The length over all is 68 feet, between perpendiculars 60 feet, the molded beam is 11 feet, the molded depth 3 feet and the draft 1 foot 6 inches. The hull is of steel throughout, and all this, together with the sundry iron work, is galvanized. Special attention ought to be directed to the novel design of this hull. In order to secure strength and lightness the usual gunwale angle is dispensed with, and the sheer strake is curved and brought inboard to form the deck stringer. The maximum radius of the curved part is about 6 inches, and the coamings are placed where the curve runs out into the flat portion of the deck stringer, and this is shown in the plan view above. The trussing is of special design, having vertical tubular pillars which combine strength and lightness. The upper and shade decks are of teak, the former laid on two thicknesses breaking joint, and the latter covered with waterproof canvas. The cabin and conveniences are of teak, and arranged as suitably as possible for ventilation, as the climate is a hot and very trying one. The contract was placed by the society with W. Sisson & Company, Ltd., of Gloucester, who constructed the machinery, designed the hull and supplied the working drawings thereof to the builders, Messrs. Salter Bros., of Oxford. The vessel throughout was inspected during construction by the Rev. F. Longland, who came to England for this purpose and has since returned to the Congo, where he will supervise the reconstruction of the vessel and put it into active service.

The machinery is arranged on the middle line of the vessel, and consists of a set of the makers' specially designed compound non-condensing engines, having partially superposed cylinders 6½ inches and 10½ inches diameter by 30 inches stroke, and driving two separate paddle wheels, the crankshafts being coupled by a drag link. This design has substantial advantages over the usual type, being light, compact and less liable to interference or damage; the passage of steam from one cylinder to another is very direct and the drainage of the cylinders excellent. The arrangement of separate wheels and crankshafts secures flexibility, and therefore much less risk of injury if the hull is subjected to any special strain or distortion takes place. As will be noticed from the illustration the framing is comparatively light, and yet quite efficient owing to the special design, as it is triangulated in two planes and the materials employed are cast steel and malleable steel only. The connecting rod bodies are tubular for lightness; the steam distribution valves are both of the piston type, and the valve gear of the makers' specially designed single fixed eccentric or elliptic type. This gear has been exclusively adopted by them owing to the very satisfactory results obtained with it in actual work extending over a number of years. It gives an excellent steam distribution, the loads on the parts are light and the surfaces ample, so that the wear is exceedingly small, while there are no sliding working parts, but pin joints either bronze bushed or made with adjustable brasses, so that the adjustment is very simple. Owing to the light loads on the parts the handling of the engine is rendered very easy indeed.



STERN-WHEEL STEAMER GRENFELL, BUILT FOR CONGO MISSION SERVICE.

The paddle-wheels are of the makers improved light framed, feathering float type, with their patent system of grease lubrication applied to the working joints of the feathering gear.

The boiler is of the makers' special watertube type for 175 pounds working pressure, constructed throughout of best mild steel, the tubes being of seamless steel, all straight and of the same length. The steam drum is made specially large, so as to give ample steam space required for the long-stroke slow-running engine. The two water drums are formed of welded steel tubes pressed into a lune-shaped section, so that there are no longitudinal riveted joints. The steam drum is of sufficient diameter to admit of the tubes being inserted and both ends expanded from it. This design of watertube boiler has ample steam space, water capacity and free surface, so as to avoid priming, there being also no necessity for any automatic

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feeding arrangement, while the grate area and furnace capacity are ample, thus enabling inferior fuel to be utilized. In the present case the furnace fittings are arranged for burning wood, this being the only fuel available.

Seamless Steel Shallow Draft Motor Launches.

A motor launch for commercial and general purposes in the Straits Settlements is manufactured by the Seamless Steel Boat Company, Ltd., Wakefield. The launch illustrated is 24

SHALLOW-DRAFT SEAMLESS STEEL LAUNCH.

feet long, 5 feet 6 inches beam and 2 feet 6 inches depth. The boat has a tunnel stern and is fitted with a two-cylinder 10-horsepower kerosene (paraffin) motor, which gives the boat a speed of 8½ miles an hour when loaded to a draft of 1 foot 2 inches.

STERN-WHEEL STEAMER FRANCESCO SALLES.

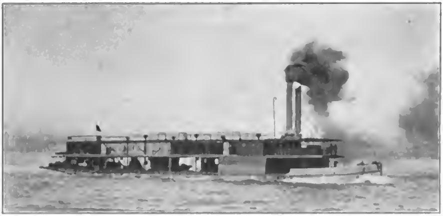
One of the large stern-wheel steamboats built last year in England was the *Francesco Salles,* built by Messrs. Cammell Laird & Company, Ltd., at their Birkenhead Works for the Madeira Mamore Railway Company of Paris, under the inspection of J. Ward, Esq., naval architect and consulting engineer for the railway company. The principal dimensions of the boat were as follows:

Length of hull..................	180 feet
Breadth, molded.................	33 feet
Depth to main deck..............	5 feet 6 inches

The hull is built of mild steel of the highest quality and subjected to Lloyd's tests, and is divided transversely by ten watertight bulkheads and longitudinally by one bulkhead extending from stem to stern, and in the way of the boilers by two extra longitudinal watertight bulkheads, thus forming in all eighteen watertight compartments, the bulkheads being specially arranged to stiffen the vessel against damage by striking floating logs, etc., and to minimize the danger of sinking. Nine of these compartments are suitable for carrying general cargo—four for coal or wood fuel, while the remainder act as store rooms and buoyancy chambers.

Sleeping accommodation has been provided in the promenade deck for fourteen first class passengers, arranged in two-berth cabins, and for the captain, pilots, mate and steward, while the engineers, boatswain, cook, seamen and firemen, etc., have spacious accommodation on the main deck. The principal deck-houses are of teak fitted with jalousie windows and doors, the tops being fitted with expanded metal, thus affording ample ventilation.

The dining accommodation consists of one long table with seats for about thirty-two persons, and one smaller table with seats for twelve persons, both arranged in convenient positions to the pantry and galley. The plumbing arrangements are



LARGE STERN-WHEEL STEAMER FRANCESCO SALLES.

very complete, having a system of steam bilge ejectors, each of about 20 tons capacity per hour, connected to the principal compartments, having a line of steel piping with gunmetal valves communicating between ejectors and boilers.

The vessel is provided with a powerful combined steam and hand-capstan windlass, one large steam winch of Messrs. Clarke Chapman's make, combined steam and hand steering gear fitted forward of Messrs. Donkins' make, a complete installation of electric light on the double-wire system, and an outfit of anchors and chains, bollards, fairleads, mooring pipes, seamless steel boats, life belts and life buoys, oil lamps, compasses, bells, spanners, and everything necessary to complete the hull in a first-class manner.

The machinery consists of a set of compound surface-

Shipbuilding Returns.

The Bureau of Navigation reports 92 sail and steam vessels of 23,282 gross tons were built in the United States and officially numbered during the month of September, of which nearly 80 percent was built on the Great Lakes. During the quarter ended Sept. 30, 350 sail and steam vessels of 56,217 gross tons were built, which is only about 60 percent of the tonnage built during the corresponding quarter last year.

Lloyd's Register of Shipping reports that, excluding warships, there were 493 vessels of 1,446,317 gross tons under construction in the United Kingdom at the close of the quarter ended Sept. 30, which exceeds by 292,000 tons the tonnage under construction during the corresponding quarter in 1910.

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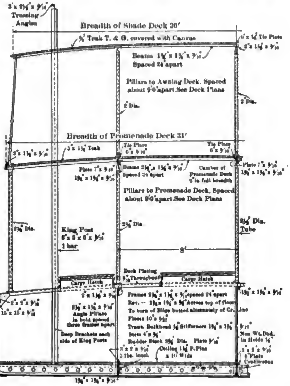
condensing engines, steam being supplied by two boilers, constructed for a working pressure of 150 pounds per square inch. The cylinders are 18 inches and 38 inches diameter by 5 feet stroke, made of hard close grained cast iron and fitted with flat type side valves; the pistons are of cast iron, having large bearing surface on lower edges and fitted with spring packing rings. The slide valve gear is of the locomotive type, with slot links bushed with phosphor bronze, the weigh shafts and levers being of forged steel. The condenser is of cast iron, having ample cooling surfaces and fitted with brass tubes and tube plates; the oil circulating and feed pumps are all of the independent type. The boilers are of the locomotive type, fitted with large furnaces, suitable for burning either coal or wood fuel, the heating surface being about 1,800 square feet; all the necessary manholes and mudholes are fitted for access, also

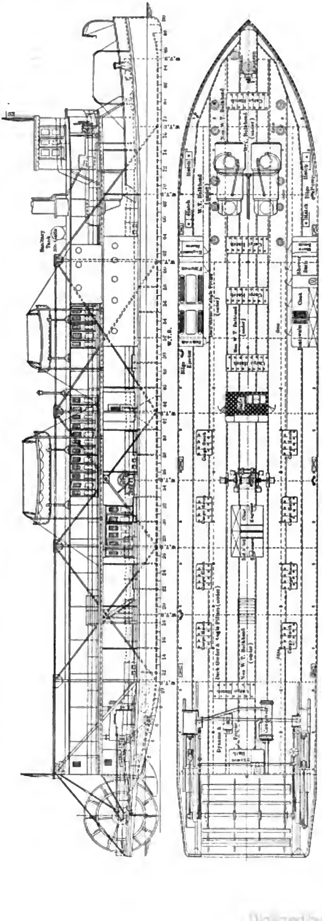


MIDSHIP SECTION.

smokebox and steam mountings, etc. The paddle-wheels are about 17 feet in diameter, fitted with twelve elm floats, which are capable of being reefed; the arms are securely bolted to cast steel centers, keyed to the paddle shaft. It was originally intended that the vessel should be erected, dismantled and packed for shipment, but unfortunately, owing to a strike of workmen, was delayed, with the result she was too late for the season on the route she was built for, and had to be placed on another of the railway company's numerous routes, thus necessitating the vessel being completed and tried under weigh in England.

On the official speed trial, which took place in the River Mersey, she developed a speed of nearly 12 knots, which was considered highly satisfactory by the owners' representatives.

After completion of trials the vessel was placed in dock and the paddle-wheels taken adrift, funnels removed and stowed, together with all movable gear, vessel ballasted and afterwards boarded up and otherwise prepared for the towage to Brazil, where the boarding was removed and the machinery, etc., fitted up ready for service.



OUTBOARD PROFILE AND DECK PLAN OF THE FRANCESCO SALLES, AN ENGLISH-BUILT VESSEL FOR BRAZILIAN RIVER SERVICE.

STERN-WHEEL MOTOR BOATS.*

BY LEWIS C. ALLEN.

Along the Ohio and Mississippi rivers alone there are thousands of stern-wheel boats—work boats used for herring fishing, clam shell gathering, towing and carrying passengers. These industrial boats are driven by internal combustion engines, and are much larger than pleasure boats. They are real competitors of the large steamboats in many instances.

About twenty years ago the single-cylinder horizontal stationary gasoline (petrol) engine was adapted to the propelling of shallow-water, stern-wheel boats, using two long drive belts, a countershaft, chain and sprockets. Countless attempts have been made to improve on this combination, but so far with small success in the large sizes.

At first sight this style of drive would appear to be about the most undesirable way of propelling a boat by an internal combustion engine, taking up, as it does, so great a portion of the available room on a boat, and making a load for a boat in itself by reason of its great weight; but in shallow draft boats all ordinary forms of propelling are disqualified because of lack of water under the boat to operate the blades in. This lack of water and space is still further augmented by the tendency that all boats have to sink at the stern, or draw down, as it is called, while running.

A great many attempts have been made to supplant the single-cylinder horizontal engine and its belt drive with a multi-cylinder engine and gears; but the single-cylinder horizontal engine, with all its drawbacks, has proved very efficient for this work. This is due in part to its slow speed and heavy fly-wheels. Then, too, you get a slight slippage of the belts on the pulleys under a sudden strain, and this is an advantage, although it would not seem so until you stop to think that the shock of reverse and starting must be absorbed somewhere.

An engine running at 200 revolutions per minute can be harnessed to a stern wheel running 35 to 50 revolutions per minute with less loss of power than a multi-cylinder engine of the same horsepower running at a speed of from 350 to 800 revolutions per minute, using the same method of speed reduction, and an investigation will show belt and chain transmission is more efficient than gear transmission. Then, too, the long shaft running fore and aft necessary with a gear transmission binds with the roll of the boat, and much care must be used in lining up the shaft, because of the necessity of great accuracy in meshing the gears.

The heavy fly-wheels of a horizontal engine balance the wheel, and are a decided advantage in a tight place, when the load is thrown on the engine suddenly, because the stored energy in the fly-wheels acts against the momentary overload. The acceleration or starting curve of a single-cylinder engine is sharper than that of a multi-cylinder. This enables this type of engine to gain its speed with greater dispatch in starting, and also helps it to resist the tendency to reduce speed when under an overload. In towing, the strong impulse of a single-cylinder engine at each explosion carries the boat along much better than a number of weaker impulses. The river men call this "grit," and they claim the single-cylinder engine has more towing "grit" than a multi-cylinder engine of the same horsepower.

KEROSENE (PARAFFIN) ENGINED RIVER BOAT USED AS A FERRY.

The cost of repairs on a single-cylinder engine is low, because every part is large and strong, and the belts absorbing the sudden shocks, as they do, make the replacements on this form of transmission few and far between. Friction clutches are used on the larger sizes of single-cylinder engine equipments to accomplish the reverse, and the wooden friction blocks also help to absorb the sudden stresses and protect the engine. It is true that the multi-cylinder engine occupies less space and is lighter in weight, but the disadvantages are so many that the actual proportion is much in favor of the single-cylinder engine. Then, too, the single-cylinder engine is the simplest and least complicated engine of the two to operate, which is a factor on the rivers, where mechanics are few.

A common form of complaint against the single-cylinder engine—the vibration—can be overcome by the use of a throttling governor engine in harness with a staggered wheel. The throttling governor engine most commonly used is a combined fuel type of engine, and burns either kerosene

* From *The Gas Engine.*

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(paraffin) or gasoline (petrol) or both, changing from one to the other without stopping the engine.

The most successful combination of belt and chain harness for horizontal, single-cylinder engines consists of a very wide-faced steel split driving pulley, fastened to the main shaft, which projects about half the distance through the pulley. A rubber disk is inserted so that it fits over the end of the main shaft; a second piece of shafting, long enough to reach an outboard bearing on the gunwale of the boat, is butted up against the rubber disk. This arrangement will not cause trouble when the boat rolls, as would a solid main shaft and outboard bearing; and it is not hard to keep the bearings in line. The cylinder end of the engine is placed toward the bow of the boat, and the the two drive belts (both on one side of the engine, as they are) enable the operator to get to all parts of the boat without going through the belts. The two belts can be carried close to the wall or bulkhead of the engine room, and the amount of space available on the boat for other purposes is greatly increased. The cross-belt is used for the "go-ahead" drive, because it has more grip on its pulleys as well as to eliminate the necessity of running the drive along the working side of the engine.

The stern bulkhead countershaft carrying two friction clutch pulleys should be at least 20 feet on centers from the engine shaft. The sprockets and chain, being located on the side of the boat opposite the belt drive, are almost an exact balance for the belts and pulleys, and by setting the engine a little off the center of the boat along the keel line a perfect balance can be obtained without using ballast. Pitmans can be used instead of a chain drive, but they are hard to keep in line and do not balance up as well. Being rigid on double centers they break much easier than a chain and give much more trouble when two pitmans are used. Rubber blocks and springs back of the boxes have been tried in an effort to eliminate this feature, but without the success anticipated. Several ratios of reduction are used. Generally the sprockets and chain do the major portion of the reducing, the proportions used being 4 to 1 in a great number of cases.

MOTOR PACKET BOAT USED ON AMERICAN RIVERS.

Loose pulleys, in combination with a tight one, are used in place of friction clutches in some cases, especially on the smaller sizes of boats. They have the advantage of being lighter and cost much less, but are not successful on wide belts, as the belts are too hard to shift. Reverse gears, such as are used in oil-field and marine work, have been tried, both on the main shaft and on the countershaft, also in connection with a large spur gear fastened to the bed of the engine; but, as a rule, they are not successful.

A large part of the trouble on a stern-wheel boat comes from the stern-wheel flanges cutting their keys and breaking their fastenings. This can only be remedied by substituting a hexagon shaft for a round shaft, as is done in steamboat practice. The strain on the wheel is further increased if the wheel is set too close to the stern bulkhead, as the water piles up on the wheel in making a quick reverse and adds greatly to the strain and also retards the speed of the boat in going ahead. The wheel should dip in the crest of the first wave back of the bulkhead. This wave is caused by the forward motion of the boat and consists of solid water coming

TYPICAL METHOD OF HANDLING FREIGHT BY A MOTOR PACKET BOAT.

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from under the boat, and gives a much better purchase for the wheel than if it were set closer.

The advocates of a bevel gear driven wheel mention the split or double wheel with staggered paddles as an advantage; and anyone using it (and it can be used just as well with a chain drive) will find it reduces the vibration of the boat materially—and it is a wonder that more of the wheels are not built double.

The amount of dip to give the paddles is a question that causes serious thought. One manufacturer shows in his catalogue an adjustable stern-wheel bearing that raises and lowers the wheel, and means for tightening the chain can be provided with this bearing. There is another way of regulating the dip that has lately come into use. Tanks or bulkheads are built in the bow of the boat, and a small centrifugal pump with a two-way connection enabling water to be pumped in or out is installed and can be driven by belt from the engine. Water as ballast can then be used to trim the boat. Experiments then will give the proper dip for greatest efficiency. Some use side tanks also, as a boat that is heeled over will not run as well as a boat in full trim.

One of the most common mistakes made by builders is to hog-chain the boat as they would a small steamboat. Just remember that the weight of machinery comes in a very different part of the boat in this case.[1] Put your hog-chain braces in with some idea of taking care of the weight of the engine, and not with the idea of making the boat look like a steamboat. If you run timbers across the boat under the engine to form a saddle and swing this saddle on auxiliary braces running to the main chain braces it will strengthen the boat and eliminate some of the vibration.

SIROCCO FANS FOR FORCED DRAFT ON THE CHESTER.

LARGE RIVER STEAMER (CHESTER) REMODELED FROM A STERN-WHEELER TO A TRIPLE-SCREW TUNNEL BOAT.

RENEWAL OF NAVIGATION ON THE MISSOURI RIVER.

Attempts have been made during the last year to re-establish navigation of the Missouri River by the organization of the Kansas City Missouri River Navigation Company. This company has purchased two shallow-draft passenger and freight boats, both of which are of the tunnel type, arranged for screw propulsion. The first of these boats is the *Chester*, which has been remodeled from a stern-wheel boat to a tunnel boat, designed originally to use combination machinery, consisting of reciprocating and turbine engines, steam being supplied by watertube boilers using oil as fuel. This type of propulsion was expected to add much to the efficiency of this method of transportation. The boilers are fitted with a mechanical draft equipment, consisting of two full-housed, right-hand, top-vertical discharge, single-inlet Sirocco fans, with direct-connected 5-inch by 5-inch vertical inclosed self-oiling steam engines, supplied by the American Blower Company, Detroit, Mich.

The other boat of this company's fleet is the *A. M. Scott*, which was illustrated and described in our November, 1910, issue. She is a light-draft steel towboat, 150 feet long, 26 feet beam, with a depth of 5 feet, equipped with triple-expansion condensing engines of 700 horsepower, driving twin screws, which give the boat a speed of 15 miles per hour. She was built by the Chas. Ward Engineering Works, Charleston, W. Va.

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Tungku Miriam, a Shallow-Draft 63-foot Motor Vessel for the British Colonies.

BY J. BENDELL WILSON.

The *Tungku Miriam* is a shallow-draft vessel of an interesting type, recently designed, built and engined by Messrs. John I. Thornycroft & Company, Ltd., to the order of the Crown Agents of the Colonies, under the supervision of Messrs. Flannery, Baggallay & Johnson, who are the consulting engineers to the Crown Agents. She has not long since taken up her station on the Pahang and Perak Rivers in the Federated Malay States, where she is used for carrying officers and supplies. Her prototype, by the same builders, was the *Spider*, a rather smaller boat on the same lines, that has been running for about four years on the Cross River in Southern Nigeria, during which period she has successfully run in the neighborhood of 50,000 miles without a breakdown, in charge of two native engineers under the supervision of a white officer.

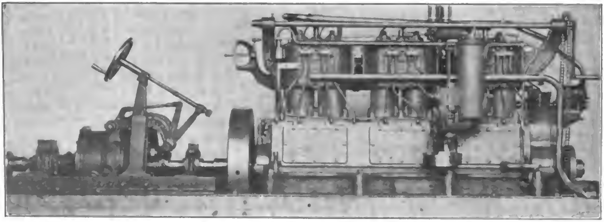
Tungku Miriam is built of steel and the hull is entirely open, with the exception of a short flush-deck forward. She is 63 feet 2 inches long over all, with a molded breadth of 9 feet and a depth of 2 feet 10 inches. Her draft with a load of 4 tons is but 14 inches, the hull being quite flat-bottomed excepting right forward. The hull is divided by six watertight bulkheads, and the boat will float with any two compartments flooded.

It is interesting to note that three semi-balanced rudders have been fitted, which give her excellent maneuvering qualities, rendered necessary by the winding nature of the rivers on which she is working. The steering control is carried to the roof of the permanent asbestos-covered wooden awning right forward, which is mounted on steel tubing, and in its turn sheltered from the sun's rays by a smaller awning. This arrangement gives the helmsman an excellent outlook over distant low-lying banks. The main awning is also used as a promenade deck, wire guards being fitted.

TUNGKU MIRIAM, A POWER CANOE FITTED WITH A 90 HORSEPOWER THORNYCROFT MOTOR.

Her machinery, which is arranged just abaft of amidship, consists of a six-cylinder Thornycroft gasoline-kerosene (petrol-paraffin) engine of the four-cycle type, driving two propellers on one shaft in a tunnel, through a clutch and reverse gear. The cylinders are each 6-inch bore by 8-inch stroke, and 70 horsepower is developed at 560 revolutions per minute on kerosene (paraffin) fuel, gasoline (petrol) being only used for starting if required. Under normal conditions the engine is run at 450 revolutions per minute.

The engine follows the latest Thornycroft marine practice, with the exhaust and inlet valves arranged on the port side. The reverse gear is controlled by a wheel, a couple of turns being sufficient to send the vessel from full speed ahead to direct astern. On the port side, between the reverse gear and the engine, the control levers are arranged on a perpendicular cast iron standard, directly overhead of which is a speaking tube carried from the steering wheel. On either side of the machinery is a large oval-shaped brass fuel tank, with gages and safety devices, yet leaving ample room for the engineers to work. The exhaust gases are carried to a water-cooled silencer on the awning, just abaft amidship.



STARBOARD SIDE OF THE TUNGKU MIRIAM'S THORNYCROFT MOTOR, SHOWING REVERSE GEAR.

On her trials *Tungku Miriam* attained a speed of very nearly 12 knots over the measured mile, and when towing a 25-ton barge she made 6.35 miles an hour.

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LIGHT DRAFT TUG MARIA HENDRIKA III.

BY D. KOOIJMAN.

Steam tugs designed for light draft river work and harbor construction, with, at the same time, sufficient sea-going qualities to enable them to do some towing at sea, have been constructed by J. Constant, Kievits & Co., Ltd., Dordrecht, Holland. One of these tugs is shown in Fig. 1. The vessel has been built in excess of Lloyd's rules and has been classed 100 A 1 for towing purposes. Her principal dimensions are:

Length, over all	100 feet
Length, between perpendiculars	91 feet 10 inches
Depth, molded	18 feet 8 inches
Breadth, molded	18 feet 8 inches

The draft is 7 feet aft, and on a mean draft of 5 feet 10 inches she carries 10 tons of coal. The total bunker capacity is 50 tons. In fore-and-aft peak tanks 15 tons of fresh water can be carried for boiler-feeding purposes; these tanks are connected with the donkey pump, and the feed pump can take the fresh water from the after peak tank. At the sides of the boiler side bunkers are situated, having large square hatches on deck, and these side bunkers are connected together by a cross bunker, which has a tunnel for communication between the engine room and stokehold. On the top of the cross bunker, the towing post and steam winch for hawsers are placed; the post is equipped with three double spring loaded tow hooks, and the winch is so arranged that the steel wire ropes can be lodged on the long barrels when the ropes are taken in, and has also two cast iron drums to maneuver the manila hawsers.

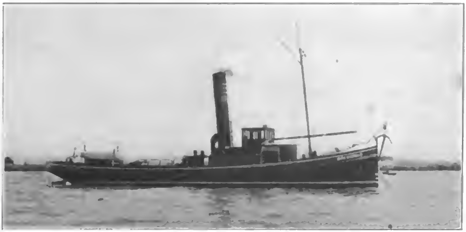

FIG. 1.—RIVER TUG MARIA HENDRIKA III.

The arrangement necessary to lodge a crew of ten has been a point of special consideration. The officers are berthed forward of the boiler space under the deck, a wide staircase leading from the steel deckhouse forward of the boiler casing. The saloon is fitted in mahogany, with seats at the sides and two small cupboards, and a teak skylight over the saloon. There are separate cabins for the master and engineer, and a double-berthed cabin for the mate and second engineer. On the port side in the steel deckhouse is the galley. The crew is berthed aft in one compartment.

HULL CONSTRUCTION.

The bar keel is 5 inches by 1¼ inches, the stem of hammered steel 3½ inches by 2 inches. The stern frame is in one piece of hammered steel, 5¼ inches by 2¼ inches, the frames are 2½ inches by 2 inches by 5/16 inch, and are double in the engine and boiler space. They extend in one piece from the keel to the deck stringer plate. The reverse frames are 2 inches by 2 inches by 5/20 inch across the top of floors only. Floor plates 10 inches by 5/20 inch are fitted to every frame. The boiler and engine bearers are 5/16 inch, the latter in one plate. The watertight bulkheads are 5/20 inch, their stiffeners are 2 inches by 2 inches by 5/20 inch. There is a keelson 5/20 inch, made intercostal with two angles 2½ inches by 2½ inches by 5/20 inch on the topside. Under the boilers there are on each side 12 inches intercostal plates, thickness 5/20 inch, secured with two angles, 2½ inches by 2½ inches by 5/20 inch, to the hull plating, and with two such angles riveted to the top. Under the engine the floor plates extend to the underside of the engine seat. These floor plates are riveted to the top plate, which is ½ inch, with two angles, 3 inches by 3 inches by ⅜ inch.

The engine is bolted to the top plates by 25 bolts ¾ inch diameter, and of which twenty pass through the angles. Intercostals of ⅜ inch steel plates are worked under the engines in way of the holding down bolts, secured to the shell and top plate by double angles 3 inches by 3 inches by ⅜ inch. There is one side stringer, extending all fore and aft of double 2½ inches by 2½ inches by 5/20 inch angles, riveted back to back and to the double lugs; they are bracketed to the bulkheads and are connected at the ends of the vessel with 5/20 inch plates forming breast hooks.

The main deck beams are 3 inches by 2 inches by 6/20 inch. In the engine and boiler rooms they are 3½ inches by 2 inches by 6/20 inch fitted on every frame and connected to the frames by steel bracket plates 12 inches by 12 inches by 5/20 inch. The shell plating on the sides and bilges is of 5/20-inch plate, the sheerstrake 3/20-inch. The bulkhead strake is 5/20 inch. The deck forward of the boiler room is of pitch pine 3 inches by 4 inches, after the boiler bulkhead it is of steel check plating 5/20 inch. The side plates of the boiler casing are 3/16 inch, with stiffeners 2½ inches by 2 inches by 5/20 inch, the top plate 3/16 inch check plate.

PROPELLING MACHINERY.

The main engine and boiler have been built by Maschinefabriek "Bolnes," v/h. J. H. van Cappellen in Bolnes, near Rotterdam. The main engine shown in Fig. 4 is of the direct-acting, inverted cylinder, triple-expansion type, having cylinders 12 inches, 17¼ inches and 29 inches in diameter, with a common stroke of 15 inches. All valves are worked by the Stephenson's overhung link gear, the reversing of the engine being operated by a handwheel. The engine cylinders

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are cast separately. The high and intermediate-pressure cylinders are fitted with a piston valve, provided with solid cast iron packing rings. The upper ends of the piston valves are 1/8 inch larger in diameter than the lower part, so as to take out the valves easily from the topside. Liners of hard, close-grained cast iron are fitted in the intermediate-pressure and high-pressure steam chests, held down by the covers on the top and bottom side. The low-pressure cylinder is fitted

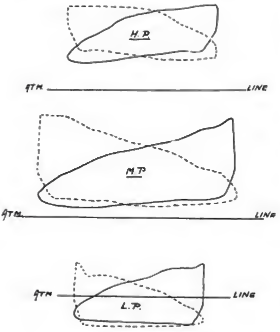

FIG. 2.—INDICATOR DIAGRAMS.

with a double-ported slide valve. The steam passages and pipes are designed for moderate steam velocities, when the engine is turning at about 200 revolutions. The minimum thickness of the cylinder walls of all cylinders is 1 1/8 inches. The cylinders are fitted together, and to their supports, by 3/4-inch bolts, driven into reamed holes. The clearances at

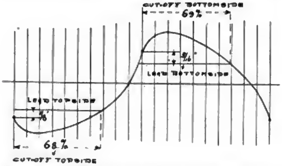

FIG. 3.—DIAGRAM SHOWING STEAM DISTRIBUTION IN HIGH-PRESSURE CYLINDER.

top and bottom are, in the high-pressure cylinder, 3/16 inch and 1/4 inch; in the medium-pressure cylinder 1/4 inch and 5/16 inch, in the low-pressure cylinder 3/8 inch and 1/2 inch. Relief valves, with a minimum diameter of 2 inches, with brass valves and seats and adjustable protected steel springs, are fitted to each end of each cylinder; 1/2 inch-drain cocks are fitted to the cylinders and receivers, thus from the high-pressure receiver a pipe leads to the casting on the ship's side for the circulation suction valve, to serve for heating the circulation water in freezing weather; the other pipes are led to the condenser. A two-way cock, 1 inch bore, may pass steam to the intermediate-pressure and low-pressure receivers for starting purposes. The steam for this cock is taken from the main steam pipe after the engine stop valve.

The engine framing consists of three front columns of forged steel 3 inches in diameter; the back columns are cast on the condenser and fitted with close-grained cast iron guide plates securely bolted on. Between the guide plates and the condenser columns water may circulate for cooling purposes. The pistons are of sound cast iron, 4 inches deep, fitted with Ramsbottom cast iron springs. The junkrings, very stiff, are held down with 3/4-inch steel bolts. The piston rods are of Siemens-Martin steel, 2 3/4 inches in diameter; the crossheads are of forged steel, with pins 3 1/4 inches diameter by 3 1/4 inches long, forged solid with the crossheads. The piston rod is fitted to the crosshead with a taper of 1 in 4, with a shoulder of 1/16 inch, being the same at the attachment to the piston. The piston rod screws are 2 inches. To the

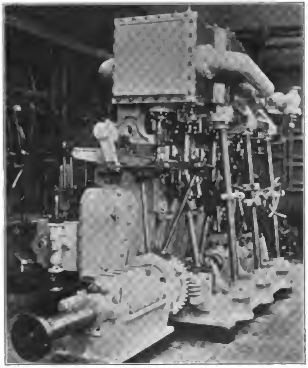

FIG. 4.—MAIN ENGINE.

crossheads are secured cast steel slippers, the slippers directly running on the cast iron slides. The crosshead pins are all hardened and truly ground. The connecting rods are of mild steel, forged from a solid bloom without welds. The top end is forked to take the crosshead brasses. The length from the center of crank pin brasses to center of crosshead brasses is 2 feet 11 inches; the diameter at the crank end is 3 inches, tapering to 2 3/4 inches at the crosshead end. The crank pin brasses are of brass lined with white metal. The brasses were carefully tinned before the white metal was poured in. The crosshead brasses are of gun metal, not lined. The diameter of the crank pin is 5 1/2 inches, the length of same 6 inches.

The crankshaft is 5 1/2 inches in diameter, of forged steel, in one piece. The cranks are set at 120 degrees, with the high-pressure crank leading. The breadth of the arms is 6 1/2 inches, the thickness 3 1/2 inches, the flanges of the shaft are 10 1/2 inches by 1 1/2 inches thick. The thrust shaft is 5 1/2

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inches in diameter under the collars, at the ends the shaft is 5¼ diameter. The thrust bearing is of the horseshoe type. There are five cast iron shoes, lined on both sides with white metal ⅛ inch thick. On the shaft are six collars, diameter 10¼ inches. The bearing surface is 220 square inches, giving at 10 knots from the mean normal thrust a pressure per square inch of 45 pounds. The bottom of the block forms an oil bath; this oil is cooled by water from the circulating pump. The bearing surfaces are all well grooved for lubrication. On each side of the thrust block is a bearing lined with white metal to support the weight of the shaft. The intermediate shaft is of the same quality as the crankshaft; the diameter is 5¼ inches. There is one intermediate shaft bearing, 8 inches long, of cast iron, lined with white metal in the lower half. The tail shaft is also of steel, 6 inches smallest diameter. The stern tube is made of cast iron, with a flange at inner end, by which it is attached to the bulkhead. The cast iron bush at the outer end is lined with white metal, and the cast iron packing gland is also lined with white metal.

The engine bed plate is of the box style of cast iron, bolted to the engine seat. The flat-bottomed bearings are of cast iron lined with white metal; the bolt holes are bored half in the brasses and half in the bed plate, so as to prevent the brasses from shifting. At the after end of the engine a turning gear is placed; a worm wheel is keyed on the flanges of the crankshaft and thrust shaft, the cast iron worm is keyed to a steel pin which may be turned by a wrought iron ratchet. The worm is arranged to be put in and out of working position easily. The high-pressure and intermediate-pressure steam valves have solid rings, which are arranged to have a little play on the valves; the valve spindles are 1¼ inches in the valve and 2 inches in the stuffing-boxes. The spindles are screwed with checknuts into the part sliding in the guide. The guide has phosphor bronze adjustable bearings. The low-pressure valve is double ported, and has a web at the back to keep the valve up to face.

The valve gear is of the Stephenson overhung type; this type was chosen because the steam distribution is in this case better than when the center of the valve spindle coincides with the center of the eccentric rod. In the latter case the steam admission on the top side of the piston is always later than on the bottom side. When the links are overhung the cut-off at top side and bottom side are very nearly equal, or at bottom side a little later, which arrangement is better. In Fig. 3 a diagram is shown, from which may be seen that the steam admission on both sides of the pistons are nearly equal.

The engine is reversed by means of a hand-wheel which turns a threaded rod. By five turns of the hand-wheel the levers are changed from full ahead to full astern. Due to the balanced high-pressure and intermediate-pressure steam valves the engine is very easily reversed. All bearings of the valve gear are adjustable, the high-pressure drag rod lever is provided with means for easily altering the steam admission in the high-pressure cylinder without stopping the engine and without altering the cut-off in the intermediate-pressure and low-pressure cylinders.

The condenser is of cast iron, and is connected to the bedplate with a horizontal joint. The back columns are cast on the condenser. The tubes, of solid drawn brass, are ¾ inch in diameter by No. 18 W. G.; they are packed in the tube plates by cotton packing and screwed glands. The tube plates are of rolled brass and ⅞ inch thick, the center plate is ½ inch thick. There are 336 tubes, which are 7 feet 9½ inches long between tube plates, giving a cooling surface of 515 square feet. A feed heater is bolted to the top of the condenser, the feed-water is therein heated by the exhaust steam; it is further heated in a second feed heater by steam from the intermediate-pressure receiver, which is led into a coil. A baffle plate is fitted opposite the exhaust steam inlet, a distribution plate is fitted between the two tube nests over three-fourths of the length of the condenser, so that the exhaust steam must flow from the aft end to the fore end of the condenser and then to the air pump inlet. The cooling water circulates two times through the condenser. The suction and delivery pipes for the cooling water are 3 inches in diameter. There are two small doors 5 inches diameter in the condenser to sight the tubes.

The single-acting air pump is of the Edward type, 10 inches in diameter, the stroke being 7½ inches; the pump chamber, the piston, the gland, neck bush, head valve seats and guards are of bronze, the rod of gunmetal. There is a weir to keep 2 inches of water over the head valves. The bottom of the pump is 6 inches below the bottom of the condenser. The waste pipe is 3½ inches in diameter; to the bottom of the hot well a 1¾-inch pipe with valve is fitted. The circulating pump is double-acting, 6½ inches in diameter by 7½ inches stroke, with bronze chamber, piston, gland, neck bush, suction and delivery valve seats and guards. The rod of gunmetal, the valves of rubber. The feed pump is single-acting, 2¼ inches diameter by 7½ inches stroke; the ram, of bronze, is rounded at the bottom; the air vessel has a capacity of four times the capacity of the pump. The bilge pump is of the same size as the feed pump, but is not provided with an air vessel nor with a relief valve. The pumps are driven from the low-pressure crosshead by cast steel levers of the T form.

The right-handed propeller is of cast iron in one piece. The diameter is 5 feet 11 inches, the pitch 5 feet 4 inches, and the projected area 14 square feet.

The boiler is fitted in the ship 2 inches to the starboard side, to balance the condenser, pumps and feed tank. It is of the two-furnace single-end Scotch type, 10 feet 8 inches diameter and 9 feet 9¼ inches long. The furnaces are of the Morison type and withdrawable. The combustion chambers are separated. The tubes are lap-welded, of iron 3¼ inches external diameter by 6 feet 9 inches long between the tube plates; the plain tubes are No. 10 W. G. thick, the stay tubes ¼ inch. The plain tubes are swelled 1/16 inch at one end, the stay tubes also at one end and threaded with ten threads per inch at both ends. The stays in the steam space have the nuts and washers in one piece, riveted to the front ends. The shell is in one plate, the longitudinal seams are double-butt straps, and treble riveted, the seam lying in the steam space; the circular seams at the ends are double riveted. The front and back end plates are in one piece. The diameter of the funnel is 3 feet 7 inches, and it is made to be lowered. The heating surface of the boiler is 1,162.5 square feet, the grate surface 350 square feet. The boiler was tested to 290 pounds per square inch water pressure.

The trial trip took place on the River Maas, between Rotterdam and Hoek van Holland. The indicator diagrams, taken on the full-power trip, are shown in Fig. 2, the boiler pressure being 195 pounds, the engine turning with 226 revolutions and indicated 412 horsepower (129 in the high-pressure, 160 in the intermediate-pressure and 123 in the low-pressure cylinders). The steam pressure in the intermediate-pressure receiver was 65 pounds per square inch, in the low-pressure receiver 9 pounds per square inch, the vacuum was 25 inches. The draft of the boat was 4 feet 11 inches forward and 6 feet 8 inches aft. The temperature of the sea was 40 degrees, of the engine room 74 degrees, of the stokehold 76 degrees, on deck 42 degrees and of the circulation discharge 125 degrees. The boat attained a mean speed of 10.3 knots.

All records for unloading iron ore in a day of twenty-four hours on any Lake dock were broken recently at the docks of the Pittsburg & Conneaut Dock Company, when 61,661 tons of ore was unloaded from eight ships at the rate of 2,569 tons per hour.

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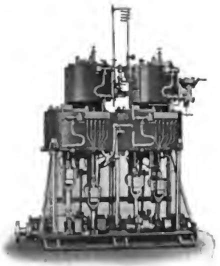
SINGLE-SCREW TUNNEL LAUNCH CONNAUGHT.

The light draft single-screw tunnel launch *Connaught*, specially designed for passenger service on the River Thames, is of the following dimensions: Length over all, 110 feet; between perpendiculars, 108 feet; beam, molded, 16 feet 6 inches; depth, molded, 5 feet; draft, 2 feet 3 inches; tunnel, 1 foot 9 inches high. The launch was built by Messrs. Salter Bros., but the lines were worked out by the builders of the machinery, W. Sisson & Company, Ltd., engineers and naval architects, Gloucester. The hull is constructed throughout of mild steel, the deck and cabins being of teak, and the vessel throughout extremely well fitted and arranged for carrying a large number of passengers with comfort.

SINGLE-SCREW TUNNEL LAUNCH CONNAUGHT.



SISSON COMPOUND ENGINE FOR TUNNEL LAUNCH.

The machinery is of the compound surface-condensing type, but not of the ordinary design, the engines being of four-crank type with partially superposed high-pressure cylinders, as in the case of the Sisson patent vertical high-speed, double-acting enclosed self-lubricating engine, but otherwise similar to their standard light framed marine engines. These engines have two high-pressure cylinders, each 6 inches diameter, and two low-pressure, each 12 inches diameter, the stroke of all four being 6 inches. The valve and reversing gear is of a type similar to that used in the above-mentioned engine, but, of course, adapted to this particular type of engine. The surface condenser is independent, and formed of a mild steel shell, galvanized after completion, and fitted with rolled yellow metal tube plates and seamless brass tubes secured by screwed glands and cotton packing. The air, circulating, feed and bilge pumps are also independent and worked by a single steam cylinder, which exhausts into the intermediate receiver of the main engines. The boiler is of the makers' special design of watertube boiler, the working pressure being 165 pounds per square inch. The vessel itself and the whole of the machinery were constructed throughout in accordance with the Board of Trade requirements so as to obtain the necessary certificate for passenger service.

Tow Boats for Florida Rivers.

The tug *Vixen*, owned by M. C. Hutto, Jacksonville, Fla., is a gasoline (petrol) boat 50 feet long over all, 11 feet beam, with a draft of 4 feet 6 inches. The engine is a 50-horsepower Buffalo heavy-duty engine, manufactured by the Buffalo Gasoline Motor Company, Buffalo, N. Y. This motor gives the boat a speed of 12 miles an hour. The illustration shows the boat at her daily work towing three lighters, 80 feet by 28 feet, loaded with 10,000 railroad ties and drawing from 5 to 6 feet of water.

RIVER TRANSPORTATION IN FLORIDA.

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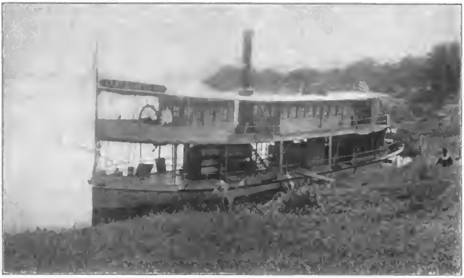
AMERICAN STERN-WHEEL RIVER BOATS.

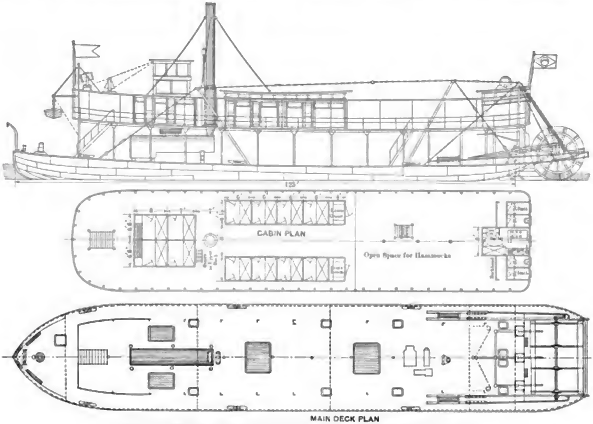
There is probably no place in the world where steam navigation on shallow rivers has reached such a magnitude as was the case about fifty years ago on the Western rivers of



AMERICAN-BUILT STERN WHEELER IN THE CONGO MISSION SERVICE.

the United States. The great demand and necessity for successful steamboats for this service resulted in the development of a type of steamboat which may be called purely American. By this we refer to the stern-wheel river steamer which has been used for freight, packet and passenger boats, and also for towing purposes where immense cargoes are carried in a single tow.

Although river transportation on Western rivers in the United States has now been overwhelmed in most cases by railway competition, nevertheless the type of river steamboat developed in early days and steadily improved has been kept in constant use, and is now being supplied to navigable rivers in foreign countries. During the last year, James Rees & Sons Company, Pittsburg, Pa., built a boat for this type for the Missionary Society of Oregon for the African Mission of that



DESIGN OF NEW AMERICAN BOATS FOR NAVIGATING THE UPPER REACHES OF THE AMAZON.

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Church, having their headquarters at Bolenge Station, Congo Belge, W. C., Africa. This boat is 75 feet long on the deck, 18 feet beam and 4 feet depth of hold. She is equipped with engines 8 inches in diameter, 27 inches stroke, supplied with steam by a locomotive type of boiler designed to burn wood. Her speed is ten miles per hour. The general arrangement of the boat is shown in the illustration.

Another stern-wheel freight and passenger steamboat was built during the year by the same firm for the Magdalena River in the Republic of Colombia, South America. This boat, named the *F. Perez Rosa*, is 170 feet long, 38 feet beam, 4½ feet depth of hold. She is equipped with high-pressure engines with poppet valves with adjustable cut-off. The cylinders are 15 inches diameter by 6 feet stroke. Steam is supplied by three tubular boilers of the Western river type, 14 feet long, 48 inches diameter.

Another contract for fourteen stern-wheel river boats for the port of Para, Brazil, to ply on the Amazon River and the several tributaries, has also been received by this concern. These boats are designed especially to reach the upper head waters of the river beyond the points which are commonly called the navigable parts of the river. The boats are designed to carry about 40 tons on a draft from 24 to 26 inches, having a speed of ten miles per hour in dead water. The length on the deck to the main transom is 125 feet, the beam 26 feet, the depth of hold 3 feet 6 inches, the sheer 3 feet. The hull and cabin framework are of steel, the hull having three longitudinal bulkheads and three transverse bulkheads, making in all seventeen watertight compartments. The cabins are on the upper deck, as shown in the drawing. The machinery for these boats consists of engines 9 inches diameter, 48 inches stroke, supplied with steam from locomotive boilers having 800 square feet of heating surface. The boats are to be lighted by electricity.

It is interesting to note that these boats, when completed, will be run by skilled American steamboat men; that is, the captain, pilot and engineer will be taken from different Western rivers in America.

A Stern-wheel Missionary Boat.

The stern-wheel steamer *Bamania St. Joseph*, built by Wilton's Engineering & Slipway Company, Rotterdam, for the Belgian Missioners in the Congo, has a length of 56 feet, a beam of 16 feet 5 inches, a depth of 3 feet 5⅜ inches, and a draft of 2 feet 5½ inches. The engine is of the twin-cylinder non-condensing type, with discharge in the funnel. The cylinders are 12 inches diameter and 29½ inches stroke. The designed horsepower was 75, with 40 revolutions per minute, giving the ship a speed of 8 knots. The boiler is of the multitubular marine type, with 340 square feet heating surface and 105 pounds working pressure. It is 6 inches diameter, with a length of 9 feet 6 inches and a special grate arrangement for burning wood. The paddle-wheel is 10 feet 4 inches outside diameter, has nine radial blades 8 feet 3 inches wide.

Single-Screw Amazon River Steamer.

The single-screw river steamer *Excellencia*, 145 feet by 30 feet by 8 feet 6 inches, has been built by the Smith's Dock Company, Ltd., Middlesbrough, for service on the Amazon River. This boat is propelled by a triple-expansion engine, with cylinders 12¼, 20 and 34 inches diameter and 22 inches stroke, driving a single screw. Steam is supplied by a single boiler at 180 pounds working pressure. The designed speed is 11 miles per hour when the boat is loaded.

LARGE ENGLISH-BUILT RIVER STEAMER FOR THE AMAZON.

The hull is built with three decks, the main deck being steel sheathed with teak, the promenade deck of teak, and the awning deck of teak covered with canvas. A teak deck-house is built on the promenade deck, containing passenger staterooms. The dining saloon is located aft on the same deck. Electric lights are installed throughout the boat, and fans are supplied in the deck-houses. The auxiliaries include an ice-making plant located on the main deck aft, a steam-steering gear, a steam windlass and two steam winches.

Tunnel Steamer for the Amazon.

Every year more rivers are being opened up in distant parts of the world, which necessitates the design and construction of

TWIN-SCREW TUNNEL BOAT BEFORE SHIPMENT.

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shallow-draft steamers to suit the special local conditions. The latest shallow-draft steamers constructed at the yard of Messrs. G. Rennie & Company are for the exploration of some of the higher reaches of the Amazon River. The primary conditions which these vessels had to fulfill were as follows: Length not to exceed 58 feet 6 inches, breadth 10 feet 6 inches, draft 2 feet 3 inches loaded. The owners were anxious to obtain the accommodation usually found on steamers of 70 to 80 feet, and great care had to be taken to utilize every available bit of space in the boat.

Regarding the general arrangement of these steamers, the upper deck is arranged to be entirely mosquito proof, with copper gauze portable panels on a wood frame. The forward part is arranged for slinging six hammocks for the officers. There is a bath and toilet arranged on this deck. Below the deck there is a small saloon with seats and table, a pantry, the captain's cabin, refrigerating room and toilet. The vessel is lighted throughout with electric light, and the refrigerating plant is also driven by electricity. Aft of the engine room are two small houses, one for a galley and one for a shower bath. The whole of the woodwork is carried out in three-ply "Venesta" wood on account of its lightness and strength.

The machinery consists of compound surface-condensing engines of 140 indicated horsepower, driving twin screws in tunnels at 500 revolutions per minute. The boiler is of the watertube type for burning wood fuel or coal. A fan is driven off each engine to assist draft.

On trial, with all weights on board, the speed of the vessel was 11.25 knots, the guaranteed speed being 10 knots. The draft forward was 1 foot 6 inches and aft 1 foot 10 inches.

GAS ENGINES: THEIR DESIGN AND APPLICATION.

BY E. W. PERCY.

(Continued from page 418.)

Referring back to Table 3 (page 352), the compression in the most modern gasolene (petrol) practice will be noted. The various compressions in practical use to-day run about as follows:

GASOLENE (PETROL) AND DISTILLATE CARBURETOR TYPE.

Conservative, heavy-built, slow-speed stationary or marine type developing power on 1/8 to 1/10 of a gallon per horsepower per hour, 65 to 70 pounds.

High-speed motor boat and pleasure boat engines, 80 to 90 pounds.

Small gasolene (petrol) engines of all kinds, 100 pounds and up.

Alcohol and kerosene (paraffin) engines, 110 to 120 pounds.

GAS ENGINES.

Rich gases, 110 to 130 pounds; weak gases or producer gas, 150 pounds and up.

Pre-ignition is largely dependent upon the size of the cylinder and the shape of the combustion chamber, as well as on the compression. For instance, with gasolene (petrol), which is more apt to pre-ignite than any other fuel in common use, a very small engine will run as high as 200 pounds compression and engines are actually manufactured in two and four-horsepower sizes, giving no trouble and never pre-igniting, whereas a 14-inch gasolene (petrol) engine cylinder will frequently pre-ignite if not carefully cooled at 90 pounds.

For economy it is essential that the combustion chamber or compression space be as nearly globular as possible when the piston is at the top end of the stroke. Combustion should begin in the center of this space and spread on all sides, and should not begin in some distant pocket or corner to slowly burn itself out and probably finishing its combustion after the exhaust pipe is opened. All engines which have made records for economy properly authenticated, etc., have been without pockets of any kind in the cylinders and have ignited at a point where the explosion could spread on all sides, somewhat as a center fire gun is fired, the charge almost detonating instead of slowly burning. The explosion of such an engine is a sharp crack, like the shot of a pistol, rather than a puff. While the engines, with pockets, may have structural and commercial advantages, although even this has been disputed, they have certainly failed in tests of economy. This is probably due to the fact that the charge is exposed to so much cooling surface at the moment of explosion, resulting in the quick collapse of the gases.

It is easy to conceive how engines without pockets, flat or domed head and cup piston form a chamber of the minimum area of cooling surface, and the explosion will show an indicator card with a higher expansion line for any given amount of fuel than with any other form of combustion chamber. This principle is not only upheld by Clerke in his "Axioms of a Gas Engine," but by ordnance experts and automobile manufacturers.

Among common forms of combustion chambers, some of the worst designs possible are as follows: First, the domed piston; a domed piston gives a shapeless combustion chamber with feather edges. The combustion will begin in some far corner of the chamber, seldom directly from the center, and spreads on all sides down into the feather edge of the piston until it is so cooled by the piston and cylinder walls that combustion cannot proceed any further and only unburnt gas is left around the piston. The same may be said of a head which is domed inwards and of pockets and recesses of any kind whatever. There probably is no more important factor of design before gas engine manufacturers to-day.

The compression of various mixtures has no effect whatever upon the subject of compression proper, but as the maximum pressure is the subject immediately succeeding compression it might be said that innumerable experiments have been made in the explosion of gases mixed with various proportions of air under various pressures with a view to establishing data; but these, like most other experiments which are not made under the operating conditions of the inside of the gas engine cylinder, are comparatively worthless to the gas engine men and better than wasting time with these purely theoretical tests it is advisable to study the many results available from actual experiments with gas engines. The same might be said about the huge, complicated and useless thermodynamic treatises upon the gas engine, none of which are accurate, however much they may assume to know what the conditions as to cooling, combustion, etc., will be within a given cylinder.

The calorific value of a fuel being known, the compression and economy being chosen with careful judgment by the designer, it is a simple and practical method for him to figure backwards from the one-eighth or one-tenth of a gallon per horsepower per hour or number of cubic feet of gas to what his charge will be in the cylinder.

To find the pressure from a given possible explosion with a given fuel it is necessary for purposes of practical design that the maximum pressure of explosion be assumed. This and other data are obtained from previous experience, together with experiments and progress.

WEIGHTS AND COST OF VARIOUS TYPES OF ENGINES.

These vary so widely that it is not possible to state them specifically without carefully classifying the various types of engines.

Taking first horizontal gas engines of large power, say 1,000 horsepower or more, of either the two or four-cycle type of the generally accepted arrangement of two double-acting cylinders arranged in tandem, together with duplicates of this arrangement acting upon the same crank shaft. These engines

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complete, with bed plates, crank shafts, valve-gearing tools, pipe-fitting accessories necessary for connection with gas producer, or other source of fuel, can be purchased in Eastern parts of the United States by the best makers for about $32 (£6.6) a horsepower. This refers to engines of the highest grade, made by reputable firms. Less desirable engines of the same power are made by large firms, not specialists in the business, for as low as $26 (£5.35) per horsepower. The first-named engines in general are exclusively of American design, the styles of which will be considered later; while the latter, made by several large firms, are imported German designs.

These types are changing very rapidly from year to year, but, in general, it may be said that the speeds and compressions are increasing, the cylinders are being multiplied and the bore and stroke per horsepower reduced; while the total capacity of the units are being increased, some having been constructed as high as 6,000 horsepower.

Of the smaller power engines, from 200 to 1,000 horsepower, single and double-cylinder engines are mostly used, same being coupled in tandem; or, in the case of 200 and 300 horsepower, only single-acting cylinders with trunk piston are used. The highest grade of engines in the case of single-acting cylinders nevertheless use hollow, water-cooled piston with rod and outside cross-head in ordinary steam-engine form, the cross-head into the cylinder being wide open. Of the engines less than 200 horsepower their name is legion and their type is well known.

The typical factory-made cheap gas engine of the horizontal type, made in large quantities for use on farms, etc., with all accessories up to 10 horsepower, may be had for about $30 (£6.2) per horsepower. Above this they cost less up to 50 horsepower, at which size they are hardly made as yet in large lots by factory methods, rather being jobbed by special order. In these assortments they cost $30 (£6.2) to $35 (£7.2) per horsepower.

Some of the special types of horizontal engines which may be mentioned as well up in popular favor are the double-opposed, high-speed engines made in sizes up to 50 horsepower; very successful engines operating quietly up to 800 revolutions per minute, which makes them suitable for direct connection with generators, centrifugal pumps, etc. These engines are also made air-cooled, and in either case they may be expected to cost in the open market about $25 (£5.1) per horsepower when purchased from reputable firms.

High grade two-cycle engines, oil injection engines of the highest grade, large gasolene (petrol) engines and other types of more or less standardized horizontal engines between 50 to 200 horsepower may be expected to cost $30 (£6.2) to $35 (£7.2) per horsepower in the open market. Extremely high-grade engines, with extra finish, etc., will run up to $40 (£8.2) per horsepower.

With the vertical engines, as with the steam engine, the most highly developed type is the marine, having to develop the maximum horsepower in a limited space and limited in weight, at the same time requiring unusual wearing qualities, reliability, economy and reasonable cost, thereby putting a heavy task upon the designer. The inevitable result has been a vertical high-speed multi-cylinder, short connecting engine, usually of the single-acting type, although the double-acting type is rapidly growing into favor.

Those engines in which the mixture is prepared outside of the cylinder have been adopted as best meeting the requirements. The two-cycle is cheap and in a wobbly, uncertain manner reversible. Its usfulness, so far as a hard-working motor is concerned, is not great, but it makes a very excellent pleasure engine, because of its lighter complication and the fact that it can receive considerable attention without delaying important affairs.

The vertical stationary engine has been very much affected by the development of the marine type, if, indeed, it does not spring from it. This type of engine is as much of a factor in large power production as the horizontal type. While not yet developed in as large units, it is perfectly capable of so being and can, in every way, accomplish the same results as the more cumbersome horizontal engine with less initial cost and with a higher speed, more suitable for modern machinery, occupying less floor space and being under less cost of maintenance. Small vertical engines of the highest grade for marine purposes with reverse gear up to 10 horsepower may be purchased in the open market for about $75 (£15.4) per horsepower. From 10 to 20 horsepower they greatly drop in value to about $40 (£8.2). From 20 to 50 horsepower their value again decreases to about $30 (£6.2) per horsepower, which is as cheap as high grade engines can be purchased. Factory-made engines can be purchased for 40 percent less, but there is no factory-made engine available to-day which can stand up to the marine work at hard going every day in the year under conditions of rough water, ice, snow, lack of attention, etc. This same type of engine, arranged for stationary purposes, will cost as a rule about 20 percent less. The weights of engines per horsepower will run about as in the following table.

TABLE 6.

HORIZONTAL.	
STATIONARY.	Weight.
	Pounds.
Large tandem constructed of the heaviest type 500 H. P. and over	250
Same construction, 500 H. P. and under	260
Standard type gas engine, 50 to 100 H. P.	200
Standard type gas engine, less than 50 H. P.	240
GAS PRODUCERS.	
Small	350
To 50 H. P.	160
To 100 H. P.	100
To 1,000 H. P. and over	75 and even 60
VERTICAL.	
MARINE TYPE.	Weight.
	Pounds.
Single cylinder, less than 10 H. P.	188
Double cylinder, less than 20 H. P.	210
3-cylinder, less than 50 H. P.	210
3-cylinder, 50 H. P. upwards	195
4-cylinder, less than 20 H. P.	110
4-cylinder, less than 50 H. P.	110
4-cylinder, 50 H. P. upwards	123
6-cylinder, same as 3-cylinder	

The cost and weight of gas producers for engines vary somewhat, depending very much upon the installation, but, in a general way, for less than 1,000 horsepower for almost any size installation, the cost of producer plant complete, with scrubber, etc., will not be far from $10 (£2.1) to $12 (£2.5) per horsepower.

(To be continued.)

Unofficial reports regarding the new Hamburg-American transatlantic steamer originally called the *Europa*, but now named the *Imperator*, state that the vessel is to be fitted with forty-six watertube boilers of a modified Thornycroft type. Propulsion is by four modified Parsons turbines, and the ship is to be fitted with three funnels, two of which are used for boiler draft and one for ventilation, so that all ventilating cowls are dispensed with. The exact dimensions of the *Imperator* have not been announced, but it is known she will be approximately 900 feet in length. She will have a beam of 96 feet and a gross tonnage of 50,000. A crew of 1,000 will be required to run the great ship, and her cabins will accommodate 4,250 passengers. Her engines will develop 70,000 horsepower.

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THE LOCATION AND DISPOSAL OF DERELICTS.

BY STANLEY V. PARKER.

(*Concluded from page 409*)

The disposal of derelicts depends largely upon their condition when found. It is the general opinion that if possible, the vessel should be towed into port or beached. This would seem to be true, because the derelict is generally of some value, and it is doubtful if a vessel well held together can be so wrecked as to make her fragments harmless without an excessive expenditure of explosive. The disadvantage is the added labor of getting her into port involved, as the derelict generally offers some considerable resistance to towing and the expenditure of coal and lines, but it would seem that,

WRECKING A DERELICT WITH MINES.

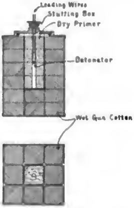
if the vessel were of any real value, the owners or underwriters would gladly pay for the expense of getting her back.

From statistics, the destruction by fire in the case of wooden vessels seems to have been very satisfactory; destruction of floating wrecks by explosives has been so little tried, and therefore so little experience has been had with it, that of its value and difficulties little of real value can be said, and destruction by ramming is in about the same category. What will here be said about the disposal of derelicts will refer to wooden vessels unless it is otherwise stated.

During the period of 1887 to 1893, 41 derelicts were towed into port, but there is no account of the experiences and difficulties encountered by the workers. Since that time many more have been towed in, but the lack of reliable information in regard to them prevents any exact consideration. We can well consider the condition of the derelict as affecting the methods employed.

In the case of a vessel with steering gear intact, a good sized hawser should be run into the derelict in order that we be not disturbed at night with a parting hawser. One of 9 or 10 inches would serve the purpose well. We may place our faith in a 6-inch line only to have to run another at one a. m. with a nasty sea to complicate the operation. The size of hawser is necessary because usually the derelict is waterlogged and offers a great deal of resistance to towing. The hawser would well be made fast to the foremast near the deck and lead to the towing vessel through a chock, being protected in the wake of chock, bobstays and other head gear by parceling or other chafing gear. A party should be sent aboard the tow to watch and steer, and the regulation lights should be provided. The party should be provided with a boat to be towed astern of the derelict with sails, signal flags, lantern, food for several days, water, axe, marline spikes, seizing and small stuff, heaving lines, life preservers, etc., in fact, everything that would be absolutely necessary if the party should be cast adrift. Otherwise the tow would not require any other than the usual towing methods.

If the steering gear is disabled beyond repair, time permits and the decks are habitable, an improvised jury rudder will save much wear and tear on the nerves of the people on the towing vessel. The hawser would be secured as above de-



UNITED STATES NAVY WRECKING CHARGE.

scribed. If the rudder could not be rigged the hawser should be secured to the tow with a span to prevent her yawing, and it has been generally preferred to towing stern first. Towing such a vessel without a span results in her taking violent sheers alternately from side to side, and I have seen such a tow actually come up abeam on either side of the towing vessel, endangering the line, racking the tow and making speed absolutely impossible. It would be a wise provision to have such a span on board the vessel as a permanent part of her outfit, ready for use at a moment's notice. It should be provided with plenty of end for taking turns or for lashing, and should have a form of thimble at the V that would prevent chafe on the line. In addition a drogue to be secured on the after end of the tow might be of assistance, and this should also be a permanent part of the outfit. These items should be kept on hand, because in the haste and confusion of making fast we are simply wasting valuable time if we stop to make spans and drogues; oftentimes we will have to seize an opportunity while a sea is making up before it becomes too rough for boating. If we are not so provided we shall have to depend on a single line, and it is well nigh impossible to break such a tow's sheer without parting the hawser, and meanwhile we are working to port at the speed of about 2 knots. It will likewise here be advisable to keep some men aboard the tow if the decks are habitable and the weather is not severely cold. If the vessel's steering gear is jammed over beyond hope of repair we might blow it away. If this is impossible we shall possibly have

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difficulty in spite of the span. A vessel towed astern of the derelict would straighten her up, but, generally, we have no other vessel with us.

If the vessel is bottom up we must find some place to make the line fast, and several ways of securing it suggest themselves. If we can get a man aboard her with tools we can cut out a section of the keel about a foot in length. Into this would be dropped a bowline on our line, and a heavy plank would be spiked across the channel. The hawser, of course, would have to be protected from chafe, and the heaviest line on board used, as we will have a heavy tow.

A heavy wrought iron shackle, to be secured to the keel or bottom of a capsized vessel, has been designed and tried. Weighing 200 pounds, it is rather difficult to handle from a small boat, but that it is practicable in some cases has been demonstrated. Built in sections it might be more readily handled.

Another scheme that has been suggested consists in boring a hole in the keel of a vessel by firing a shell through it. This has been tried with a 6-pounder; but the wood being more or less spongy the hole closed up quickly after the passage of the shell. If we are successful we can reeve our line through the hole, or better, provided with an iron or steel bar, insert it in the hole and secure the line to a shackle made fast to the bar. A vessel on her beam ends would nearly always afford some place to which we could secure a line.

A DERELICT THREE-MASTER THAT WAS TOWED TO PORT.

In towing steel vessels the same general methods above described would be used except those relating to capsized vessels. A steel vessel on her beam ends would rarely be met with. If battened down she would present no insurmountable difficulties, and the value of such a vessel would undoubtedly lead us to use every effort to get her into port.

A steel vessel bottom up would indeed be a curiosity, but vessels in such a condition have really been known of. To tow her by securing a line to her rudder post or shaft might be feasible.

The resistance to motion through the water increases so rapidly with the increase in speed that we need not expect to be able to make very great speed with our tows in their usual condition—waterlogged or capsized. We should, as said before, use our heaviest line. If under those circumstances we wish to compute the strain on the line for certain speeds we would not find it a monumental task to do so roughly, but undoubtedly most of us would rather rely upon our judgment.

A TYPICAL DERELICT.

These capsized vessels could only be taken into certain depths, of course.

The destruction of the derelict should be given considerable thought. The advisability of its partial or complete destruction by fire should be considered, and if practicable should certainly be adopted. A vessel in ballast burned to the water's edge would certainly sink. In case we do not complete the destruction by fire we can use explosives to finish the work. Statistics collected from 1890-1893 show that of seventy-six derelicts set on fire seventy-two were thereby destroyed.

The attempt to destroy the *Fannie E. Wolston* by fire failed because she was so badly waterlogged, and it would generally be difficult to destroy by fire a vessel in her condition. However, in a good many cases if it were feasible to start a hot fire with the assistance of kerosene (paraffin), even though slightly waterlogged, we might accomplish our purpose, as the wood of the parts near the flames would be prepared for the fire by its heat. In the case of a partially successful attempt to destroy by fire, as said before, we could resort to explosives to complete the destruction. In fact, in some cases we would be compelled to use it from the first. The most obvious question then is, "What explosive shall we use?" and the natural answer would be "The most violent." But safety in handling and storage plays an important part, and the explosive must be unaffected by water, or at least its receptacle should exclude the water if not. The high explosives, together with black

A DERELICT PARTLY DESTROYED BY FIRE.

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powder, in the order of their explosive strength, are as follows, the standard being nitro-glycerine, 100:

Explosive gelatine	106.17
Nitro-glycerine	100.00
Gun-cotton	83.12
Dynamite No. 1	81.31
Rackarock	61.71
Picric acid explosives	50.82
Black powder, fine	28.13

Explosive gelatine is then the most violent of the high explosives; in fact, it is so violent that generally some other substance is incorporated with it to reduce somewhat this violence. It is composed of a mixture of nitro-glycerine and a nitro-cellulose completely soluble in ether-alcohol. In its camphorated form it is comparatively insensitive to shock except when frozen, and then it is extremely sensitive and dangerous. As nitro-glycerine and its mixtures ordinarily freeze at about 40 to 45 degrees F. their use on board ship, where, at times of the year we commonly experience such temperatures, would not be advisable.

Nitro-glycerine is next on the scale, but on account of its sensitiveness, its high freezing point, and the danger of its leakage unnoticed, it is eminently unfitted for stowage on board ship.

We now come to gun-cotton. It is highly nitrated cellulose (insoluble in ether-alcohol). Its great value depends on the fact that when wet it is comparatively insensitive to shock, and can only be detonated by the explosion of dry gun-cotton in contact with or quite near it. As we can dry the cakes of wet explosive as we need dry primers (there being but 25 percent moisture in them) we need have no large amount of dangerous explosive aboard except when actually engaged in its use. The value of gun-cotton has long been recognized, and it is a standard military explosive, being used in mines, torpedoes, wrecking charges and in the field for the destruction of structures and material. In handling the explosive it is essential in submarine blasting that its form be convenient and that the dry primer be protected from the water. The standard navy wrecking charge is constructed as follows:

A sheet copper or sheet iron case, rectangular in section, tinned inside and out, 12¾ inches long and 9 inches square inside, is the receptacle for the explosives and the primer case. The primer case, fitting inside the outer case, is 8¼ inches long by 3 inches square inside, and is closed at one end. In the sheet iron mine it is of tin, in the copper mine of copper. Around the filling hole of the large case at the top is soldered a brass ring with a flange, and this flange is threaded for the reception of a brass cover. In the assembled position the flange of the primer case seats on a rubber washer inside of the flange of the brass ring. The screw cover screws down over a rubber washer over the primer case flange, thus making a watertight joint around the circumference. A boss on the center of the cover plate provides a screw seat for a cap and a peculiar form of stuffing-box is formed in it by the insertion of a rubber ball, drilled through in two places for the entrance of the leading-in wires.

The large case is filled about the center with eight piles of six cakes of wet gun-cotton each, making a total of 48 wet blocks, and to this is added two wet blocks placed in the center under the bottom of the primer case, thus making in all 50 blocks of wet gun-cotton. These blocks are 2.9 inches by 2.9 inches by 2 inches in size.

Between the piles of blocks on the sides and over the two blocks in the center the primer case is inserted, its flange resting on the washer inside the brass cover ring. This case contains a single pile of four dry gun-cotton blocks, each block bored out in the center so that a continuous central channel leads from the top to the bottom of the pile. The detonator, a fulminate of mercury electric exploder, is inserted in this channel, and its wires are spliced to the leading-in wires, so that the splice will be inside the case, the leading-in wires having first, of course, been led through the holes in the ball packing. The cover cap confines the ball, compresses it, and makes a watertight joint about the leading-in wires. The mine loaded weighs from 50 to 60 pounds. For firing it a battery of electric cells or a form of Farmer's machine, a small, handily operated but powerful magneto, are commonly used, and a standard insulated cable is used in connection with it.

The method of handling the mine and the number to be used depend on circumstances. The suggestion for using wrecking outfits, contained in the naval ordnance pamphlet No. 343, December, 1905, says:

"So long as the unit mine charge is large enough to cause disintegration of the wreck in its immediate vicinity, it is better to distribute such units at different important points rather than to group them at one spot. It has been found, however, that a single mine charge is rather light for isolated use, except with very weak structures, and ordinarily the use of more than one at any given spot is advisable. Good judgment on the part of the officer ordering the arrangements is necessary.

"The mines should be submerged as much as possible and placed under the wreck, as the explosive effect is greatest in the direction of least resistance, which is usually upward. As the destructive effect of a charge of gun-cotton upon a body decreases proportionately to a fairly high power of the distance of the center of gravity of the mine from the body, it is necessary that the mine be held as close as possible to the part of the wreck to be attacked.

"In dealing with lumber-laden wrecks it is well to blow off the upper decks, so as to allow the cargo to float out, as little can be done toward destroying the wreck so long as the cargo remains intact. If she be a floating derelict the deck should be sufficiently destroyed to allow the lumber to float out, and then the bottom sufficiently damaged to sink her.

"A mast can easily be removed by exploding a mine near its base."

The direction in regard to submerging the mine is of considerable importance. The water acts as a tamping and prevents the excessive radiation of the explosion in all directions.

If we could determine in what part of the ship the explosion would have the greatest effect on weakening its structure we would be able to work intelligently at it. The destruction of the deck beams would wreck the parts of the structure which hold the sides together, and this would seem to be a very much desired result. It might be of value in some cases, but the general opinion is that once the bow and stern have been wrecked we will have very little trouble with the rest of the structure. A combination of the two ought to give good results when we are so situated as to be able to use them. The use of a number of mines in series would facilitate the destruction in this case.

A line of mines under the keel athwartships at each end of her could be placed with the assistance of sweeps such as are used for placing collision mats, and their explosion at the same time in series would undoubtedly rack the structure greatly, and probably would remove bow and stern. The further destruction of the hulk could be accomplished by running with a series of hogging lines a number of mines along her keel to be exploded in series at the same time. Of course, the expenditure of explosive would be considerable, but to destroy a derelict that was in good condition and strongly held together could not be accomplished without this expenditure. Generally such a vessel would be towed into port or first burned. In any case, placing the mines *under* a vessel would place the mines in an advantageous position and provide

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them with a magnificent water tamping. The fragments of the vessel, if large enough to constitute a menace, could then be treated separately.

A vessel capsized presents a rather difficult problem. We can treat her as we have just described for a vessel in her normal position, provided we can get our mines close enough up under her to get them near the decks. This would be complicated by the difficulty of getting lines under her jibboom and past her masts. As to the first objection, when we consider the magnificent tamping that the mines will probably have, the effect of the explosion will not be so very slight, and as to the second, in good weather, one such line could be got under her forecastle by letting two boats with a leaded sweep between them pull down from ahead of the derelict and others by pulling from astern. Our mines would be hung from this line. If we are unable to get the mines under her, it becomes necessary to get them inside of her, but exploding gun-cotton inside of her without the fine tamping before mentioned would be a poor substitute for the first method. The expedient of firing a high explosive shell into the derelict has been suggested, and with a 5-inch gun firing such a shell we could easily make holes in her bottom, and in bad-boat weather pretty well destroy her with several shots.

Ramming might be resorted to at first to rack the derelict, but it would hardly be wise in most cases, unless our destroyer was particularly strengthened forward. Small vessels would ordinarily be too lightly built to attempt seriously such an operation. However, if our bows are strong enough to resist the shock, ramming would undoubtedly greatly weaken the derelict and start the work of destruction.

What has just been said refers to wooden vessels, and the destruction of floating derelict steel vessels would probably present no necessity for the use of explosives except for blowing a hole in a compartment or in her bottom. They would naturally be towed into port.

STRANDED WRECKS.

If a stranded wreck has six or seven fathoms or more water over her decks it will generally be sufficient to remove her masts. As the directions before mentioned state, it will be accomplished by exploding a mine or mines at the partners. This is not always as easily accomplished as we might expect, as the vessel may be lying in a swift tide way and her yards and gaffs may still be in place, and it consequently is difficult to land the mine where needed. The use of a grommet of chain or cordage will be of assistance if the mast is clear of yards and gaffs; if it is not, we shall have to do the best we can, lacking the services of a diver. Except in bad swells a diver would be of incalculable value. It will generally be unnecessary to cut the rigging of a vessel, as it will be parted by the jump of the mast. The explosive should be handled preferably from a ship's boat, and the boat should be clear of the wreck at the time of the explosion. The mines are secured to the lines by slinging them with small stuff, and they should not be handled by the leading wires; a small bight of these should be strapped to the boss of the mine's case, so that no strain will come on the stuffing-box. If the vessel is in such a position that her hull itself is in the fairway, and there is not water enough over her to allow vessels to pass, we shall have to destroy the hull also, and here the plan of blowing off stern and bow first would be used. By the time her stern, bow and masts were gone, more mines could reasonably be expected to totally wreck the vessel. If then the fragments are a menace we should have a lighter equipped with stout derricks to get them out of the way. Here again we would need a diver. If the current is bothersome or dangerous to the diver we can well postpone our operations to slack water each day.

ANNUAL MEETING OF THE NAVAL ARCHITECTS' SOCIETY.

The nineteenth annual meeting of the Society of Naval Architects and Marine Engineers will be held Nov. 16 and 17 at the Engineering Societies' building, 29 West Thirty-ninth street, New York. The usual banquet will take place on the 17th, and a notable feature will be the presence of the society's distinguished honorary member, Sir William White, who will be presented with the John Fritz medal by representatives of the societies of Civil Engineers, Mechanical Engineers, Mining Engineers and Electrical Engineers.

Shipbuilding in Scottish Yards.

According to the Glasgow *Herald* there has been a slight falling off recently in the tonnage of new shipbuilding contracts, and the orders reported during September were considerably fewer than the monthly average for the year. It is stated, however, that more large cargo steamers have been ordered from Clyde and Northeast Coast yards than have been made public, and the activity in most of the marine engineering works seems to indicate a continued demand for high-class propelling machinery. There is no decrease in the production of new tonnage. The output of the Clyde yards during September was thoroughly satisfactory, and the total for the nine months shows that the year will take at least third highest place in tonnage statistics up to date. The trouble with the holders-on has passed meantime, and it is believed that arrangements will be made whereby stoppages of work of that particular kind will be obviated in future. Freights continue fairly good, and the number of idle vessels is small. The large tonnage which has been completed this year has nearly all found employment, and owners are still willing to take delivery of new ships as early as builders can manage to hand them over. The great majority of the berths in the yards are occupied, but the recent advances of wages and the low price at which contracts have to be booked are keeping profits at a low level.

NLSECO OIL ENGINES.

In the May and October issues of International Marine Engineering brief descriptions were published of the type of Diesel oil engine developed by the Maschinenfabrik Augsburg-Nurnberg Company of Germany. This engine is now being placed on the market in the United States under the name of the "Nlseco" engine by the New London Ship & Engine Company, Groton, Conn. These engines are single-acting, working on the two-stroke cycle with combustion of the liquid fuel under constant pressure. On the up-stroke of the piston, air is compressed in the working cylinders to a high-pressure, and shortly before the end of the up-stroke a spray valve opens and oil is injected into the cylinder. The high temperature of the compressed air ignites the oil and causes combustion, which during the first part of the down-stroke takes place under constant pressure. During the latter part of the stroke the products of combustion operate the engine by expansion. At the end of the working stroke the burnt gases are exhausted through ports uncovered by the piston, and the cylinder is scavenged by pure air supplied by a scavenging piston.

The cylinders are water-cooled, and the pistons are also cooled by special arrangements to avoid any danger to lubrication in case of leakage. The wrist pin, or gudgeon pin, is placed well below the hot portion of the cylinder, being placed

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in the scavenging piston which, besides supplying the scavenging air, serves as a crosshead to relieve the working piston of any side thrust. Forced lubrication is used throughout the engine, the system serving to cool the main crank-pin and wrist-pin bearing, as the oil is used in a closed circuit and cooled by a suitable cooler.

marine work, other items than the fuel economy must be taken into account. In general, oil engines have been found to save something like 40 to 50 percent in the weight and space required for the machinery and fuel, offsetting the slightly greater first cost of the installation and affording increased carrying capacity and earning power of the vessel.

LIGHT-WEIGHT, HIGH-SPEED, 850-HORSEPOWER NLSECO ENGINE.

The fuel is injected into the cylinders by compressed air furnished by a two-stage air compressor driven from the crankshaft. This compressor has a capacity in excess of the fuel injection requirements.

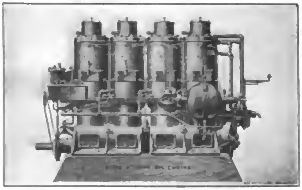
The control gear of the engine is located at its forward end, and is so arranged that the operations of starting, stopping, reversing or changing speed are all accomplished by the simple movement of a hand lever or hand wheel, which, with the necessary gages, speed indicators, etc., is grouped at this station, so that the operator can keep posted on the various conditions affecting the working of the engine.

These engines are usually made in six-cylinder units, which are found to give good balance and freedom from vibration as well as a very uniform turning moment without the necessity of using a fly-wheel. The scavenging and fuel valves are mounted in cages, so that they can be easily removed for examination and ground in when required.

The most important points about any marine engine involve a consideration of the final economy of the engine. In the case of the oil engine remarkable results are given for the actual fuel consumption per brake-horsepower per hour. In the case of the "Nlseco" engine, a fair average fuel consumption is said to be .5 pound per brake-horsepower per hour, this figure varying slightly on account of the size and speed of the engine, being lowest for large and slow-speed engines and a little higher for small and high-speed engines. The average price of such oil in the principal seaports is 3 cents a gallon, and reducing the figures for fuel consumption to cost the average fuel cost is found to be .2 cent per brake-horsepower-hour. This, if compared with the cost of gasoline (petrol) or steam power for similar installations, shows a great advantage for the heavy oil engine, as far as fuel cost is concerned, the cost for gasoline (petrol) being about seven and one-half times as great and for steam about two and one-half times. In comparing the different forms of motive power, however, for

MIETZ & WEISS OIL ENGINE.

A 75-horsepower, three-cylinder oil engine is being installed in a commercial motor boat, 56 feet long and about 12 feet beam. This engine, which is manufactured by August Mietz, New York, is a reversible engine coupled directly to the propeller shaft. It is of the vertical type, with cylinders 10 inches diameter by 12 inches stroke, running normally at 340 revolutions per minute. The speed can be reduced to 80



FOUR-CYLINDER MIETZ & WEISS OIL ENGINE.

revolutions per minute for constant running, so that the boat will be kept barely moving. There are two large air tanks and one emergency tank in the engine room, which are usually kept up to a pressure of 175 pounds per square inch by a small air compressor attached to the rear cylinder of the engine and operated by an eccentric from the main shaft. There is also a small auxiliary compressor, which is operated by a 2-horsepower Mietz & Weiss vertical oil engine, but this is

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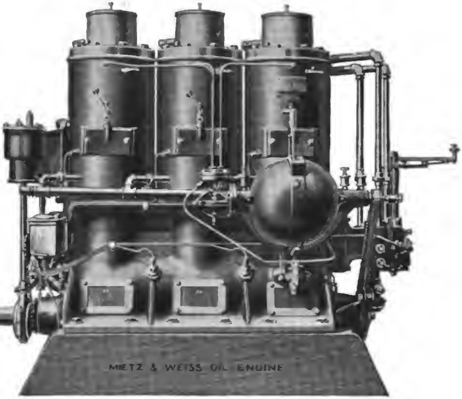
intended to be used only in exceptional cases, whenever the air pressure should fall below 65 pounds, or for the initial pumping up of the tanks. With this air storage compressor, it is claimed the engine can be started and reversed from ten to twenty times, and when the engine is running full speed ahead it can be reversed full speed astern in less than seven seconds.

Ordinary oil fuel is used for this engine, costing in New York harbor about 3 or 4 cents per gallon. The fuel consumption is said to be not over .9 pound per horsepower-hour at full load, so that for constant operation at full speed it would require 75 gallons of this oil for a ten-hour run, which, at 4 cents per gallon, would bring the cost of fuel to $3 (£0.615).

In accomplishing reversal of the engine in this way there is one feature which requires particular attention, and which is very important in this type of engine: the fuel oil which is supplied to the cylinder under pressure by a small plunger pump under direct control of the governor, must be controlled in such a way that no oil will be injected into the cylinder during period of reversing the direction of rotation of the engine, but also just as soon as the engine has started in its rotation in either direction the oil must be immediately and automatically injected. For this purpose there is arranged at the lower projecting end of the rotating valve, where it is driven by a bevel gear from the main shaft of the engine, a pinion driven by a friction collar. This pinion engages in a



THREE-CYLINDER MIETZ & WEISS OIL ENGINE.

The reversing mechanism of the engine is known as the S. & W. distributor. It consists of a rotary valve with positive drive from the main shaft of the engine, controlling the flow of air from the air pressure tanks to the cylinders in proper order for rotation of the engine either ahead or astern, under control of the lever at the front of the engine. In the casing in which this valve rotates there are cored as many ports as there are cylinders in the engine. Each cylinder is connected by a pipe to its port in the valve casing. The valve is made with a single partition, for the purpose of directing the air to the cylinder for rotation in either direction. Directly in front of this rotating valve is the hand lever-controlled valve to which the air flows from the tank. This lever valve is also made in two sections, for the purpose of directing the air to one or the other section of the rotary valve for running the engine either ahead or astern. The controlling lever moves over a segment, to which it can be locked by a spring bar extending to the handle of the lever. When the handle stands in the central position the air is shut off entirely; when it stands in the extreme right-hand position the engine runs ahead, and in the extreme left-hand position the engine is reversed.

segment which carries a cam acting on the stem of a small by-pass valve. The first movement of the hand lever throws this segment in a central position. The segment is locked and no oil can pass into the engine. A further movement of the lever unlocks the segment and allows the air to start the engine, and immediately the frictional pinion carried on the projecting end of the rotating valve moves the segment to one side and closes the by-pass and then the oil is pumped to the engine. This takes place for rotation in either direction.

This oil-controlling action with a reversing mechanism is claimed to provide an absolute control of the oil, and is, of course, of great importance. If there were no such control the oil could be injected immediately on starting the engine in either direction, and there would be an explosive mixture at the start of the compression stroke of the piston at tank pressure, which is generally about 175 pounds per square inch. The compression pressure in the engine being about 100 pounds per square inch, this would bring the internal pressure up to over 1,500 pounds per square inch, and the explosion pressure which follows would be approximately 4,500 pounds per square inch, which is considerably higher than the highest normal pressure which is ever obtained in these engines.

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LETTERS OF INTEREST FROM PRACTICAL MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

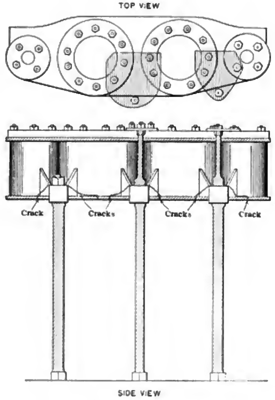
Repairs to a Jacking Engine.

EDITOR INTERNATIONAL MARINE ENGINEERING:

The accompanying sketch gives an idea of a breakdown to our starboard jacking engine and how it was repaired:

The lugs by which the cylinder casting is secured to turned columns broke through, as shown by dotted lines, which left the front part of the engine without support. The cause of breaking were flaws in casting and water in cylinder. The engine was 5 inches by 7 inches, with two cylinders and two piston valves.

After breaking the engine could not be used. The worm was in gear, we were going out next day and the worm



FRACTURES IN STARBOARD JACKING ENGINE.

could not be removed without running the jacking engine. A hasty repair job was started and completed within eight hours.

As will be seen by the drawing, the nuts on top of columns were removed and extensions put on columns, similar in appearance to socket wrenches, but with the lower ends tapped for threads on the column. Plates of ½-inch iron were gotten out of such shape as to permit bolting to the cylinder heads by use of longer studs, and to receive the top end of the extensions, with a nut above and below the plates. The engine was then warmed up and the top nuts secured. Then the bottom nuts were screwed up tight. This took care of expansion. The job has been installed six months and is as good as a new engine.

All three lugs broke and were repaired this way, but only two plates and extensions are shown, while the third shows the original form.

G. C. ELLERTON,
Chief Machinist, U. S. N.

Ft. Munroe, Va.

Trouble on an Oil Tank Steamer.

EDITOR INTERNATIONAL MARINE ENGINEERING:

An engineer, invested with the responsibility of one of the vessels of sorts that go kicking about the world in the happy-go-lucky style that belongs to the boats of the smaller owners, is sometimes tempted to cast the eye of envy at the little tin gods in smart uniforms that entertain the ladies on the liners when they are not toying with a spanner. The difference is marked, but if experience is anything it is pretty safe to say that the man who has to get through as best he can gets the experience in chunks. As an example of the way the engineer has sometimes to get a move on his wits, the following little anecdote about trouble on an oil tank steamer may be interesting.

On one occasion it was discovered that the line between the pump room and the forward tanks on the boat had become holed. Of course, these pipes should not have been made of cast iron, but they were, with the result that they became corroded until a hole was formed. This was only discovered when it became necessary to pump the forward tanks out. Naturally the pumps would not draw the oil because the vacuum in the pipe line was lost; the forward tanks were nearly empty, there being only about 3 inches of oil left in them, but it was, of course, necessary to get the remainder of the oil out.

As the tank in which the damaged pipe was situated was full of gas, no one could venture to go down in order to stop the leak. The oil depot manager, however, was anxious to get that oil and get the ship away, so that he rose to the occasion by offering $35 (£7) to anyone who could stop the leak. An engineer on the boat thereupon had a brain-wave and got those dollars as follows: On the ship there happened to be a football for which there were two bladders. The engineer secured those two bladders and pumped them both full of ordinary air. He tied a piece of string round the cock of one bladder and held the other one in his mouth. He also provided himself with a clothes pin and secured this firmly to his nose. Previously to attending to his own personal appearance in this manner he had got a piece of canvas and smeared it thickly with white lead, and also a ball of marline. When all was ready he got some helpers to lower him quickly by means of a sling down to the bottom of the tank. The pump had been kept going so that the engineer soon guided himself in the dark to the place where he heard the whistling sound of the air being sucked into the pipe line. He now and then allowed himself to inhale the air from the football bladders and kept himself going long enough to fasten the canvas round the leak. When this was done he was quickly hauled up to the deck again, none the worse for going into the tank. Everybody on board, however, thought that he had earned that $35 (£7). The ship was soon pumped dry again after the leak had been stopped and was able to get away from the depot.

In the writer's opinion it ought to be compulsory for every vessel having holds in which foul gas can accumulate, especi-

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aily such as in oil tank steamers, to carry a set of self-contained breathing apparatus, such as are now made by several well-known firms. Anyone who has been "gassed," even slightly, will know that it is not a nice experience and can be easily carried too far. Some of these sets are quite light to wear and give enough oxygen to allow a man to work freely for an hour if necessary; and some of them are suitable for immersion under water, which is an advantage of first-class importance under some circumstances in marine repair work.

Pennsylvania. C. B. S.

Repairing a Broken Low-Pressure Cylinder at Sea.

Editor International Marine Engineering:

We were on a voyage from Hong Kong to Kobe, with about 4,000 tons of general cargo for that port. The engines of the steamship "A——" were running at full speed, and all of a sudden a loud report was heard in the engine room, followed by the engines coming to a sudden stop. The engineers made an external examination, but could find no clue to the trouble; so we lifted the low-pressure cylinder cover, and then we discovered a hole in the side of the cylinder measuring nearly 4 feet square. We also found all the broken pieces of metal on the top of the piston.

As the cylinder was surrounded by an outer shell, forming a steam jacket, it was decided to attempt a temporary repair, and we made it in the following way:

Seven pieces of wood, 6 inches wide by 2 inches thick, were firmly wedged together; their faces were planed flush with the cylinder wall. The wood was drawn hard up with bolts to the jacket wall, and hard wood strips were fitted and screwed to the wood, so that they came in contact with the piston. We occupied eleven hours in making the repairs; we replaced the cover and set the engines away at slow speed. Everything about the repair proved very satisfactory and enabled the vessel to reach port without any further accident. When we reached port a new cylinder was fitted.

Camden, N. J. F. J. S. N.

Indicator Cards from Triple-Expansion Engine.

Editor International Marine Engineering:

The accompanying reproduction of indicator diagrams and data relating to same came to me recently. As these represent the average practice in triple-expansion engines in the mercantile marine, I thought they might interest your readers. A careful study of the diagrams taken in connection with the data given should prove of value to marine engineers in charge of similar work, and also to students of engineering who are taking special interest in steam distribution in multi-expansion engines. The name of ship, port of departure, etc., are immaterial to the abstract study of the diagrams, so I omit them.

I would like to have the opinion of those who may be interested in such matters concerning the distribution of power in the three cylinders. Should not the low-pressure cylinder, if any, develop a little more power than either of the two others? Is there any good reason why the high-pressure should develop more power than the intermediate and low-pressure? Here is the log:

Boiler pressure	180 pounds.
Vacuum	23½ inches.
Revolutions per minute	58.1

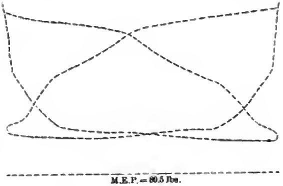
Expansion adjustments:

H. P., 27 inches; I. P., off;* L. P., off.*

Temperature of sea-water	84 degrees F.
Feed-water to boilers	220 degrees F.
Water in boilers	379 + degrees F.

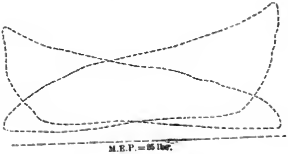
* No cut-off other than lap of valves.

Revolutions in 23 hours 42 minutes	81,920
Distance run by the engine in knots	283
Distance run by observation in knots	245
Slip of propeller, 18.4 percent; per hour.	10.34 knots.
Coal consumed in 23 hours 42 minutes	38 tons.
Clinker and ash	137.31 cwt.
Percentage	18.1



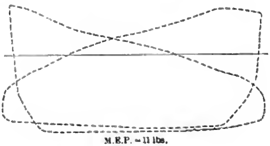
M.E.P. = 80.5 lbs.

HIGH-PRESSURE.



M.E.P. = 25 lbs.

INTERMEDIATE-PRESSURE.



M.E.P. = 11 lbs.

LOW-PRESSURE.

Engine dimensions:

High-pressure cylinders	28 inches.
Intermediate-pressure cylinders	46 inches.
Low-pressure cylinders	75 inches.
Stroke	48 inches.

	M. E. P.	I. H. P.
High-pressure diagrams	80.5 lbs.	737.18
Int.-pressure diagrams	25.0 lbs.	584.35
Low-pressure diagrams	11.0 lbs.	684.4

Total indicated horsepower	2,006 +
Coal consumed per horsepower-hour	1.69 pounds.
Mean immersion of ship	23 feet.
Sea	Smooth.
Time out of drydock	Two months.

Scranton, Pa. Charles J. Mason.

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REVIEW OF MARINE ARTICLES IN THE ENGINEERING PRESS.

Ships.

Hudson River Day Line.—A very brief description of some of the best-known ships of this famous line, from the *Mary Powell*, built in 1861, to the *Hendrick Hudson* in 1906, the *Robert Fulton* in 1909, and the *Washington Irving* now building. In the general regard of the traveling public none has been more popular than the *Mary Powell*, though the later boats are larger and more elegant in appointments. Illustrated; 1,500 words.—*The Marine Review*, September.

The Electric Arc.—An experimental vessel built by McLaren Bros., of Dumbarton, to demonstrate the efficiency of electric reduction gear for use between a fast-running engine and a slow-running propeller. The boat is 50 feet between perpendiculars, 12 feet beam, with 4 feet 6 inches draft, with 6-cylinder 45-brake-horsepower Wolseley gasoline (petrol) engine, driving a 3-phase alternating-current dynamo. Current from this goes to motor connected direct to propeller shaft. The exciter is direct current, and is driven by belt from main shaft. Both motor and generator have two different sets of windings, giving different number of poles in their circuits. By varying the combination of these working together different speeds are obtained. Control is accomplished by means of two simple switches. A series of trials has shown the equipment to be a success both for running and for maneuvering; switch can be changed instantly from full ahead to full astern without danger of injury to the machinery. Article shows drawings of general arrangement, wiring diagram of electric circuits, and a photograph of the boat running; 900 words.—*The Marine Review*, September.

British and German Torpedo Craft.—A discussion of military and tactical qualities rather than engineering considerations. States the relative strength of the British and German navies in torpedo craft, and discusses whether the margin of safety for British interests is sufficient in this line. Lists the more important classes of such craft in both navies; 2,800 words.—*The Engineer*, September 8.

The Argentine Battleship Rivadavia.—A brief detailed description of this interesting ship being built at the yard of the Fore River Shipbuilding Company, and launched there the 26th of August. With a length of hull of 585 feet; beam, 93 feet, and normal draft 27 feet 6 inches, her displacement will be 26,500 tons. Propelling machinery consists of turbines driving triple screws, a separate engine room being provided for each set. The designed speed is 23 knots. 1,200 words.—*The Engineer*, September 15.

Naval Architecture.

The Rolling of Ships.—By Professor J. H. Biles. Address to the Engineering Section of the British Association for Advancement of Science. An effort to account for the disappearance of ships at sea, of which no record is at hand for the cause of their loss, by a study of the known conditions of stability of the vessels and their probable behavior under different conditions of waves. The work is entirely analytical and follows the theory of Froude in his calculations of the angle of inclination produced by a train of waves. The results of experimental work by Colonel Russo of the Italian navy shows that by changing the initial conditions an almost infinite number of results might be obtained. 3,800 words.—*Engineering*, September 1.

Our Present Knowledge of the Vibration Phenomena of Steamers.—By Dr. O. Schlick, M. I. N. A. Read at jubilee meeting Institution of Naval Architects. A brief review of the complete subject as investigated by Dr. Schlick in his long experience with the vibrations of ship machinery. Beginning with the earliest forms of the problem, when torpedo boats, with reciprocating machinery, caused their designers to take account of the oscillations produced by engines and propellers, the various phases of the question are dealt with up to and including the more complicated ones which the turbine have introduced. The author explains vibrations of the first, second, third and fourth orders, and treats comprehensively of their causes and remedies. The analytical side of the question is passed over, and the whole paper is one of practical help for the engineer who must overcome the inconveniences caused by unbalanced engines or untrue propeller blades. The latter cause is more common than generally supposed, and very often the machining of a wheel causes a disagreeable shaking to disappear. This remedy and care in placing machinery in a hull so that vibrations of hull and machinery may neutralize each other are urged by Dr. Schlick as a remedy. 5,000 words.—*Engineering*, September 1.

Marine Engineering.

The Marine Steam Turbine from 1894 to 1910.—By the Hon. Sir Charles A. Parsons. Read before jubilee meeting Institution of Naval Architects. Gives the paper in full, which is a complete detailed account of the vessels engined by the Parsons turbine all over the world. Beginning with the formation of the first turbine building company in 1891, the author carries out each step in the development until the latest contract. Attention is paid in detail to figures showing relative economy of turbine and reciprocating engines under various conditions, merchant ship types best suited to turbines and the results obtained, reduction gearing, its scope and results. The types of turbines are considered and compared both in theory and in the results of trials.

Article contains plots showing economy and diagrams of comparative sizes of war and merchant ships fitted out and turbines installed; 8,500 words.—*The Marine Review*, September.

Diesel Engines for Sea-Going Vessels.—By J. T. Milton, vice-president Institution of Naval Architects. The last instalment of a series which evidently gives the paper in full. In this part the author takes up the points of design to be considered for marine Diesel engines. After a consideration of the effect different types of Diesel engines have upon the bending and twisting moment, the design of crankshafts is taken up in some detail. The question of air pump design is considered from the standpoint of emergencies and providing for air compression in case one pump became disabled. 3,300 words.—*The Steamship*, September.

The Steam Engine Contra the Internal Combustion Engine.—By H. C. Vogt. States that while the great thermal economy of the internal combustion engine is well known that the steam engine is still the most easily maneuvered, and may still be made more efficient by carrying out more carefully things that are already well known about its design. Mentions superheating and the scheme of taking steam from low-pressure cylinder direct to superheater and thence into turbine before returning to boiler. Then he considers points of boiler design, mentioning a series of experiments performed in Copenhagen upon model boilers of different types of the same size and under the same conditions which lead him to think the locomotive and small-tube express types the most efficient from the standpoint of theoretical design. Suggests improved points in the design of both types. 2,400 words.—*The Steamship*, September.

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The Economics of Steamship Propulsion.—By Andrew Hamilton, M. I. N. A. The title of this article indicates very accurately what it contains. Mr. Hamilton considers the design of the power plant of a ship for given requirements and gives the cost per indicated horsepower for different types of installation, considering in the order named the engine, turbines, boilers, fuel oil burning, and producer gas engines. He takes up the tendency to design even tramp steamers of the present day with finer forms forward in order to save a part of the first cost of larger power plant which would otherwise be required. Under each of the divisions considered he states the weight generally required and the cost complete. 3,900 words.—*The Steamship*, September.

Diesel Marine Engines.—By Herr Th. Saiuberlich. Read before Schiffbautechnische Gesellschaft. In this, an extract of the original article, is given a review of the Diesel engine field at the present day, and then describes and shows several drawings of the service boat *Frerichs*, built by J. Frerichs & Co., for service on the North Sea. The boat is about 55 feet long, and is driven by a 4-cylinder, 4-cycle Diesel engine, direct connected to shaft and turning 360 revolutions per minute. At this speed it develops 200 effective horsepower, which drives the boat about 10 knots. Total weight of machinery about 10,000 kilograms. The operating mechanism is of the simplest and the engine is reversible. Special attention was paid in the design to cheapness of construction and simplicity of operation. 1,600 words.—*The Steamship*, September.

Internal Combustion Engines for Ocean-Going Ships.—The first article of a series in which the author will describe the ocean-going ships fitted with oil engines. In this is a list of such vessels now under construction and drawings, photographs and details of one from the list, the *Toiler*, built by Messrs. Swan, Hunter, and Wigham Richardson, for service on the American Great Lakes. With dimensions of 248 feet by 42 feet 6 inches by 19 feet depth molded, she carries 2,600 tons deadweight on 14 feet draft, which is the limiting condition imposed by the Welland Canal. In outward appearance this vessel resembles the usual type of lake freighter except that there is no funnel. Internally, everything is different. Propelling machinery consists of two Diesel engines of 180 brake-horsepower, each driving twin screws at 250 revolutions per minute. Weight of this plant is said to be only one-half that of steam giving same power and fuel consumption one-fourth that required of coal-burning motive power. Article also includes description of the *Electric Arc*. Both vessels illustrated with photographs and drawings. 3,300 words.—*The Shipbuilder*, summer number.

Eight Hundred-Horsepower Diesel Marine Engine.—Built by Richardsons, Westgarth & Company for a boat being built for Sir Raylton Dixon & Company, Ltd. The engines are of the two-cycle, single-acting type, with four cylinders 20 inches in diameter with 36 inches stroke. At 115 revolutions per minute they are expected to give 800 brake-horsepower. In general appearance they are very much like steam marine engines of the same size, the usual marine design being followed as closely as may be, for ease and reliability of operation. Auxiliary machinery is driven by steam. Carrying capacity of the vessel complete will be 3,150 tons. The owners have several boats of same class and size with different types of power plant, and comparisons of this with them will be interesting. 800 words.—*The Engineer*, September 15.

Electric Drives for Screw Propellers.—By H. A. Mavor. A study of the principles of economic propeller design in combination with engines with high rotative speeds, showing the advantages of an electrical system of power transmission. The author holds patents covering a system of electrical transmission whereby power from several power units may be used by one or more propellers. Describes in brief three vessels, designed or building, in which these ideas are carried out.

Frieda, turbo-electric steamship for American owners; 300 feet long, with deadweight capacity of 5,000 tons; speed, 12 knots. Turbo-electric set is for 1,500 kilowatts, three-phase, 50 cycles, running at 3,000 revolutions per minute. Working pressure is 200 pounds per square inch, and vacuum 28½ inches. Auxiliaries are motor driven. Main shaft driven by three-phase motor, capable of 1,900 brake-horsepower at 84 revolutions per minute. This equipment costs and weighs less than the normal equipment. The coal saving is 10 tons per day.

Oil-Electric Tank Barge for Canadian Service. Machinery for this boat consists of three Diesel non-reversible engines, each direct connected to an alternating-current generator. The current from these are led to separate windings in a motor keyed to the single propeller shaft, which turns at a slow rate. By using one, two or three motors the advantage of full power economy is secured while running at less than full speed. The cost of this installation is about 10 percent more than normal, but the carrying capacity of the barge is said to be greatly increased.

Electric Installation on United States Navy Collier, a plant, which is being installed in the collier being built at the Mare Island navy yard, consisting of a 5,000-kilowatt steam turbo-alternator. Current is led to two motors, one on each shaft. Steam is supplied by Scotch boilers. Cost, weight and economy are said to be better than for normal reciprocating engine outfit. 1,700 words.—*Engineering*, September 8

Electrical Steering.—By B. Parker Haigh. Read before B. A. A. S. Discusses the conditions under which a steering gear works and what might be expected of a power gear. Classifies electrical steering gear as follows:

A. Steering gears in which the motor is started and stopped for every motion of the rudder.

1. The motor being supplied with current at variable voltage from a special generator.
2. The motor being controlled by reversing switch and resistances.

B. Steering gears in which the motor is kept running continuously, mechanical control being introduced in one of the following forms:

1. Friction clutches with gearing.
2. Hydraulic transmission with pumps
3. Magnetic friction clutches on motor shaft.

The author regards the types under *B* heading to be the most practicable, and proceeds to consider questions of design for such machines. He is the inventor of one type of magnetic clutch machine, and gives results of tests on this gear. Illustrated; 3,000 words.—*Engineering*, September 8.

Floating Crane for Unloading Ore.—Built by John H. Wilson & Company, of Birmingham, for unloading ore at Huelva, Spain. Designed to lift 7 tons at 42 feet 6 inches radius. Power is supplied by double-cylinder engine, 8 by 12 inches, taking steam from a vertical cross-tube boiler working at 100 pounds per square inch. Speed of lifts with full load is 80 feet per minute, and with light load 200 feet per minute. The barge on which crane is mounted is 90 feet over all, 41 feet extreme breadth, and 8 feet deep. The framing is 3 by 2½ by 6/20 inch angle steel, spaced 24 inches on centers. Reverse framing is 2½ by 2½ by 5/20 inch angle. Bracing below deck is furnished by four athwartships and two fore-and-aft bulkheads. Design provides that with greatest load at greatest angle from center line the angle of cant is not over 1 degree. Freeboard not less than 3 feet. Shows photograph and drawing of general arrangement; 800 words.—*The Marine Review*, September.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

Chain Towage on German Rivers.

Conditions on German rivers are somewhat peculiar, because during certain parts of the year the depth of water becomes exceptionally low and at other times, when the water is high, the speed of the current increases to such an extent that navigation up-stream by an ordinary type of shallow draft boat becomes somewhat difficult. In the early days of river navigation a system of chain and rope towage was devised to meet these conditions, so that steam tugs fitted with a mechanically operated drum, or wheels, would wind themselves and a tow of barges up the stream along a rope or chain that was permanently anchored in the river. This is an unusual kind of towage, and at the present time its use in Germany is decreasing. In fact, the method of rope towage was abolished several years ago, although the method of chain towage still exists, and continues to prove a profitable method of carrying on river traffic.

On rivers of other countries most of the towing is done by shallow-draft, side or stern-wheel paddle steamers or tugs fitted with screw propellers, and, where fuel is cheap and there is no immediate necessity of special refinements in the design of the propelling machinery, this system of towage is very successful. The principal advantage of the chain towage, however, over that with the paddle or screw lies in the avoidance of slip, and where there are fast-flowing currents and small depths of water this matter becomes important. When using the chain method of towing, the propulsive efficiency of the tug is affected only by the ordinary resistances in the engine itself and the losses in connection with the transmission, together with certain losses due to the raising and stretching of the chain or to slipping. In this way the actual coal consumption of the chain tug becomes only about one-third that of a paddle tug when the tow is going up-stream. On the other hand, there are disadvantages in the method of chain towage which at first seem difficult to overcome. The type of boat is unsuitable for any other use, and the heavy first cost of the propelling machinery, including the chain or rope and the maintenance of this equipment, offset, in a measure, its advantages.

Full details of this type of river towage are illustrated and described in this issue, and in the next issue the rope tug will be taken up. There is a marked difference between the tugs used for these two methods of towing, in that the rope tug is equipped with twin screws to enable it to make the down-stream trips independently of the rope, while on the up-stream journey the combined rope and screw propulsion can be used. On the chain tug, propulsion both up and down-stream is obtained by winding the chain over the drums and wheels, special appliances being provided for detachment when an up-stream boat meets a down-stream boat. The chain is usually carried over the center line of the boat, and engine-driven water turbines are installed on each side to provide jets of water to assist in bringing the boat around sharp bends. The direction of the jets can be changed by an adjustable elbow, and they can be used for direct propulsion when necessary. The abandonment of rope-towing service on German rivers indicates that the chain towage will also be given up before long, chiefly on account of the increasing competition of the railways and the modern development of the paddle and screw tugs, combined with improvement of the rivers and the conditions for navigation. But wherever conditions are found similar to those which formerly existed on the German rivers this method of towing can undoubtedly be utilized for the cheap transportation of freight.

Inland Waterway Traffic.

Inland waterway traffic is a subject which is now being widely discussed in many countries. A hasty glance at the various types of shallow-draft boats presented in this issue, which are designed for service in various parts of the world, will give some idea of the great variety of conditions which affect the type of river boat to be built. Much of the expansion of river

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traffic dates back to an early period before railroad transportation became a serious rival; this was particularly true in the United States, where the Western rivers at one time were practically the only means of transportation of freight from certain sections of the country to the sea coast. That this has not been maintained, however, is due to the rapid development of efficient railway traffic and to the lack of co-operation between the railroads and river steamboat companies.

Everyone recognizes the cheapness of freight transportation on open rivers, but if the river does not form a direct connection between some great productive center and the seacoast ports there is not much to stimulate water traffic unless the railways can be depended upon as feeders and the various river ports developed into efficient terminals adequately equipped for the storage and transsshipment of freight economically. With such conditions, river ports would not be destinations for either railroad or water traffic, but the entire system of transportation would be a combined rail-and-water system. This system has been developed on the two great rivers in Germany, and from the results obtained there it is shown very plainly that success depends upon the maintenance of a clear, open channel in the rivers, the establishment of good terminals, with facilities for storing and handling freight, and the transmission of freight from rail to water. It is not necessary to provide a great depth of water for inland navigation, as boats can be designed for efficient work on very shallow draft. Most freight transportation on inland waterways is carried on by towage. On the Western rivers in the United States immense cargoes of coal are carried in this way from Pittsburg to New Orleans in tows, which consist of from twenty to thirty barges fastened together four abreast and five or six fore-and-aft, with a single stern-wheel steamer at the stern to act as tug and rudder. In Germany much of the cargo is carried up the lower portions of the Rhine in small sea-going steamers and in barges and lighters from 600 to 1,500 tons, which are towed by single-screw tugs of the type described elsewhere in this issue. On the upper portions of the river express freighters of the side-wheel type carrying 6,000 tons of cargo are used, while through the rapids chain towage is in vogue.

Packet or express freight service is carried on in a variety of ways according to the volume of commerce and the natural conditions. On American rivers this traffic has been largely depleted in recent years by the competition from railways; but the old stern-wheelers, which were so numerous in ante-bellum days, still predominate. Freight is carried on the main deck of these boats and partly in the holds, the hurricane and texas decks being devoted to passenger accommodation. Part of the main deck space is occupied by the boilers, engines and fuel bunkers. Since the channels in the rivers on which these boats operate are continually changing, and the depth of water varying so that new obstacles are always met, the type of boat which originally proved most efficient for meeting these conditions will probably remain in use until clear, open channels can be maintained. Boats of this type always make their landings bow-on, and the cargo is loaded and unloaded by trucks over a long landing stage or gang plank. Since the freight is piled on the open levees, no opportunity is given for mechanical handling. On German rivers, however, the express freighters are similar to the tow boats, except that they are of higher speed. Deck hatches are accessible to cranes on shore, which handle the freight and transfer it to wagons or railway cars. There are many rivers in all parts of the world where a large volume of small shipments is carried by gasolene (petrol) motor boats. In America many of these boats are of the stern-wheel type, with horizontal engines of the stationary type connected to the paddle wheels by a combination belt and chain transmission for propulsion. Vessels of this type are also used for ferry work and as tramps where there is sufficient traffic. Many shallow-draft motor boats, with screw propulsion, are used for tow boats with small flats or barges which are suitable for handling a considerable volume of bulk cargo. In the rapid improvement in mechanical features of this class of boats it is to be expected that more river traffic will be developed in the near future. Heavy oil engines, which are now being perfected, will add much to the possibilities of this traffic.

Besides the actual navigable rivers for shallow-draft navigation, the recent improvement of inner-coastal routes on the Atlantic Coast of the United States will open a new means of inland traffic. If the proposed improvements in these waterways are soon completed, there will be a complete through-line, which is navigable with safety the year round from Boston, Mass., to Richmond, Va. Losses from sea transportation between these points in the last two decades indicate that the safety of such a service will easily repay the cost of new construction, and, on account of the savings resulting from its operation, increased water-borne transportation should rapidly ensue.

All inland waterway transportation depends upon the establishment of complete and economical terminal systems, designed and equipped so that bulk and package freight can be handled quickly and cheaply and with a minimum amonnt of damage to the goods. Individuals and corporations cannot accomplish this at once, but Federal, State and municipal aid must be obtained and the faith of the people interested in commercial, industrial and transportation must be aroused to the economical advantages of a properly equipped inland waterway traffic where the terminals are controlled so that they can be used freely and impartially by all carriers, whether by rail or water. With this the advantages of improved waterways and of the improved designs of shallow-draft boats, which are illustrated in this issue, can be utilized.

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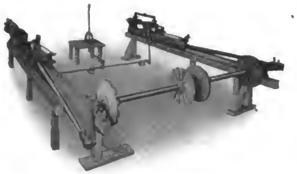
ENGINEERING SPECIALTIES.

Centralized Valve Gear for Stern Paddle-Wheel Engines.

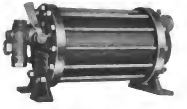
Light-draft river boats, especially those of the stern-wheel type, when used in rivers where there are overhanging trees and considerable foliage on the banks, frequently meet difficulties by entangling these obstructions with the eccentric or cam rods and causing breakdowns. Builders have attempted to correct this difficulty by using makeshifts, but a new type of valve gear has been placed on the market by the Marine



Iron Works, Chicago, Ill., which is designed to do away with this difficulty. As can be seen from the illustration, eccentric rods, cams and links have been eliminated, so that damage to the valve gear by obstructions is impossible. Also the length of the paddle wheels can be increased, as no space is required for the eccentrics or cams. The valve gear itself is in sight of the engineer and is accessible. The valves have a variable cut-off, which enables greater economy when the engines are operated under normal load, and also admits increasing power when circumstances demand an overload.

The Lytton Steam Trap.

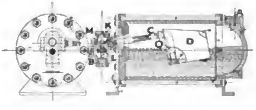
In the operation of a steamship the thorough draining of the water of condensation is fully as important as any other feature in the power plant, and unless it is thoroughly done danger to the engines, leaky joints in the piping, insufficient duty from the heating surface, when required for heating or drying, are some of the most important difficulties to contend with. The Lytton steam trap for draining condensed water, which is illustrated, is so built that all the working



EXTERIOR VIEW.

parts, with the exception of the bucket float alone, are on the outside of the receptacle, and, therefore, in sight and readily accessible, so that any possible troubles, which may happen even in the best of apparatus, can be immediately located and corrected without the necessity of pulling the trap to pieces. Also by this arrangement many of the automatic functions of the trap can be performed by hand from the outside, so that if any solid matter has lodged under the valve during discharge it can readily be removed by submerging the float and allowing the trap to flow through for a short time.

In operating the trap, when it is first installed, it is necessary to either fill the receptacle approximately one-half full of water or to hold the hand lever forward, which will raise the float *D* and allow the discharge valve *L* to remain closed until sufficient condensation has flowed from the cistern to the trap to support the float in the position shown in the sectional view. When this condition has been established, the water flowing through the trap in the inlet opening *A* will raise the float *D* until it strikes the outer casing. When the trap is filled, the water will flow into the float, causing it to drop to the bottom. This will cause an upward movement of the lever *K*, which raises the auxiliary valve *M*, and admits



SECTIONAL VIEW.

the pressure in the trap to the under side of the piston top to the main valve *L*, which opens the main valve and the water flows out of the trap. The water will flow from the trap until it is level with the top of the float with the float at the lowest position, when, almost instantly, sufficient water will be drawn out to raise the float again, thus closing the discharge valve until the receptacle is again full and the float drops.

Besides the features already referred to, the manufacturers of this trap, the Lytton Manufacturing Corporation, Franklin, Va., call particular attention to the way in which the valve operates, since all the float has to do is to raise the nickel auxiliary valve, admitting pressure to a piston having a larger area than the main valve, so that the pressure lifts it from its seat. Thus, since the discharge valve is practically balanced, its size is not limited by the pressure, and a large valve opening is therefore obtained with a consequently increased discharging capacity.

A Condenser Packing Tool.

A leaky condenser is something which causes as much trouble and irritation on board a ship as any single mishap. The cause of leaking can be traced to many sources, but a very prevalent one is that the packing laces are not carefully laid in. It is a tedious job, and carelessness after hours of the work is almost pardonable.

Mr. Edward P. Strode, of Fortieth street and First avenue, New York, has invented a tool for inserting condenser tube packing which makes the work an actual pleasure. Ten to twelve tube ends can be readily packed per minute, and experts have packed more than twice this number in the same time. What is of the utmost importance is that each tube is packed precisely like its neighbor. Broadly speaking, the packing tool as shown by the illustration is a pistol. It is loaded with a lacing, which then shoots into the tube plate around the tube, and by a blow sets it there. The tool is simple in the extreme, and unless absolutely abused would last for years. It is actuated by compressed air at 80 pounds pressure.

Looking at the illustration at the left of the tool will be seen a tapered square, followed by a round portion, which is slotted from end to end. To the right is seen a trigger, very much in the same position as it would be in a pistol, and on the front and side of the handle is a second trigger. In the bottom of the butt is tapped a hole to receive a coupling for

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the air tube, the handle, of course, being hollow. The tapered square is inserted in the condenser tube, which brings it to a center. If this portion was left round, the little burr often left by the cutting-off machine would prevent proper centering. Just inside the slot, on the cylindrical portion, is a shaft, which, when the thumb trigger is pressed, admits air to a little turbine at the back, which causes it to revolve rapidly. A lacing is cut to length and inserted at the end of the slot, where it is grasped by a spring clamp and is whisked out of the side in a second. The second trigger is then pressed, and a little plunger which envelops the rotary portion shoots for-

ward, sliding the coiled lacing off the rotating part and over the condenser tube, setting it firmly in place. The side trigger is then pressed again, giving a second blow, and the work is done.

The machine is simple. The little valves are only ordinary bevel seated affairs, which can be reground most advantageously, and the rebound of the plunger or hammer is accomplished by means of a coiled spring, which is only pressed a distance equal to the depth of the tap holder in the tube sheet.

Machine Versus Hand Method of Stoking.

One of the best features of the best mechanical stokers is that they do not throw any green coal upon the fire itself. Matters are so arranged that the coal is coked by the time it reaches the incandescent bed of coals. It is doubtful whether a human stoker could properly take care of this matter. It

seems probable, on the other hand, that with the highest type of mechanical stoking grades of coal can be used which would otherwise have to be wasted. This has been proved in many instances on shore, and the same is undoubtedly true on board ship. In one instance a 6,000-ton lake freighter, having two Niclausse watertube boilers, each containing 3,340 square feet of heating surface, was equipped with Jones stokers supplied by the Under-Feed Stoker Company of America, Chicago, Ill., as shown in the illustration. When these boilers were first installed they were stoked by hand, and the coal consumption for round trips between the head of the lakes and Lake Erie ports amounted to about 400 tons of slack coal. The use of the mechanical stokers, however, resulted in a marked increase in economy, as with them the fuel consumption for the round trip was reduced to about 300 tons of slack coal, or a gain in economy of 25 percent.

A Useful Freight Chute.

The illustration shows a freight chute constructed by Mr. G. A. Swain, superintendent of delivery piers of the Southern Pacific Company, at their New York terminal, for use in the delivery of small freight from the warehouse lofts to the main floor of the piers. These piers were equipped with straight wood chutes, but their use demonstrated that the

straight chutes were too rapid for small bags, namely, rice, beans, dried fruit, meal and lightly-constructed case freight, so the iron spiral staircases leading from the main floor to the lofts were utilized by fitting galvanized iron chutes onto the steps, with a landing platform at the foot of the staircases. These chutes have been in operation for about six months, and are said to have proved of great advantage, eliminating damage to the various light commodities handled on the piers.

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The Brush Electric Lighting Set.

In our July number we made some mention of an installation of the Brush electric generating set in a vessel on the Pacific Coast, the outfit being used not only for lighting but running a wireless telegraph plant and other electrical conveniences. The capacity of the lighting set referred to was 4 kilowatts, and the makers (The Charles A. Strelinger Company, Detroit, Mich.) have since that time developed and placed upon the market a 2-kilowatt lighting set, consisting of a 4-horsepower engine direct connected to a 2-kilowatt generator, and which is illustrated herewith. Its capacity is sufficient for a maximum of 100 16-candlepower tungsten lamps, or a lesser number of lamps may be used in connection with many other electrical devices. This outfit is extremely compact, requiring a space of but 40 inches in length and 22 inches in width, the total weight being about 680 pounds.

Corrections.—In the description of the A. C. generators and induction motors, manufactured by Messrs. T. W. Broadbent, Ltd., Huddersfield, which was published on page 292 of our July issue, the statement that these generators delivered from 6 kilowatts at 750 revolutions per minute, etc., should read "from 60 kilowatts at 750 revolutions per minute, etc."

On page 388 of the October issue the caption for Fig. 2 should read 1,500 horsepower instead of 15,000.

On page 403 the caption of the illustration should state that the lightship illustrated is off Cape May instead of Cape Ann.

On page 404, in the third paragraph and seventh line, "adherent limitations" should be changed to "inherent limitations."

On page 404, in the cost of bids from the Fore River Shipbuilding Company, £164,000 should be £159,500.

On page 409, the displacement of the *Rochambeau* should read 17,300 tons instead of 70,300 tons, and the length over all 547 feet 9 inches instead of 597 feet 9 inches.

On page 251 of the June issue, in the article "Holtrop Automatic Lubricator," the end of the first sentence should read "cut in the box" instead of "cut in the shaft."

TECHNICAL PUBLICATIONS

The Gas Turbine. By Henry Harrison Suplee, B. Sc. Size, 6 by 9 inches. Pages, 262. Illustrations, 93. J. B. Lippincott Company, Philadelphia, Pa. Price, $3 net.

This work seems to us most timely, as the prime-moving world is tending most strongly to continuous-motion engines; and while the reciprocating motion of steam engines is coupled with certain inherent troubles, these are greatly augmented in the internal-combustion engine. Therefore, the rotary principle of a gas turbine is most alluring. In Mr. Suplee's book there is much which is of value, even if taken only as a collection of what has been attempted, let alone its admirable treatment of the subject educationally. The difficulties of a practical gas turbine are great, and we can agree with the author that the most promising road is that which leads towards the "mixed type," as he terms it.

The Design and Construction of Ships. By Prof. J. Harvard Biles. Two volumes. Size, 6½ by 9 inches. Pages, 846. Illustrations, 561. Plates, 40. J. B. Lippincott Company, Philadelphia; Charles Griffin Company, Ltd.. London. Price, two volumes, $15.

It would be utterly impossible to even briefly outline Prof. Biles' work and do it justice. While he lays no claim to originality, the information concerning old things is made to seem new by its clear and concise explanation, and throughout his book there is always that pleasant feeling to the reader that if he could only see Prof. Biles he would learn a great deal more. In other words, there seems to be a tremendous reserve force. The book grew out of lectures on the various topics delivered at Glasgow University. This, of course, would account for its clearness, and it is supposed to be especially adapted for students; but we venture to say that the practicing engineer finds himself often in as much need of clearness and conciseness as does the student, and to both the book of Prof. Biles is invaluable.

Cape Cod Canal. Size, 5¼ by 8 inches. Pages, 64. Illustrations, 30. Maps, 2. Published by J. W. Dalton, Sandwich, Mass. Price, 25 cents.

This booklet is called an "illustrated story of the new Maritime Highway," a project first conceived by the Pilgrims, the canal that will make Cape Cod an island. The information, coupled with the illustrations given, is instructive and pleasantly imparted. It draws attention to making Cape Cod an island, and also to the fact that a large part of the Cape was at one time an island.

Handbook for Iron Founders. Issued by the Frodair Iron & Steel Company, Ltd. London. Size, 4 by 6½ inches. Pages, 126. Numerous tables. Price, 3s.

The publishers of this little handbook are people who make a business of foundry work, or, more properly, of cast iron mixtures. They are, in fact, advisory engineers, and while they recognize the value of analysis of iron and understand thoroughly the effect of silicon, manganese, phosphorus, carbon, etc., they are frank enough to say that this knowledge does not of necessity make a successful foundryman, and that foundry work is not yet an exact science. We quote from them as follows: "Laboratory tests may be vastly helpful in a foundry and may insure it against wide and serious divergences of result. It could never be expected that, in the case of any particular casting, a specification based on chemical analysis and physical tests could be laid down which would yield the desired result with absolute certainty. All founders are painfully aware of this, for even the most successful will from time to time have a casting to make, the difficulties of which

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yield to no scientifically established rules, and are not overcome until after many failures and a good many hot arguments between foundry foreman, draftsman, chemist and patternmaker." This refreshingly open and fair statement must inspire confidence. American and British authorities are quoted, and the information is so given that it is applicable in any country. The only criticism we have to make on the neat little volume is that owing to the use of gilt on the edge of the pages it would seem wise if the publishers would send an oyster knife with each volume in order to get at the valuable information contained therein.

Practical Marine Engineering. Third edition. Size, 6 by 9 inches. Pages, 794. Illustrations, 350. New York, 1911: International Marine Engineering. Price, $5.

Previous editions of this book have been found so valuable to marine engineers and students that it was considered desirable to publish a third edition involving some additions to cover recent developments of marine engineering and bring the subject matter up to date. The book was originally written by Prof. W. F. Durand, formerly head of the Department of Naval Architecture, Cornell University. The additions, which include chapters on steam turbines, internal-combustion engines, producer-gas plants and oil fuel, have been contributed by recognized experts in these various fields. Few books written on engineering subjects are intended to give detailed information from a practical point of view. They usually deal with the theoretical part of the subject that can be thoroughly understood only by those who have made a scientific and technical study of engineering. In this case, however, it was the purpose of the author to provide help for the operative or practical engineer, either for the man who has already entered the profession or who may wish to perfect himself more fully in many branches of the subject, or for the applicant for the lowest round of the ladder, or for the young man whose attention has just turned to this field and who may wish some simple and fairly complete presentation of the subject from the practical standpoint. To do this it was, of course, necessary to simplify the work and omit much of the material which could be understood only by those who have had the advantage of higher mathematics and engineering education. It is understood that the reader has some knowledge of the essential principles of marine engines, boilers, fuels, etc., not as a designer but as a user of the machinery.

The first part of the book contains an adequate treatment of the materials used in engineering construction, of the different kinds of fuels, and then goes on to describe the prominent types of marine boilers, with their accessories and relative performances. Following this, the principal discussion is of engines and auxiliaries, describing their individual parts, installation and uses. Operation, management and repair are treated in a single chapter, and this gives much valuable information to the man whose duties require the knowledge usually gained by wide experience on board ship. Valves and valve gears, steam engine indicators and indicator cards are treated in separate chapters. The principles of propulsion and powering are most important to the marine engineer, and can only be understood by a thorough study of the subject. In dealing with this the author has used many examples showing the methods of calculation for different types of propulsion and the means for computing the power for given types of ships. The first part of the book is concluded by chapters on refrigeration and electricity.

In Part II., which is called "Computations for Engineers," an elementary discussion is given of the mathematics necessary for this work. A general knowledge of the subject is presupposed, but the most essential points of this work are given and illustrated with many useful problems. This feature of the work is designed to be of help to those who wish to qualify as licensed engineers. In connection with this an appendix is added containing a list of questions which would be asked in an examination for such a position. References are given for the pages in the book which give the information necessary to answer these questions.

Part III., which is the new part of the book, has not been intended to give an exhaustive discussion of the subjects involved, but to present the general principles and describe the details of the machinery. In the chapter on turbines the prominent types of marine turbines are given in detail and actual installations illustrated. The auxiliaries required for turbine installations are also described in full. Similarly, with internal-combustion engines, the prominent types are described and the engines illustrated by photographs and drawings. The advent of gasoline and heavy oil engines brings a comparatively new subject before the marine engineer, and one which requires careful study for efficient operation. Producer gas plants are described rather briefly, giving particularly the method of generating producer gas and the type of engine necessary for using this as a fuel. In closing, a chapter is devoted to the specifications, methods of burning and stowage of oil fuel.

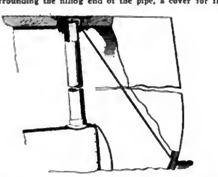
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

990,688. DECK-PLATE FILLER FOR VESSELS USING OIL FUEL. ALEXANDER WINTON, OF CLEVELAND, OHIO.

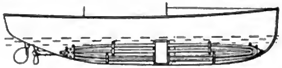
Claim 1.—The combination with the filling pipe of a fuel tank, of a deck-plate surrounding the filling end of the pipe, a cover for the deck-



plate, and a lock for the cover operated from the inside of the hull of the boat. Six claims.

1,000,310. OUTBOARD CONDENSER. CHARLES WARD AND CHARLES E. WARD, OF CHARLESTON, W. VA.

Claim 4.—In an outboard condenser, the combination with a boat, of a header secured to the side of the boat, the said header being divided into



compartments, pipes extending a distance from one compartment of the header and returning to another compartment of the header, and means constructed and arranged to be operated from the interior of the boat for closing any number of the said pipes. Five claims.

1,000,198. ROWLOCK. LEOPOLD ROTHGERY, OF DETROIT, MICH.

Claim.—In a rowlock, in combination with a thole, a band ring pivotally secured thereto, a loom ring made in two parts adapted to engage through said band ring, the said two parts in their assembled condition being provided with a circumferential groove adapted to engage a holding member projecting inward from the band ring.

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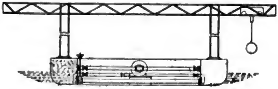
1,000,152. FLOATING DERRICK. FRIEDRICH CORRELL, OF NEW YORK, N. Y.

Claim 1.—In combination: a pontoon or barge; a derrick carried thereby, and adapted to control a load; a number of communicating compartments adapted to retain a liquid ballast; and means to control the



flow of same in such a manner that the pontoon is maintained in a substantially level position under various positions and conditions of the load. Thirteen claims.

1,000,786. METALLIC BOAT. FRANK H. DARROW, OF ALBION, MICH.

Claim.—In a boat, a sheet metal bottom and sides, said bottom and sides being secured together at their outer edges to form a fluid-tight joint, inner and outer end posts, the outer posts being triangular in cross section and arranged at the opposite ends of the boat and adapted to receive between themselves the inwardly bent ends of the side pieces, said posts being bolted together to firmly grip the ends of the sides, a series of ribs arranged in and secured to the bottom and sides of the boat, inner side rails secured to the upper edges of the ribs and to the inner end post, outer side rails secured to the upper edges of the sides and to the ribs, said outer side pieces being secured at their opposite ends to the outer end posts, and sheet metal fastening and protecting plates adapted to be bent into engagement with the outer end of the outer end post and with the engaging ends of the outer side rails. One claim.

1,001,476. LIFE-PRESERVER. JACOB STROBEL, OF NEW YORK, N. Y.

Claim 1.—A life preserver, having an air chamber provided with an inlet port, a valve controlling said port, a retainer for holding said valve in closed position, and means within said air chamber and operable from the exterior thereof, for moving said retainer to inoperative position. Six claims.

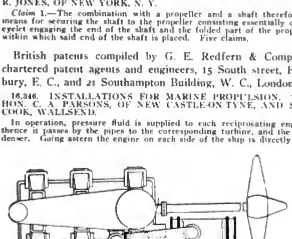
1,000,999. PROPELLER. OSCAR A. DANIELSON AND LYMAN R. JONES, OF NEW YORK, N. Y.

Claim 1.—The combination with a propeller and a shaft therefor, of means for securing the shaft to the propeller consisting essentially of an eyelet engaging the end of the shaft and the folded part of the propeller within which said end of the shaft is placed. Five claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

16,346. INSTALLATIONS FOR MARINE PROPULSION. THE HON. C. A. PARSONS, OF NEW CASTLE-ON-TYNE, AND S. S. COOK, WALLSEND.

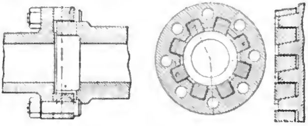
In operation, pressure fluid is supplied to each reciprocating engine; thence it passes by the pipes to the corresponding turbine, and the condenser. Going astern the engine on each side of the ship is directly con-



nected with its condenser, the turbines being idle. A reversing turbine thus becomes unnecessary. For maneuvering, the reciprocating engines can be operated independently either both ahead, both astern, or one ahead and the other astern. The turbine on the side of the engine running astern will run idly in the condenser vacuum, while that on the other side, when the engine on that side is running ahead, will also be running and driving the center propeller ahead, and this by its wash on the rudder will assist in turning the vessel.

17,068. MARINE PROPULSION. THE HON. C. A. PARSONS, NEWCASTLE, AND S. S. COOK, WALLSEND.

This is for a marine turbine installation having additional or cruising turbine parts connected to a propeller shaft by couplings such as shown



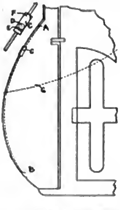
so that the added thrust produced by the power of the additional turbine parts may be balanced in these parts or transmitted to suitable absorbing means.

17,612. APPARATUS FOR CONTROLLING THE DEPTH OF SUBMERSION OF A BODY IN A LIQUID. J. R. DA COSTA, NEWCASTLE-ON-TYNE.

Relates to submarines, etc. The depths are marked on a stem, and any mark is brought to the pointer by turning the hand wheel. If the craft is below this level water will enter and raise the float, causing the disc to complete an electrical circuit, including the electro-magnet, which then opens a valve to admit compressed air for driving out some of the water from the balancing chamber. When the correct level is reached the water tends to leave the float, breaks the contact, and the valve closes. If the boat is above the required depth the float falls and is supported by the disc on hooks which make a circuit causing an electro-magnet to open a valve and allow air to escape from the balancing chamber and water to enter. The apparatus may be operated by hand.

18,408. MEANS FOR PREVENTING THE RACING OF MARINE ENGINES. P. DAVIS, CHESTER.

According to this invention, two pipes with valves intercepting the steam valve and connected with a slide valve to turn off and on the steam as the sea exposes and covers the propeller, are brought into instant operation by a tube open at the bottom and sunk into the outer edge of the rudder; this tube is carried up the rudder post and connected with an instrument for changing the course of currents of elec-



tricity called an electrepeter, the wires from which are connected with a switch and second electrepeter to tilt over from side to side by two motors and eccentric wheel attached to a frame connected to the slide valve and running in the groove of a fixed table over a continually oscillating bar running in the same groove, two adjustable bolts on the bar meeting the eccentric wheel and carrying the frame with the lever of the slide valve to turn steam off and on as required to prevent racing.

14,181. ELECTRICAL ARRANGEMENTS FOR PROTECTING SHIPS' BOTTOMS, ETC. J. E. JAMES, BOLTON.

Electrodes or current discharge points are carried by insulating devices fixed in the plates and these preferably discharge high-tension currents into the water from coils to produce a strong electrical field over a suitable area, the current returning via the vessel shell; return wiring, collecting points, etc., being dispensed with. It is found that alternating current of high tension is most destructive to low forms of aquatic life.

11,131. DEVICE FOR CALMING ROUGH SEAS BY MEANS OF OIL. G. DOLNE DEHAN, SCLESSIN, BELGIUM.

A previous device for this purpose was a receiver filled with oil projected by a howitzer and open during its flight, the oil being kept in by the air pressure. This method does not allow a greatly inclined trajectory when the receiver capacity exceeds certain limits. Another receiver is kept closed during projection, the opening being effected by the shock to the device on striking water. This method also presents the same difficulty, as the shock would not be sufficient to open the receiver. These drawbacks are avoided by this invention, which consists in retaining the cover by spring hooks at the instant of projection, these releasing the cover as soon as the device is expelled. The cover is a plug of wood, and is held in place during the flight through the air by means of the air pressure, but floats on the water when the device strikes, thus releasing the oil. A modification is adapted for projection by hand.

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International Marine Engineering

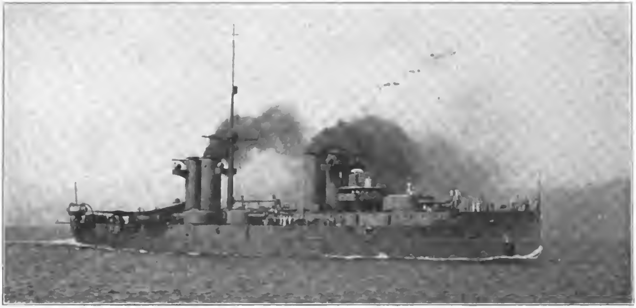
DECEMBER, 1911.

ITALY'S FIRST TURBINE-DRIVEN CRUISER, THE SAN MARCO.

BY DAGNINO ATTILIO.

The first Italian turbine cruiser, the *San Marco*, has recently completed a series of very successful steaming trials at Spezia. She was launched at Castellamare, Italy, and engined by Messrs. Ansaldo, Armstrong & Company, of Sampierdarena. She has the following dimensions:

Length over all	461 feet.
Length between perpendiculars	427 feet.
Extreme beam	69 feet.
Depth	39.9 feet.
Mean draft	23.6 feet.
Maximum draft	24.4 feet.
Metacentric height	3.94 feet.
Normal displacement	10,110 tons.



TURBINE-DRIVEN CRUISER SAN MARCO.

Her armor consists of a belt, with a maximum thickness amidships of 7.87 inches, decreased to 3.16 inches at the ends, and running from stem to stern with a width of 7 feet 3 inches, of which 4 feet 11 inches is below the waterline. The protective deck has a thickness of 1½ inches. The battery is an extremely powerful one, including four 10-inch guns, 45 calibers long, mounted in pairs in turrets, forward and aft, with an arc of fire of 260 degrees. There are eight 7.5-inch guns, 45 calibers long, in pairs in four turrets at the corners of the superstructure. They have an arc of fire of 160 degrees. The secondary battery includes sixteen 3-inch guns, eight 3-pounders and four Maxims. There are three 18-inch torpedo tubes, all submerged.

The machinery installation of the *San Marco* consists of steam turbines with the usual auxiliary machinery, electric lighting machinery, steam heating and evaporating plants, deck machinery and appurtenances for handling and maneuvering.

The turbines are of the Parsons type, designed for a steam pressure at the turbines of 210 pounds (gage), and will make about 435 revolutions per minute, developing 20,000 shaft-horsepower. There are four shafts, each fitted with one propeller. The installation comprises six ahead turbines, the high and intermediates are used with low-pressure for cruising in order to secure economy, and four backing turbines, two of which are high-pressure turbines coupled one with each of main high-pressure ahead turbines, and two low-pressure turbines are incorporated into the exhaust ends of each of the low-pressure turbines. The outboard shafts are operated entirely by main high-pressure turbines, the starboard inboard by the low-pressure (starboard) turbine and the intermediate-pressure cruising turbine, and the port inboard by the low-pressure (port) turbine and the high-pressure cruising. In maneuvering the propellers work always in pairs at the same side. All four shafts turn outboard.

The turbine casings are parted horizontally. The lower half carries the box-shaped fore and aft bearings, thrust and adjusting block.

The following data of the turbines are interesting:

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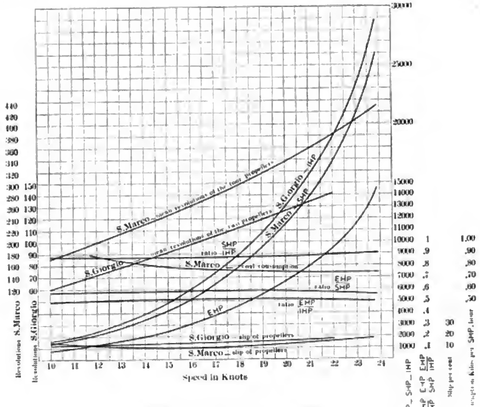
	Number of Expansions.	Mean Diameter.	Length Including Glands.
		Inches.	
Main H. P. port and starboard	6	49	15 feet 6 inches
L. P. port and starboard	6	87	11 " 11[illegible] "
H. P. cruising	3	48[illegible]	11 " 7[illegible] "
I. P. cruising	3	55	12 " 3[illegible] "
H. P. astern port and starboard	3	49	7 " 1[illegible] "
L. P. astern port and starboard	3	64[illegible]	11 " 11[illegible] "

Number of tubes, 8,944.
Diameter, outside, 5/8 inch.
Thickness, 3/64 inch.
Length of tubes between the plates, 7 feet 10¼ inches.
Cooling surface, 11,840 square feet.
Exhaust inlet (rectangular), 48½ inches by 80⅝ inches.
There is one auxiliary and one dynamo condenser, located



RESULTS OF TRIAL RUNS OF THE SAN MARCO.

DATA OF BLADES OF THE TURBINES.

	Rows.	Heights.
		Inches.
Main H. P.—First	13	1
Second	13	1[illegible]
Third	13	2
Fourth	13	2[illegible]
Fifth	13	4
Sixth	13	5[illegible]
Main L. P.—First	5	3[illegible]/16
Second	5	4[illegible]
Third	5	6[illegible]
Fourth	4	7[illegible]/16
Fifth	4	7[illegible]/16
Sixth	4	7[illegible]/16
H. P. cruising—First	22	[illegible]
Second	22	[illegible]/16
Third	22	1
I. P. cruising—First	20	1[illegible]/16
Second	20	1[illegible]
Third	20	2
H. P. astern—First	9	1
Second	9	1[illegible]
Third	9	2[illegible]
L. P. astern—First	5	3
Second	5	4[illegible]
Third	5	4[illegible]

The main condensers are located one in each engine room at the after end of the low-pressure turbines. They are oval and of the surface condenser type. The principal data of each main condenser are:

in the forward port engine and dynamo room, respectively. The dimensions of both are:

Number of tubes, 1,550.
Cooling surface, 1,076 square feet.
Length between tube plates, 50⅝ inches.

The boiler equipment consists of fourteen units in four fire-rooms. The total grate surface of all the boilers is 1,409 square feet, and the heating surface 48,201 square feet, the ratio is 34.4 to 1. The working pressure is 250 pounds. Forced draft system with closed fire-room is used, one blower being provided for each boiler, driven by a vertical inclosed self-lubricating steam engine.

The official mooring trial, the preliminary progressive trials, the six-hour forced draft full power trials, as well as the twenty-four-hour natural draft trials, were successfully made, and finally a ten-hour contractor's steaming radius trial was completed.

Experiments were made in using the turbines in three ways, first, for comparatively low speed with all six ahead turbines in operation; this combination resulted in a smaller quantity of steam being required than with either of the other two combinations. Steam was then admitted initially into the high-pressure cruising turbine, exhausting into the intermediate-pressure cruising turbine, and from the latter through

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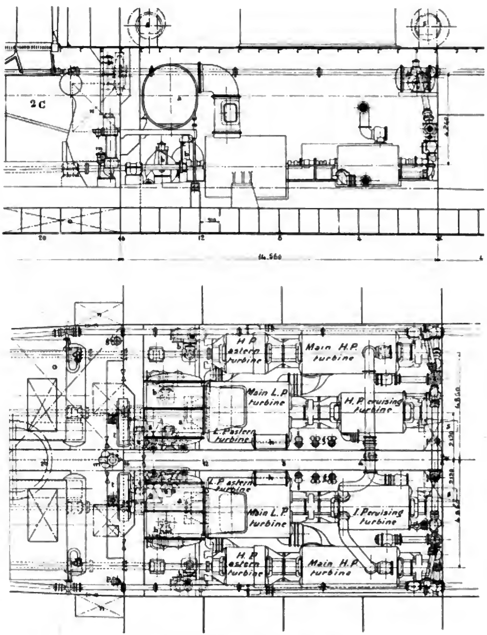
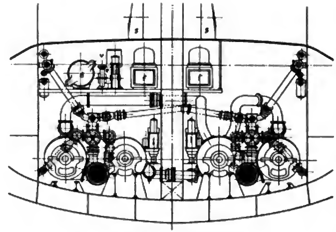
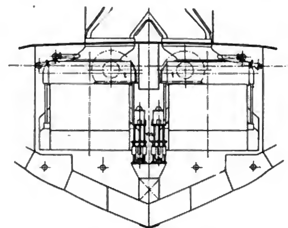


INBOARD PROFILE AND PLAN OF ENGINE ROOM.



SECTION THROUGH ENGINE ROOM.



SECTION THROUGH BOILER ROOM.

a—Main condensers.
b—Main circulating pumps.
c—Main air pumps.
d—Auxiliary condenser.
e—Aux. circulating and air pumps
f—Evaporators.
g—Oil pumps.
h—Oil coolers.
i—Oil cooler pumps.
l—Fire and bilge pumps.
m—Feed pumps.
n—Main feed tanks.
o—Reserve feed tanks.
p—Drain pumps.
s—Engine room aerating fans.
t—Forced-draft fans.
u—Ash hoists.
v—Aux. feed-water filter.

separate pipes to each of the main high-pressure turbines. From these latter steam was exhausted into the low-pressure turbines and finally into the condensers. Second, for speed above 20 knots the five-turbine combination can be used. Steam is admitted initially to the intermediate-pressure cruising turbine, passing thence to the two main high-pressure turbines, and from each of them to the low-pressure turbine. The high-pressure cruising turbine revolves idly in a vacuum. Third, for highest speed only the four main turbines were used, steam being admitted initially to each main high-pressure turbine, exhausted into the low-pressure and then into the condenser, both cruising turbines revolving idly in a vacuum.

In any of these arrangements the power is governed by throttling, though in the six-turbine combination a by-pass valve is fitted, between the first and second expansion, which may be used, within limits, for this purpose. All maneuvering is done with the four main turbines. All the turbines are drained to the air pump. Glands are bolted to the forward and after casing of each turbine. In order to prevent leakage a steam pressure of about 1 pound above the atmosphere is usually maintained in the gland when cruising by means of a system of piping.

A Cockburn's flexible throttle valve is fitted in the main steam pipes, with an emergency governor gear.

The propellers are cast solid of manganese bronze. Their dimensions are:

Diameter, 7 feet 6½ inches.
Pitch, 6 feet 10⅝ inches.
Number of blades, 3.
Total area of blades, 27 square feet.
Shafting, outside diameter, 9⅜ inches.
Shafting, inside diameter, 4⅝ inches.

TEST.

Duration of the Test in Hours	Number of Boilers in Use.	Average Pressure in Fire-room in Inches of Water.	Pressure of Boilers Steam.	Pressure in H. P. Cruising Turbine.	Pressure in L. P. Cruising Turbine.
10*	4	Nil	245	105	42
18	14	Nil	230	Nil	Nil
6	14	1	245	Nil	Nil

Duration of the Test in Hours.	Pressure in Main H. P. Turbines.	Pressure in the L. P. Turbines.	Displacement of the Ship	Draft Before Test in Feet.	Draft After the Test in Feet
10*	17	12 inches of vacuum.	10,050		
18	140	2.5	10,050	24.2	23.5
6	200	10	10,175	24.2	23.95

Duration of the Test in Hours.	Average Number of Revolutions.	S. H. P.	Apparent Slip.	Vacuum in the Condensers.	Average Speed
			%	Inches.	Knots.
10*	196.2	2,350	13.3	28	12
18	374	15,700		27	21.64
6	427.6	23,030	19.5	27	23.75

* Steaming radius.
Wetted surface 1,420 square feet.

The coal consumption per shaft-horsepower during the steaming radius test was 1.06 pounds, and with natural draft it was 1.60 pounds. During the steaming radius test the exhaust of the auxiliary led into the main high-pressure turbines.

The total weight of machinery installation, including propelling machinery and appendages, auxiliary machinery, piping, boilers and fittings, smoke pipes and up-takes, lagging and covering, floorings, ladders and grating, fittings and gears, stores, tools and spare parts, carried on board is 1,284 tons, and with the water in the boilers, 1,320 tons.

The trial requirements of the *San Marco* were based on the results of her sister ship *San Giorgio*, fitted with reciprocating engines, but the *San Marco*, when going at full power, was required to give a half knot more than the *San Giorgio*; this condition was easily surpassed.

A MODEL TEST ON A STEAMER.

BY G. G. HOLBROOK, S. B.

The work which is the basis of this article was performed by the author in the summer of 1909 on Lake Minnetonka, Minnesota. The object of the experiments was to determine the relation between the actual power required to drive a vessel and the power as determined by a series of model tests, by means of simple and inexpensive apparatus. The tests were made in open water, using a small gasoline (petrol) launch for towing the model and weighing the pull with an ordinary equal arm scale balance. Although it is not customary to carry on model tests in open water, it was desired to demonstrate that valuable information could be obtained in this way with such apparatus as could readily be obtained in any locality. The concordance of the results from this test compares favorably with model tests made in towing tanks, and seems to justify the procedure adopted.

The boat selected as a basis of this test was a 70-foot wooden steamer owned by the Twin City Rapid Transit Company, of Minneapolis, Minn., and operating on Lake Minnetonka. The steamer was one of a fleet of six boats, exactly alike, constructed by the Rapid Transit Company from designs by R. C. Moore, of Wayzata, Minn. The boats were built to convey passengers from the terminals of the suburban trolley line at Excelsior, a town on the shore of Lake Minnetonka, to different points on the lake. As the boats ran on schedule time to meet the trolley cars, it was desirable that they should be able to operate in all kinds of weather, carry a large number of passengers, and be capable of a fairly good speed. The dimensions of the *White Bear*, the boat used, are as follows:

Length over all....................	70 feet 3 inches.
Beam, extreme....................	14 feet.
Draft, extreme....................	5 feet 5½ inches.
Displacement (light)..............	35.5 tons.
Weight of machinery..............	9.2 tons.
Carrying capacity..................	120 passengers.

The outboard profile and body plan of the boat are shown in Figs. 1 and 2. The boat is wide for her length, to give a large carrying capacity on small draft. The freeboard is rather low, but was sufficient for the protected waters where the boat was used, since the greatest sweep of unbroken water is about 10 miles.

The boat was powered with a three-cylinder, triple-expansion, reciprocating steam engine with the following dimensions: Diameters of cylinders, high, 5½ inches; intermediate, 9 inches; low, 15 inches; stroke, 9 inches. The engine was rated at 150 horsepower at 300 revolutions per minute, but at the maximum power developed in the boat gave an indicated horsepower of 115 at 238 revolutions per minute. The engine exhausted into a jet condenser which maintained a vacuum of 22.5 inches. The boiler was of the Roberts watertube type, with 21.7 square feet of grate surface and 2,300 square feet of heating surface. For maximum power, the boiler pressure was held at 240 pounds by the gage. The propeller was a four-bladed, cast-bronze wheel with a diameter of 43¾ inches

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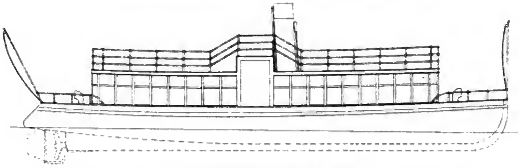

FIG. 1.—OUTBOARD PROFILE OF THE WHITE BEAR

and a mean pitch of 78 inches. The propeller was not well designed, the pitch varying both axially and radially, and the blades being very thick. This rendered it very difficult to get a fair value for the efficiency of the propeller.

A progressive speed trial was run on the *White Bear* after she had been pulled up on a marine railway, thoroughly scraped, painted and overhauled. In order to get accurate data on the boat, measurements were taken on the hull and propeller while she was hauled out. The lines of the boat were afterwards faired up and the propeller laid down and the efficiency calculated. A course 5,035 feet long was laid off on Lake Minnetonka in 90 feet of water and carefully surveyed. The day of the trial was nearly ideal, with very little wind. Four runs were made at a speed of approximately 6 knots, two runs at 7, two runs at 8, two runs at 8½, two runs at 10, and two runs at the maximum speed of 10.28 knots. Five indicator cards were taken on each run; the times were

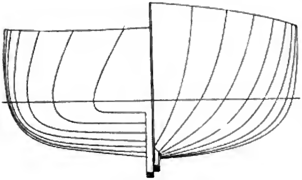

FIG. 2.—BODY PLAN.

read with a stop watch and the boiler pressures and revolutions were recorded. The draft was also taken before and after the test. The results of the speed trials are tabulated in Fig. 3.

The model used in this test was made one-eighth the size of the actual boat, or 8¼ feet long. She was built from the original lines of the ship, which differed from those obtained by measurement by a small amount, easily corrected. The model was built of two thicknesses of thin cedar planking over solid molds, which were fastened to a rigid backbone, giving a very substantial and watertight construction. A short deck was fitted in the bow of the model, to keep the water from splashing in during the test, while the after part was left open to permit ballasting. As soon as the load line was determined by measurements in the actual boat, the same line was located on the model and she was ballasted to float on that waterline. The ballast consisted of bags of sand, weighing in all 80 pounds. The model itself weighed 68.5 pounds, so the total displacement was 148.5 pounds. The center line of the propeller shaft was located on the model as shown in Fig. 4, and the towing cord attached to the bow in that line. This rendered any change of trim occurring in towing the model virtually the same as caused in the actual boat by the thrust of the propeller.

Considerable experimentation was necessary to devise a satisfactory towing arrangement for the model, for on its

RESULTS OF SPEED TRIAL						
SPEED KNOTS	6.37	7.12	7.85	8.40	9.89	10.28
REVS PER MIN.	131.0	148.9	168.0	183.1	223.5	238.0
RED. M.E.P.	334.9	44.79	55.98	66.69	102.58	119.83
I. H. P.	17.6	26.8	37.8	48.9	91.9	114.8

FIG. 3.

efficiency depended the success of the entire undertaking. A sketch of the towing device is shown in Fig. 5. A 30-foot gasoline (petrol) launch with a 14-horsepower engine was used to provide the motive power. In order to have a steady foundation to support the scales for weighing the pull of the model, they were mounted on a temporary platform set up on the deck of the sailboat which was towed by the launch. The sailboat was a broad, shallow boat of the skimming-dish type, was easily towed and afforded a very stable support for the scale. The sailboat was towed directly astern of the launch and connected to it by a rigid strut, 12 feet long. If the engine of the launch missed an explosion, and so tended to make the speed irregular, the momentum of the sailboat would be transmitted to the launch through the strut, and so would minimize any variation in speed. To give the sailboat greater stability about 2,000 pounds of sand ballast were placed in the

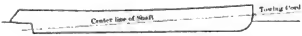

FIG. 4.—POSITION OF TOWING CORD FOR MODEL.

boat, almost doubling her displacement. This additional weight materially assisted in keeping the speed of the launch steady. It was desirable to get points on the resistance curve of the model at as low a speed as possible. The problem arose, therefore, to slow the speed of the launch down to about 1½ miles an hour and yet have the engine turning over fast enough to run steadily. This was accomplished by taking a plank, 8 feet long and 2 feet wide, weighted on one edge, and placing it athwartships under the sailboat directly in front of the bilge boards. The plank exposed a large area to the line of motion of the boat, and so greatly increased her resistance. With this arrangement in place it was found that a speed of one and one-tenth miles an hour could be obtained with the

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engine running steadily at between 200 and 300 revolutions per minute.

After considerable investigation as to the best type of weighing apparatus, it was decided to use an ordinary equal arm scale balance. The scale arm was graduated in ounces and quarter ounces up to 1 pound, and additional weights, when needed, were placed in the scale pan. The scale was mounted on a platform on the port side of the mast of the sailboat. The towing cord was conducted over bicycle wheels with the tires removed, as frictionless pulleys, from the model to the scale. One wheel was secured in a horizontal position on the end of a 12-foot boom swung out to the side of the boat. The other wheel was placed vertically under the weighing platform and led the cord up to the scale. The model was towed about 4 feet aft of the outer end of the boom, in which position it could rest in quiet water, usually undisturbed by any waves from the launch. The towing cord consisted of strong fishing line which had enough elasticity to take up sudden shocks and jerks, yet when stretched out taut by a steady pull would transmit all variations of resistance large enough to be detected by the scale.

In the preliminary runs it was found that the pull varied incessantly, and to such a degree that it was impossible to balance up the scale. The horizontal arm would vibrate so violently as to hit the stops and prevent any possibility of accurate weighing. To surmount this difficulty the device illustrated in Fig. 6 was attached to the scale. Two rubber bands were looped over yokes, as shown. One yoke was fastened to the same ring which held the towing cord, and the other was fastened to the framework which supported the scale. The latter was secured so that the tension in the elastics could be adjusted to any desired amount. A pointer was fastened to the cross-bar of the balance, which moved up and down over a vertical scale. The tension in the elastic was regulated so that with no pull on the towing cord, and the sliding weight set at 8 ounces, the arm of the balance was horizontal. This brought the pointer over the zero mark on the scale. Other divisions were marked on the vertical scale, corresponding to the position of the pointer when the sliding weight was set at different points, 2 ounces apart. With this arrangement it was found that the rubber bands took up small, irregular variations in pull; and by a careful setting of the sliding weight the pointer could be made to vibrate over equal distances on either side of the zero line. When this condition was obtained the weights balanced the average pull.

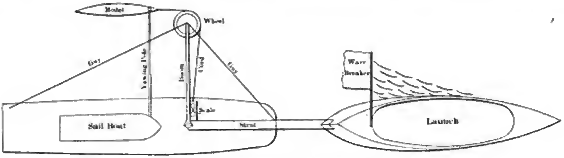

Fig. 5.—Experimental Towing Device

It was found that the model had a tendency to yaw occasionally from one side to the other when being towed. This yawing brought an increased pull on the scale and vitiated the results. To prevent this a long spike was placed in the bow of the model and a wire loop fastened to the end of a bamboo pole. This loop was then placed over the spike and the other end of the pole held in the sailboat. The distance from the loop to the boat was adjusted so that when the model was towing straight the loop did not touch the spike. If the model started to yaw, however, it would be checked by the spike striking the side of the loop and the model would again resume its true course. It was found that successful runs could only be made in very quiet water; a slight wind and its accompanying waves would spoil the runs, and at some speeds the bow waves of the launch interfered with the model slightly. A piece of heavy canvas was suspended on a horizontal pole and held on the port side of the launch. The position of the pole was adjusted so that the bottom edge of the canvas dragged over the water. This broke up the waves from the launch, so that they produced no effect on the actions of the model.

An important part of the test came in the laying out of a course for the model runs. This was done in a bay of Big

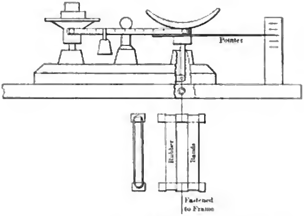

Fig. 6.

Results of Model Test

Speed Model Ft. per Sec.	2.0	3.0	4.0	5.0	6.0	7.0
Frict. Res.	0-3.7	0-7.8	0-13.1	1-3.7	1-11.5	2-4.5
Resid. Res.	0-2.8	0-4.9	0-8.6	1-00	2-1.0	5-0.5
Speed Boat Knots per Hr.	3.35	5.03	6.71	8.39	10.06	11.74
Frict. Res.	80-12	160-15	286.0	429-12	599-7	794-3
Resid. Res.	95-6	164-5	286-3	530-0	1091-11	2665-13
Eff. H.P.	1.81	5.01	11.77	24.73	52.25	124.7
Ratio $\frac{E.H.P.}{I.H.P.}$	.548	.528	.529	.521	.525	—

Fig. 7.

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Island, Lake Minnetonka. The bay was well sheltered from the wind, and had water of sufficient depth for the test close to shore. A course approximately 500 feet long was laid off, with range poles every 100 feet and a free run of 200 feet at each end of the course. One row of range poles was driven into the bottom close to the shore, and another row, parallel to the first, was placed in about 5 feet of water. These poles were driven down so that 4 feet were left projecting out of the water. The course line was located parallel to the line of stakes and about 250 feet out from shore in 10 feet of water. The line of the course was defined by sight poles set up on shore, two at each end of the course, to enable the man steering the launch to get onto the course readily.

It may be well to give a brief description of the manner of running the tests and the positions of the observers. One man steered the launch and tended the engine. He had to use great care to get the launch and the sailboat squarely on the course and running steadily before coming to the first line of range poles. Another person was stationed in the launch to take the time readings in passing the successive marks on the course. A split-second stop watch was used, so the time over

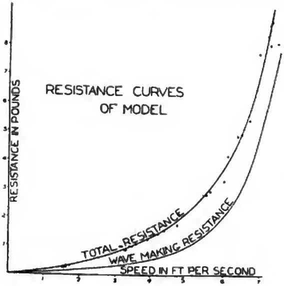

FIG. 8.

the whole course was obtained independently of the summation of the individual readings. Another man recorded the time readings as called off by the timer and the pull as reported by the man in charge of the weighing apparatus. On the sailboat one man took the pull readings and kept the pointer as near the zero mark as possible by shifting the sliding weight. Another man steered the sailboat on the turns at the end of a run and kept her directly astern of the launch during each test. A third man held the pole which kept the model from yawing and disengaged any weeds or floating debris which the model ran afoul of during the run. A tender was towed from the sailboat for use in case it was necessary to make any adjustments to the model during the series of runs.

After the apparatus was all put into working order, sixty runs were made over the course at speeds from 1 to 5 miles an hour. The data from these runs was carefully faired up and unreliable runs discarded. The displacement of the steamer was calculated from the measured lines and found to be 79,635 pounds, or 35.75 tons. The wetted surface of the hull was calculated by Taylor's mean secant method and amounted to 967.75 square feet. The resistance curves of the model were drawn, as shown in the accompanying figure. Average speeds in feet per second were used as abscissæ and the corresponding average pull in pounds as ordinates. Each run was plotted and the best representation curve was drawn. It was necessary to sub-divide this resistance, as experimentally determined, into the frictional and residual or wave-making resistances. The wetted surface of the model was

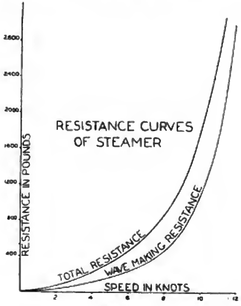

FIG. 9.

calculated from the wetted surface of the boat by the theory of mechanical simultude, and was found to be 14.75 square feet. The frictional resistance of a ship, according to William Froude's formula, is $R_f = F S V^n$, where R_f is the frictional resistance in pounds, F is the coefficient of friction, S is the

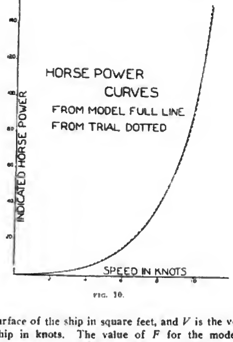

FIG. 10.

wetted surface of the ship in square feet, and V is the velocity of the ship in knots. The value of F for the model was .01153 and the exponent n 1.825, as determined from Froude's tables. By the use of this formula it was possible to compute the resistance of the model due to skin friction at different speeds. A curve through these points gave the curve of

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frictional resistance. The residual resistance, the other component of the total resistance, is composed of stream-line resistance, eddy-making and wave-making resistances, and so forth. These resistances cannot be readily separated, so the curve plotted as wave-making resistance has ordinates equal to the difference of the total and frictional resistance ordinates.

The next step was the construction of curves for the steamer similar to those for the model. The frictional resistance was calculated directly from Froude's formula, using the value of F as .0091 and n as 1.825. By the laws of the resistance of ships at corresponding speeds—that is, speeds which vary according to the square root of the length of the ships—the residual resistance is proportional to the displacements of the vessels. Applying this to the steamer and its model, the residual resistance of the boat is to the residual resistance of the model directly as the displacement at speeds which are proportional to $\frac{\sqrt{70.25}}{\sqrt{8.75}}$. This, however, assumes that the displacements of the boat and model are proportional to the cube of their lengths. Using the displacement of the steamer as calculated, and multiplying by the ratio $\frac{(8.75)^3}{(10.25)^3}$, it was found that the displacement of the model should be 153.9 pounds. As tested, the model weighed only 148.5 pounds. This discrepancy is due to the fact that the steamer was built somewhat fuller than the original design called for, and so, at a given load line, would have a proportionally greater displacement than the model. Before the residual resistance of the model could be used in calculating the residual resistance of the boat it had to be raised to the proper value for a model with 153.9 pounds displacement. Using the theory of mechanical similitude, the residual resistance for boats of the same length and at the same speed varies as the two-thirds power of the displacement. Therefore, the corrected resistance of the model equaled the observed residual resistance multiplied by the ratio $\frac{(153.9)^{2/3}}{(148.5)^{2/3}}$. Using this corrected resistance, the residual resistance curve of the steamer was easily determined. The sum of the ordinates of the frictional and wave-making resistance curves at any point gave the ordinate for the curves of total resistance which was next drawn.

Next, the effective horsepower of the engine at different speeds—that is, the power utilized in actually propelling the boat—was determined. The total resistance of the steamer at a given speed, multiplied by that speed in feet per second and divided by 550, gives the value of the effective horsepower at that speed. The effective horsepower curve, whose ordinates are obtained as just described, was affected by a factor to reduce it to indicated horsepower, so that it could be compared with the indicated horsepower curve obtained from the speed trial. Indicated horsepower equals effective horsepower divided by the product of the efficiency of the engine, the efficiency of the propeller and the hull efficiency of the boat. The product of these last three factors is called the efficiency of propulsion. An engine efficiency of 87 percent was adopted as a fair value after comparison with other engines of the same type and power. The efficiency of the propeller was more difficult to estimate, due to the irregularities in pitch and thick blades. The efficiency was calculated from data and curves worked out by D. W. Taylor and allowance made for the bad features of the wheel. The combined efficiency of the propeller and hull ranged from 58½ percent to 63 percent. The indicated horsepower curve was derived from the effective horsepower in the manner just described, and was plotted in the same diagram as the horsepower obtained from the speed trial. These horsepower curves check up very well, and since the curves cross and recross it would indicate that there is no very large constant error entering the work. The variance between the curves is in most cases less than 2 percent. The indicators used in obtaining the indicated horsepower on the speed trial are not accurate to better than 2 percent, so the results check within that allowable deviation.

There is a means of comparison between model work and actual performance which has been found more satisfactory in practice than a direct comparison of indicated horsepower. This consists of finding the ratio of the effective horsepower from the model test to the indicated horsepower from the speed trial. In the accompanying table of results, Fig. 7, the value of this factor is given for the test under discussion. In Fig. 7 also are given the values of the resistances of the steamer and model in pounds and ounces and the effective and indicated horsepower.

The results obtained in this experiment in a great measure vindicate the use of the simple apparatus used in testing. They should also demonstrate the practicability of model testing in open water as a means of estimating the power necessary to drive a ship at a given speed.

STEEL STEAM COLLIER NEWTON.

The steamship *Newton*, which was launched at the yards of the Fore River Shipbuilding Company, Quincy, Mass., Sept. 25, 1911, forms a notable addition to the fleet of the New England Coal & Coke Company, of Boston. She is of the same general type as the *Everett*, *Malden* and *Melrose*, constructed for the above company about four years ago by the Fore River Shipbuilding Company, and has been especially designed for rapid and economical handling of bulk coal freight between the South and Boston.

The *Newton* is a single-screw steamer with the machinery located aft, constructed of steel with scantlings, in accordance with the American Bureau of Shipping and British Corporation for the highest class awarded by these societies, and the principal dimensions are as follows:

Length from fore side of stem to aft side of rudder post	389 feet.
Beam, molded	54 feet 6 inches
Depth, molded to spar deck	31 feet.
Load draft	23 feet.
Deadweight carried on this draft exclusive of water and bunker coal	7,200 tons.

GENERAL ARRANGEMENT.

The general arrangement of the vessel is such that she has a straight stem, semi-elliptical stern, one continuous complete steel deck, and a full poop, bridge and top-gallant forecastle. Accommodations are provided in the 'midship house for the officers, with saloon, guest room, spare room, pantry, storerooms, baths and toilets; and on the bridge deck is a specially arranged suite for the captain, with a commodious chart room and pilot house over it. The long poop encloses quarters for the firemen, seamen, oilers and petty officers, and in the Liverpool house on the poop deck are arranged the quarters of the engineers, with officers' and engineers' mess, baths and toilets. The crew of the *Newton* comprises forty-three men.

The space allotted to the carrying of cargo has been subdivided by watertight bulkheads into five large holds, constructed on what is known as the self-trimming system. This consists in sloping the hatchways from their side coamings to the side of the ship at an angle of about 45 degrees, the triangular prism formed by this line with the topsides and the

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spar deck being cut off and utilized as topside ballast tanks, to be filled with water when the vessel is running light. In addition to these ballast tanks a deep double bottom is provided right fore and aft for the carriage of water ballast besides the usual fore and after peak tanks. The great capacity for water ballast thus provided will insure a good immersion of the vessel when in light condition, thereby providing greater stability and guarding against emersion of the propeller in this condition.

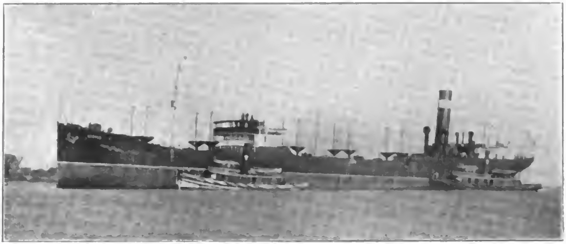
The double bottom is divided longitudinally all fore and aft by a watertight center keelson with the compartments on each side of same handled by independent pumping systems. By filling or draining tanks on either side the vessel may always be kept in upright position while loading. This condition, which is not obtainable in any other colliers on the American coast except the *Everett*, *Malden* and *Melrose*, eliminates the necessity of trimming cargo while loading, and the holds may be filled to their maximum capacity of 7,200 tons in less than six hours. This vessel, in fact, closely approaches the perfect self-trimmer—the unattainable ideal of all shipowners.

runs by gravity from a daily service tank supplied by the fresh water sanitary pump. The officers' lavatories are supplied with hot as well as cold water.

The electric light plant consists of one 25-kilowatt, direct-connected General Electric Company marine generating set with a combined generating and distributing switchboard. The distribution is on the two-wire system, and supplies current for one 18-inch searchlight, about 150 16-candlepower incandescent lamps and the required running and signal lights.

Living and public rooms throughout the vessel are provided with steam heat designed to maintain a temperature in zero weather of 65 degrees F. Cowl ventilators are fitted to all living quarters.

The life-saving outfit consists of two 24-foot wooden lifeboats, one 16-foot wooden dinghy and one 20-foot wooden gig, fitted with a gasoline (petrol) engine. The lifeboats are stowed on the navigating bridge and handled by ordinary round bar davits. The dinghy and gig are stowed on skid beams outboard of the poop deck house, and handled by davits of the Mallory type.



LARGE STEAM COLLIER NEWTON, BUILT BY THE FORE RIVER SHIPBUILDING CO.

Each hold is operated through two cargo hatches 30 feet in breadth by 15 feet in length. The hatch covers are of steel, and of special construction, to insure absolute watertightness and quick handling of the covers in opening and closing. The vessel is usually unloaded by means of grabs, but a set of kingposts and cargo booms will be supplied for use in emergency or when grabs are not available.

The vessel will be rigged with three pole masts, the fore and main masts being of steel and the mizzen mast of wood. A complete suit of sails will be provided, comprising fore and main sails and staysails.

The poop deck from the front of the house aft and the bridge deck are laid with 3-inch by 5-inch clear long-leaf yellow pine, the holds are ceiled with two 2½-inch thicknesses of North Carolina pine and the flat of the coal bunker with 3-inch North Carolina pine.

The joiner work and furniture in quarters is finished generally in oak. Transoms and seats are upholstered in dark green rep or pantasote. The floors in officers' and engineers' quarters are covered with heavy brown linoleum, in the pilothouse, chart room, captain's office and saloon with rubber tiling; the galley floor is laid in unfinished red tile and the bathrooms in ceramic tile.

The sanitary arrangements are very complete, running water being supplied to all fixtures. The salt water is kept under pressure by a salt water sanitary pump, while the fresh water

PROPELLING MACHINERY.

The propelling machinery, located in the stern of the ship, consists of a vertical inverted, three-cylinder, triple-expansion engine, with cylinders 25, 41, 68 inches diameter, having a stroke of 48 inches, supplied with steam at 190 pounds pressure by three single-ended Scotch boilers working under a heated forced draft system.

The bed-plate of the main engine is of the usual box section type of cast iron in three sections, having six main bearings of cast iron lined with white metal. The bearing caps are of forged steel. All lower halves of main bearings may be removed while the crankshaft is in position. The crankshaft is of the built-up type, of forged steel throughout, in three interchangeable reversible sections. The diameter of the shaft at the bearings is 13¾ inches. The crank pins are 14 inches diameter by 14 inches long, the crank slabs 26 inches wide by 9½ inches thick, and all couplings are 26 inches diameter by 3¼ inches thick, joined by six steel bolts.

The cylinders are supported by six cast iron columns of box section, three front and three back. All crosshead guides are fitted for water circulation. The cylinders are arranged, beginning at the forward end of the engine, high-pressure, intermediate-pressure and low-pressure. The high-pressure cylinder is fitted with a liner, and the valve is of piston type, 13 inches diameter, taking steam in the middle and exhausting over the ends. The intermediate and low-pressure cylinders

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are fitted with double-ported slide valves, working on cast iron false seats. All valves are fitted with balance cylinders for taking weight of valves and gear. In addition, the intermediate and low-pressure slide valves are fitted with balance rings on the back for relieving pressure on valve seat.

The pistons are of conical form, the high-pressure is of cast iron, while the intermediate and low-pressure are of cast steel. All pistons are fitted with Mudd's rings and cast iron followers. The piston rods are 6 inches diameter, the low-pressure being fitted with a tail rod 4 inches diameter. Piston rods and valve stems are packed with metallic packing. The forged steel crossheads are secured to the piston rods by steel nuts, the lower ends of the rods being tapered to fit the crossheads. Crosshead slippers are cast iron faced with white metal, and crosshead pins are 7 inches diameter and 7½ inches long. The connecting rods are forged steel, 9 feet between centers. The top and bottom end boxes are cast steel lined with white metal, the caps being secured by forged steel binders. The valve gear is of the usual Stephenson double-bar link gear type.

An 8-inch balanced throttle valve worked by a hand-wheel, and a butterfly valve worked by a hand lever, control the supply of steam to the high-pressure valve chest. The receivers are cast with the cylinders. The main exhaust pipe to the condenser is of copper, 21 inches diameter.

The reversing gear consists of a direct-acting steam cylinder, 12 inches diameter and 18 inches stroke, secured to the back of the intermediate-pressure cylinder. A reverse shaft, 6½ inches diameter, carried in bearings at the back of the engine, transmits motion from the reverse engine to the links. The cut-off of each valve may be adjusted separately by means of a sliding block worked in slotted reverse shaft arms. Smooth action of the reversing engine is secured by a 6-inch diameter piston working in a hydraulic cylinder. A 6-inch by 6-inch single-cylinder reversible turning engine is fitted at after end of the main engine bed-plate on sliding adjustable foundation.

The thrust shaft is 13¾ inches diameter, with nine collars 20 inches diameter, 1⅞ inches thick, forged solid with the shaft. The propeller shaft is 14 13/16 inches diameter, protected throughout its entire length by composition sleeve shrunk in place. The propeller is secured to the tapered end of the shaft by a forged steel nut and feather. All shaft couplings are 26 inches diameter, 3¼ inches thick, connected by six forged steel bolts 3½ inches diameter.

The thrust bearing is of the usual horseshoe type, having nine adjustable cast iron horseshoes faced with white metal. Each shoe may be adjusted separately, while the entire bearing may be moved fore and aft by means of wedges. The bottom of the pedestal forms an oil chamber into which the collars project. The stern tube bearings are of composition, lined with lignum vitæ.

The propeller is of the built-up type, 16 feet 9 inches diameter, 18 feet pitch, 92.3 square feet developed area, having four adjustable bronze blades secured to a cast iron hub by bronze studs and nuts. The pitch may be adjusted from 17 feet to 19 feet.

BOILERS.

The boilers are 14 feet 2 inches mean diameter and 12 feet 6 inches long, arranged in a single fire room. Each boiler has three Morison furnaces, 44 inches inside diameter, and three combustion chambers. The tubes are 2½ inches outside diameter. The total heating surface for the three boilers is 7,407 square feet, with 165 square feet of grate, giving a ratio of about 45 to 1. The grates are about 5 feet long.

Air for the heated forced draft is delivered to the furnaces by a fan located in the engine room and driven by a 6-inch by 5-inch vertical engine, working at a steam pressure of 125 pounds. The fan is 84 inches diameter, and at 312 revolutions per minute delivers 24,000 cubic feet of air per minute at a pressure of 3 inches of water. On each up-take there is a heater box containing 198 3½-inch tubes 3 feet 6 inches long, around which the air passes before entering the furnaces.

The vessel is fitted with one double circular stack, 9 feet 6 inches outside diameter, about 80 feet high above the grates.

AUXILIARIES.

The air pump is of the Edwards type, 24 inches diameter, 20-inch stroke, driven by beams and links from the low-pressure crosshead. The body of the pump is cast iron, having a composition liner.

The condenser, placed on brackets at the back of the engine, has a cylindrical steel plate shell with cast iron water chests and covers. There are 1,394 ¾-inch brass tubes, 11 feet long between tube sheets, giving a cooling surface of 3,011 square feet. The tube ends are packed in the usual manner with corset lace packing secured by brass glands screwed into rolled composition tube sheets. Circulating water for the condenser is taken from a centrifugal pump of the Fore River type, having 12-inch suction and discharge. The pump, driven by an 8-inch by 8-inch vertical engine, has the following connections: Suction from sea and discharged overboard through condenser, also a small connection is fitted to the evaporator.

The following additional pumps are fitted: Two feed pumps, 10 inches by 7 inches by 10 inches vertical duplex Blake, Admiralty type, with suctions from sea, after tank, auxiliary condenser, feed tank and boilers, and discharge through the feed-water heater or direct to the boiler through the main or auxiliary feed line, or overboard. The connections are such that either pump can be used independently of the other. When acting as feed pumps they are automatically controlled by a float in the feed tanks.

Two ballast pumps, 10 inches by 12 inches by 10 inches, vertical duplex, with suction from sea, bilge manifold, ballast manifolds, and from engine and fire-room bilges, and discharge to fire main, ballast manifolds and overboard.

Two bilge pumps, 4½ inches by 20 inches, plunger type, connected to the main air pump crosshead, have suction from the engine and fire-room bilges and bilge manifolds, with discharge overboard.

One salt-water deck service and fire pump, 6 inches by 4 inches by 6 inches, horizontal duplex, with suction from sea and discharge to the sanitary system, fire main, deck-washing pipe and engine-water service. This pump is interchangeable with the auxiliary condenser circulating pump.

One fresh-water pump, 3½ inches by 4 inches by 4 inches, horizontal siimplex, with suction from fresh-water tanks and discharge to ship's fresh-water system.

One auxiliary condenser circulating pump, 6 inches by 4 inches by 6 inches, with suction from sea, discharge end of condenser and after tank, through the auxiliary condenser overboard or to the top-side tanks and deck service lines.

One 2-inch Hancock injector is fitted, with suction from the reserve feed tank, auxiliary condenser and sea, discharge to the auxiliary feed line and hose connection.

An auxiliary condenser containing 602 square feet of cooling surface is located in the engine room. Circulating water for this condenser is taken from the deck service and fire pumps.

A feed-water heater of the Quiggins vertical type is located in the engine room on the discharge side of the feed pumps. The heater has a rated capacity of 2,700 horsepower.

One 25-ton evaporator of the Blake type is installed in the after end of the engine room. Steam for operating is taken from the auxiliary steam line, and the vapor is discharged to the condenser, feed tank and after tank.

The refrigerating plant consists of a 1-ton Brunswick am-

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monia compressor driven directly by a vertical engine. Both fire-room ventilators are fitted with sheaves for hoisting ashes. A Hyde double-cylinder ash-hoist engine is fitted for raising ashes to the spar deck, where they are handled on trolley ways on each side of the ship. A hand ash-hoist gear is also fitted.

DECK MACHINERY.

The steering gear is of the Hyde steam and hand-gear type, with an 8-inch by 8-inch engine, operated by a telemotor, with steering stands located in pilot house, on flying bridges and on poop deck house aft. An emergency steering gear is fitted, consisting of a tackle leading from a spare tiller to winch on spar deck.

A No. 11 Hyde steam-brake windlass is located on the forecastle deck, operated by a worm and spindle from a 12-inch by 12-inch vertical engine on deck below. The wildcats on the windlass are suitable for 2¼-inch stud-link cable. Large quick operating warping ends are fitted on each side of the windlass. Ten double-cylinder 8-inch by 8-inch Hyde reversible steam winches are located on the spar deck for cargo and hatch-handling purposes. A Hyde steam, quick-warping capstan is fitted on the poop deck with the engine above the deck.

GAS ENGINES; THEIR DESIGN AND APPLICATION.

BY E. W. PERCY.

(*Continued from page* 459.)

EXPLOSIVE MIXTURES.

Many things affect the pressure value of an explosion in a confined space. The principal features are ignition, proportions of mixtures and pressure under which they ignite. By means of many experiments and methods too complicated to detail here, it has been fairly well established that the explosion in an engine is about as follows: First, the mixture is ignited at a given point, and from this point a little ball of flame extends in all directions. The ignition and the forming of this little ball of flame occupy most of the time necessary for ignition, as after the ball has attained a certain size the mixture seems to detonate and to burn so quickly that it is not possible to measure the time. The reason for this is that when the mixture is ignited, especially if there be a fat, hot spark or other certain means of ignition, combustion spreads on all sides, increasing the temperature and pressure until the temperature and pressure of the entire mass has been so raised that it detonates or all takes fire at once from its own heat, irrespective of the combustion traveling out from the original point of ignition. This, of course, refers to modern engines of fairly high compression whose charge is mixed outside of the cylinder and introduced *en masse*. In an old-fashioned engine of very low compression, or injection engines, the process would be very different to that of the engines in most general use, which employ gas or carbureted mixtures.

The pressures obtainable by different mixtures have been worked out in great detail by many experimenters, but most of these experiments have not been under gas-engine conditions, but rather with pure gases with atmospheric pressures undiluted with other gases. However, some practical and valuable experiments have been performed by Clerk and afterwards by Grover. Strong and weak gases show decidedly different characteristics in these experiments. Vapors of gasoline and distillates may be said to show practically the same characteristics as gas, but as there is no accurate way of measuring their volumes the only way of obtaining data relative to vaporous mixtures is to note the effect on the engine or on the experimental cylinder for a definite period of time in the different experiments and then check the amount of liquid used. In pressures and temperature they may be said to bear a general relation to strong gases in proportion to their respective calorific values. It is generally supposed that products of combustion when mixed with fresh charges decrease the maximum pressure and entirely reduce the efficiency of the charge. This supposition is entirely nullified by experiment and by the statement of Grover (page 217, third edition). The experiments carried out by Grover show that the greatest rise in pressure takes place when there are about 30 percent of particles of combustion present under a provided charge. This determines definitely that gas-engine men need not carry scavenging devices to an extreme. While such devices have shown an increase of power it is rather due to the extra mixture admitted to the cylinder than to any increase in efficiency. Making a general review of the experiments the following data may be synopsitized:

Mixtures—When the proportion of gas to air is 1 to 15 the explosion is very weak.

When the proportion of volume is 1 to 16 the mixture can rarely be ignited.

When it is 1 to 4, or 5, the mixture is so rich that it can rarely be ignited.

The maximum point is, of course, purely a matter of chemistry of the fuel, but in a general way it may be said that a mixture of 1 to 10 and 12 is about right.

Relative to inert gases present about 55 percent of the products of combustion may be introduced without preventing the ignition; more than this is apt to so act.

In general, it may be said that the following is true of mixtures of all kinds:

With weak mixtures the maximum pressure is least and the excess of pure air is greatest.

The maximum pressure obtained from a given quantity of gas rises as the excess of air is diminished by the addition of particles of combustion, but this does not hold good when the volume of pure air to gas approaches the proportion of 10 to 1.

The explosion becomes more rapid when excess of air is replaced by neutral gases.

The time limit in the exploding mixtures is an important item in most mixtures of maximum pressure, and is reached in one-eighth to one-quarter seconds; that is, with low compression, with cold cylinders and jump-spark ignition. Under high compression, hot cylinders and hot make-and-break spark, the time would be inconceivably short; at the same time, if the spark is unduly retarded or the mixture unduly rich, combustion will still be in process and the charge goes into the exhaust pipe. These things should be carefully taken into consideration in designing an engine, especially a high-speed engine, as the combustion takes an additional amount of time.

Carbureted mixtures may be taken at the volume of air because they consist primarily of finely divided spray of a nominal volume carried in the air, but when the air becomes heated this spray is vaporized, and occupies a volume approximately equal to that of gas of equal calorific value. No experiments are known which establish this fact, but general action of the engine valves, etc., seem to indicate that such is the case. When an engine, particularly a high-speed engine, persistently blazes in exhaust pipe it is important that the richness of the mixture be reduced or that the speed be reduced or the spark advanced if any economy is to be hoped for.

Temperatures—Maximum temperatures of explosion frequently go as high as 4,000 degrees, but this does not mean that any part of the engine must be made to withstand 4,000 degrees, because the maximum temperature varies almost directly with the maximum pressure and its duration is infinitestimally short. Hence the gas-engine man is not vitally concerned with the maximum temperatures of mixtures, even for purposes of design. If the mixture contains considerable

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hydrogen, every provision should be made for cool gas and avoidance of heat.

With very high compression, *i. e.*, 150 pounds upwards, in engines having gases high in the percentage of hydrogen, special provisions must be made for heat and for a large difference in expansion between the cylinder walls and the jacket walls on account of their difference in temperature. The maximum pressure is found to vary almost exactly with the heat units present in the mixture.

The ignition temperature of the various gaseous mixtures is about as follows:

Hydrogen combines with oxygen at about 1,100 degrees F.

Producer gas combines with the oxygen of the air at about 3,700 degrees F. Hence it is easy to see that if a high compression is carried and the engine has good ignition, the combustion will not have to proceed very far before the pressure and temperature are such that the whole mass will detonate.

Pre-ignition should be most carefully guarded against. In small engines there is comparatively small danger of pre-ignition on account of the large amount of cooling surface in proportion to the volume; but as the cooling surface increases as the square of the dimension of the engine wall, while the volume increases as the cube, it is easy to see that a point is reached in which the volume is so much greater in proportion to cooling surface that the center portion of the mixture can become very highly heated from compression and may pre-ignite.

When one remembers that in large gas engines of 24 inches diameter or thereabouts, and with 300 pounds maximum explosion pressure, the total pressure would be about 132,000 pounds, or nearly 70 tons, which would be very apt to wreck the strongest built engine. For this reason it is not advisable to build gas or oil engines of the carbureted type larger than 18 inches in diameter.

In connection with the exploding of mixtures on account of their already mentioned high temperature and small entropy or mass, it is probable that the introduction of water into the cylinder may become a very important factor of gas-engine design in the future, but it will not be done in the present haphazard manner. Among its many advantages are that it raises the thermal efficiency, permits compounding, may dispense with jackets by injection on the suction stroke, and the exhaust may be handled in the same manner as the exhaust of the average steam engine is used to-day for the heating of houses, etc.

Carburetion and Mixtures—The making of proper mixtures for the gas engine with fixed gas is a very simple proposition, simply requiring valves or orifices so arranged that the air and gas flow to the engine in certain fixed proportions in a continual stream. But with liquid fuels considerable complication is involved, because the fuel must first be vaporized and then mixed with air in suitable proportions for combustion and explosion.

The liquid fuels, so far as the gas engine is concerned, divide themselves into two classes—those that vaporize at atmospheric temperatures and those that require higher temperatures. The first class includes gasoline (petrol), naphtha, benzine and lighter distillates; the second class includes the heavy distillates—kerosene (paraffin), alcohol, etc. There are many different carbureters for carbureting the first, and they include the many well-known types used on automobiles and marine and stationary engines.

All of those in common use depend upon the spraying of a jet of fuel drawn into a rapidly-moving current of air, and may be divided into three classes. They are the gravity feed, the float feed and the overflow. In the gravity feed the fuel is led to the jet directly from a source of supply by gravity. The objection to this type of carburetor is that the level of the fuel may be changed and the pressure otherwise changed, causing a difference in the amount of fuel discharged from the jet.

The float-feed type involves the use of a small needle valve, controlled by a float. This and the gravity feed are the most commonly-used types of carburetors because of their greater reliability, and they will submit to a fairly sudden change of conditions, but they are by no means perfect.

In the overflow type of carburetor the pressure at the jet is maintained constant by means of an overflow pipe, which in turn requires a pump to supply the fuel. This type of carburetor is liable to the same variations as the float feed, and has the additional complication of the pump, and the additional advantage of allowing the fuel tank to be below the engine, or, as in the case of a stationary engine, to be buried in the ground, making this type of carburetor almost a necessity for installations in which the tank is required to be buried to meet underwriter specifications, etc.

In addition to these three general types of carburetors are a number of special carburetors which aim to deliver fuel in definite proportions to the amount of air used. Some of them make use of small pump plungers, others fans, driven by the air current. In general, their mechanism has been found faulty as regards wearing qualities or reliability or as regards their inability to deliver definite quantities of fuel in the rapid succession required, yet it is quite possible that such a carburetor will be developed on a practical basis.

In making a carbureted mixture and planning for same it is necessary to carefully distinguish between a mixture in which the particles of fuel are in suspension, seen in fine drops or spray, or in the later stage of the mixture in which it is in the form of vapor well mixed with air. During the first stage it is necessary that the air travel at the very highest velocity or the suspended fuel will condense on the sides of the pipe and run downwards or back to the carburetor, but after the fuel has changed from suspended particles to properly mixed vapor it can travel at a much lower velocity without condensation. In connection with this it should be noted that the velocity of gas in the inlet pipes is as many times greater than the piston velocity as the area of the piston is to the area of the pipe.

The cycles, or number of piston displacements per revolution, have no effect upon the gas velocity, provided there are less than four displacements of mixture per two revolutions, for the reason that when the inlet valve is open and the piston sucking the charge in, the charge must travel in proportion to the full piston velocity, irrespective of the fact that there may be only one piston displacement of mixture in two revolutions. This fact is somewhat modified if the chamber of the valves or the branch pipe have a relatively large volume in which to store mixture between strokes.

If a certain velocity through the carburetor, and for some distance beyond it, is not maintained, and the mixture has its velocity reduced before the suspended particles are all vaporized, these particles will condense and run back into the carburetor, which accounts for the mixture growing weak and firing back when the engine is brought down to low speed, together with the fact that there is less vacuum to draw out the fuel through the nozzle, from which we gather that if it is desirable, as in a marine engine, to have the speed of the engine controllable over a wide range of volume, a very small pipe should be used which will maintain sufficient velocity for carburetion when the engine is running most slowly. It may be said that the proper velocity for the best results is from 5,000 to 7,000 feet per minute; lower velocities than these are apt to deposit fuel on the sides of the pipe, but in the case of a marine engine, running at, say, 250 revolutions per minute, in which a maximum speed of 75 revolutions per minute is frequently desirable if the pipe be designed for the maximum speed, it is easy to see that at maximum the mixture would have an immense velocity.

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As a matter of fact, in some well-designed engines this velocity will exceed 25,000 feet per minute, but this limits the horsepower, because the amount of mixture which can be gotten in the cylinder is limited, also through rarefications it reduces the compression, which, in turn, reduces the economy and condemns the arrangement in general. Still, the ability to run a marine engine and hoisting engine and certain other types successfully and reliably at very slow speeds is a most valuable commercial attribute, but when designed with such small pipes, at high speeds it becomes necessary to readjust the fuel valve, because the mixture would become too rich. On the other hand, if the engine be slow with the valve at proper adjustment the mixture will become so rich that the engine will backfire. With large pipes it is almost impossible to run the engine slowly, because the mixture becomes so weak through condensation that the engine misses or fails to explode; with the engine in such a condition, besides being covered with condensed fuel and the curve of the suction channel in the carburetor being filled with a small amount of fuel, it is natural that as soon as the engine is speeded up and the draft increased through these pipes, the mixture is heavily primed with this free fuel and becomes so rich as to fail to ignite and the engine misses fire.

(To be continued.)

The thirty-seventh annual convention of the National Marine Engineers' Beneficial Association will be held in Detroit, beginning Jan. 15, 1912. The headquarters will be at the Hotel Tuller.

THE WESTINGHOUSE MARINE TURBINE REDUCTION GEAR.

Until recently there have been but few attempts to construct gearing for the transmission of large powers at unusually high-tooth speeds. The importance of a system of noiseless gearing to be interposed between a high-speed turbine and the screwshaft of a vessel involving the transmission of many thousands of horsepower, has made the attainment of this object an exceedingly attractive field of investigation.

The most serious problem confronting the designer of such a system of gearing has been the development of a mechanism to insure an elastic, uniformly distributed tooth pressure between gear and pinion to avoid the concentration of an excessive tooth pressure at any single point of the working face, which would result in rapid deterioration and ultimate destruction of the teeth. This problem—which is by no means an easy one—it is claimed, has been effectively and interestingly solved in the Westinghouse marine turbine reduction gear.

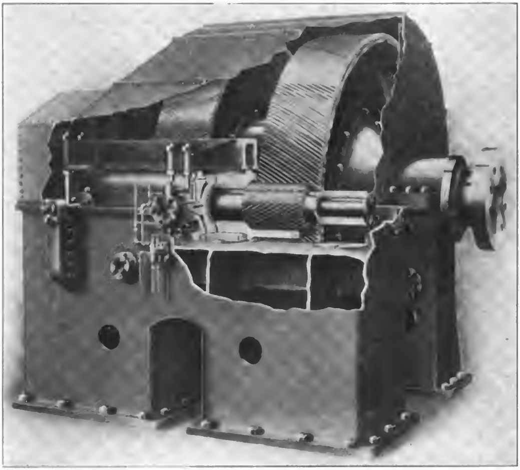

FIG. 1.—PART SECTIONAL VIEW OF WESTINGHOUSE TURBINE REDUCTION GEAR INSTALLED ON THE U. S. COLLIER NEPTUNE.

Fig. 1 is a perspective view—partly in section—of one of the gears installed on the United States ship *Neptune*. Each gear transmits approximately 4,000 horsepower at a speed of 1,250 revolutions per minute for the pinion shaft, and about 130 revolutions per minute for the low-speed or driven shaft. Naturally, double helical gears are used on account of the quiet running qualities of this type, and the fact that the opposing helices automatically balance the end thrust.

The low-speed gear shaft rests in bearings seated in the main casing, and up to this point the design is fairly conventional.

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The essential and distinctively novel feature of the design is the hydraulically-supported frame which carries the pinion shaft and its bearings, and by virtue of which the pinion shaft is self-alineing, responding instantly to the smallest unbalancing of the tooth pressure.

This method of suspending the pinion bearing frame, it is claimed, not only insures the perfect balancing of tooth pressures but the fluid cushion interposed between the pinion shaft and the main casing of the gear silences in a large measure the noise usually associated with the operation of high-speed toothed gearing, and prevents all shock or jar from the rapid contacting of the teeth. After a considerable period of operation the gear teeth take on an excellent polish, and show no signs of pitting or other deterioration that usually accompanies hard and continuous service.

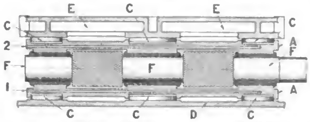

FIG. 2.—DIAGRAM OF HYDRAULICALLY-SUPPORTED FRAME.

The action of this hydraulically-supported frame may be more easily understood by first inspecting Fig. 2, which is a purely diagrammatic section stripped of all mechanical detail that might be confusing, and which illustrates the simple elemental principles of the design. Fully elaborated detail sections are shown in Figs. 3 and 4, and the symbols used in the description refer to the same parts in all of the illustrations.

Referring then to Fig. 2, *A* represents the frame carrying the bearings of the pinion shaft, *D* is a portion of the main casing, and *E* is a rigid strut or beam secured to the main casing by means of a series of steel columns which are shown in Figs. 1 and 3. It will be noted that *A* does not fit closely between the parallel faces of *D* and *E*, but has freedom for a slight upward and downward movement.

On the upper and lower surfaces of *A* are three circular pads bored out to form shallow cylinders in which are fitted short pistons, *C*; 1 indicates a passage or port, which communicates with the three shallow cylinders on the lower side of the frame *A*, and 2 indicates a similar port communicating with the corresponding cylinders on the top side of *A*.

When the gear is working, the reaction on the pinion teeth will tend to force the frame *A* against the casing *D* or the beam *E*, depending on the direction of rotation. If the reaction on the pinion teeth tends to force the frame *A* downwards against *D*, then if oil or other suitable fluid under sufficient pressure be introduced at 1, it will be readily seen that the frame *A* will be lifted clear of the casing, and will actually float on the fluid in the cylinders. Similarly, if the direction of rotation be reversed so that the tendency is to force the frame *A* against the beam *E*, the introduction of fluid under pressure at 2 will prevent the frame *A* from coming in actual metallic contact with *E*. Since all three cylinders of the set that may be in action are connected to the same source of fluid supply, the slightest difference in tooth pressure on either side of the middle point of the pinion shaft *F* will cause the frame *A* to yield at the point where the pressure is unduly high. In thus yielding the excess pressure is relieved, and automatically transferred to the point in the working face of

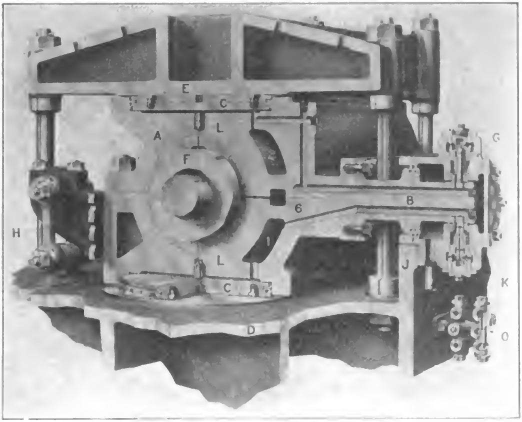

FIG. 3.—DETAILED SECTIONAL VIEW OF THE WESTINGHOUSE REDUCTION GEAR.

the pinion at which the tooth pressure was, at the instant, below normal.

The broad, underlying principle of the design is, therefore, the supporting of the pinion shaft in a frame which literally floats on oil, and which has no metallic or other rigid connection to the main casing. The practical application of this principle involves the accurate and automatic regulation of the fluid pressure in accordance with the load on the gear. The means by which this is accomplished will be understood from a study of the actual detail sections, Figs. 3 and 4.

Fig. 3 is a section through the floating frame at the middle bearing. The frame is split in a horizontal plane for convenience in removing or inserting the shaft and bearings; 1 and 2 are the longitudinal oil passages communicating with the supporting cylinders, and 6 is a duct which conveys lubricating oil at low pressure throughout the length of the pinion frame

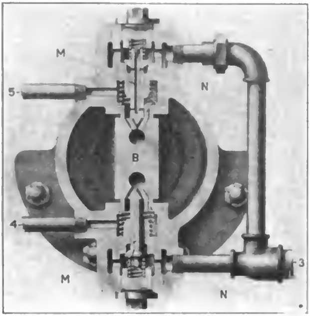

FIG. 4.—SECTION THROUGH VALVE BOX.

and distributes it by means of side outlets to the bearings and to the pinions. *B* is an arm which projects into the valve box *G*, and which contains passages communicating with 1 and 2. *H* is a link which hinges the frame *A* to the casing *D*, so that the slight vertical motion of the frame is multiplied at the end of the arm *B* which controls the oil valves.

For many years it has been known in a general way that if oil be fed to a rotating journal at the point of minimum pressure, it will be carried by the journal to the point of maximum pressure, and if a means of egress is provided the oil may be discharged against a pressure substantially equal to the maximum bearing pressure. Heretofore, practically nothing has been known, however, regarding the quantity of oil that might be pumped through a properly-designed bearing. In the development of this gear it was found that by suitably proportioning the bearings and supporting pistons the former could pump all of the oil required for floating the pinion frame.

Referring to the section through the bearing as shown in Fig. 3, it will be seen that there are small passages connecting the top and bottom of the bearing with the upper and lower cylinders respectively. The bearings draw in oil from the lubricating system, and discharge it through the check valves *L* into the supporting cylinders, and were it not for the automatic regulating mechanism in the valve box *G*, would build up a pressure considerably greater than is required to keep the pinion bearing frame floating in its normal position.

Fig. 4 is a cross section on a larger scale through the valve box *G*. If the direction of rotation of the pinion is such as to bring the lower set of balancing cylinders in action, the excess pressure will tend to raise the arm *B* slightly, and as the ring valve *N* cannot follow it on account of coming up against a shoulder, the surplus oil will escape into the valve box.

Referring back to Fig. 3, *J* is a floating packing, which prevents the overflow oil from spilling directly back into the main casing, and compels it to run off through the drain pipe *K*. This pipe discharges into an open funnel, and the constant overflow of oil is an unfailing indication that the gear is functioning properly. From this funnel the oil may be returned to the main casing to be circulated again through the lubricating system.

When starting, it may be desirable, though not absolutely necessary, to supply the oil to the supporting cylinders from an outside pressure source until the gear attains the normal

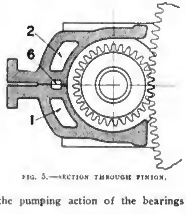

FIG. 5.—SECTION THROUGH PINION.

speed and the pumping action of the bearings is fully established.

In Fig. 4, oil from such an outside source of pressure may be introduced at 3, and led to the upper and lower valves as indicated. If the direction of rotation of the pinion is such as to depress the frame, the arm *B* depresses the ring valve *N* and the conical valve *M*, pushing the latter from its seat. The stem of the valve *M* is hollow, as shown in the section through the upper valve. When the valve *M* is opened the oil passes through the hollow stem, as is clearly shown, into the lower circular port in *B*, and thence to the passage 1 (Fig. 3), which connects with the lower set of cylinders, and is prevented by the check valves *L* from escaping into the bearings. When the balancing pressure has been attained, *B* rises to its neutral position, allowing *M* to seat and prevent further entrance of oil. If, by reason of a reduction of the load, the oil pressure in the supporting cylinders becomes excessive, *B* rises slightly above its neutral position, relieving the excess pressure in exactly the same way as when the oil is being pumped by the bearings. The total movement of *B* for adjusting over the entire range of load is only a few thousandths of an inch.

When the direction of rotation is reversed the operation is just the same, except that the necessary functions are performed by the upper valves instead of the lower ones.

From the foregoing description it will be readily seen that the oil pressure in the supporting cylinders is always exactly in proportion to the torque that is being transmitted. By virtue of this fact a simple pressure gage connected inside of the valve *M* will, if the speed in revolutions per minute be known, indicate the instantaneous load on the gear, so that the Westinghouse reduction gear is not only an efficient transmission device, but a most accurate and sensitive dynamometer as well.

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The connections to the pressure gages are indicated at 4 and 5 (Fig. 4). If recording gages are used instead of simple indicating gages, and a graphic speed recorder is connected to the gear, the charts from these instruments would constitute a continuous log of the power transmitted.

The pressure gages may be located in any convenient position, and as far away from the gear itself as may be desired. The direction of rotation is always evident from an observation of which of the two gages is indicating pressure at the time.

If the gages were placed at any considerably height above the gear their indications would have to be corrected for the hydrostatic head of the oil column. Furthermore, if the gages were located at a great distance from the gear there might be some annoyance from leakage, solidification or air pockets in the oil piping. For long-distance indications an ingenious little device has been worked out, which translates the oil pressure to a compressed air supply, which may be conducted to the pressure gages wherever they may be located. This translating device is indicated by *O* (Fig. 3).

Fig. 5, a section through the floating frame and pinion, illustrates the simple way in which the lubrication of the gear teeth is accomplished. The frame encloses the pinion except for a portion of the circumference where the teeth engage with those of the larger gear. From the passage 6, lubricating oil passes to the pocket in which the pinion is located. The shape of this pocket is such that the oil cannot run out, but must be picked up by the teeth of the pinion. The oil, when picked up by the pinion, is thrown off again by centrifugal force, but owing to the construction of the frame it can escape only by being discharged directly into the teeth of the large gears just at the point of engagement.

In Fig. 1, at the left of the casing, is shown a bracket, through the upper end of which is a screw-adjusted strut bearing against the pinion frame. A similar bracket and strut (not shown in the illustration) are located at the other end of the casing. These struts are for adjusting and maintaining constant the depth of engagement of the gear teeth. They do not interfere with the movement of the pinion frame in a vertical plane.

In order to obtain a flexible drive between the turbine and the gear, and at the same time to keep this gear in close proximity to the turbine, the pinion shaft is made hollow, and the driving shaft passes freely through this bore and is connected to the pinion shaft at the end furthest away from the turbine. This is an old and fairly well-known construction, which has been incorporated on account of its making the apparatus more compact, and not because any novelty is claimed for it.

While the Westinghouse reduction gear was originally designed for marine propulsion, in order to harmonize the high speed which is the essential characteristic of an efficient steam turbine, with the comparatively moderate limiting speed for an efficient propeller, its adaptability for other purposes is opening up a field even broader than the one primarily contemplated. The design of direct-current dynamos of fairly large capacities, to operate at the high rotative speeds necessary for direct connection to efficient steam turbines, has always presented difficulties that were seemingly unsurmountable. These difficulties have all been eliminated by interposing the reduction gear between the turbine and the dynamo, so that each element of the combination may operate at the speed for which it is best adapted. Similarly, centrifugal pumps for large capacities at moderate heads are not at all suitable for direct turbine drive, but turbine and pump may be connected through the reduction gear constituting a highly efficient and attractive unit. Naturally, for this sort of service in which the direction of rotation is never reversed only one set of balancing cylinders and regulating valves is required. These are only two out of a large number of new opportunities for the steam turbine that will present themselves as soon as it is realized that the handicap of inherent high rotative speed can be removed by a thoroughly reliable and durable system of gearing having an efficiency of over 98½ percent, and that such a system is now an accomplished fact.

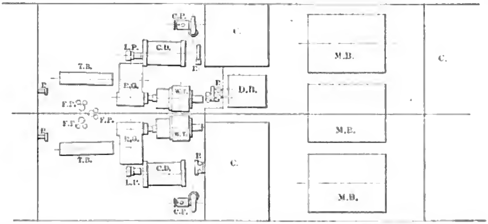

FIG. 6.—MACHINERY ARRANGEMENT OF THE U. S. COLLIER NEPTUNE, EQUIPPED WITH THE WESTINGHOUSE REDUCTION GEAR.

In addition to the two 4,000-horsepower gears installed on the United States ship *Neptune*, twelve 1,000-horsepower and 2,000-horsepower sets have been sold for driving direct-current generators and for other purposes. A number of these have already been in service for some months, running at speeds as high as 3,600 revolutions per minute, with results that are most gratifying in every particular.

The annual report for 1910-11 of Lloyd's Register of Shipping states that during the past year classes were assigned by the committee to 616 new vessels whose registered gross tonnage amounted to 1,098,476. Of these vessels 544 of 1,089,123 tons were steamers and 72 of 9,353 were sailing ships. Of the total, 65¾ percent were built for the United Kingdom. As compared with figures for the preceding twelve months there was an increase of 165,420 tons in steamers and 3,110 tons in sailing vessels. Fifty-four of the steamers were over 5,000 tons and five of them over 10,000 tons. At the present date there are several vessels of over 10,000 tons being built. The ships now under construction to the societies' classifications aggregate 1,198,792 tons gross, of which about 16 percent is being built abroad.

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VENTILATION OF PASSENGER SHIPS.

BY ANDERSON MACPHEE.

The efficient ventilation of ships where large numbers of people are congregated is of the very first importance. Looking back through the comparatively small stretch of twelve years, when the writer made his first voyage as a marine engineer, and comparing what was considered ventilation then with what is now demanded by a better educated people, one must concede that there has been a great improvement. In the old days when passengers went "below" they were greeted by odors of engine grease, cooking, etc., that sent all but the most inured hasily on deck again, and getting one's sea legs really should have been called getting one's sea nose. When electricity became more common, fans were installed in the cabins and saloons, but, while imparting a sense of comfort, these only serve to stir the air up and do not ventilate. There is no longer any excuse for these objectionable features, as, with the facilities now at our disposal, every passenger ship should be equipped with some system of supply and exhaust ventilation, combined in such a way as to eliminate all foul or vitiated air and, at the same time, maintain a comfortable temperature. This is easily accomplished by putting all kitchens, pantries, lavatories, etc., under exhaust, the latter being heated by the warm air drawn from their surroundings.

The writer was privileged in his connection with "The Thermotank Ventilating Company," of Glasgow, to design, superintend the installation of, and test many such ventilating equipments for ships, among which are the well-known liners *Mauretania* and *Lusitania*. During the first two voyages of the Italian immigration steamer *Ancona* between Genoa, Naples, New York and Philadelphia he acted as guarantee-engineer for the company, and instructed the ship's crew in the operation of the thermotank system, and it was in acting in this capacity that various improvements suggested themselves. The system is designed to be used either as a plenum system when heating or as an exhaust system when no heating is required. In immigrant ships, transports or war vessels, where large numbers of people are congregated, there are many advantages in being able to reverse the air currents by changing from supply to exhaust. At night the supply system may be used to heat and ventilate the compartments; then, during the day, the exhaust may be used for a time to more thoroughly clear out all impurities in the air. In numerous tests made under regular sailing conditions on the *Ancona* this proved to keep a very much purer atmosphere, the percentage of carbon dioxide and other impurities being much lower than when the supply was on day and night. Several times during the voyages, however, machines were found to be neither exhausting nor supplying air, but simply churning or drawing from the atmosphere and returning again. Difficulty was experienced at times also in maintaining a suitable temperature by the use of the two air-mixing dampers or by throttliug the steam at the valve under hand control. At times the compartments were too cold and again too hot, the fluctuations often producing very uncomfortable conditions. These and many other actual experiences led to the design of the ventilating machine known as the thermofan, now put on the market by the Schutte & Koerting Company of Philadelphia.

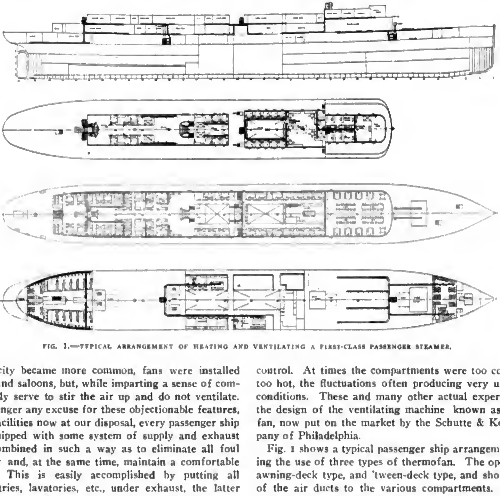

FIG. 1.—TYPICAL ARRANGEMENT OF HEATING AND VENTILATING A FIRST-CLASS PASSENGER STEAMER.

Fig. 1 shows a typical passenger ship arrangement, illustrating the use of three types of thermofan. The open-deck type, awning-deck type, and 'tween-deck type, and showing the run of the air ducts to the various compartments. These ducts wherever possible should be run at or near to the floor level, not at the ceiling, as is so often done. The reason for this is that the prime object, after considering the ventilating end, is to heat to an even temperature the various compartments. Actual tests have shown that when the heated air enters at the top it remains at the top; in fact, a well-known captain informs the writer that he has found differences as high as 20 degrees F. between the top and the bottom of his room where the duct was at the top; this in mid-winter (Atlantic weather), even where outlets are provided at the bottom of the cabins to the alleyways. Best results are not obtained if the ducts are run at the ceiling.

A further point to be considered in the air distribution is the difference of temperature between inside and outside staterooms. There are two successful methods of dealing with this problem. One is to run separate ducts to inside and

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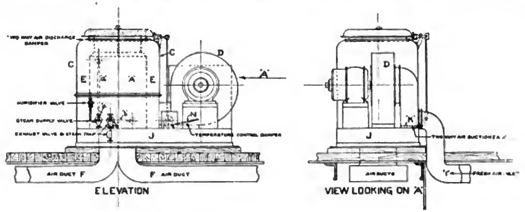


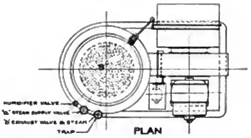
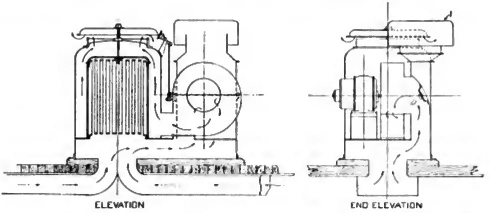


FIG. 2.—OPEN-DECK TYPE THERMOFAN.

outside rooms, each under separate control. The principal objection to this is that it complicates the construction of the thermofan, or multiplies the units. The better method is to equip the outer rooms with auxiliary electric heaters, the efficiency in heat being thus made up at will by the occupant, or these electric heaters may be put under thermostatic control so that they only operate when actually required, thus making a great saving in electric current without interfering with the supply of fresh air in any way.

The design of the ducts is a matter to which little, in the way of theory, can be applied, each individual case having to be treated from a different standpoint. Only experience can teach the engineer how to deal with that problem on shipboard. Speaking generally, velocities up to 2,000 feet per minute are permissible, but only rarely above. The great difficulty is to strike the happy medium between the large ducts with low velocities and the increased horsepower required when the ducts are small and velocities high. In a well-designed layout all the unsightly features of the exposed ducts can be taken care of in architectural features.

There is one more point in connection with the run of the ducts which must receive careful consideration, and that is the distribution and gradation of the louvers or air registers. Close to the source of supply they must be made small, and yet, if made too small, drafts will be set up owing to the high velocity of the air leaving the louver. The writer has found a range of from 8 square inches to 30 square inches in six sets all that is necessary to meet the varying conditions. These louvers at the same time must be adjustable, so that on test they may be set to their correct position, otherwise one compartment is liable to have too much air to the detriment of some other. The question of humidity now arises. In most



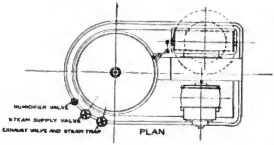


FIG. 3.—SHELTER-DECK TYPE THERMOFAN.

heating systems, both on land and sea, this matter is left severely alone, to the great discomfort and loss of health of the occupants. Dealing with this question brings us to the actual description of the machine.

As already mentioned, there are three types designed so as to suit the varying locations available on shipboard. Fig. 2 illustrates the open-deck type, and this may be taken as typical of all three, the modifications in design for the awning and 'tween-deck types being illustrated in Figs. 3 and 4. Referring to the letters: *A* is the heater which is cylindrical; steam is led into it through the stop valve and piping *a;* the condensed

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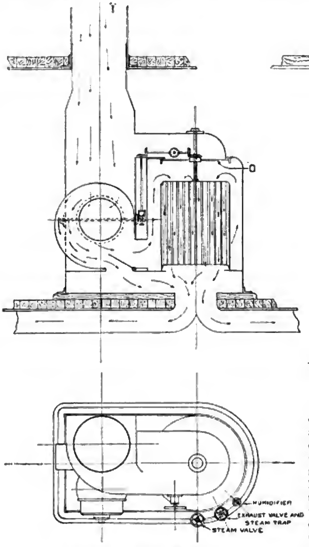
water is taken off through the steam trap and exhaust valve *b*. The heater is surrounded by a sheet steel casing *C*. Air is drawn from the atmosphere through the intake duct *I*, is directed to the fan *D* by the damper *K* and discharged into the annular space *E*. It is heated by contact with the shell in its upward passage and further heated in its downward passage through the tubes *B*. The fan *D* is constructed with two-way discharge controlled by the damper *N*. When *N* is



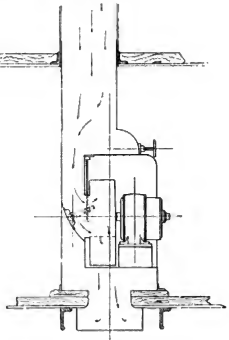


FIG. 4.—'TWEEN-DECK TYPE THERMOFAN.

in its lowest or horizontal position all the air is discharged through the heater. As *N* is gradually moved towards the vertical position, part of the air is discharged into the mixing chamber *J* without being heated; thus by adjusting the position of damper *N* any temperature of the air desired can be discharged through the distribution ducts *FF*. The damper is moved by a quadrant, which is geared to a small motor of about ⅛ or ¼ horsepower. A reversing switch operated by the thermostat already referred to controls the motor. Any variation in the atmospheric temperature immediately puts the motor into operation and supplies more cold or more hot air as required. In place of the small electric motor a steam cylinder may be used to operate the damper, the movement of the piston being under control of two electric solenoids which open and close the steam ports.

The thermofans are designed in various sizes, delivering 1,000 cubic feet of air per minute to 10,000 cubic feet; the delivery, however, of each machine can be varied by regulating the speed of the fan motor, the motor in all cases being supplied with finely-divided regulating rheostats. The reason for making this rheostat in fine divisions is because a slight increase in the speed of the fan means a very considerable increase of the volume of air delivered, or a slight decrease in the speed of the fan means a considerable decrease in the volume of air delivered.

THE LARGEST NAVAL COLLIER IN THE WORLD.

BY K. G. MARTIN.

Productions of the great Cramp ship-building yards are ever of interest to those who have aught to do with maritime affairs, and therefore a unique and most successful naval unit constructed in the face of predictions of disaster should be worthy of closest study by the individual, be he naval architect, mechanical engineer, one interested in the efficient and rapid handling of material, or one imbued only with the thought that here is another instance of American supremacy. When the United States government asked for bids on a collier of capacity exceeding that of any before constructed, the Cramp Company made their proposals together with competing companies who usually bid on government work. Proposals for the construction of smaller colliers had already been made to the United States government, but this was the first one of so large a capacity. The Cramp Company then asked for bids from the various coal-handling apparatus concerns, and after careful and extended consideration selected the system specified in the tender of the Mead-Morrison Manufacturing Company, although this was by no means the lowest price quoted for the required installation. The selection of this system was no less a compliment to the Cramp Company than to the manufacturers, for it was unproven in naval work, and it was necessary for the ship constructors to foresee the possibility of successful application of the conveying mechanism to this gigantic floating coal mine.

The bid of the Cramp Company having, after due deliberation, been accepted by the government the construction of the ship was commenced, and in October, 1910, she was placed in commission. The largest collier built up to this time had an ultimate capacity of 7,500 tons of coal, and as the *Cyclops* was to carry 12,000 tons, one of the points receiving a great deal of attention was its ability for deep-sea work under adverse conditions. That the best possible distribution of weight to meet the varying conditions between full and no load, and that efficient methods of overcoming these variations are provided, was demonstrated by the exceptional behavior of this vessel during a very rough passage to Denmark. Water ballast tanks are used, and by means of the fore and aft conveyor bucket, coal can be transferred from one end to the other, and thus trim the ship and relieve undue stresses.

The photograph of the entire ship shows the ample freeboard with a full load. The derrick poles, booms, etc., which look so solid and heavy are actually very light, being modeled on the latest bridge and building box-girder types, possessing great stiffness and rigidity without superfluous metal. The over-all length of the *Cyclops* is 542 feet, the beam 65 feet, and the depth 39½ feet, so the vessel can follow wherever the battleships go and coal from any regular dock or wharf. Reciprocating engines of 7,200 indicated horsepower drive the collier at a normal speed of 14 knots, although this has been exceeded even when fully loaded with a total displacement of 19,360 tons.

The coal is distributed in six holds of 1,743 tons capacity each, and in bunkers of 2,042 tons capacity, from which the ship takes such coal as she needs for her own steam. The forward hold is divided into four compartments, in which either oil fuel or special coal can be carried for the use of submarines or torpedo boats. Should the bunkers become exhausted, coal can be conveyed by the fore and aft trolley from the main cargo holds to the bunkers. The handling apparatus comprises twelve units, identical in construction and capacity, each operating over a hatch to the hold, two hatches being fitted to each hold. Over the bulkheads separating the holds a mast is fitted, carrying at the sides a pair of booms, the opposite booms at each side, parallel to the beam of the ship constituting the unit. On the cableways between these booms travels a bucket of the clam-shell type, which may be made to discharge vertically at a distance of 22 feet from the side of the ship. Greater distance may be obtained by "shooting" the coal exactly as with a hand shovel and with approximately the same degree of accuracy. A fore and aft bucket is also employed to shift coal from hold to hold for trimming the ship or for supplying certain holds in case only one or two can be brought into use.

While not on the official records of the Navy Department it is of interest to note here that on the occasion of the rough voyage referred to above the captain's meals, including liquids, were several times sent forward to him on the bridge in this bucket when he did not wish to leave his post and go aft. In quickly answering calls to different parts of the vessel the crew often make use of the same conveyance, and these points speak well for the steadiness and smoothness of operation of the apparatus. It may be from this idea that the new transports are being equipped with moving stairways between decks and with moving platforms or gangplanks at the sides for rapid handling of troops and their equipment.

All the buckets on the *Cyclops* have a capacity of 48 cubic feet, 1 1/5 tons of coal, and, operating simultaneously, are guaranteed to unload the 12,000 tons in ten hours; but this figure is merely comparative, as one unit delivered 76 tons in twenty minutes to government specifications regarding handling, height of lift, distance of travel, etc.; this being a record for such service. The cross-deck buckets usually handle from 100 to 180 tons an hour, making three round trips a minute, the fore and aft bucket doing about half of this because its run is longer. All the hoist engines are steam operated, the hoist end being large and the trolley end smaller, a high efficiency in steam consumption thus being obtained. In steaming order the booms are drawn down and crossed lengthwise of the ship, and all cables are lashed fast, but so carefully have details been handled that the vessel can be "cleared for action" in a very short space of time; in fact, this placidly puffing, caterpillar-looking affair has been transformed into a roaring, seemingly chaotic volcano, vomiting coal at the rate of almost 8 tons a second, within the space of fifteen minutes. This rate, of course, can only be maintained as long as the buckets can drop into coal of sufficient depth to get a full load.

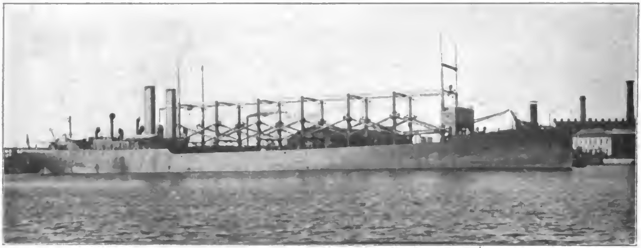


FIG. 1.—NAVAL COLLIER CYCLOPS.

The complement for operating the ship itself consists of thirty officers and men, and the coaling end takes thirty more, while on a war footing the total amounts to 200, including reserves, marines, gunners, etc. Searchlights are always in position for night work, and provision is made for a light battery to be installed in the event of hostilities to repel boarding parties and torpedo attacks.

The steam winches for lifting and trolleying the buckets are each operated by one man at the present time, although it was successfully demonstrated that one man could handle both engines from a single point, and it may be that future colliers of this type will have one-man control. This has not been possible on previous colliers owing to the lack of accurate control of the bucket, and consequent injury to its own men and equipment and those of the war vessel and scattering of coal. Some battleships of the older types can only coal by

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FIG. 2.—DECK ARRANGEMENT OF THE COLLIER, LOOKING AFT, SHOWING THE COAL-HANDLING MACHINERY.

bag, but the change from bucket to bags is made in less than twenty-five minutes. Thermometer readings of coal temperature in the holds can easily be taken through tubes located at the points of greatest heating.

Thus the *Cyclops* is prepared to accompany or meet a whole fleet and supply it with fuel, the capacity of the present-day warship usually making up such a fleet being from 500 to 2,000 tons of coal, and in effect takes the coaling station to the fleet instead of the fleet having to run to the station with added loss of fuel, the capacity of this collier being equal to many naval coaling yards.

It can also run in between a ship and barge or pile and

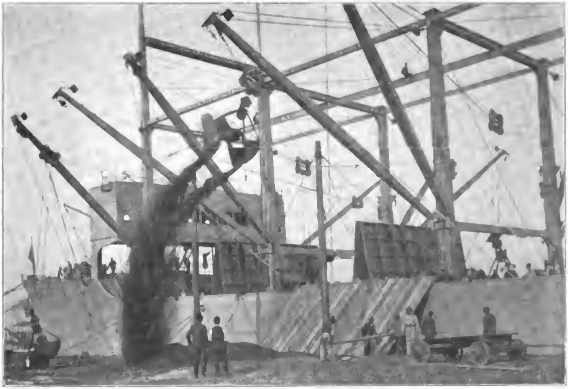

FIG. 3.—"SHOOTING" THE COAL FROM ONE OF THE CLAM-SHELL BUCKETS ON THE CYCLOPS.

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transfer the load without affecting its own supply in the holds as well as to supply the ship direct when at sea.

That all this has been accomplished with the regular standard apparatus, except wherein the government called for parts to be made to its special specifications, should be a matter of considerable satisfaction to the Mead-Morrison Company, and after a year in service is meeting with the approval of those severest and most able critics—the men who have to do with the actual handling of the ship.

Several English writers upon naval affairs have questioned the advisability of constructing colliers of such large capacity, pointing out that naval bases are being increased in size and number, and that oil-burning vessels must be looked forward to. Naval bases, however, have a way of being far off in time of need, and are discouragingly stationary. Nor do war vessels venture near them unless pressed very hard for fuel, as their movements are thereby more easily forecasted and their definite location for some time determined by the watchful agents of the opposing power. The oil burners may loom up for a time but the internal-combustion engine is more likely to be the next big step, and in either case the problem of handling liquids is a simpler matter. At the present time the dreadnought can barely make the run from England to China on her own bunkers; and suppose, then, that she cannot be met by a ship able to fully coal her in a short time, but has to go quickly into action with a carefully ambushed coaling station awaiting her as a choice? A collier can dodge, a coaling station can't. And perhaps as answering these critics officially the specifications now being drawn up by the government have been largely influenced by the behavior and capabilities of the *Cyclops*, constructed for $900,000 (£185,000), as against $1,500,000 (£308,000) for previous smaller, inefficient colliers.

CHAIN AND ROPE TOWAGE ON GERMAN RIVERS.

BY K. DIETZE.

(*Continued from page* 439.)

The towing service on the Main is shared by two companies. On the short lower reach of the river the Actien-Gesellschaft Main-Kette has three chain steamers of about 130 indicated horsepower at work, which with this power attain a towing speed of about 3.5 miles per hour, while on the upper reach the Royal Bavarian government has carried on a chain towing-service since 1898. The chain towing-steamers on the Main are almost the same as those on the Elbe, the similarity extending in particular to the establishment of turbine propulsive installations (*g* in Fig. 5, page 436) for the down-stream journey, which are also applied to assist the up-stream work, as in the case of the Elbe steamers *Baensch* (Fig 5) and *Zeuner*. The reason for this lay in the great improvement in the steering qualities of the vessels which the turbines effected, and which the very sharp bends in the river rendered necessary. Here, also, the engine room for the driving machinery of the winding machinery and turbines and the condensing installation are arranged in the middle of the vessel in each case. Forward of these are the boilers and bunkers, and abaft them, supported by a bulkhead, the turbines *g*. The foremost and aftermost spaces are utilized for the accommodation of the crew (as in Fig. 5).

The gripping wheel *m*, designed by Bellingrath (Figs. 5, 6 and 7), is also made use of here. On account of the severe and greatly fluctuating stresses which the leading-on sheave (*l* in Fig. 5 and *b* in Fig 6) in front of the gripping wheel has to withstand, it is supported by a stay *b'* (Fig. 6) with a spring buffer and fork. Chain lockers, lined with wood, before and abaft the gripping wheel prevent any chaffing of the bight of the off-going chain against the steel parts of the vessel. The axle of the drum, made of the best quality of steel, rests in a cast steel framework, which is attached to heavy-built girders at the bottom and at the deck of the vessel. At the top the whole is covered over by a plated hood. The towing hawser is led over a horizontal roller, and held fast by blocks which are attached to spring buffers.

A double cast steel tooth-wheel gearing, with a ratio of 1 to 10, connects the gripping-wheel with the engine, on the crankshaft of which is mounted a brake-sheave operated from the deck. This enables the engine to be held in check in case of fracture of the chain or while the tug with the barge train is lying at anchor. The chain-engine is of the horizontal twin compound description, with the well-known tandem arrangement of the cylinders. The plummer blocks, guides and cylinders are attached to the bottom girders of the vessel separately, and are well stayed to one another to enable them to take the stresses to which they are liable. The crankshaft, with the two cranks set at 90 degrees with each other, rests in three bearings. The connection with the winding gear is formed by a flange at one end of the crankshaft, the other end taking the fly-wheel, which is provided with eccentric weights in order to compensate mass action. With a 50 percent admission of the high-pressure cylinder and a speed of 150 revolutions, the engine indicates about 130 horsepower. At a towing speed of from 3.5 to 5.5 feet per second it can exert a pull of 4 tons.

Each cylinder has an ordinary flat slide valve. In addition each low-pressure cylinder is provided with an auxiliary slide valve, by means of which the engine can be started when subject to a heavy load. The admission at starting is for the same reason set at 78 percent, which is reduced to 50 percent after the desired speed has been attained. The Klug reversing gear is operated from the engine room by means of a separate hand-wheel with vertical screwed spindle.

Each of the main turbines (Figs. 5 and 8) is driven by an independent vertical compound engine of the ordinary pattern, with Klug reversing gear, which can be operated by means of a hand lever. Under ordinary conditions of working this engine is not reversed. Reversing is resorted to only when it refuses to start or when the water-supply channels *c* (Fig. 8) to the turbines are to be scoured out. On the steamer Baensch (Fig. 5) horizontal reciprocating engines are fitted for actuating the turbines. The condensing installation is for the three engines in common, a slow, even starting of the winding gear being thereby attained. The independent steam flooding pump is a two-cylinder, quadruple-acting Worthington.

Special interest attaches to the turbine installation *g* (Figs. 5 and 8) on the *Zeuner* principle, which, in order to improve the steering qualities of the vessel, is sub-divided into two independent aggregates arranged at the sides of the vessel. The principal dimensions of each turbine are as follows:

	Inches.
External diameter of the working wheel................	34
Diameter of the nave of the working wheel.............	17.5
Number of blades of the working wheel *a* (see Fig. 8)..	15
Number of blades of the contractor *b* (see Fig. 8)......	16

Viewed from aft the port engine turns in the direction of the hands of the clock, and the starboard engine in the opposite direction. The water enters the supply channels *c* (Fig. 8) through the grated low-lying openings *c'* (Fig. 8), and is led through a system of guide plates *d*, which form a continuation of the contractor blades *b* to the turbine blades *a*. Here it is accelerated and pressed through the blades of the contractor *b*, after which it is led back outboard through the exhaust channels *e*, and ejected in a direction parallel to the longitudinal axis of the vessel. The blades of the turbine and of the contractor are of steel, and are cast into the bronze bosses. The turbine shaft is taken at one end by the fixed contractor *b*, and at the other rests in a bushed bearing in the supply channel *c*.

To give sternward motion to the vessel the direction of the

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outflowing jet of water is, by the aid of a rotating elbow piece *f* (see Fig. 8), reversed, the water being pressed through a reverse jet pipe *h* that is fixed to the vessel. The manipulation of this elbow piece can be effected from the deck for the two engines at once, or for each of these independently by means of hand-wheels and spindles *u* (see Fig. 5), by which the necessary good steering qualities are insured to the vessel. The jet pipes *h* are protected by considerable extensions of the breadth of the deck *v* (see Fig. 5). With the turbines the vessel attains a down-stream speed of 9.3 miles per hour with a 1.86-mile current and a power development of the turbine engines of 65 indicated horsepower each, with from 225 to 250 revolutions per minute and a 50 percent admission of the high-pressure cylinder.

For all the engines of each of the Main vessels the steam, of 147 pounds working pressure, is supplied by an ordinary cylindrical, direct-flame boiler, with a dome and two furnace tubes. The heating surface is 600 square feet and the grate surface 19 square feet. The river water used for the feed is taken direct through the skin of the vessel by the aid of two injectors. An independent Worthington pump leads the condensed water from the air pump to the boiler, so that the main engine is free of all separate pumps.

The coal consumption amounts to about 55 pounds per mile run by the vessel per hour. The newer steamers for the Main work with superheated steam (300 to 320 degrees), and are fitted with Schmidt superheaters. The installation of the chain towage-service on the 125-mile stretch of the Upper Main is stated to have cost $550,000 (£113,000), while the regulation of the river over the same distance cost $800,000 (£165,000).

Not very long after the introduction of chain towage the rope towage-system also made its appearance on the Rhine, where it was well suited to the peculiarities of the river and soon made its way. In 1871 the Central A. G. für Tauerei und Schleppschiffahrt took its rise in Cologne (at a later time in Ruhrort), with the intention of conducting a rope towage-service between Emmerich and Strassburg. After several experimental trials made on different reaches the service was confined to that between Bingen and Rungsdorf (75 miles), on which a number of rapids occur. In 1905, however, when the regulation of the river was becoming very far advanced, and the competition of the paddle and screw tugs had in consequence become insupportable, the service was finally abandoned.

The idea of rope towage arose in France, and was very quickly taken up. Except on the Rhine, however, it was never adopted in earnest in Germany; such services as were instituted were soon given up, although men of authority for the most part characterized the rope system as an improvement on that of chain towage. The above-mentioned company employed eight towing vessels (Tauer) with an aggregate of about 1,400 indicated horsepower. These make use of the rope only in up-stream work, at the end of which they release the rope and proceed down-stream with separate engines driving ordinary twin screws, which, on account of the considerable drafts of water possible in the Rhine, can work economically. These conditions give the rope towing-vessels (Fig. 9) a different outward appearance. The necessity for throwing off the rope entails the arrangement of the heavy winding gear at the side of the vessel, bringing with it a number of unpleasant consequences, such as a strengthening of the hull, which is also subjected to lateral stressing, as also impairment of the steering qualities, etc. At any rate, rope towing-vessels with the rope led along the center lines of their decks have not proved satisfactory. Since, however, the disconnection of a rope is not nearly so simple a matter as that of a chain, the rope towing-vessels *must* be in a position to set themselves free for the down-stream journey in order to pass each other. The institution of a separate rope for the down-stream journey would also, apart from these considerations, be undesirable, for the reason that, especially during the down-stream journey of a vessel without train, the not very flexible rope would be subjected to very little stress, and, on account of the insufficient friction thereby set up, would be liable to spring off the wheels, and thus cause constant interruptions of the work. Like the chain tug the rope tug also has a downward sheer forward so as to leave room for a considerable lateral movement of the rising rope. Wooden transverse bow pieces prevent the rope from fouling the deck fittings. The form and arrangement of the afterbody thereby is much the same as in other vessels. Good steering is ensured by the presence of two rudders—one 8.5 and the other 9.75 feet in breadth—which are worked from the bridge by means of rods and chains. The whole of the 'midship part of the vessel is taken up by the engines, boilers and bunkers, the spaces before and abaft these being utilized for the accommodation of the crew. The principal dimensions of the rope vessels are the following:

Length over deck....................	150 feet.
Length between perpendiculars........	138 feet.
Breadth, molded	24 feet.
Depth, molded, amidships...........	8.2 feet.
Draft	3.1 feet.
Displacement	209 tons.

The wire rope passes first over a large reception guide-wheel *a* (Fig. 9) of 9 feet in diameter, which can move

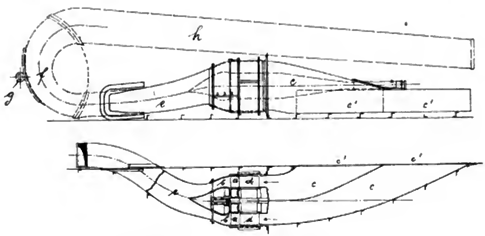

FIG. 5.—PROPELLING WATER TURBINE ON A CHAIN TUG.

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freely in a lateral direction. For this purpose the latter is mounted on a flap, which is free to turn round the axis *bb*. This axis is inclined in such a way that it touches the periphery of the wheel *a* and that of the following guide-wheel *c*. In every lateral position of the wheel *a* the leading of the rope into the plane of the wheel *c* is thus ensured. The wheel *a* then has the same functions to perform as the outrigger in the chain steamers. The axle of the wheel *c* has a fixed mounting on the hull. The diameter of the wheel *c* is also 9 feet. It is fixed in such a low position that the rope runs with a vertical lead onto the rope drum proper, *d*. Since the rope passes down to the end wheel *e* in the same manner, it girdles the upper half of the periphery of the rope drum *d*. The guiding end wheel *e* (7.5 feet in diameter) is mounted in such a low position that when the rudder is put over and the course of the vessel lies inclined to the direction of the rope, the latter does not come in contact with the bottom of the vessel. In like manner to the reception guide-wheel *a*, the off-leading guide-wheel *e* is supported by a flap, which, though in less degree than the wheel *a*, is free to move in the lateral direction round the axis *ff*.

The rope drum *d* is one of the well-known Fowler flap drums, and works in the manner that pairs of opposing flaps in the hollow of the tire of the wheel lay hold of the rope with a grip corresponding with the tensile stress exerted. From this it will at once be seen that a large proportion of the section of the rope must be discounted for wear occasioned by these flaps, while on the other hand, the advantages attaching to the Bellingrath chain grip-wheel, that the rope drum is engirdled by the rope over only a part of its periphery, remains. Other methods of holding the rope have also been proposed, such, for instance, as the "Wernigh" device, which was applied to two rope tugs on the Oder. Somewhat as in the case of the chain, the rope was here led over two driving drums, from which it had, by reason of its light weight and small flexibility, to be led away again by separate mechanism. This latter apparatus consisted in a number of wheels, the tires of which were divided in a direction vertical to the axis. Much as in the ordinary chain grip-wheel, with indentations corresponding with the chain links, these Wernigh wheels were provided with projections and depressions, which corresponded with the strand windings of the rope made use of, and grasped the latter with these when the halves of the wheel were pressed together. The trials made with the Wernigh constructions are said to have given satisfactory results, although the apparatus was characterized as somewhat complicated. The same designer then brought out a new rope sheave with an undulating groove, by means of which, in particular, the wear of the rope was considerably reduced. At the same time this new design brought the advantage that the rope could be led along the center line of the vessel as in the case of the chain. Information as to the manner in which the vessels made their down-stream journey has not been obtainable, but at any rate such vessels have been on service on the Lower Rhine with good results.

The flap drum that is principally in use on the Rhine has a diameter from center of rope to center of rope of 10 feet. It is mounted at the side of the vessel, and is actuated from the engine by a two-grade gearing with a reduction ratio of about

$$\frac{51}{20} \times \frac{102}{22}.$$

The driving engine *f* (Fig. 9) for the drum is a twin-cylinder engine of 160 to 180 indicated horsepower (diameters of cylinders of each engine 14.5 inches and stroke 24 inches), making about 80 to 100 revolutions and working with jet condensation *g*. It differs, however, in arrangement from the engines of the chain tugs on the Main, in having one of its cylinders at each end of the winding gear. Cylinders, slide-ways and crankshaft bearings rest on a cast iron bed-plate in common, on which also the heavy seat for the drum axle is mounted (see Fig. 9). One of these half engines at the same time drives the pumps, while the condenser air pump *g* is connected in tandem fashion with the other. The engines are not provided with means of reversing, which also, in presence of the separate propulsive engines, is not absolutely necessary. The *Tauer No. 3* can tow a train of 5.5 tons at a speed of 4.5 feet per second, thereby developing 145 indicated horsepower.

As already stated, two twin engines *h* each drive a screw 3.8 feet in diameter, with which a speed of 9.3 to 11 miles per hour is attained on the down-stream run with a tow-train of four empty barges. An ordinary return-flame cylindrical marine boiler *i*, with dome, supplies the steam for the whole engine installation. The working pressure is about 100 pounds, and the consumption of coal about 3 to 3.3 pounds per indicated horsepower per hour. A funnel-shaped coal bunker *l* is built into the vessel in such a manner that it is possible to get past it from forward to aft at each side of the vessel.

The hull of the vessel herself is built of steel, and is similar in its general structure to that of a chain tug. It differs from that of the latter, however, in that its bilge is rounded off throughout, and in certain structural alterations rendered necessary by the removal in this case of the winding gear with the large cast metal rollers to the side of the vessel. In order to enable the high-lying receiving wheel *a* to be swung out to a sufficient degree the side of the hull had to be provided with a recess *m*. To this end the side was drawn in up to a point a little below the wheel, and the deck cut out in a segment so as to form an open niche made watertight against the hull by plating. The hull has a further recess *n* for its full height abaft the low-lying off-leading wheel *e*, so as to admit of a lateral motion of the latter. The recessing of the hull required for the extreme lateral movement is swept in an easy curve back into the normal form of the vessel. Specially worthy of note are two bilge keels *o* of from 4.8 to 7.2 inches in height, which are worked under the vessel at a distance of 4.25 feet from each side of her center line and carried up forward. They serve the purpose of keeping the rope free from the bottom of the vessel in case of strong weed formation on the bed of the river, or of a very much inclined direction of the rope in relation to the vessel. The movable swinging axle of the wheel *a* is kept in its place by means of a very strong gallows-like structure *p*, consisting of three built girders, which in their turn are supported below by strong web frames. A similar structure, which, however, could be kept very much lighter, and which accordingly is attached directly to the protective plating of the flap drum, bears the axle of the off-leading wheel *e*. To facilitate the throwing off of the rope and their own eventual dismounting, the horizontal axles of all the rope-wheels have bearings at one end only, as a result of which, it is true, the transmission to the vessel of the components of the pull on the rope becomes very unfavorable. In view of the greatly varying direction of the lead of the rope to the flap drums these forces are in themselves very great, so that there can be no question but that the hull must here be subjected to very considerable local strengthening. Even when the vessel is at rest the large dimensions of the flap drums and leading wheels render the whole winding gear exceedingly heavy; the unsymmetrical distribution of the weights and the recessing of the vessel's side make it especially necessary to strengthen the hull, so that, as already observed, the total displacement, and therewith the draft, must when compared with those of a chain tug, be relatively very great, which again, of course, considerably adds to the cost of the installation. The cheapness of the rope, which is generally claimed as an advantage by the opponents of the chain, is hereby in part made up for. Of

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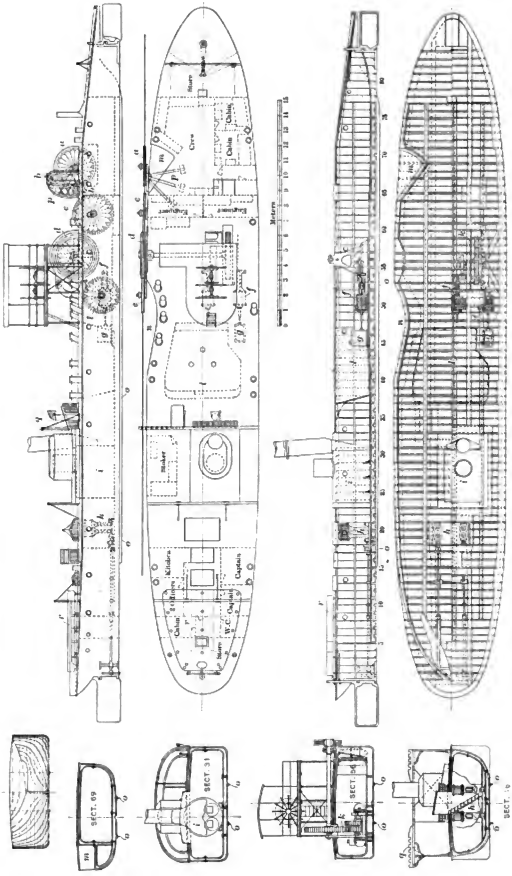

DETAILS OF A ROPE TOWING TUG FORMERLY USED ON GERMAN RIVERS.

interest at this point is the method of leading the tow-rope over a large towing bar *g* (Fig. 9).

It would appear that it had not always been found possible in the designs to give due consideration to the effect exercised by the tension of the rope on the fore-and-aft and athwartship trims of the vessel, for we find in some of the steamers a ballast tank *r* with three longitudinal partitions arranged on the deck at the stern, the object of which is the subsequent correction of lists and improper fore-and-aft trims during the up-stream or the down-stream journey. In other respects the hull presents no peculiarities. The spacing of the frames is 20 inches throughout.

Special arrangements are made at the end points of the rope, in so far that a barge with a heavy winch and a large drum is installed at each of them, for the purpose of regulating the tension of the rope when it is being thrown off or taken up by the tug.

For driving the winding gear of the rope-vessel for the *Danube* (*Vaskapu*), which has already been mentioned, a compound engine of 300 indicated horsepower is provided, which is coupled to the winding drum by a threefold wheel gearing. The revolutions of the rope drum (8.2 feet in diameter) were thereby reduced in the ratio of 30 : 1. The large toothed wheels and the rope drum were made of cast steel. Special apparatus was provided for taking up the rope and for pressing it down as it ran off the last wheel, and another apparatus looked after its regular winding onto the winch. In contrast to the Rhine Tauers the rope was in this case led along the center line of the deck. As in the case of the chain tug it could, for the sake of the steering, be swung laterally (Lombard Gévin Lyon system) by means of separate leading paths at the fore and after ends of the vessel, which were operated from the bridge. It had been found possible considerably to reduce the twist which occurs with special frequency in a wire rope by coiling it onto a drum in the makers' works with a tension of 24 tons by means of mechanical appliances.

A few further particulars of matters of general interest connected with the towing services on the German rivers may be given in conclusion. It is the practice for the towing hawsers for the up-stream journey to be provided by the tug, while for the down-stream journey the towed vessel must herself carry suitable hawsers. On the Rhine, if the cargoes be less than 350 tons, additions are made to the rates of the towage tariff amounting to from 25 to 75 percent as the amount decreases from 350 to 250 tons or less. Wooden vessels must, in general, pay 75 percent more than others without regard to their size or cargo, while for lighters a lump sum or a special rate per ton of cargo-carrying capacity is agreed upon. The permissible length of the tow-train varies very considerably on the different rivers, and it is often the case, for instance on the Rhine, that each barge in the train is connected by a separate towing hawser with the tug herself. This arrangement offers many advantages in towage work, as, for instance, releasing separate barges and in steering. The abandonment of the rope towing-service is the typical fate of the towing companies on the German rivers. In view of the steadily increasing competition of the railways and the further development of the paddle and screw tugs, combined with the careful regulation of the rivers, the existence of the chain traffic will gradually lose its justification more and more, and as it ceases to pay its field of work will diminish in extent. In countries, however, in which still untamed waterways run through the country unutilized the Tauerei represents an exceedingly cheap method of dealing with the transport of bulk goods.

The Bureau of Navigation reports 108 sail and steam vessels of 10,938 gross tons were built in the United States and officially numbered during the month of October. Seventy-three percent were steamers.

THE AMERICAN NAVAL REVIEW.

From every standard of comparison the most notable fleet ever assembled by the United States was that reviewed by President Taft and Secretary of the Navy Meyer at New York Nov. 2. It involved the greatest number of American vessels ever mobilized, with the greatest total displacement, and represented the maximum in fighting effectiveness probably ever gathered at one point by any nation.

As indicating something of the increased strength of the United States navy it is interesting to contrast the number of vessels and their total displacements which took part in the other important naval reviews of recent years. In the international naval review at New York in March, 1893, there were fourteen American naval vessels of all classes, with an aggregate displacement of 39,436 tons. President Roosevelt, in September, 1906, reviewed, at Oyster Bay, the Atlantic fleet, then comprising forty-five vessels displacing 279,612 tons. During the Jamestown Exposition there was mobilized at Hampton Roads in June, 1907, a fleet of thirty-three vessels displacing 285,251 tons. When the Atlantic and Pacific fleets met at San Francisco in May, 1908, they combined a total of forty-six vessels displacing 407,924 tons, and in September, 1909, at the Hudson-Fulton celebration forty-three vessels were assembled with a total displacement of 316,762 tons. This latest review at New York included 102 vessels of all classes displacing about 577,285 tons, which does not include the eight submarines, of which no figures were available. Concurrently at Los Angeles a review was taking place of twenty-four vessels of 116,000 tons displacement, giving a grand total of 126 vessels displacing 694,000 tons. Perhaps the most striking evidence of progress is, that of all the vessels in the New York review the only ones that were a part of the navy at the time of the Spanish War were the battleships *Iowa*, *Indiana* and *Massachusetts*, the gunboats *Castine*, *Nashville*, *Marietta* and *Petrel*, a few of the small torpedo boats and some of the fleet auxiliaries.

The following table shows the number of vessels of each class in the Atlantic fleet and their total displacement:

	Tons.
24 battleships	366,864
2 armored cruisers	29,000
2 cruisers	6,950
22 destroyers	15,463
16 torpedo boats	2,994
8 submarines	.....
3 tenders to torpedo fleet	8,466
4 gunboats	4,737
9 miscellaneous	40,733
8 colliers	93,938
1 oil tanker	6,159
3 tugs	1,981
102 vessels of all classes	577,285

Exclusive again of the submarines these vessels represent a total horsepower of 946,811, for the supplying of which there are 567 boilers, with an aggregate of 46,360 square feet of grate surface and 2,062,000 square feet of heating surface. All of the battleships, cruisers and torpedo boats except the battleship *Iowa* have watertube boilers. This is an interesting reversal of the condition of affairs at the time of the Spanish-American War, when outside of the torpedo boats there were only four warships then equipped with watertube boilers. Seventeen of the destroyers burn oil as fuel, and the four latest battleships—*Delaware*, *North Dakota*, *Utah* and *Florida*—burn oil in conjunction with coal. The fleet has attached to it a fuel oil tankship to carry the reserve fuel oil supply for these vessels, serving the corresponding function of the eight colliers carrying the coal supplies for the other vessels.

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THE AMERICAN ATLANTIC FLEET AT ANCHOR IN THE HUDSON RIVER.

The aggregate coal bunker capacity of the fleet is 81,450 tons. Adding to this the coal cargo capacity of the colliers, 58,813 tons, the fleet can sail away with a total of 140,263 tons of coal. Propelled simultaneously at their full power all of the vessels would consume coal at the rate of 20,000 tons a day.

With its full complement the fleet would carry 27,344 men and 1,660 officers, a total of 29,004, and it is safe to say the actual figure is in the neighborhood of 25,000 men.

The average speed of the vessels is 21.6 knots. The fastest vessel is the destroyer *Paulding*, which is capable of a speed of 32.8 knots. Placed end to end, touching, the vessels of the fleet would extend a total length of 29,942 feet, or over 5⅔ miles. If passed in review in single file at an average distance apart of 300 yards the fleet would form a line extending nearly 23 miles, and at an average speed of 10 knots would take about two hours to pass a given point.

It is self-evident what such a fleet as this means to the shipbuilding and ordnance manufacturing industries, but there are also less intimately associated industries that played an important part in the equipment of this fleet. We are advised, for example, by the Blake & Knowles Steam Pump Works, 115 Broadway, New York City, that it has installed pumping equipment on sixty-five of these vessels, which is a large percentage considering that nine of the remainder carry no steam pumps, including the submarines and one sailing vessel, and that eight of the others, principally colliers, were built abroad. The number of pumps this company has installed on the fleet exceeds 1,000, and their cost represents nearly a million and a quarter dollars.

PERSONAL.

MR. DE COURCY MAY, who has been president of the New York Shipbuilding Company for some years, has resigned the presidency but remains chairman. Mr. Samuel M. Knox, formerly secretary and treasurer, becomes president.

MR. ROBERT C. MONTEAGLE, for several years chief engineer of the Atlantic Works, East Boston, has been made assistant manager and engineer of the Lockwood Manufacturing Company, East Boston, Mass.

MR. C. D. CHASTENEY has resigned his position as sales manager of the De Laval Steam Turbine Company, Trenton, N. J., having acquired an interest in the Turbine Equipment Company, 30 Church street, New York, which company represents the De Laval Steam Turbine Company in New York State, parts of New Jersey and Connecticut. Mr. Chasteney was graduated from Stevens Institute of Technology in 1901, and has been with the De Laval Steam Turbine Company since the organization of the American company over ten years ago.

A Shipbuilding Record.

The Great Lakes Engineering Works, Detroit, recently delivered in record time a fleet of eleven vessels. On March 17, 1911, contract for these vessels was signed. They comprised four steamers, the *Penobscot, Seaconnet, F. J. Lisman* and *M. E. Harper*, and seven barges, named *Providence, Searsport, Bangor, Boston, Lynn, Portsmouth* and *Salem.*

The steamers are of a uniform size of the following dimensions:

Length over all	261 feet.
Length between perpendiculars	253 feet.
Beam, molded	43 feet 6 inches.
Depth, molded	26 feet 6 inches.
Depth water bottom	3 feet.
Capacity, gross tons	4,000
Engine, triple expansion, 21, 34½, 57 by 42 inches stroke	1,350 horsepower.
Boilers, Scotch, 13 feet diameter, 12 feet 1¼ inches long, 175 pounds working pressure; positive heated draft	2

The barges are:

Length over all	268 feet.
Beam, molded	36 feet.
Depth, molded	22 feet.
Capacity, gross tons	2,650

All of these vessels were built in the yards of the Great Lakes Engineering Company, and delivered before the 1st of October, so as to pass through the Great Lakes and St. Lawrence River in advance of navigation being closed by ice. The vessels were built for the Harper Transportation Company, of Boston.

In addition to this order the company delivered in November for the Atlantic coast two steamers which will trade to Southern ports, the West Indies, etc. These steamers are of the following dimensions:

Length over all	261 feet.
Length between perpendiculars	253 feet 3 inches.
Beam, molded	43 feet 6 inches.
Depth, molded	28 feet 5 inches.
Depth of water bottom	3 feet.
Engine, triple expansion, 1,480 horsepower, 21½, 35½, 58 by 42 inches stroke	
Boilers, Scotch, 14 feet 2 inches diameter, 12 feet long over all, 180 pounds working pressure; positive heated draft	2

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This means that you can cast locomotive frames, high pressure steam valve bodies, hydraulic and steam cylinders and other severe duty machine parts in Vanadium Steel and get Carbon Steel forging qualities—great toughness, strength, freedom from crystallization and fatigue, and remarkable durability.

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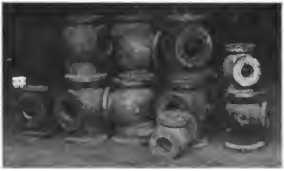

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CONGESTION OF FREIGHT TRAFFIC AT NEW YORK STEAMSHIP TERMINALS.

We present herewith three views which show some of the glaring defects of the present arrangement of steamship terminals at the port of New York. The lack of mechanical appliances for handling freight is evident in Figs. 1 and 3. The present cost of transferring cargo could be cut down 50 percent by the use of mechanical cargo-handling appliances, and these would insure greater rapidity and eliminate the re-handling of freight by manual labor. Such features are of great importance when the necessity for overcoming the congestion of freight traffic at the steamship terminals is considered. Rapidity of freight movement, reduced handling costs and increased capacity of existing terminals can be obtained by the adoption of improved mechanical methods.

FIG. 1.—USUAL METHOD OF HANDLING MISCELLANEOUS FREIGHT AT NEW YORK STEAMSHIP TERMINALS.

In Fig. 3 the congestion is very evident, and yet only a small part of the space in the pier shed is being used on account of the impossibility of tiering the freight to any greater height by hand methods. The introduction of mechanical methods of handling freight would permit higher tiering and practically double the single-story pier capacity. The saving in the investment in port installations by high tiering are evident from the fact that usually only about one-third of the floor space is available for storage, and that if the freight is handled by manual labor the tiering cannot be carried above 5 feet, whereas with mechanical handling the tiering could be carried to 20 feet and increase the capacity of the pier in proportion. Congestion is also apparent on the street along the water front, a typical example of which is shown in Fig. 2, where the substitution of motor trucks for horse drays would greatly facilitate the rapidity of moving the freight to and from the piers, besides reducing the cost from 20 to 40 percent.

TRANSFERRING CARGOES FROM SEATTLE DOCKS.

Along the water front in Seattle, Wash., the wharves are constructed of pile piers with slips between them in which sea-going vessels are berthed. Railroad street extends along the water front and separates the docks and piers from the large warehouses. The space provided on the docks is limited and numerous warehouses are provided across the street.

The equipment shown in Fig. 1 was installed for transferring the large volume of miscellaneous freight handled daily between the dock and the warehouses. It consists of an overhead bridge extending from the wharf across the street to the warehouse, which contains an overhead freight conveyor (or flight conveyor, as it is called) traveling 60 feet per minute. The conveyor is 250 feet long between centers.

Fig. 2 shows a view of the wharf and the method of transferring the cargoes directly to the end of the conveyor line. Fig. 3 shows the other end of the conveyor line distributing the filled barrels on the second floor of the warehouse. Wooden conveyor flights, 3 inches thick, 12 inches wide and 36 inches long, constructed of Puget Sound fir, are secured to two strands of 180 Jeffrey steel thimble roller chain, forming practically a continuous apron, on which the freight, such as baled hay, cement in barrels, large packing boxes and the like is carried. At the warehouse end of the conveyor are sprocket wheels, which mesh with the two link chains, and placed on a shaft are geared to a line shaft that is belted to a continuous-speed, alternating-current 10-horsepower motor.

The illustrations show a cargo of cement being unloaded. The ship was docked within 15 feet of the receiving end of the conveyor. The barrels were placed in slings, containing six barrels in a load, and were hoisted from the hold by means of the vessel's derrick in connection with an electric hoist on the dock, which landed the sling load at the foot of the con-

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FIG. 2.—CONGESTION IN WATER-FRONT STREETS AT NEW YORK STEAMSHIP TERMINALS.

FIG. 3.—"FULL PIER" IN A NEW YORK PIER SHED, SHOWING SMALL PART OF SPACE OCCUPIED BY HAND TIERING.

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FIG. 1.—OVERHEAD FREIGHT CONVEYOR FROM PIER TO WAREHOUSE, AT SEATTLE.

veyor, whence the barrels were rolled directly to the conveyor while it was in motion, the barreled cement weighing 400 pounds per barrel. Over three thousand barrels were readily handled in eight hours, although the maximum capacity of this conveyor is about 1,200 barrels per hour. The handling of this cement required eighteen men at the rate of 27½ cents (1/2) per hour, including all the labor necessary. Under the old arrangement where this material was handled by means of trucks, no less than twenty-eight men were required, thus resulting in a saving of ten men by the use of the conveyor, this saving amounting to $22.00 to $25.00 (£4.5 to £5.1) per day on an eight-hour shift, or at the rate of $56.00 to $75.00 (£11.5 to £15.4) per day on a three-shift basis of eight hours each. The complete cost of the entire outfit, including the necessary alterations at the dock and warehouses, including a new roof, truss and several other incidentals, amounted to approximately $6,745 (£1,380), so that it is readily seen that the conveyor will pay for itself within a short period of time. The conveyor is built so that in addition to handling package freight of any kind it can also be used to transport loose brick, pig iron, sacked sugar and miscellaneous freight.

This conveyor system was installed by the Pacific Engineering Company, of Seattle, and operated by the Galbraith & Bacon Company. The machinery was built according to special designs by the Jeffrey Manufacturing Company, of Columbus, Ohio.

This departure from the old system of handling freight has enabled ships to be unloaded and reloaded more rapidly without delays from the congested traffic and blocked streets.

FIG. 2.—PIER END OF CONVEYOR.

FIG. 3.—WAREHOUSE END OF CONVEYOR.

That the purchase of coal on specifications needs to be followed up with analyses of the deliveries has been amusingly demonstrated by a recent incident. A certain board had for some time been buying coal on specification, but only recently did it take any steps to see whether it was actually getting the quality it was paying for. Lately it had made the first analysis of the coal delivered, and discovered that the coal was below the stipulated quality. As a result of this analysis, costing $10 (£2), the coal dealer paid a rebate of $873.01 (£174 12s.).

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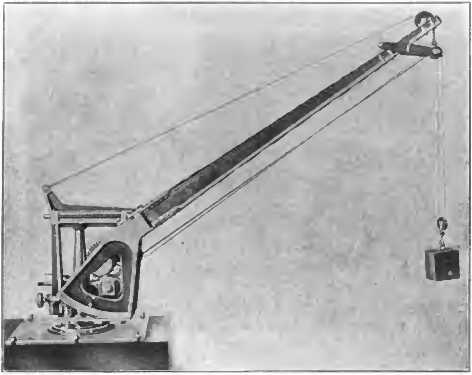
AN IMPROVED CRANE.

One of the simplest mechanical appliances which has been used in engineering work for many centuries is the ordinary jib crane or derrick, consisting of an upright or mast with a boom or gaff for hoisting and moving weights. Although the jib crane is universally used in engineering and industrial work as well as in factories and transportation terminals, yet practically the only features of this crane which up to this time have been improved are the methods of manipulation or the application of power for operating the crane. There have been numerous improved winches, steam and electric, but, as a rule, this part of the equipment requires separate foundations and anchorage removed from those on which the cranes or derricks themselves are mounted. It is very seldom that the motive power is located practically on the same level and within the area occupied by the derrick or crane itself. As a result of experience with the Welin quadrant davit, which in itself performs some of the functions of an ordinary jib crane or derrick, there has been developed by Capt. A. P. Lundin, of New York, and Axel Welin, of London, a quadrant crane having all the advantages of a self-contained machine, in which the crane and operating devices are mounted together in such a manner that a single operator can handle the crane for hoisting and lowering the load and moving it in a horizontal plane, so that the crane will serve with rapidity and precision every cubic foot of space within its reach.

The crane is mounted on quadrants, and is moved back and forth by a screw, which, on account of the movement of the quadrants and the method of compensating the load, is subjected only to a thrust in a true axial direction, and therefore can work without undue friction. The quadrant arrangement, with its traveling fulcrum along the base of the frame, not only reduces the length of the beam but also reduces the bending moment on the beam and eases the manipulation of the load after it has been hoisted. By the compensating arrangement of the hoisting tackle a stout wire rope or chain, permanently fixed to a point on the inboard end of the frame, runs over a sheave at the top of the crane and is fixed to tne top block of the tackle proper. From the illustration it is evident that this block automatically drops in relation to the top of the beam, as the latter is swung back by means of the screw. The actual reduction in the bending moment on the beam is thus reduced in a 4-ton crane from 120-foot tons to 51-foot tons, or nearly 60 percent, and therefore permits building a very much lighter crane than would otherwise be possible if the crane were operated from a fixed pivot and required the excessive power which is usually needed in topping an ordinary jib crane. To top an ordinary jib crane with its maximum load requires approximately 50 to 100 percent more power than is necessary in hoisting the load itself, whereas in the quadrant crane the combination of moving fulcrum and compensation of the falls makes it necessary to use for topping the beam only one-sixtieth of the power required for hoisting the load. Of course, to hoist the load requires practically the same power as any other crane.



A FOUR-TON QUADRANT CRANE.

The crane can be operated by electricity, steam or compressed air, as the case demands. In the 4-ton crane illustrated a 35-horsepower motor would be used for hoisting the load, a 1½-horsepower motor for swinging the crane, and only a ½-horsepower motor for operating the screw which tops the crane. The horizontal swinging motion is, of course, done by the usual method used in a crane, but it has the advantage that a full, unobstructed swing of 360 degrees can be obtained.

As to the use of such a crane on board ship for handling cargo, aside from the rapidity of manipulation and precision which can be obtained with this crane, it is interesting to note how easily the movements of the weights can be controlled. That is, they can be landed exactly as desired, and all landings can be made perpendicularly, which is acknowledged to be a great saving in labor and other expenses in handling cargo on board ship. In other words, it is not necessary to drop the load each time in one and the same place in the hatch. Where this is done it requires a great number of men to remove the

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load just dropped in time to make room for the next, while with the improved quadrant crane the load can be dropped at different points in the hatch, giving the handlers more time to stow away and naturally increases the speed of loading and discharging the ship.

With a portable quadrant crane of a capacity of 2½ tons and an outreach of close on to 20 feet, the entire weight, including drums, motors, etc., will barely amount to 4 tons. If this is compared with the 2½-ton electric cranes now used on board transatlantic ships, which weigh something like 8 tons each, the advantage of weight saving with the quadrant system is clearly demonstrated, not to mention the space saving, which is also considerable, particularly if the cranes are portable and can be dismantled and stowed away when not in use. On board ship the quadrant crane has the inestimable advantage of doing away with what is often a veritable forest of masts, booms and spars, necessary for expeditiously handling of cargo, coaling, etc. Considering all the winches necessary to operate this elaborate apparatus, and the many hundred feet of steam pipe necessary for conducting steam to the winches; the frequent leaks in the joints of the steam piping, which bends under the strain of the ship in a heavy sea, and has to be gone over by a whole staff of engineers before the ship arrives in port, the advantages of the self-contained quadrant crane become apparent.

If a ship is equipped with a number of quadrant cranes conveniently located for handling cargo and baggage and for coaling, not only can the total weight of the equipment be considerably decreased, as compared with the usual equipment of masts and booms and the time of loading and discharging of the ship and the consequent expense decreased, but after the loading and discharging have been done in port all of the cranes except one forward and one aft can be dismantled and placed either on deck or stowed in the hold.

Although these cranes may prove to be exceedingly useful for cargo ships in particular, and, in smaller sizes, for handling coal and baggage, etc., on passenger carriers, yet perhaps their greatest field is on land as wrecking cranes on railroads, cranes on docks and wharves, and cranes on building sites, besides cranes for steam shovels and various other plants of that kind, where the advantages of the lightweight self-contained machine are obvious. In some shipyards ordinary jib cranes are still used alongside the building berths, and frequently in such cases topping of the cranes is dispensed with on account of the large power required and the danger attending this operation. In such instances the usefulness of the cranes would be greatly augmented by utilizing the quadrant system of cranes and enabling the operator to have perfect control of the crane under all conditions. Also a light quadrant crane could be used to advantage in handling the work at heavy shipyard tools, enabling one man to have complete control of heavy plates, bars and forgings at such work as punching, shearing, rolling and machining.

HANDLING FREIGHT FROM STEAMSHIP TO DOCK BY A DOCK ELEVATOR.

THE OTIS DOCK ELEVATOR.

The dock elevator illustrated has been installed at a number of steamship docks along the Atlantic coast, one of the most recent installations being at the docks of the Metropolitan Steamship Line in Boston, where three of these machines were installed simultaneously, replacing the old form of moving platform, which has been discarded. The Otis Elevator Company, of New York, manufacturers of this device, are now installing two large machines for the Boston & Maine Railroad Company at their Mystic Wharf in Boston. The mechanical construction of the Otis dock elevator is quite simple. It consists of an endless chain provided with projecting steel lugs. This chain is supported, and slides in a lubricated steel channel located about 6 inches above the floor. The chain passes over a sprocket wheel at each end of the incline, the upper sprocket wheel being keyed to a driving shaft, which in turn is journaled under the floor. This driving shaft is in line with the hinges which support the inclined floor or "drop." These hinges are of heavy cast steel construction, provided with a large hollow forged shaft through the 4-inch diameter hole of which passes the driving shaft of the elevator. In this way the mechanism is always at the proper level, notwithstanding the different positions which the inclined platform may take. At one end of the main driving shaft is keyed a large gear wheel, which is driven by a steel pinion journaled about 1 foot above the floor line of the dock.

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The pinion is carried on a countershaft, which is provided with a brake pulley. On the other end of the countershaft is a large belt pulley, from which a belt leads to a 10-horsepower electric motor contained in a housing. In this way all important mechanism is placed on the floor and can be easily looked after. At convenient position to the operation of the machine is provided a starting, stopping and reversing switch. There is also a special starting box provided, which enables the operator to change the speed of the elevator from slow to high speed. This control device is quite important, as frequently there are special truck loads of great weight to be handled, and at such times the machine is slowed down so that the men are able to handle it with facility. The operation of the dock elevator is as follows:

A man with a loaded truck walks onto the inclined hinged platform or "drop," and the axle of the truck drops in the recess between the steel lugs on the moving chain, and it is thus drawn up the incline without any manual effort on the part of the truckman. It will be seen that the truckman walks up the incline with his feet on opposite sides of the narrow partition along the top of which the chain slides. By this means there is no chance for the feet of the workman to be caught, as is the case with the moving platform which this type of machine seems to be replacing. The men are, as a matter of fact, assisted up the incline, because they lean back upon the truck handles and the truck really pushes them up. There is absolutely no possibility of the truck slipping backward, which was frequently the case with the old-fashioned moving platform. The men therefore feel a confidence in this machine which was lacking in the old-style moving platform.

This machine is almost as valuable for carrying loads down the incline as it is for carrying them up, and it works in either direction with equal facility. In the Boston & Maine installation two of these dock elevators are to be located on one platform and are to be run in opposite directions, and each machine is to be independent of the other. By this means it will be possible to carry loads in both directions simultaneously, or, if desired, the speed of unloading can be doubled by running both machines in the same direction. As there is a tidal drop at this dock of about 20 feet these machines are likely to save a large amount of time and labor in handling freight.

REVIEW OF MARINE ARTICLES IN THE ENGINEERING PRESS.

Powerful Dredge for Panama Canal.—This vessel, named *Corozal*, and built by William Simons & Company, at Renfrew, is an extremely powerful bucket hopper dredger for use on the Panama Canal. It is of twin-screw type, driven by triple-expansion engines working at 180 pounds pressure, and steam is supplied by two Scotch boilers. All auxiliary machinery is independent of main engines. Dredging gear can be operated by either propelling engine, and is arranged to give three speeds, depending on kind of material to be dealt with. Two sets of buckets are provided, one for soft clay and one for hard. The bucket ladder is a steel ladder, which, with its equipment, weighs over 240 tons. The ship has a hopper capacity for 1,200 tons. 450 words and photographs.—*The Engineer*, October 20.

Three Ferry Steamers.—Hulls built by Nüscke & Company and machinery by the Anstalt Akt.-Ges., Stettin. Length over the deck, 98.4 feet; length between perpendiculars, 80.2 feet; breadth, 35.1 feet; depth at side, 12 feet, and loaded draft, 8.9 feet. Machinery consists of compound engine 11.4, 23 by 15.7 inches, and a two-furnace single-ended Scotch boiler, working at 150 pounds pressure. There is a propeller at each end of the vessel, which turns at 210 revolutions per minute. The rudder at each end works within a well formed by double stern post. Engine is designed to indicate 280 horsepower. Although the article is not long it is accompanied by a complete set of detail drawings for hull and machinery. 1,800 words, 5 large plates and several smaller-sized drawings and two photographs.—*Schiffbau*, October.

French Battleships Jean Bart and Courbet.—The most powerful ships ever built for the French navy were launched Sept. 22 and 23. Their keels were laid about the 10th of last November, and they were launched with about one-third of their completed weight in place. When completed their principal features will be as follows: Displacement, fully loaded, 23,457 tons; length between perpendiculars, 541 feet 4 inches; breadth, 88 feet 7 inches; mean draft, fully loaded, 29 feet 1 inch; horsepower, 28,000; speed, 20 knots. The double bottom is carried up to the lower protective deck, and above this are two others, making three in all. This is the first time such a plan has been tried. The upper, main and lower protective decks are, respectively, 1.18, 1.9 and 2.76 inches thick. For the first time since 1899 the protection of the fore part of the ship has not been completely carried out. The armament consists of twelve 12-inch guns and twenty-two 5.5-inch quick-firing guns and four 47-millimeter guns and four underwater torpedo tubes. The *Courbet* is furnished with Niclausse and the *Jean Bart* with Belleville boilers. Each ship has twenty-four boilers grouped in four boiler rooms and served by three smokestacks. The normal coal capacity is 900 tons and the maximum 2,700 tons, giving a steaming radius of 8,500 miles at 10 knots, or 2,300 miles at 20 knots. The vessel is driven by two sets of Parsons turbines on four shafts, with a working pressure of 256 pounds per square inch. The engines are designed for 28,000 shaft horsepower. 2,500 words and photograph of launching of *Jean Bart*—*The Engineer*, October 20.

H. M. S. Medina.—The Peninsular and Oriental liner chartered for the conveyance of their Majesties the King and Queen to India. For this trip accommodations have been very largely refitted, and a special crew will have charge for the voyage. The ship is 570 feet long, 62 feet 9 inches beam, and 20,000 tons loaded displacement. There are seven decks and passenger accommodation for 450 first class, 220 second class, besides a crew of 160. The machinery consists of two quadruple expansion engines, 30½, 44, 63, 89 by 54 inches stroke. Steam is furnished by four double-ended and four single-end boilers, working at 215 pounds pressure. 550 words.—*Engineering*, October 27.

Italian Dreadnought Conte di Cavour.—This is Italy's second dreadnought, and has the distinction of mounting the most numerous all-big-gun battery yet put into a modern warship. The main battery consists of thirteen 12-inch guns, six of which are mounted three in a turret, forward and aft. All can be trained abeam and five ahead and astern. Secondary battery consists of eighteen 4.7-inch guns placed on the broadsides and fourteen 14-pounders. Designed displacement of the ship is 21,500 tons, and speed 22.5 knots. Steam is to be supplied by watertube boilers to turbines. Further details of machinery are lacking. Article is accompanied by photographs of ship before launching and as she will appear at sea, and sketch showing general arrangement of armament, also a table comparing this with other recent dreadnoughts of the other nations. 1,300 words.—*The Marine Engineer and Naval Architect*, October.

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A Steam Launch.—Messrs. Simpson, Strickland & Company, of Dartmouth, specialists in the building of high-class steam launches, have recently turned out a boat embodying somewhat unusual features. Of 42 feet length over all, with 9 feet beam and 4 feet 6 inches depth, and carvel built of mahogany, the boat possesses a degree of comfort and seaworthiness unusual in so small a craft. Propelling machinery consists of a triple-expansion engine, 4¼, 6¾, 10 by 5 inches, which, running at 600 revolutions per minute, with 250 pounds boiler pressure, indicates 62 horsepower, and drives the boat 12 miles per hour. Besides photograph of the boat article contains drawings of boiler and engine. 900 words.—*The Engineer*, October 20.

Kaiser Franz Josef I.—On Sept. 9 this vessel, the largest liner constructed in Austria, was launched from the shipyard of Messrs. Cosulich Bros. at Monfalcone. The ship is 500 feet long, of 62 feet breadth, and 42 feet 9 inches depth to shelter deck, and is expected to attain a speed of 19 knots. Displacement 16,500 tons at 26 feet draft, gross registered tonnage 12,500 tons, and deadweight carrying capacity 7,500 tons. Passenger accommodations are provided for 160 first class, 480 second class and 1,400 third class. Propelling machinery was designed and constructed by Messrs. David Rowan & Company, of Glasgow, and consists of twin-screw quadruple expansion engines, balanced on the Yarrow-Schlick-Tweedy system, capable of indicating 13,000 horsepower. Steam is supplied by six double-ended and one single-ended boiler fitted with Howden forced draft. The auxiliary machinery throughout is of the best. The vessel has been built to Lloyd's highest class. 940 words and photograph of vessel after launching.—*The Marine Engineer and Naval Architect*, October.

Marine Engineering.

Jet Propulsion.—An editorial discussion of this subject which presents some facts little thought on, which, taken by themselves, would indicate a higher efficiency to be possible than is actually obtained in practice. The other side of the question is treated later, and effectually sets aside the too sanguine hopes of jet propulsion enthusiasts. For while it is unquestioned that the jet itself is higher in efficiency than any screw propeller, yet the difficulties encountered in taking into a ship the water to be used as the jet and imparting to it velocity that can be efficiently used for the propulsion of the vessel more than offset any theoretical advantages. 1,500 words.—*Engineering*, October 27.

The Progress of the Parsons Marine Turbine.—Being a review of the fourteenth annual report of the Parsons Marine Steam Turbine Company, Ltd., which gives a list of new ships just completed or building propelled by this type of machinery. Among others are mentioned the following: Warships—For France, six battleships of the *Danton* class, two larger battleships recently launched, and two other battleships recently authorized. For Germany, armored cruiser *Moltke* completed, three battleships and four cruisers ordered. United States, battleship *Utah* completed, three battleships authorized and seven destroyers now building. For Austria, Russia, Spain and Turkey, each a battleship building. For Japan, four armored cruisers now building. Merchant Ships—New Cunard steamship *Aquitania* at John Brown & Company; two new steamships for the Hamburg-American Line; new high-speed French liner *La France;* two new passenger ships for the Canadian Pacific service in British Columbia. 1,300 words.—*Engineering*, October 13.

Care in Using Liquid Fuel.—A bulletin has just been issued by the Navy Department dealing with this interesting and very important subject. Although fuel oil as supplied to ships is the residue of petroleum after distillation, and is not itself explosive, yet gases from it when mixed with air are liable to be dangerous if exposed to any flame or spark. Hence the value of these rules to all who have to do with the loading or using in any way of fuel oil. As given in this article the rules are too numerous to be given here, but are well worth looking up by those using oil fuel. 1,000 words.—*Marine Review*, October.

Measurement of Shaft Horsepower.—A resumé of the difficulties inherent in the measurement of shaft horsepower under conditions usually found in marine engineering, followed by a description of a type of torsion meter, the Denny-Edgecomb, which is said to fulfill every requirement for accurate, precise and easy reading of shaft horsepower for turbines, reciprocating steam engines or internal-combustion engines. The meters are purely mechanical in type. Connections are fitted for taking readings directly and simultaneously in engine room, chief engineer's room and captain's cabin. 3,500 words and photographs of the meter.—*The Engineer*, October 20.

Miscellaneous.

The Anschutz Gyro-Compass.—This instrument has the advantage to the navigator that it points to the true north and is unaffected by the presence of steel. It depends on the principle enunciated by Foucault that a gyrostat with only two degrees of freedom will at any point on the earth's surface except the poles tend to set itself with its axis of rotation parallel to the earth's axis. As used with a ship's compass the gyrostat is suspended beneath the compass card with its center directly in line with the north and south line. The gyrostat is electric driven and rotates about 20,000 times per minute. It is calculated that the directive force on the card is about fifteen times greater than in the case of a good liquid compass. 400 words.—*The Steamship*, October.

First Principles of Navy Yard Management.—By Assistant Naval Constructor Richard D. Gatewood, U. S. N. A comparison of staff and line organization as applied to industrial plants, navy yards in particular. Shows the weakness of the strictly military type discipline in the construction and repair of government ships. 2,500 words.—*The Marine Review*, October.

Automatic Coaling of Ships.—At Holyhead there has been in service for about a year a coaling barge that has attracted considerable attention. Of about 154 feet over all and 27 feet breadth, the structure of the barge is divided into eighteen coal bins, nine on each side of a longitudinal well which extends the length of the boat given up to cargo. In this well are carried and operated two elevators, which hoist coal from the bins into chutes which lead to the vessel to be coaled. The elevators are operated by the upper drum, driven by gears from a double-cylinder, direct-acting engine. The barge is propelled by twin-screws driven by two sets of compound engines, 6¼, 12½ by 8½ inches, working at 90 pounds pressure. The elevators are moved forward or aft by a chain lead driven by a donkey engine in the stern. Steam is furnished by a Blake patent vertical cylindrical boiler. It is placed in the stern and steam is conveyed by flexible tubing. The system is one which admits of much flexibility, both in design of the barges and in the actual operation. The number, size and arrangement of the bins and elevators may be made to suit conditions, while propelling machinery may be made anything convenient. In actual work the elevators may be moved or the position of the barge changed while the coal already loaded is stowed and trimmed. Chutes may be turned to get a good radius of action. Elevating mechanism is said to operate economically. The barge can coal a ship at the rate of 300 tons per hour. Sketches showing general arrangements and 'midship section, together with photograph of barge in operation, given with description. 1,000 words.—*The Engineer*, Sept. 29.

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NINETEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The nineteenth annual meeting of the American Society of Naval Architects and Marine Engineers was held Nov. 16 and 17 at the Engineering Societies building, New York. The meetings were opened by a very interesting address on current progress in shipbuilding and marine engineering by Mr. Stevenson Taylor, president of the society. Following this the report of the secretary-treasurer was read, showing an increase in membership of seventeen during the year, fifty-one new members were elected, eight deaths occurred, and twenty-one resignations and five suspensions were recorded. The financial condition of the society was very satisfactory. The resignation of Capt. W. J. Baxter as secretary-treasurer on account of ill health was sincerely regretted by every member of the society. To fill his place the society elected Mr. D. H. Cox, a selection which was unanimously approved. Seventeen papers were read and discussed, abstracts of which follow:

No. 1—On the Maximum Dimensions of Ships.

BY SIR WILLIAM H. WHITE, K. C. B., F. R. S., D. SC., LL. D., D. ENG.

ABSTRACT.

The subject has an interest for naval architects, shipowners, dock and harbor authorities, travelers and all classes of engineers. What seem to be chiefly needed are reasoned replies to certain questions: 1. Is it probable that the dimensions of ships will continue to grow at the rapid rate which has prevailed in recent years? 2. Will an upper limit to the sizes of ships be reached? 3. What considerations, if any, are likely to determine such a limit, for either merchant ships or warships? Probably the most useful procedure will be to make a detailed statement of facts and principles which will, for the most part, command general assent; and in doing so it may not be out of place for me to state my own conclusions on points of controversy:

I. It will be agreed that the law of growth in dimensions has operated hitherto on all classes of ships, and that its action has on the whole been beneficial. Members of this society treat as axiomatic the statement that economy in propulsion and over-sea transport has been, and always will be, promoted by increased dimensions. Stronger materials of construction have been made available; more efficient types of machinery and propellers have been devised; higher steam pressures have led to greater fuel economy, and higher rates of revolution have favored relatively lighter propelling apparatus. But after each such improvement has been introduced and utilized, the law of growth in dimensions has inevitably reasserted its claims on naval architects, and been again brought into operation in order to secure still further advantage in respect of speed, carrying power, or other features of ship design. Successive vessels belonging to each and every class have been made larger than their predecessors.

II. It must be noted, however, that—notwithstanding the remarkable developments of the last ten years—the number of ships of extremely large dimensions is relatively few. Whatever may be the future growth in size of the largest ships built for special services, the bulk of the maritime business of the world will always be done by ships of relatively moderate dimensions, and they will continue to be the largest contributors to the revenues of port and harbor authorities.

III. Naval architects will agree that, provided the money is forthcoming for building still larger ships, their construction will be possible; and that considerably increased dimensions will present no serious difficulty even if the materials for shipbuilding already available were not improved upon. The margin of possibility indeed appears to go far beyond any probable demand.

IV. Existing physical conditions in the seaports, harbors and docks of the world, necessarily impose limits on the draft of water of ships. Much has been done, at great cost, to improve accommodation and to provide increased depths of water; but it is well recognized that the increase in dimensions of ships above described has been chiefly in lengths, breadths and molded depths; the increase in drafts of water when fully laden has been relatively small. The earning powers of ships are thus lessened, and in these circumstances it is natural that a demand should have arisen, and should still continue, for greater depths of water and better accommodation for ships of the largest size.

V. Up to the present time the response made to the appeal from shipowners for increased accommodation for larger ships by authorities of the great seaports of the world has been neither niggardly nor unsatisfactory. Extensive and costly works are in progress which will provide accommodation for the largest ships now building, and leave some margin for further developments.

VI. The marvelous growth of the world's commerce in modern times has enabled these great engineering works to be undertaken hitherto under conditions which have, in most cases, either yielded fair returns to investors in dock and harbor securities, or which have been considered by governments beneficial to the whole nation and worthy of adoption irrespective of the return upon capital expenditure. The growth of traffic in most of the great seaports has also enabled earlier docks to be fully utilized by vessels of smaller dimensions than those for which the latest docks have been constructed. But while this has hitherto happened it seems not improbable that a point may be reached beyond which dock and harbor authorities will not care to go into expenditure in order to meet further increase in dimensions and drafts in a relatively small number of the largest ships; and it is well understood that this consideration particularly applies to increase in draft of water, since the cost of dredging grows rapidly with increase of depth.

VII. A brief summary of facts relating to the dimensions of locks and dock entrances recently constructed or now in process of construction is given as indicating the outcome of inquiries set afoot by responsible authorities in regard to the provision of suitable accommodation for the largest ships likely to be built.

VIII. When the particulars for locks, docks and approach channels are considered in the light of dimensions of ships it will be seen that the margins provided in most of the recent engineering works are not very great in regard to length and breadth, although they are expected to prove sufficient for many years to come, because of commercial considerations.

IX. It is a fact worth noting that ships of the maximum dimensions now built or building are not easily accommodated or moved in the largest docks and harbors. The vessels are wonderfully handy, but they necessarily require large spaces for their maneuvers, because they are so long and heavy, and in the busy waters of their terminal ports caution is required. Even in the terminal ports of the transatlantic steamers difficulties are necessarily experienced, and although they have been overcome so far they must be accentuated by any further increase of size.

X. For cargo steamers and warships no such fixed conditions or terminal ports exist. The former class are built to seek cargoes everywhere and to deliver them wherever desired. Consequently experience has led to the adoption of relatively moderate dimensions and draft of water, in order that their possible field of operations may be extended widely. Moderate draft of water is an important feature of warship design; and the tendency in recent years to a considerable increase in the deep load-drafts of warships is, from this point of view, objectionable. For warships as well as for

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merchant ships expenditure on ships and armaments must be considered concurrently with that on harbors and docks.

XI. Enlarged dimensions, of course, enable certain advantages to be obtained outside the fundamental gains of economy in sea transport or increased speed, such as maintenance of speed at sea in rough weather and increased uniformity of service between terminal ports; greater steadiness and good behavior in rough water and increased comfort for passengers; better and more spacious accommodation for larger numbers of passengers; the attraction which many passengers have toward the "biggest ships afloat." Further increase in the dimensions of ships will have little or no effect upon regularity of performance of service between terminal ports, and large dimensions are not necessary to secure moderate rolling and easy motion.

XII. It would appear that the main determining factor in regard to maximum dimensions for future mercantile vessels must be found on the commercial side and not on the technical. If ships cannot be made to pay dividends on the capital sums invested in them—after meeting working expenses and cost of up-keep, and making due allowance for insurance and depreciation—they are not likely to be built.

XIII. For warships other considerations than those of first cost and cost of maintenance must determine the maximum dimensions which should be adopted. As outlined by Sir William in a paper before the society last year his conclusion, based upon long-continued study of the problem, is that the wiser course in warship building would be found in a return to more moderate dimensions and a reduced unit cost for capital ships.

No. 2—Dock Facilities in New York City—Present Facilities, Proposed Improvements and Enlargements.

BY WILLIAM J. BARNEY.

ABSTRACT.

Attention is called to four broad divisions of freight handled in the port of New York as aids in considering the present facilities, their disadvantages and the proposed improvements and extensions: First, "trans-shipments," which include the freight that enters and leaves New York merely as a port of entry for trans-shipment on its way between foreign countries and other parts of our own country; second, "city imports," comprising the foreign freight coming into the port of New York for direct consumption in the city of New York, especially on the Island of Manhattan for retail distribution therefrom; third, "passengers," preferably to be landed in Manhattan because of the hotels, theaters, shops and railroad stations, and, fourth, "railroad city" traffic, or goods from the hinterland, for consumption in the boroughs of New York, and their own exports thereto, which must of necessity pass over the bulkheads and piers of these island boroughs. The logical plan for handling these four classes of freight would be to reserve the water front and the immediately adjacent upland for the maritime commerce; that is, for the "trans-shipments," "city imports" and "passengers"; on the other hand, to receive the "railroad city" freight and supplies for the city at depots and freight yards so far removed from the water front as not to curtail the maritime development and the cheap handling of maritime freight. For handling "trans-shipments," and also for "city imports," there is to-day one great terminal in New York developed and managed by private interests, and two other freight terminals of importance. Aside from these terminals little has been done in an organized manner for "trans-shipments," but the port authorities have in view the installation by the municipality of terminals for "trans-shipments" and "city imports" in South Brooklyn, on the east shore of Staten Island and at Jamaica Bay.

In connection with this presentation of the present water front freight terminals in the harbor and their proposed extensions, the present lack of mechanical equipment is worthy of note. Practically no piers in New York harbor, aside from the "Chelsea Piers," are equipped with cranes and other mechanical freight-handling devices.

On the North River, the upper sections of Manhattan, where developed and not occupied by parkways, are at present largely occupied by river lines, small crafts and barges handling building materials and coarse freight. The lower Manhattan water front on the North River is a natural location for the large passenger and packet express steamers, since their passengers and cargoes are destined particularly for Manhattan. There is one large transatlantic passenger and packet freight installation in the port of New York—the Chelsea Section, between Twelfth street and Twenty-third street. Of ninety-five piers on the North River below Sixtieth street, forty-one piers, or nearly one-half, are occupied by the railroad companies or the "city railroad" freight. Excepting the New York Central, the great trans-continental railroads reaching this port terminate on the Jersey shore, and the freight cars are carried on car floats over from the Jersey side to the various piers of the different railroads in Manhattan. This method of handling the "railroad-to-the-city" freight results in a floating freight yard from the Battery north to Twenty-third street, a part of the water front which is imperatively required by the growing maritime interests in the port. Therefore, to provide properly for the steamship lines and yet to conserve the railroad facilities of the city, freight cars must be given a common point of entry to the city upland in a less congested district of Manhattan with track connections into the downtown wholesale and business districts. It is therefore proposed to install a series of car float transfer bridges between Thirtieth and Fortieth streets on the North River, and there to concentrate the delivery of all car floats now occupying the water front in lower Manhattan, and by means of ramps or inclined planes to bring these cars from these car floats up onto an elevated railroad to run south from Twenty-fifth street along the marginal way. It is further proposed, by means of elevated sidings from this elevated railroad, to place these cars into the second story of large freight terminals or warehouses, etc., on the east or inshore side of West street. The freight is there to be unloaded onto receiving platforms either by storage or for delivery at the street level to trucks, etc., by chutes, elevators, or other mechanical devices. The reverse procedure will handle outbound shipments. By practically doubling the maritime capacity of the central part of New York harbor it is believed by the department that such an installation and reorganization of the port facilities will more than handle the prospective growth of maritime commerce for many years to come, and also meet and solve the difficulties presented by the increasing length of transatlantic steamers.

No. 3—Some Model Basin Investigations of the Influence of Form of Ships upon their Resistance.

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

ABSTRACT.

In a paper three years ago before the society upon the influence of the shape of the 'midship section upon resistance I showed that within the range of a limited number of experiments the influence of the shape of the 'midship section upon resistance, while appreciable, was not great, and for the variations practicable in a given case would usually be almost negligible. The present paper gives the results of some experimental investigations of the effect of shape toward the extremities. The field is a very broad one, and the experi-

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ments are far from completion. The results now given, however, are complete in themselves, and it is believed throw a light on the portion of the field they cover. Two series of models, namely, Series Nos. 29 and 32, were used. The displacement in fresh water was in every case 2,250 pounds, and the length of each model 20 feet. The 'midship section coefficient was in each case 0.96 and the ratio of beam to draft 2.5. The longitudinal coefficient of Series No. 29 was 0.60, and Series No. 32, 0.64. Hence the beam and draft in Series No. 32 were slightly less than in Series No. 29. It will be observed that each series consists of sixteen models. This resulted from the fact that in each case four different curves of sectional area were used and four different waterlines. The waterlines were largely the same for the two series. Each curve of sectional area being combined with each waterline resulted in sixteen models. In addition the models of each series, which all had the same 'midship section, were made in halves, so that each bow could be combined with each stern, resulting in 256 possible combinations for each series. As will be explained later there were a number of different combinations made during the experiments, but not 256. For convenience and simplicity the stern profiles are rectangular. The bow profiles are practically rectangular. The curves, of sectional area, have a value at the bow, or, in other words, the bow below water is of a simple bulbous form. In each case half of the displacement was forward of the center and half of the displacement abaft of the center. The waterline, however, had a greater area abaft the center; the coefficient of the after half of the waterline of Series No. 29 being always five points greater than that of the forward half of the waterline. In each case of Series No. 32 the after waterline coefficient was ten points larger than the forward waterline coefficient. This was done to make the waterlines approach more closely average practice.

The resistance being due partly to the surface and partly to the disturbance created, the first question to be investigated is the relative surfaces of the various models. It is found that the variation of wetted surface is not great. Bearing this in mind we may safely say that the effect of practicable variations of shape of sectional area curves and waterline fineness upon wetted surface are comparatively small. Fine ended curves of sectional area result in somewhat greater wetted surface, but the difference is not more than 2 percent or so for very great variations of sectional area.

Let us take up now the experimental results. Bearing in mind that comparatively few vessels are driven at speeds greatly above that corresponding to 4 knots for the 20-foot model, it is found that the variation of resistance corresponding to very radical variations of form of the three models in each case are after all not great. It is interesting to note the critical speed, a little above 4 knots, at which the models change place materially. Models which are of the extreme type, combining full ended sectional areas and fine ended waterlines, are the worst below 4 knots, while between 4 and 5 knots they show themselves the best. This is a typical result and shows that the features of a model should be adapted to suit the speed.

Taking up now the question of residuary resistance rather than the total resistance, a study of the results shows the tendency to straighten out or change relative positions beginning, roughly, at or a little below the speed length ratio of 0.9, corresponding closely to a 4-knot speed for a 20-foot model.

For Series No. 29, where the longitudinal coefficient was 0.60, in every case the fine bow appears to be the best at low speeds. Moreover, the fine bow in combination with the full stern appears better than the fine bow in combination with the fine stern. At higher speeds the fine bow with the full stern loses its superiority. Considering Series 32 (longitudinal coefficient 0.64), while the fine bow appears to be a little the best at low speeds, it does not show as much superiority as it does for the Series No. 29, and at the higher speeds, too, the fine bow is relatively worse. Broadly speaking, the fine ended curves of sectional area have the better of it at and below a speed length ratio of about 0.9, while at the high speeds they are the worst in every case. It was difficult to separate the effect of the bow from the stern. Undoubtedly the resistance of a given stern will be different as it is combined with varying bows, and vice versa. It was not practicable to test all bows with all sterns, as this would involve testing 256 models for each series. Some investigation was made, however, of the stern effect by combining a single bow with all sixteen sterns in each case. The common bow used was one where a rather full waterline was combined with a rather fine ended type sectional area curve. The results where the curves are grouped by waterlines show remarkably small variation for all speeds, indicating that we may materially vary shape of curves of sectional area aft without material effect upon resistance. With the same curves grouped by curves of sectional area for moderate speeds these again show comparatively small variations, but at high speeds the variations, while not great, are appreciable, and the results unwelcome. W. Froude many years ago laid down the dictum that, broadly speaking, the U-bow and V-stern were favorable to speed. Now the fuller the waterline aft and the finer ended the curve of sectional area the more the stern approaches the V-type. The first group of curves indicate clearly that for usual speeds the V-type of stern is superior, but the second group shows at about a speed length coefficient of 0.95 a change in relative positions of the curves, and in every case the fine waterline aft is the best at high speeds. Careful consideration of these results will, it is believed, warrant the conclusion that the primary factor involved here is waterline fineness, the variations with changes in curves of sectional area being subsidiary. There is not much to choose between the sterns with fine ended and full ended curves of sectional area. Of course, in practice we would wish to use with a fine waterline aft a fine ended curve of sectional area to avoid a bulbous stern.

There remain two questions to be considered, namely, what is the best combination of coefficients in the case of each series, and how much can we affect the resistance by adopting this best combination? For the minimum resistance at the high speeds we need to materially fine the ship at the waterline and fill it out below water. The broad conclusion to be drawn from the results I have obtained are confirmed by other experiments which agree in indicating that the type of form suitable for low and moderate speed length ratio below 0.9 is not at all adapted for high-speed length ratios of 1 and above. The reason is, I think, to be sought in the relative dimensions of the ships and the waves which it makes. At the low speeds only the ends of the ship, and more particularly the forward end, materially affect the resulting waves, which, after all, are small and offer but comparatively small resistance. At the high speeds, however, the whole fore-body has to do with the creation of the waves, and we decrease resistance by making the waterline as fine as possible and putting as much as possible of the displacement well below water, where the pressures, due to its thrusting itself into the undisturbed water, will be as much as possible absorbed in doing the necessary pumping aft of the water and not in raising the surface into waves.

It will be found upon studying the contours and lines that while for medium speed work lines of the U-type are excellent, there is material decrease in resistance for high speeds by approaching the type of the bulbous bow. It is true that the latter models indicate also a bulbous stern, but we have found that the main factor here is the fine waterline aft for high speed, and not the full ended curve of sectional areas. As pointed out already the models of Series Nos. 29 and 32 are

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not of high-speed type, and I would not feel warranted in drawing any conclusions from them as to high-speed work did not results so far from high-speed models appear to agree with those from Series Nos. 29 and 32. I think, then, there is little doubt that for high-speed work up in the region where $\frac{V}{\sqrt{L}}$ is from 1 to 1.2, the bulbous type of bow is distinctly superior as regards resistance. While there are some practical objections to it, they do not seem to be very serious, and I see no reason why in many cases some approach to the bulbous type could not be made to advantage. The extreme U-type of bow, where the fore foot is carried as far forward as possible and the sides are practically vertical, the waterline being made as fine as possible, is the nearest approach to the bulbous type of bow that can be made without departing from conventional ideas, and where adopted this type of bow will give less resistance for high-speed work than bows of less pronounced U or V-type.

No. 4—The Resistance of Some Merchant Ship Types in Shallow Water.

BY PROFESSOR HERBERT C. SADLER.

ABSTRACT.

During the past two years a number of models of various merchant ship types have been tested in water of varying depth in the "tank" at the University of Michigan. The characteristics of each form are given in the paper with the curves. They range from fine to full types. Some of the broader types of from five to six beams to the length and one with V-shaped sections have also been added. In each case the curves represent the residuary resistance in pounds per ton of displacement. The false bottom was fixed at definite depths, and all models were tested at these depths of water. As many of the models represented actual vessels, and were not of the same length, they were loaded in each case to their respective load-drafts, hence the depth-length or depth-draft ratio varied in most cases.

In connection with the above it may be of interest to note that various "humps" in the resistance curves occurred at practically the same speed irrespective of the length of the model, which indicates that the speed at which the maximum resistance occurs is a function of depth of water rather than size of ship.

Cross curves representing the variation of resistance in terms of depth of water are given on each diagram; also curves showing the approximate speed-length ratio at which the residuary resistance begins to increase as compared with deep water.

Results were obtained for a typical set of merchant ship forms varying in prismatic coefficient from about 0.5 to 0.85, where the first "hump" in the curve for a given depth occurs at nearly the same speed for all types. There is, however, a tendency for the maximum to occur at a higher speed as the form of the vessel becomes finer.

With curves for two vessels of the same dimensions and practically the same prismatic coefficient or curve of sectional areas, but differing only in area of 'midship section, and hence block coefficient, the curves of residuary resistance per ton of displacement in shallow water have the same characteristics as those of deep water; but as the humps occur at earlier speeds and are much more pronounced in the shallow water, the form with the finer 'midship section appears to have an advantage over the fuller type, particularly at what may be termed the "practical" speeds for this form.

In similar sets of curves for a slightly fuller vessel than the previous one, the same general characteristics appear to hold in both cases.

Curves were obtained for a broad vessel with practically V-shaped sections throughout. In this case the vessel was tried at two drafts. The "humps" occur at the same speeds for each draft; also these are not so pronounced as in the types with fuller 'midship sections. This is probably due to the fact that the mean draft of the 'midship section is much less in this than in the previous cases.

It is often of interest to know at about what speed the first "hump" is likely to occur for a given depth of water. The speed-length ratios at which this maximum resistance may be expected have been plotted on a depth-length ratio base. In this case the total resistance of the model has been taken. Other published results have been added for comparison, and from these, which are mostly for torpedo boat destroyers and vessels of a somewhat similar type, it appears as if the "hump" for a given depth of water occurs at slightly higher speeds in the fuller forms. Observations of the wave formation at the critical speeds confirm those already given by previous writers. At or near these speeds the vessel tends to form a train of waves at the stern, which extends for some distance from each side of the ship and at right angles to the same. After passing this point the normal type of bow and stern wave gradually reappears. It is possible, therefore, with the limited dimensions of the tank, that the sides may have some influence upon the results at these speeds. As, however, the first critical speed, especially at the smaller depth-length ratios, would be practically impossible of attainment in the types given, any slight error involved does not have much weight.

No. 5—Panama Canal and American Commerce.

BY LEWIS NIXON.

ABSTRACT.

That commerce will be stimulated by the opening of the Panama Canal is generally admitted, but that its advantage will be uniform to all countries is, of course, impossible. The men who framed our Constitution and who in Congress later carried out its intentions and ideals in laws, thoroughly understood that the three pillars of national greatness and prosperity were commerce, agriculture and manufacturing. We neglect the commercial pillar, although the proportion of exports which consists of foodstuffs and staples that foreign countries must have to feed their people and their factories is falling, while the proportion of manufacturing commodities in which we have to meet the competition of the world is increasing. What this society probably wants to know is, Are there means by which the vast sum spent for the Panama Canal can be of help to the varied interests of this country instead of furnishing issues of bonds with which to aid the continuance of our present currency system, the existence of which is as much a tax upon us as is the non-existence of a merchant marine? This canal is a thoroughfare through our territory and should be free to our vessels. A rebate to our own vessels would be a cowardly compromise. Mexico, Central America, the West Indies and the northern shores of South America are at the door of the Panama Canal. As trade and transportation focus to the Isthmus, and the governments surrounding it become stable and safe fields for investment, so that their vast potential resources may contribute to the world's commerce, I look to see in a few years the Caribbean Sea and the Gulf of Mexico girdled by prosperous cities, with trade rivaling in activity and prosperity the cities of the Great Lake basin. By treaties with these countries we should extend our coasting laws to them, with the understanding that all vessels owned and operating under the flags of either party to the treaty, say on Jan. 1, 1912, shall

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enjoy reciprocal liberty of commerce in the ports of either party, after that date vessels constructed in either country to have the same privilege. My earnest conviction is that we must return to our early policy of discriminating duties and tonnage taxes if we are to revive our merchant marine in the foreign trade. As to the establishment of mail lines to South American ports there are two points needing attention. We must not gage our service by comparison with existing ships running from the United States to South America, but by comparison with ships running from European ports, and the question of renewals should be carefully considered. Personally, I think thirty years the absolute minimum for such contracts. In this way, as needed, new and better vessels will be added, and the older vessels will go into the freight or the accommodation and reserve service so essential to a growing line.

No. 6—Experiments on the Froude.

BY PROFESSOR C. H. PEABODY.

ABSTRACT.

The paper describes experiments made on the resistance and propulsion of ships by the aid of navigable models made at the Institute of Technology. The prototype chosen for the investigation was the revenue cutter *Manning*, which was tested by the writer in 1899. The model was made one-fifth of the length of the *Manning*, and, although properly called a model, the craft, which was named the *Froude*, is a miniature steamer of considerable size and displacement, which handles and behaves like a ship and not at all like a steam launch. The *Froude* is indirectly propelled by a gasoline (petrol) electric generating set and an electric motor with a chain drive to the propeller shaft. Measurements of the friction of the propelling machinery were made first by aid of a friction brake attached behind the propeller when the boat was hauled up, and later by a friction brake installed within the hull, when brake tests were made with the propeller removed but otherwise with the boat under service conditions. The experiments with the *Froude* consisted in making a series of progressive speed trials over a measured course, usually an eighth of a knot long. A continuous recording device was installed for recording the data from the progressive speed trials. A model of the *Manning* was also made and tested in the model basin at Washington for results to be compared with the progressive speed trials of the *Manning* itself and also of the *Froude*. A propeller for the *Froude*, planed according to the working drawing of the *Manning's* propeller, was installed after being tested at the model basin. These investigations were carried on in 1910 and 1911. The work in 1910 was to install, adjust and rate the machinery and instruments and learn the limitations of the experiments, and also to make tests with the propeller. Tests were made with the propeller hub successively 3, 6, 18 and 30 inches abaft the stern post. The comparison of the thrust and power curves obtained showed that the location of the propeller with regard to the stern of the boat and the broad stern post had a large effect on thrust and power required to drive the boat. The results led to the conclusion that a large waste of power is due to setting the propeller in the eddy astern of the rudder post, and that when the propeller is once free from that eddy there is only the normal and regular gain that may be expected from carrying the propeller well away from the stern.

Considering all the elements that entered into these investigations, the author feels justified in claiming an error of precision of 1 percent for results of tests at full power and speed; at slower speeds and smaller powers the errors are liable to be larger, perhaps as much as 2 percent. There are certain anomalies, especially at low powers and speeds, for which no explanation is offered. They are too well marked to be attributed to errors or uncertainties on observation or reduction. Among these are the curious variations of wake, and especially the indication of negative thrust deductions. To the author's mind it appears possible that the degree of precision of the work may be sufficient to reveal real anomalies in the accepted convention concerning the intersection of hull and propeller. He considers the most noticeable feature to be the small wake computed for the normal setting of the propeller 1 inch from the stern post, more especially as the wake for the 3-inch setting while the propeller is still affected by the eddy behind the stern post is what may be reasonably expected. The gain in propulsive efficiency for the latter setting, as indicated by a comparison of the shaft horsepowers, is only 3 percent.

One of the most interesting and important results of these investigations is the comparison with the progressive speed trials of the *Manning* reported by the writer to this society. The question of direct interest to the shipbuilder and the naval architect is the power which should be given to a certain ship to give a desired speed. As a contribution to the answering of this question the comparison was made of the actual observed power of the *Manning* with an estimation of power from the resistance of the 23.5-foot model, as determined in the model basin, together with an estimate of the wake and the thrust deduction from the tests of the *Froude*. He shows that an estimate of the power for the *Manning* from the 23.5-foot model would be in excess, apparently, 15½ percent. This discrepancy is considered by the author as normal instead of exceptional, since, in the case in hand, the speed length ratio is 1.17, which indicates an abnormally high speed for a ship of the type of the *Manning*, and the power probably increases as the fourth power of the speed, if not more rapidly, instead of the cube of the speed, as the power of a ship is commonly assumed to vary. If the fourth power be taken in this case then an over-estimate of 16 percent in the power would give only 4 percent excess in speed. The author enumerates several elements which enter into an analysis of this discrepancy, and concludes that an estimate could be made of the influence of each element which would be plausible, if not probable, in such a way that the entire discrepancy could be explained away if necessary.

Since the investigation in 1910 showed such an exceptional influence from the broad stern post, it was decided to fit a fair-water to give conditions more nearly like those of ordinary practice for steamships. The main object of the investigations in 1911 was the determination of the influence of the pitch and area of the propeller on propulsion. Three propellers were made, each 2 feet in diameter, with a projected area ratio of about .6 of the disk area. Three pitch ratios were chosen, one normal and the other two abnormal, one being much less and the other much greater than obtains in practice. Variations of both pitch and width of blades in these two experiments were much greater than are likely to be assigned to any given design, even by engineers who differ widely in practice; consequently the conclusion is that the practical efficiency of well-designed propellers is very little affected by ordinary variations of pitch and width of blades. To this conclusion may be added that all propellers having ovoid forms of blades are sensibly equal in efficiency.

No. 7—The Effect of Waves upon a Taffrail Log.

BY PROFESSOR HAROLD A. EVERETT.

ABSTRACT.

The causes of the erratic behavior of taffrail logs have been variously ascribed to poor mechanical construction, wake and torsional elasticity of the log line. Some years ago the Institute purchased a log intended to eliminate the first and last sources of error, and in order to do away with the second it

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was proposed to tow this log from a long spar projecting from the side of the ship. The results of those trials showed such an erratic behavior of the log constant that it led the author to suspect that another source of trouble than any of those previously mentioned was the real cause, namely, the effect of the waves which the ship carries along with herself. Considering only the stern wave system we should expect to find a log which was towed behind a ship alternately over-running and under-running as the ship gradually increased in speed. These variations would correspond to the successive traveling of hollow and crest past the log as the transverse waves behind the ship gradually lengthened with the increasing speed. As the ship is propelled through the water at gradually increasing speed the bow-wave system when it reaches the stern alternately increases and decreases the height of the transverse waves of the resultant stern system. If the bow waves were of equal height to the stern waves at the time of their reaching the stern system, the resultant waves would be twice as high as the individual waves when the two systems came crest to crest, and would be nil when they came crest to hollow. The speeds of the ship at which these two events occur can be figured with reasonable exactness. They, of course, correspond to the speeds of maximum and minimum wave interference, and the theoretical conception of these speeds has been verified by experimental work in towing basins and elsewhere. The author shows how to construct a curve showing the variations of the log factor due to this effect of the waves upon a log towed at a constant distance from the ship during progressive speed trials, taking into account the calibration curve for a log towed in still water. On progressive speed trials of two steamships a recording log was towed, obtaining the ratios of the speed curve to the log curve, and these ratios were plotted on the speeds of the ship as abscissæ. Superimposing this plot upon the curve for variation of the log factor for successive speeds, it was found that the points determined coincided with the curve of log factor variations, thus bearing out the author's theory of the effect of waves upon the log. The results of these trials show definitely: (1) That any taffrail log is seriously affected by the wave system carried along by the ship. (2) That in order to be available for measurement of distances at different speeds it must be calibrated by obtaining many points at closely adjacent speeds and in some manner that takes account of the wave action. (3) The length of the log line must be unchanged throughout calibration and subsequent running; and (4) that a taffrail log as a close measurer of speeds is a questionable instrument.

No. 8—The Raising of the Drydock Dewey.

BY NAVAL CONSTRUCTOR L. S. ADAMS, U. S. N.

ABSTRACT.

The drydock *Dewey* sank at Olongapo, Subic Bay, Philippine Islands, May, 1910. The cause for the sinking was at the time unknown, and three methods were proposed for attempting to raise the dock. The author gives a detailed description of the dock and its position after sinking, and then describes the work carried out in raising the dock. All three methods were tried. The first two failed and had to be abandoned, while the third was carried out successfully. The first method consisted of introducing compressed air into certain of the bottom tanks on the port side, which was most deeply immersed. It was found that after installing the manhole doors and plugging all vent pipes the compressed air which was introduced leaked through the bulkheads, which proved to be non-watertight at the tops, allowing the air to pass through them from one tank to another. The second method involved clearing the compartment, which contains the forward centrifugal pump for operating the dock, of water and operating the dock's own pump by steam furnished from a tug. Clearing this compartment of water necessitated building a steel cofferdam and installing pumps. The end bulkheads of this compartment were not watertight, and were inadequately stiffened, requiring extensive shoring and calking. Due to defective stop valves the pump took water from the high tanks before removing any from the low tanks. Considerable progress was made in this direction, but after some time it was found that the dock's own pump was in such bad condition, due to having been working in mud and salt water and from excessive inclination, and also due to the breaking of the oiling gear, it needed overhauling. This method was then abandoned. In the third method the whole top and bottom decks and the side walls and machinery space on the sunken side were made watertight. Then by clearing this whole space of water, which would provide nearly 3,000 tons of buoyancy, and then by utilizing the dock's own pump to raise her, or by mounting pumps below, the dock could be raised. This was successfully accomplished. As soon as the dock was raised a careful examination showed that the cause of the sinking of the dock was due to the fact that the vent pipes from the tanks were badly corroded and had given way in places, thereby leaving large areas open to the sea. When the dock was up these vent pipes were always above the surface of the water, but when the dock had been lowered for docking these vent pipes were mostly under water, and the water entered them and gradually filled the ballast compartments of the dock, which caused the sinking. The work, and those who accomplished this gigantic task, deserve the highest praise and commendation.

No. 9—The Best Arrangement for Combined Reciprocating and Turbine Engines on Steamships.

BY G. W. DICKIE.

ABSTRACT.

It so happens that both types of steam engine have an economical and a wasteful end. In the turbine the steam begins its work in the wasteful end and finishes in the economical end, while in the reciprocating engine this is reversed. I believe that the best result in steam consumption could be gained from having the terminal pressure for the reciprocating part of the engine power at or about 30 pounds absolute, or a little above the usual low-pressure receiver pressure in triple-expansion engines. Notwithstanding the important advantages claimed for the arrangement of two reciprocating engines and one turbine, as used on the White Star Liners, I believe that better results, with installations up to 20,000 horsepower, can be secured by having one reciprocating engine on the center line delivering steam to a turbine on each side at about 30 pounds absolute. This would admit of the center-line engine developing about 40 percent of the total power, and, when exhausting straight to the condenser, at least 60 percent of the full power. The larger and most effective propeller would be on the center line, where its efficiency would have the best propelling effect. The smaller side propellers would not require so wide projections from the side of the ship, and would thus cause less disturbance to the water in the after run. With the large propeller in the center, the side propellers could be run at a higher number of revolutions than would be advisable for the center propeller were it turbine-driven. This would permit of the turbine rotors and casings being of a moderate diameter. In a 20,000-horsepower set of engines, with the center-line shaft making, say, 78 revolutions, I would have the side shafts running about 400 revolutions, which would give a diameter of about 8 feet to the rotor. This would enable the turbines to be placed alongside the reciprocating engine in any merchant ship having that amount

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of power. With the reciprocating engine closing its work with a terminal pressure of 30 pounds absolute, a simple compound engine would give satisfactory results. The wet and dry air pumps could be operated through levers worked from the crossheads of the low-pressure cylinders, and the feed pumps independently. This arrangement admits of a cooler engine room than can be obtained where the hottest parts of the machinery are in the wings and, in most cases, under deck. In the arrangement proposed by the writer the hottest parts of the machinery are directly under the casing that leads up through all the decks to the open air above. Two objections to this arrangement should be considered, viz., the sacrifice of the maneuvering power of two propellers on reversing engines for that of one, and the loss of backing power if a breakdown should occur. In reply to this it is claimed that the advantage of a simpler and cheaper arrangement with the most effective propeller on the center line of the ship and the promise of better economy should outweigh any possible advantage for maneuvering that the twin screw has over the single-screw ship, and the possibilities of breakdowns with the simple type of reciprocating engine proposed are very remote.

No. 10—The Parsons Marine Steam Turbine and its Application to Various Classes of Vessels.

BY E. H. B. ANDERSON.

ABSTRACT.

The object of this paper is to put before the members of this society some of the various arrangements of turbine machinery in past and present vessels which are fitted with Parsons turbines. In torpedo boats and small fast steam yachts the pioneer three-shaft arrangement of machinery is still installed. In the earliest turbine destroyers four shafts were fitted. This design was followed in the next destroyers by the standard three-shaft arrangement, to which was added two cruising turbines in series, arranged at forward end of each low-pressure turbine. For small fast cruisers the three-shaft arrangement has been found very satisfactory. Among the smaller cruisers and scout cruisers the four-shaft arrangement has been adopted largely. In battleships and cruisers of the *Dreadnought* type, four shafts are fitted. In the latest ships of this type, cruising turbines have been dispensed with, and although it was recognized that the addition of cruising turbines improved the economy to a large extent, the complication, together with the fact that such turbines are often running idly, decided against installing them in ships of this type, especially where cruising turbines are fitted in parallel. The main difference in the machinery layout of American battleships compared with those of the *Dreadnought* type, is that the cruising turbines are arranged in series instead of in parallel. In the mercantile marine the three-shaft arrangement of turbine machinery similar to that installed in the first ship, the *King Edward*, is still used in almost all ships except those of very large power. In 1905 a two-shaft arrangement of machinery was installed in the steam yacht *Narcissus*. The *Lusitania* and *Mauretania* have four-shaft arrangements of turbines, which consist of two independent sets. A modified arrangement of turbines has been adopted in the French liner *France*, now nearing completion, which will further improve the economy, as the turbines are arranged in series similar to the Spanish battleships. A similar arrangement of machinery is being adopted in the new Cunard liner *Aquitania*, now under construction on the Clyde, and also for several other ships. The combination arrangement of turbines and reciprocating engines has also given good results, as instanced by the *Otaki*, *Laurentic* and *Olympic*, and notable other installations are now being made.

The first application of a geared turbine was made by the Parsons Marine Steam Turbine Company in 1897, and later, in 1910, the steamship *Vespasian* was fitted with a geared installation of turbines. At the present time two fast destroyers are nearing completion in England having geared turbine machinery driving two shafts. Two Channel steamers for the London & South Western Railway Company are also under construction. With regard to the question of multiple shafts, the present tendency among certain naval authorities is to cut down the number of shafts and turbines in vessels of the destroyer classes. A difference of opinion appears to exist as to whether two, three or four shafts are most suitable from an economical and a practical point of view. The arrangements of the engine-room bulkheads and the sub-division of the machinery space are also discussed.

As regards the steam consumption of turbine machinery, in the *Turbinia* the measurements figure out giving a water rate of about 15 pounds per horsepower, all purposes at full power. In H. M. S. *Amethyst* the water rate in pounds per horsepower for all purposes at full power averaged 13.60 pounds. This agrees very closely with a figure of 14.0 pounds per shaft-horsepower which was obtained with United States destroyers. In battleships of the *Dreadnought* type the water consumption in terms of shaft-horsepower of main engines averages about 13.0 pounds for turbines only. In large cruisers of the *Indomitable* type the consumption for turbines only averages about 12.0 pounds per shaft-horsepower. In ships of the mercantile marine the steam consumption of the turbine machinery for all purposes in terms of shaft-horsepower of main engines averages about 15 pounds, and in large installations, such as the *Mauretania*, about 14 pounds. In vessels fitted with a combination system of reciprocating engines and low-pressure turbines, a saving in coal consumption of about 12 percent is made, compared with similar ships having quadruple-expansion reciprocating engines only. In a battleship or cruiser installation an arrangement of geared cruising turbines would effect a saving of at least 20 percent at a cruising speed of 12 knots, this comparison being made with an installation having direct-coupled cruising turbines. A further increase in economy can be obtained by increasing the coefficients of the turbines. This would improve the results without any increase of machinery weight, due to a saving in the boiler-room installation. A further economy of steam consumption is realized by arranging to pass all available auxiliary exhaust steam at suitable stages into the turbines instead of passing this direct to the main condensers.

In 1905 the total amount of Parsons turbine machinery of the marine type completed amounted to about 270,000 horsepower. At the present time the total horsepower completed and under construction amounts to approximately 6,400,000, of which about 5,300,000 is to be fitted in warships; of this total 1,900,000 horsepower has been ordered during this year. In the German naval programme of this year a total shaft-horsepower amounting to 281,000 is being installed in ships fitted with Parsons turbine machinery, being 58 percent of the total ordered this year.

Papers 11-17.

The other papers read and discussed at the meeting were: "Ship Calculations, Derivation and Analysis of Methods," by Naval Constructor T. G. Roberts, U. S. N.; "Economy of the Use of Oil as Fuel for Harbor Vessels," by Engineer-in-Chief C. A. McAllister; "The Marine Terminal of the Grand Trunk Pacific Railway, Prince Rupert, British Columbia," by Frank E. Kirby and William T. Donnelly; "Cargo Transference at Steamship Terminals," by H. McL. Harding; "Heavy Oil Engines for Marine Propulsion," by G. C. Davison; "Automatic Record of Propeller Action in an Electrically-Propelled Vessel," by W. L. R. Emmet; and "Some Applications of the Principles of Naval Architecture to Aeronautics," by Naval Constructor William McEntee, U. S. N. Abstracts of these articles will appear in the January issue.

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Naval Architects' Meeting.

After the period of depression which has existed during the last few years in the shipbuilding industry it is gratifying to note the progress which has been made in naval architecture and marine engineering and in the improvement of terminals and harbors to meet the rapidly increasing demands of present conditions for a larger and more efficient merchant marine and a stronger naval power. At the nineteenth annual meeting of the Society of Naval Architects and Marine Engineers recently held in New York papers were presented containing some valuable investigations regarding the resistance of ships, discussions of the recent remarkable developments in propelling machinery, and descriptions of modern methods of handling freight at steamship terminals and proposed improvements in existing terminals to promote maritime commerce. These subjects formed the basis of one of the most interesting and instructive meetings that the society has ever held.

Three papers were read dealing with various problems regarding the resistance of ships. They presented the results obtained from towing models in basins at the Government station in Washington and at the University of Michigan, and also from progressive speed trials of a navigable model at the Massachusetts Institute of Technology. Investigations in such a field, where current practice in the design of vessels varying widely in form and conditions of service depends largely upon speculation and deduction from theory and practice without definite information as to the actual effect of various factors influencing the resistance, are of inestimable value, and the presentation of the results of these researches to the engineering profession is most praiseworthy. The investigations by Naval Constructor Taylor at Washington were upon the effect of the shape of the bow and stern of a vessel upon the resistance. At an earlier date he had shown that the effect of the shape of the 'midship section of a ship upon resistance, while appreciable, was not great, and for the variations permissible in a given design would usually be almost negligible. The number of variations, however, that can be made in the shape of the hull toward the extremities is so great that it is not to be expected that the present investigations could cover the whole field. As far as they extend, however, they furnish a source of valuable information upon a hitherto debatable subject, and a careful study of the work will be very useful to designers. Professor Sadler's investigations upon the resistance of some types of merchant ships in shallow water are another example of the value of model-basin experiments for obtaining necessary data which ordinarily cannot be obtained in complete form from the performance of ships at sea. Experiments with navigable models for the solution of problems relating to the resistance and propulsion of ships are a somewhat new departure from former methods of doing such work, although they have been carried out in one or two instances in the design of a large, fast steamship, the results of which, however, have not been available to the public. The value of this means of investigation was clearly demonstrated before the society by Professor Peabody in a paper describing the results of a long series of experiments on such a model, the prototype of which was a revenue cutter tested by the author of the paper several years ago. In addition, a model of the ship was made and tested in the model basin at Washington, giving an exceptional opportunity to compare the actual observed power to drive the ship at certain speeds with the estimation of power from the resistance of the towing model, together with an estimate of the wake and thrust deduction from the navigable model. Important investigations of the effect of the pitch and area of the propeller on propulsion and the effect of a broad stern post and the location of the propeller with regard to the stern on the thrust and power required to drive the boat were made, and the results are a most welcome addition to the present knowledge of naval architecture. It is to be hoped that this experimental work will be continued in the future.

Besides the group of papers dealing with experimental work on resistance and propulsion, several papers of interest were read regarding the recent developments in propelling machinery, including turbines, combination machinery, oil fuel and heavy oil engines. The possibilities of the different forms of propelling machinery were well set forth, and in some cases some very valuable data from actual practice were given showing the gain in fuel economy that can be made under certain conditions. It is usually difficult to obtain accurate data covering the performance of propelling machinery in merchant marine practice, because there is seldom an opportunity to make a complete series of tests, or, if such tests are made, the results are withheld for private use. The advent of the heavy oil engine as a prime mover in vessels requiring several hundred horsepower for propulsion has been too recent to furnish much indisputable data regarding its performance. The advantages claimed for the heavy oil engine are well known, but few have had sufficient experience with their use to give us much light on their disadvantages and the probable methods of overcoming them. In the paper presented on this subject the author goes into the mechanical problems connected with this type of engine in some detail, taking up the materials, piston speeds, lubrication, piston packing and stuffing-boxes. In summing up, he states that the only problems which have had to be solved are those due to the high pressures and temperatures in the cylinders. Whether the present solution of these problems has resulted in reliable action of the engine and immunity from frequent and extensive repairs remains to be proved.

While the naval architect is chiefly concerned with the problems of hulls and propelling machinery, there are some correlative subjects which have an important bearing upon his work. One of these, the question of marine terminal facilities, was brought before the society in a very comprehensive manner by papers dealing with the arrangement and equipment of a new marine terminal at Prince Rupert, British Columbia; the proposed improvements in dock facilities in New York, and the improvement of cargo transference at steamship terminals. These problems are constantly confronting those interested in shipping at nearly every seaport, and, while improvements have been carried out in some instances, greatly increasing the capacity of the port and reducing the cost of trans-shipments, in many others practically nothing has been done except minor changes by private interests which control only a small part of the dockage facilities, and, as a result, congestion in the movement of freight occurs.

Some light was thrown on this matter by the paper dealing with cargo transference, in which is shown the feasibility of increasing the rapidity of freight movements, of reducing the handling costs and of increasing the capacity of existing terminals by the adaptation of improved mechanical methods. Only the question of miscellaneous package freight was discussed, as methods for handling bulk freight have, as a rule, already been utilized to much greater advantage.

Another subject which has great influence on the design of ships, particularly those of the largest size, is the physical properties of seaports and harbors where limits on the draft of water of ships are necessarily imposed. As pointed out by Sir William White, the natural growth of the size of ships to meet the rapidly increasing development of maritime commerce has been accompanied by extensive and costly engineering work in deepening harbors and approach channels. As the cost of this work increases very rapidly with the depth, the main increase in dimensions of ships has been in lengths, breadths and molded depths; increase in drafts of water when fully laden having been relatively small. Further considerations of the maximum dimensions of ships by Sir William White in his paper on the subject are most timely, especially as the latest designs of transatlantic vessels are surpassing in size by a considerable margin the splendid achievements in the *Lusitania* and *Mauretania*. Current reports indicate that the advances made in dimensions by the *Olympic*, *Titanic*, *Aquitania* and *Imperator* are to be exceeded by a new White Star liner, which will probably be about 100 feet longer than the *Olympic*. This continuous growth in the size of vessels which must be accommodated in New York harbor emphasizes the importance of increasing the dock facilities in the port and adapting the harbor accommodations for maneuvering this class of ships, which, for commercial considerations, seem likely to maintain the transatlantic service in the future.

Many of those who were able to attend the meetings regretted that there was not more time to discuss some of the papers more fully. No matter how complete and valuable the papers presented before the society may be, there is much to be gained (and upon this a large share of the value of the society lies) from a thorough discussion of the subjects by those who have been associated with similar work in a variety of ways, and who are best fitted by their professional and practical experience to add much valuable information needed for the future progress of the work. One of the principal objects of the organization is for the interchange of professional ideas and opinions, making it possible to combine the results of research and experience in the many lines of work connected with naval architecture and marine engineering. Much discussion of the papers takes place outside the professional sessions, which, if there were more time, would take place in the meetings themselves. All this has aroused a general feeling that the annual meeting should extend over three days instead of two, as has been the custom. The continual growth of the society and its increasing importance in the engineering world are good reasons for extending the time allotted to its professional sessions for a more thorough discussion of the papers presented.

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ENGINEERING SPECIALTIES.

The Kind Marine Diesel Engine.

Ing. P. Kind & Company, Turin, Italy, manufacture heavy oil internal-combustion engines for stationary plants, locomotives or for marine work. What is of most interest to-day is the reversible marine engine which is now being developed in two types—a heavy slow-speed engine for merchant marine work and light high-speed engines for fast ships and for warships. In the smallest reversible four-cylinder high-speed marine engines of 40 to 50 effective horsepower the number of revolutions vary from 500 to 650, while in the light high-speed engines of 3,000 effective horsepower the number of revolutions is reduced to 350 per minute. When the running expenses and endurance of the engine are the most important points under consideration, the number of revolutions in the normal type of Diesel engines is reduced to 150 per minute in the large sizes and to about 350 to 400 in the smaller engines By using bronze and the best qualities of steel the weight of the high-speed engines for naval purposes is reduced to 33 pounds per horsepower, while the weight of the normal light engines ranges from 44 to 66 pounds per horsepower.

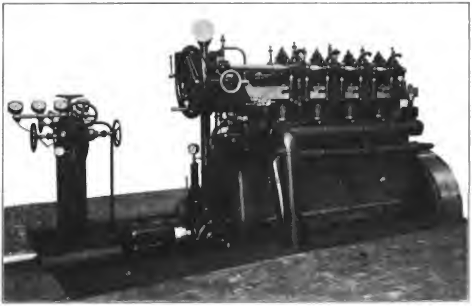

FIG. 1.

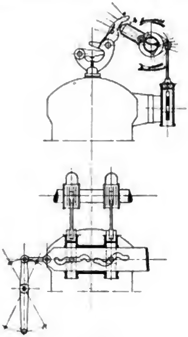

FIG. 2.

These engines are of the two-stroke type, and have either scavenging valves set in the cylinder head or scavenging ports, which the working piston opens after opening the exhaust ports. According to the type of the engine the scavenging air is furnished either by a special pump set attached to the engine, by an independent pump or by step pistons connected with each working piston.

Figs. 1, 2 and 3 show a 100-horsepower engine designed to run at 375 revolutions per minute. The cylinders are mounted on strong iron columns, and the crankshaft chamber is completely closed in by removable walls and is well ventilated. Each working piston in which the piston pin is fixed is furnished with a separable ring, which gives the necessary scavenging air for one cylinder. The scavenging flaps, which in engines of greater horsepower are substituted by piston valves, are set in the cylinder itself. In order to obtain a perfect combustion space and perfect scavenging, the scavenging valves are inclined. The scavenging cylinder is also separable from the working cylinder.

The distributing system and the maneuvering of the engine is quite different from any other type. In Fig. 3, which represents the fuel oil and air-starting distributing system, it is easy to see that through the displacement of the sliding piece *b* in a plane perpendicular to the cam shaft, the entire lifting diameter, corresponding to the profile of the cam, will be displaced at the corresponding angle, and that it is also possible to obtain the whole displacement corresponding to the reversing of the engine. During the same time, according to the form given to the curved piece *e*, and to the profile of the cam, the lifting corresponding to the cam is over the different positions of the sliding pieces *b*, totally, partly or not at all, transmitted to the valves. On account of the special form of the curved piece *E*, which receives the movement, and of the cam, it is possible to have any desired time for the beginning and duration of the lifting, which is claimed to be a great advantage for running ships where great variations in the number of revolutions and in the power required must be taken into consideration.

While reversing of the scavenging valves is obtained by turning the cam shaft, the starting and fuel valves are reversed as explained above. The common displacement of the sliding pieces of both the starting and fuel valves' distributing system takes place through a rotative eccentric or a cam disk shaft, or through a removable curved ruler. This displacement, which is obtained through the movement of a single lever or hand-wheel, causes the starting, reversing and overloading and any desirable speed changes in the engine. This same maneuvering device controls at the same time the distribution of oil fuel in the oil fuel pump and the control of the starting air when necessary, and causes the turning of the cam shaft in order to reverse the scavenging valves when necessary. When reversing the engine there is a speed device which prevents the introduction of fuel oil while the engine is still running in the opposite direction. In the engine shown in the illustration the circulating water is furnished by a centrifugal pump, and the filtered lubricating oil for lubricating the crankshaft and connecting rods and for cooling the working and scavenging piston is furnished by a wheel pump. The air injection pump is a two-stage pump, with suction directly to the atmosphere.

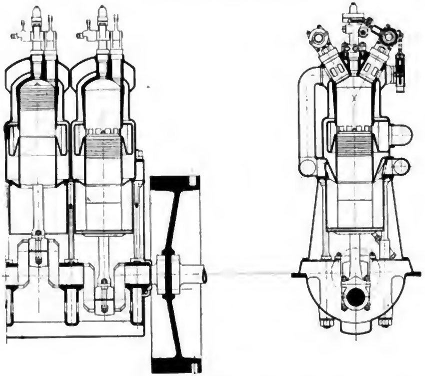

FIG. 8.

An Electric Punkah.

Messrs. Hogan & Wardrop, of 2 Gresham buildings, Basinghall street, London, E. C., have recently put on the market a new form of electric fan, which is a directly-driven punkah. The essential "flick" at the end of the stroke, which long experience has enabled the India punkah wallah to develop into an art, is exactly reproduced in this present fan, and occupying little head room it is especially suitable for marine use, but can, of course, be arranged to suit any height of ceilings. A general view of the punkah is shown herewith, and, as will be seen, it comprises a motor working horizontally, and by means of worm reducing gear the speed is brought down to about forty strokes a minute; the rotary motion of the motor is mechanically converted to a rectilinear action by the connecting rod secured directly to the rigid frame of the punkah.

Another point in the use of this type of fan which will appeal to the thoughtful reader is that on account of the intermittent character of the wavelike disturbance of air given by the motion of the fan there is not the objectionable draft produced by the steady blast of air which is characteristic of the ordinary rotating fan blade.

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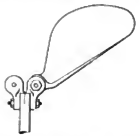
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,002,796. PROPELLER. GUIDO ANTONI AND UGO ANTONI, OF PISA, ITALY.

Claim 1.—A propeller adapted for water or aerial navigation comprising a driving hub and a blade rigidly and immovably connected



thereto and having a diminishing thickness in a direction from its root to its periphery or tip and from its leading edge to its following edge which renders the thinner portions of the blade capable of flexing under the influence of the medium upon which the blade acts. Two claims.

1,002,184. APPARATUS FOR RAISING SUNKEN VESSELS. JOSEPH B. SERRES, OF HOULTONVILLE, LA.

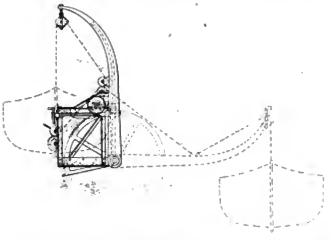
Claim 1.—A pontoon, upper and lower conduits in said pontoon, a valve controlling each of said conduits, the valve of said lower conduit being provided with a rod extending within said pontoon, and a float pivotally mounted within said pontoon, and connected with said rod. Three claims.

1,002,023. LIFE-SAVING DEVICE FOR SUBMARINE VESSELS. DAVID CHAPPELL, OF LLANELLY, ENGLAND, AND JOHN CHAPPELL, OF PITTSBURG, PA.

Claim 2.—In a life-saving device for vessels, the combination with a vessel having the shell thereof provided with an opening, of a casing suspended from the edges of said opening, a life boat fitted in said opening and having the top thereof closed, anchoring screws carried by said life boat for retaining said life boat in said casing, releasing screws carried by said life boat and adapted to elevate said life boat relatively to said casing, said casing, life boat, and the closed top thereof having manholes formed therein, and trap doors normally closing said manholes. Two claims.

1,002,032. DAVIT. WILLIAM L. CHAPMAN, OF NEW YORK, N. Y.

Claim 1.—In a davit apparatus, the combination of frames adapted for attachment to a vessel or support, davits fulcrumed on horizontal pivots at approximately the lower and outer limit of said frames, the upper extremities of said davits extending both inboard and toward each other, whereby the initial outboard movement of the davits tends to raise the

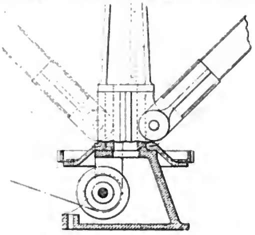


boat from its chocks, and whereby the ends of the boat may readily swing past the davit, toothed sectors in fixed relation to said davits respectively and extending upward and inboard from the pivots thereof, and gearing engaging said sectors for swinging the said davits outboard. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

21,250. SHIP'S DECK CRANE. J. PATTERSON, GLASGOW.

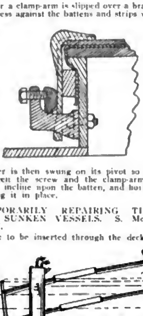
The invention relates to that type of slewing crane for ships' decks in which, while the jib is slewable about a fixed post, the gearing and motor operating it are stationary. The invention provides an improved arrangement of the lower fair lead pulley in that, while slewing in a com-



plete circle, the whole may be arranged above the sole plate. The jib is pivoted on a collar-like member made in halves and bolted together about a cylindrical part formed near the lower end of the post. This member bears a toothed wheel by which it is operated from the fixed motor. By the invention the base is enlarged and gapped on the side next the winding barrel and on a spindle within this base is a fair lead pulley capable of moving endwise. To this fair lead pulley the rope passes down axially to the fixed post, from a pulley carried upon a collar, to which are attached the jib guys, and which is thus constrained to move with the jib and the collar-like member.

28,340. HATCHWAY FASTENER. M. MULHOLLAND, CLEVELAND, OHIO, U. S. A.

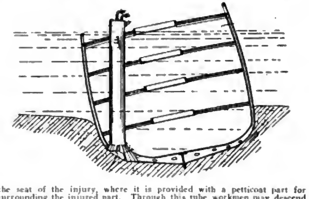
With this fastener a clamp-arm is slipped over a bracket attached to the coaming so as to press against the battens and strips which lie outside the



canvas. The keeper is then swung on its pivot so that its wedge-head is interposed between the screw and the clamp-arm to instantly force the latter down the incline upon the batten, and horizontally against the strips, while locking it in place.

16,594. TEMPORARILY REPAIRING THE HULLS OF STRANDED OR SUNKEN VESSELS. S. McGILL, OF NEWCASTLE, N. S. W.

Relates to a tube to be inserted through the decks and extending to



the seat of the injury, where it is provided with a petticoat part for surrounding the injured part. Through this tube workmen may descend and effect repairs to allow the salving of the ship, an air lock and air supply being arranged.

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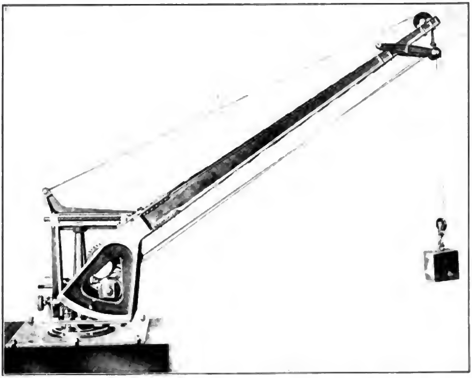

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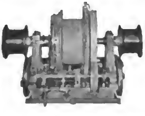

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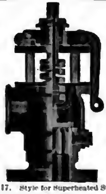

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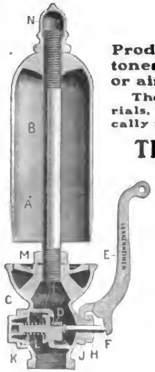

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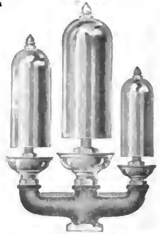

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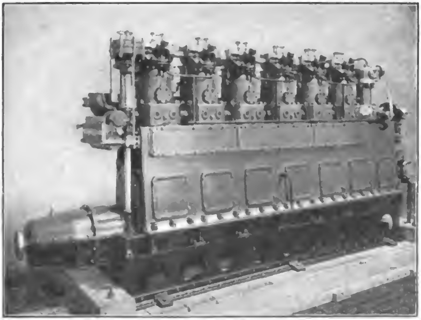

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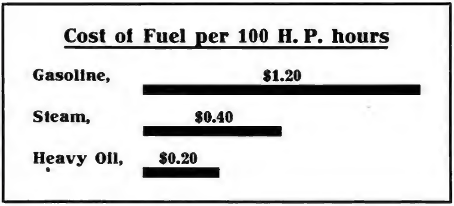

Manufactured by New London Ship & Engine Company, Groton, Conn.

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TRADE PUBLICATIONS.

AMERICA

Hydraulic jacks and tools of all sorts are described in catalogues published by the Watson-Stillman Company, 188 Fulton street, New York. This company's types and sizes of jacks cover a wide range of capacity and permit one man without severe effort to move any weight up to 500 tons. "Watson-Stillman hydraulic jacks being heavy for their rating have a greater safety factor and handle a large overload safely. Thoughtless workmen often put a pipe on the handle of a hydraulic jack to increase the power. We provide liberally for just such emergencies."

"American Vanadium Facts," published by the American Vanadium Company, Frick building, Pittsburg, states under its Trade Facts column that "Where tools are used under conditions that admit of danger to the operator, the integrity of the tool for the purpose of insuring the workman from injury is a matter of first importance. The use of vanadium steel parts in the Vulcan chain pipe wrenches, made by J. H. Williams & Company, Brooklyn, not only gives a decided increase in strength, but a larger factor of safety that is ample protection to the operator. The Bourne-Fuller Company, Cleveland, Ohio, announces that 75 percent of its trade is buying Scott's unique high-speed steel (chrome-vanadium) for pneumatic and other chisels with the best results."

Milling Cutters.—Milling cutters have become an everyday tool and have been improved constantly, and can be obtained now in almost any size and form. Catalogue 18-A of the Standard Tool Company, Cleveland, Ohio, gives prices and descriptions and sizes of an endless number of most admirably designed milling machine cutters. The skill required to make high-grade milling cutters is not appreciated, as the machine world has got used to almost perfection in this line. Yet the selection of proper steels, its hardening and treatment, the form of the cutter, etc., demand study and close attention and a very long purse to carry out experiments and get proofs which alone finally carry conviction to the customer and a pleasant sensation to the manufacturer that his product will not only sell but stay sold. The company named above aims to produce only cutters of the very highest grade, and their catalogue gives every information concerning them, and it is certainly a pleasure to look over.

"Steam Turbine Centrifugal Pumps and Other Centrifugal Machinery" is the title of a 32-page booklet, or album, issued by the De Laval Steam Turbine Company, of Trenton, N. J., illustrating and describing briefly the several lines of machinery manufactured by that concern, including single-stage turbines for driving machinery of all kinds and for rope and belt transmission; turbine-driven centrifugal pumps for water-works, for general water service in industrial plants, and for boiler feeding, hydraulic pressure work, etc.; velocity-staged turbines without gears for direct connection to high-pressure blowers, centrifugal pumps, etc.; multi-stage impulse turbines with gears for driving large direct-current generators, fans, centrifugal pumps and other moderate or low-speed machinery; multi-stage impulse turbines without gears in large sizes for direct connection to high-speed alternators; motor and belt-driven centrifugal pumps for all services and heads; multi-stage centrifugal air compressors and De Laval speed reduction gears for various services. Copies of this booklet will be sent upon request to those interested.

"File Filosophy" is the title of a booklet published by the Nicholson File Company, Providence, R. I. This is a complete work on different styles of files and their uses, and a copy will be sent free to any of our readers upon application.

Heavy oil marine engines are described in a pamphlet of 22 pages published by the New London Ship & Engine Company, Groton, Conn. These engines are sold under a positive guarantee as regards fuel consumption, which is stated to average less than ½ pound per horsepower-hour. Fuel costs 2 to 3 cents a gallon. This is stated to be the ideal motive power for power boats, tugboats, yachts, barges, fishing and sailing vessels, cargo vessels and fast passenger vessels. It is built in units of from 50 to 2,500 horsepower. Two types, heavy, of about 80 pounds per horsepower, light, of 40 pounds per horsepower. They are reversible and self-starting.

The Lyle line-carrying gun for steamships and towboats is described in a catalogue published by William Read & Sons, 107 Washington street, Boston, Mass. This company also makes a breachloading line-carrying shoulder gun, which is stated to be small and compact, readily carried by hand, and invaluable for lifeboats, large yachts and towboats in picking up a wreck at sea and in allowing one boat to approach another in a heavy sea at a safe distance. Projectiles are of the Lyle type as used by the government life-saving stations, and will carry the line from 200 to 400 feet. William Read & Sons state that about thirty of these guns are in use on board United States revenue cutters. All interested should write for a copy of this catalogue and mention International Marine Engineering.

Monel metal propellers are described in circulars issued by the Ruggles-Coles Engineering Company, 50 Church street, New York. The United States torpedo boat destroyers *Fanning, Perkins, Roe, Sterrett, Terry* and *Walke* are each equipped with three-bladed Monel metal propellers made by the Bayonne Casting Company, of which the Ruggles-Coles Engineering Company is the general agent. The statement is made that Monel metal propellers stand up to the terrific high speeds of torpedo boat destroyers with a minimum distortion; that they withstand the shocks better than manganese bronze and retain their polish longer, their finish being similar to pure nickel. Merchant ships as well as naval ships are equipped with these propellers, and the Ruggles-Coles Engineering Company is prepared to make quotations on any size up to 27,000 pounds weight in one piece.

Oil fuel burners for marine, stationary and locomotive furnaces are described in circulars published by the Ingram Oil Fuel Burner Company, Box 206, Newport News, Va. "This burner is equally effective with either steam or air as the atomizing agent, and is not affected by a reasonable amount of water in the oil. It is highly efficient with very low-pressure on both the oil and the atomizer, and the best results are obtained with 70 pounds on the steam and 50 pounds on the oil. Preheating the oil is unnecessary, and by its use the danger and the worry due to leaky joints in pipe lines conveying oil at a high temperature and under heavy pressure are obviated. We do not handicap the users of our burners with a multitude of don'ts to confuse the operator, as they are so simply constructed that the minimum of skill and intelligence is necessary for their successful operation. Should you still be doubtful as to our claims we invite you give them a practical test at our expense."

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Over 1,000 Blake marine pumps sailed out of New York harbor Nov. 2 on the Atlantic fleet. Of the 102 warships of this fleet sixty-five are equipped with Blake pumps, and of the remaining thirty-seven nine carry no steam pumps and eight were built abroad. Send for Catalogue BK 106-43, published by the Blake & Knowles Steam Pump Works, 115 Broadway, New York.

A complete tool catalogue is published by the Billings & Spencer Company, Hartford, Conn. Among the large number of tools described in this catalogue are four sizes of combination pliers, which the Billings & Spencer Company states are the original pliers first marketed by the company thirty years ago, and standard to-day. Like all this company's tools they are guaranteed.

Gages for pressure and vacuum are described in Catalogue M-1 published by the Schaffer & Budenberg Manufacturing Company, Brooklyn, N. Y. This company makes a gage for every conceivable purpose and is also prepared to do repair work of every description on any instrument, whether it is of its own manufacture or not. Owing to the company's extensive facilities its charges are stated to be extremely moderate.

Blow-off valves are the subject of an illustrated catalogue published by the Nelson Valve Company, Philadelphia, Pa. These valves are made of iron for 300 pounds working pressure, and steel for extreme service. "We guarantee the Nelson blow-off valve. It is patented. Its name is trademarked. We couldn't afford to put our name on it if it was not right. If after sixty days of use you are not satisfied send back the valve and we will refund the price you paid for it."

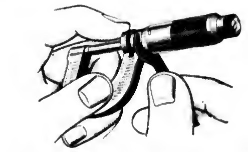
A combined jaw and friction clutch is described in a folder published by the Positive Clutch & Pulley Works, 30 Lansing street, Buffalo, N. Y. "The combined jaw and friction clutch combines the advantage of a friction clutch, to gradually pick up the speed of a driven shaft or pulley, etc., under load, with the positive drive of a jaw clutch. The frictions are not obliged to carry the load, but are used only for the purpose of operating the jaws."

"Why spend $8.00 for gasoline or $3.00 for steam when you can get the same power for $1.00?" is the question asked in a catalogue published by the Marine Producer Gas Power Company, 2 Rector street, New York, manufacturer of producer-gas plants. The company makes these plants in sizes from 25 to 5,000 horsepower, and states that they can be used with almost any gasoline engine. The catalogue gives full information on how to install and operate a producer-gas plant.

What Kerr turbines are doing in United States government service is the subject of a catalogue published by the Kerr Turbine Company, Wellsville, N. Y. "Government officials make no purchases foolishly. The investigations and specifications are rigid, and final acceptance is based upon tests that are thorough even to minute details. It is therefore significant that Kerr turbines have met every government requirement for efficiency, regulation, steam consumption, temperature, etc., and that thirty-five Kerr turbines averaging over 150 horsepower each are now giving satisfactory service in government lighthouses, public buildings, training schools, navy yards, arsenals and on the ships of the United States navy."

"Plymouth Products" is the title of a series of booklets published by the Plymouth Cordage Company, North Plymouth, Mass. Plymouth strength is made by certain tests, as all Plymouth rope is said to go through rigid inspection. An illustration in one of this company's catalogues shows one of these inspections, in which a 45,000-pound pull failed to snap a 7½-inch rope, although it was only expected to hold 43,000 pounds. Plymouth rope is especially recommended for tug hawsers, which get the hardest kind of usage. Rope used in this work generally goes to pieces quickly, making wearing power a question of vital importance.

Just what you have been looking for in a Scotch boiler—rapid circulation—is found in the Robb-Brady type, according to Bulletin No. 3, just issued by the Robb Engineering Company, Ltd., South Framingham, Mass. "Positive circulation without a pump or other device. The circulating passage around the boiler empties below the furnace. Hot water and steam must flow up between the furnaces and pass to the steam drum through the rear neck. The combustion chamber is cylindrical—no flat top, no girder or crown-bar stays. No longitudinal stays. Special hand holes for cleaning rear tube sheet. Built in sizes from 50 to 300 horsepower. Working pressure up to 225 pounds."



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of the Starrett Micrometers is a feature that enthuses all mechanics. It takes up any wear quickly and accurately—not by the trial hit-and-miss way of the movable anvil. This is obtained by placing over the barrel a thin, graduated sleeve, which carries the base or zero line, instead of having it marked on the barrel itself. If, at any time, on account of excessive wear, the zero line is not correct, a small turn of this sleeve with a small spanner wrench will remedy the error. A wrench is sent with each micrometer.

Catalog 19L is free.

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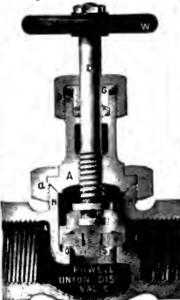

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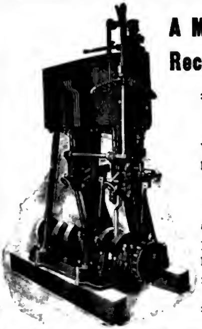

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MARINE IRON WORKS
2036 Dominick St.
CHICAGO
Marine Machinery Specialists

New folder on "Diamond" front end soot blowers. A lot of sound, hard-headed logic on fuel economy has been worked into the new 12-page folder just issued by the "Diamond" Power Specialty Company, Detroit, Mich., on its front end soot blower for marine work. Anyone connected with the marine trade and interested in saving fuel should send for a copy of this two-colored illustrated folder.

The simple adjustment of the micrometers made by the L. S. Starrett Company, Athol, Mass., is a feature that is stated to be especially appreciated by all mechanics. It takes up any wear quickly and accurately, "not by the trial hit-and-miss way of the movable anvil." Micrometers are only a few of the large number of instruments of precision described and illustrated in Catalogue 19-L, which will be sent free upon application to any of our readers.

"Keystone Grease" is the title of an illustrated booklet published by the Keystone Lubricating Company, Department V, Philadelphia, Pa. "This booklet comprises a general treatise on the several densities or consistencies of Keystone grease. It outlines and describes the difference between their general make-up as well as thoroughly designating the general class of machinery which each one is physically appropriate to lubricate. There is also described the proper, correct method by which each density should be used and applied to the various classes of machinery bearings. Correct application contributes very considerably to the achievement of maximum good results from the use of Keystone grease; so we, therefore, earnestly impress upon the engineer or person intending to test or use Keystone grease the importance of reading over, thoroughly, this booklet and applying the grease according to instructions."

Another edition of the "Smooth-On Instruction Book" has just been issued by the Smooth-On Manufacturing Company, 572 Communipaw avenue, Jersey City, N. J. This book tells all about Smooth-On iron cements, sheet packings, corrugated metal gaskets, and shows when, where and how to use them. "The great value of Smooth-On to the manufacturer and user is because of its peculiar chemical properties, namely, of metalizing and of expanding when metalizing, and it can be prepared to act quickly or slowly, according to the requirements of particular uses. These properties make Smooth-On a valuable substance in the making of chemical iron cements. To this subject the chemist of the Smooth-On Manufacturing Company has given careful study for fifteen years, and has succeeded in compounding the valuable iron cements known so generally throughout the world as Smooth-On iron cements. These cements are made each for a special purpose; they are carefully prepared by a chemist, and when correctly used they make permanent repairs. The different Smooth-On cements are explained in the following pages; a careful study of them will prove interesting and profitable. The illustrations are made from photographs of actual subjects, and show some of the many ways in which the Smooth-On cements have been used and the results obtained."

The use of the triplex chain block in the lifting of loads is the subject of a booklet published by the Yale & Towne Manufacturing Company, 9 Murray street, New York. A free copy of this booklet will be sent to anyone mentioning this magazine. "The lifting of loads is a universal need—a vital factor in every man's business. The triplex block is the simplest, safest, most efficient and most economical load lifter in the world. It lifts loads under all conditions, in all places, from a palace to a sawmill, a garage to a warship. When one man pulls on the hand chain of the triplex block he can lift any load from 200 pounds to 20 tons—two men can lift 40 tons. The load is always automatically held at any point during the lift. You can go away and let it hang ten seconds or a year. It will not come down until you are ready. Then you lower it by pulling lightly on the reverse side of the hand chain. The triplex block has the strongest, simplest, smoothest-running, wear-resisting system of gears ever devised to multiply lifting power. It so multiplies the strength of one man as to make him master of every lifting problem. Many loads must also be transported—moved horizontally. The triplex block not only lifts its load easily, and holds it suspended safely, but when hung from a trolley running on an overhead track the load may be moved easily wherever the overhead track goes. One man can push the load as easily as he lifts it. In foundries, machine shops, factories, sawmills, mines, quarries, warehouses, in power houses and boiler rooms, on railways, ships and docks, thousands of triplex blocks are daily lifting and transporting thousands of tons, at a saving in labor which frequently repays the whole cost of installation in six months. Everyone who has lifting and transporting to do should write for the book about triplex blocks. A postal brings it."

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Oil engines of 2 to 600 horsepower are described in a catalogue published by A. Mietz, 130 Mott street, New York. These engines use kerosene, fuel oil, crude oil and alcohol, and Mr. Mietz states that 150,000 horsepower are in operation.

"Be Ready for the Long Dark Nights" is the title of Bulletin No. 22 just issued by Kerr Turbine Company, Wellsville, N. Y., describing and illustrating installations of their turbo-generator sets for lighting. This folder is well worth reading by any one who is figuring on an independent lighting plant. A copy will be sent upon request.

The new "Buffalo Book" is now on the press, and every one of our readers who is interested in gasoline motors of any size and for any purpose should write to the Buffalo Gasolene Motor Company, 1209-21 Niagara street, Buffalo, N. Y., for a copy. This books tells all about the new models and the refinements of design which mark the 1912 "Buffalos."

"Ready-to-Run" ventilating sets are described in Booklet MC-9 published by the B. F. Sturtevant Company, Hyde Park, Mass. "Originally designed for ventilation their development for other uses has been nothing short of wonderful. They require no installation work, simply unpack; plug the cord into the light receptacle and turn the switch. They are built in five sizes, with capacities from 35 to 1,250 cubic feet per minute."

The Whitney portable hand metal punch No. 1 is described in circulars issued by the W. A. Whitney Manufacturing Company, Rockford, Ill. This punch is especially constructed for boiler, tank and stack work and structural builders' requirements. The weight is 21 pounds. It has detachable pipe handles, and the capacity is a 9/16-inch hole through ¼-inch boiler plate.

"The Whole Kewanee Family" is the title of a booklet published by the National Tube Company, Frick building, Pittsburg, Pa. Among the advantages claimed for the Kewanee union are: Brass to iron thread connection—no corrosion; brass to iron ball joint seat—no gasket; 125 pounds compressed air test under water—no defective fittings; solid three-piece construction—no inserted parts; easily disconnected—no force required.

Every engineer and ship and engine builder should send to the Lunkenheimer Company, Cincinnati, Ohio, for a free copy of its new catalogue of engineering specialties. This is a booklet of several hundred pages profusely illustrated, and describing a very complete line of engineering specialties, such as valves, cocks, whistles, oil cups, etc.

Sirocco Bulletin No. 284-ME has just been published by the American Blower Company, Detroit, Mich. It describes and illustrates fans for mechanical drive and ship ventilation. These fans are claimed to have enormous volumetric capacities for small space requirements, and being small the cost of installation is brought down to the minimum.

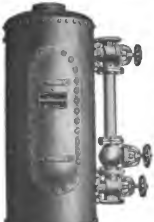
TRADE PUBLICATIONS

GREAT BRITAIN

The Falcon Iron Works, Ltd., Oldham Lanes, have issued a number of pamphlets containing illustrations and details of winding or hauling engines of different patterns from 5 brake-horsepower to 1,000 brake-horsepower, including the ordinary geared engine, worm geared capstan engines, endless rope haulage gear and long-type of engine. Electrically-driven haulage gears are made in sizes from 5 brake-horsepower to 500 brake-horsepower. Details are also given of the "Falcon" friction clutch, the automatic tub axle greaser, and a patent rope haulage clip.

Feed Heater Heaters are described and illustrated in a new List (No. 211) issued by Holden & Brooke, Ltd., of Sirius Works, West Gorton, Manchester. These are made on Brooke's patent "High Velocity" system. It is claimed by the firm that "by virtue of this system alone, as has been proved by quite independent investigations, the maximum heat extracting capacity of metal surfaces is obtained, and consequently the highest temperature of feed water." The principle of this system is based upon the fact, not generally appreciated, that heat transmission is dependent upon maintaining the greatest possible degree of difference in temperature on the two sides of the heating medium; and it is urged that, in practice, by the "High Velocity" system feed-water can be delivered 20 percent hotter than by ordinary heaters.

Reilly Multicoil Heaters



and **Evaporators are in stock** at the shops, Pier B, Jersey City, awaiting your rush orders. Coiled, flexible copper tubes, ground union joints (no expanded ends), and the Reilly manhole door, giving access to all interior parts, give the marine engineer an auxiliary which **saves coal, increases Condenser capacity,** and needs **no repairs.**

Send your vessel to our pier for her next repairs; and install the auxiliaries at the same time.

Reilly Multicoil Evaporators Improved Type

?

Do you want to know?

THE GRISCOM-SPENCER COMPANY

90 WEST STREET, NEW YORK.

FORMERLY THE JAMES REILLY REPAIR AND SUPPLY COMPANY.

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Night signaling at sea by flash lamp is described on a circular published by the Signaling Specialties Supply Company, 59 Fenchurch street, London, E. C. "Endall's Morse code lamp is the only signaling apparatus which, in addition to making an 'all-round' or general signal, enables the operator to direct a message to any desired quarter, thus giving an 'individual' or private signal."

The Cooper roller bearing, made by the Unbreakable Pulley & Mill Gearing Company, Ltd., 56 Cannon street, London, is described in circulars the manufacturer has just issued. "As specialists in the mechanical transmission of power we have carefully watched the performance of the various types which have appeared—and for the most part disappeared. First came the solid roller of mild steel running directly on the journal—result, mutual destruction with anything but comparatively light loads. In the hope to preserving the surfaces, rollers of the 'flexible' type were introduced, made either of rolled plate or spirally-wound spring steel. The former were liable to fracture, which meant stoppage of rollers and immediate or subsequent trouble. Under heavy loads the other 'flexible' type require to be closely watched, because of the liability of the rollers to elongate, in which case sufficient end pressure on the cages and housings is set up to interfere with their free running. Unless this is immediately detected and the bearing dismantled, and the spiral rollers shortened, the complete bearing and the shaft will be damaged, if not ruined. To protect the shaft journal and confine the damage to the parts less costly to renew, thin sheet steel liners are sometimes provided. With this type, whatever may be the saving claimed or effected, there is undoubtedly grave risk of damage, and, what is worse, of stoppage. It is only roller bearings in which all bearing surfaces are hardened and ground that have in our experience proved their durability in heavy service. The majority of these, however, have been fitted with rollers of small diameter and considerable length, and, being hardened right through, these are apt to fracture. Further, owing to the annular space available for the cage being narrow, and the cage itself relatively long, it cannot be made sufficiently stiff to maintain the rollers in true alignment."

The Perco patent power hammer is described in the literature published by Perkin & Company, Ltd., Junction Works, Leeds. "The hammer head will accommodate dies for a great variety of work. The length of stroke can be adjusted. It is strongly built of best cast steel and iron, and, having no complicated parts, it is easily repaired should anything get out of order. All working parts are at the top, in full view of the workman. The hammer head, anvil, guides, glands on the crank plate and crank pin with nut, also friction coupling and strap pulley, are turned or planed. There are flanges on the crosshead against the outer side of the guides, to hold them in position, and on the one side of the crosshead there are set screws to regulate the position of the guides when worn. All wearing parts are large and carefully made. The four columns carry the top plate with driving shaft, pulley and friction coupling. The friction clutch is fitted with a brake, working automatically when the coupling is disengaged, and the hammer stops instantly, with the ram always at a certain distance from the anvil. The coupling is easily operated by the treadle, and the blow can be better controlled by the foot than in any other way. The hammer head runs in planed guides, always maintaining a true vertical position at every point, and is thus capable of doing accurate and rapid work. The guides, which are of steel, are adjustable and easily renewed. The motion is applied to the head or ram by means of a connecting rod (sliding in a sleeve or collar, and fastened by a set screw) and a strong bow spring with iron straps. The spring is of best open-hearth steel, carefully hardened, and the straps of wrought iron. By means of the spring and the connecting straps the strength of the blow is much increased, as the ram from the rebound of its blow on the material being forged, and from the action of the connecting rod, is quickly drawn up, thereby contracting the spring. This accumulated power is then released in the next fall."

BUSINESS NOTES

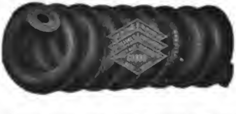
AMERICA

The steamers *Seaconnet*, *Penobscot*, *F. J. Lisman* and *Mary E. Harper*, owned by the Harper Transportation Company, Boston, Mass., have all been recently equipped with "Diamond" front end soot blowers, made by "Diamond" Power Specialty Company, Detroit, Mich.

COBBS HIGH PRESSURE SPIRAL PISTON

And VALVE STEM PACKING

IT HAS STOOD THE TEST OF YEARS AND NOT FOUND WANTING



IT IS THE MOST ECONOMICAL AND GREATEST LABOR SAVER

WHY? Because it is the only one constructed on correct principles. The rubber core is made of a special oil and heat resisting compound covered with duck, the outer covering being fine asbestos. It will not score the rod or blow out under the highest pressure.

NEW YORK BELTING AND PACKING CO. LIMITED

91 and 93 Chambers Street, NEW YORK

LONDON, E. C., ENGLAND, 11 Southampton Row

CHICAGO, ILL., 130 West Lake Street
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THE UNITED STATES GOVERNMENT'S REPRESENTATIVE at the Turin Exposition has notized the International Acheson Graphite Company, Niagara Falls, N. Y., through the Department of the Interior, Bureau of Mines, in Washington, that the Jury of Awards of that Exposition has awarded that company a grand prize on the exhibit of its products.

RECENTLY A TERRY TURBINE centrifugal pump set was installed on the United States battleship *Arkansas*, and it is said that this is the first time a steam turbine has been adapted to this use on any naval or mercantile vessel. On land turbo-pump sets have been extensively used for a variety of purposes with the most satisfactory results, and it is anticipated that they will fulfill all expectations in marine work.

THE STEAM YACHT *Carmina*, owned by Mr. F. S. Smithers, is being laid up for the winter at Tebo's yacht basin. We understand that the boilers which were installed in the spring by the Roberts Safety Water Tube Boiler Company, Red Bank, N. J., made ample steam without the aid of the blowers that were used with the watertube boilers that were removed. The *Carmina* cruised more this season than last year, and was capable of making 2 miles better speed under natural draft over and above that done by the former boilers with forced draft, and at the same time her total coal bill for the past season was less than formerly.

"THE TURBINE-DRIVEN FAN FOR FORCED DRAFT is now the accepted standard in the United States navy, taking the place of the former forced draft sets consisting of fan driven by high-speed engine. These engine-driven sets on the older boats of the navy were a source of much trouble and occasioned frequent breakdowns. The new turbine sets deliver 28,000 cubic feet of free air per minute against 5-inch static pressure water gage in the stokehold. Two sets are placed in each stokehold, and the turbine is hung from girders directly beneath the ventilator cowls. Of the eight United States destroyers recently contracted for, seven will have four Terry turbine-driven forced draft sets. These destroyers are the largest and most powerful ever built in this country, and are equipped for burning oil fuel. Of the twenty-one oil-burning destroyers previously ordered by the government seventeen are equipped with Terry turbines. The uniform success of these destroyers is in a measure due to the very satisfactory operation of the turbine-driven blowers."

AMONG THE FOREIGN ORDERS recently received by the Terry Steam Turbine Company, Hartford, Conn., are three turbine-driven blowers for Chinese cruisers and a 15-kilowatt turbo-generator set for Russia.

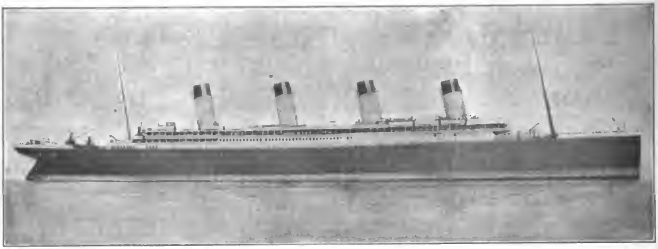
THE PUSEY & JONES COMPANY, Wilmington, Del., has just placed an order with Ruggles-Coles Engineering Company, 50 Church street, New York City, general agents for the Bayonne Casting Company, Bayonne, N. J., for two 66-inch propellers to be cast of "Monel" metal for a large private yacht which they are building.

THE MAIN OFFICES of A. Eugene Michel and staff, advertising engineers, have been moved into the Park Row building, 21 Park Row, New York, where larger space has been secured, as necessitated by constantly increasing business. Temporarily the photo retouching and illustrating department will remain in the Hudson Terminal buildings, but all business will be managed from the new offices.

THE BUSCH-SULZER BROS. DIESEL ENGINE COMPANY, South Side Bank building, St. Louis, Mo., announces that by virtue of purchase and agreements with Mr. Adolphus Busch, purchaser of the American Diesel Engine Company, Messrs. Sulzer Bros., Winterthur, Switzerland, and Dr. Rudolph Diesel, Munich, Germany, the company is the exclusive owner of patents, manufacturing and selling rights for the United States and Canada. Parties interested in this type of engine, either for marine or stationary work, are invited to correspond with the company. The Eastern sales office is 11 Broadway, New York, Mr. W. R. Haynie manager.

MR. C. R. VINCENT, for many years president of the Ball & Wood Company, has assumed the managership of the "Monel" metal department of the Ruggles-Coles Engineering Company, 50 Church street, New York City, general agents for the Bayonne Casting Company. At its foundry in Bayonne, N. J., the latter company has for some years been making with success castings of this remarkable alloy, that is said to be stronger than steel and less corrodible than bronze. Some of these castings range over 25,000 pounds in weight. Sheets, rods, wire and screens of the same metal will also be handled by the company with which Mr. Vincent is associated.

WELIN DAVIT AND LANE & DE GROOT CO.
CONSOLIDATED
305 Vernon Ave., Long Island City, N. Y. Tel. Greenpoint 2581
Manufacturers of Welin Quadrant Davits, the only reliable boat-launching apparatus on the market; manufactured in twenty distinct types and sizes. Over 4000 Davits now in use.



Steamships "OLYMPIC" and "TITANIC" fitted throughout with Welin Quadrant Davits

The Lane & De Groot Life Boats and Life Rafts are the Standard of quality.
Also builders of bronze, steel and wooden launches and other marine appliances.
The famous A-B-C Life Preservers. One-third lighter and smaller than any other belt made.
All our appliances approved by U. S. Inspectors.

London House: THE WELIN DAVIT & ENGINEERING CO., LTD. 5 Lloyd's Avenue, London, E.C.

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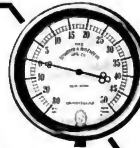
Gauges



The S. & B. line of Gauges for pressure and vacuum is complete. We have an instrument for every conceivable purpose. Moderate-priced instruments of highest quality. They are all described in our Catalog M-1. *Obtain a copy.*

Repair Work

We are prepared to do repair work of every description on any instruments, whether they be of our own manufacture or not. And owing to our extensive facilities our charges are moderate. *Try us.*

The Schaeffer & Budenberg Mfg. Co.

BROOKLYN, N. Y.

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Sewage Ejector

This Water-jet Eductor is used extensively

ON BOARD SHIPS

for discharging waste water from baths, lavatories, etc., which are situate near or below the water line.

It is absolutely reliable and requires no attention whatever. There are no moving parts to wear out and be replaced.

Further information, prices, etc., on application.

SCHUTTE & KÖRTING COMPANY

PHILADELPHIA, PA., U. S. A.

We understand that several orders have been secured by Alex. Chaplin & Company, Ltd., of Govan, for cranes, and about twenty, steam and electric, and of varying type and power, are in hand for home and abroad. The firm recently supplied three overhead electric cranes of 60-ton capacity. These were built and installed within sixteen weeks in the new engineering shops of the London & Glasgow Shipbuilding & Engineering Company, Ltd., Govan. Two of them are of 47 feet and the third of 42 feet 6 inches span. They are three-motor cranes, the speeds for the several operations of lifting, cross-travel and long-travel being: Lift, 60 tons at 5 feet a minute, 25 tons at 11 feet 6 inches a minute, and lighter loads up to a speed of 15 feet a minute; cross-travel, 60 feet to 90 feet a minute; long-travel, 200 feet to 240 feet a minute. All the motors are wound for direct current at 500 volts.

Under the heading of "Naval Shipbuilding Expenditure" the *Mechanical World* recently said: "It is doubtless correct to characterize expenditure on armaments as economic waste, but it is a waste which is recognized throughout the whole world. The money devoted to military and naval objects might be applied to better purposes in any country, but so long as any one nation continues to arm itself for offensive or defensive action, the other civilized nations seem compelled to follow the example for the sake of self-protection. Although the expenditure on naval armaments in the United Kingdom is enormous, it requires only a little consideration to show that the outlay confers great benefits upon a large number of workmen who are employed in the various departments which, combined, produce warships complete. The stoppage of a shipbuilding programme for a single year would throw many thousands of workers out of employment, and from this point of view the cessation of naval shipbuilding would be exceedingly disastrous to many thousands of other persons who would be directly affected by it. But there is no prospect either now or in the future of any such state of affairs being brought about in this or any other country. The First Lord of the Admiralty, who recently referred to the question of economic waste of expenditure on armaments, again expressed the hope that it may be possible to reduce the naval estimates for 1912-13. It is, however, quite clear that the First Lord is not so confident of the realization of this hope as he was six months ago, as he declared that our expenditure must depend upon the scale adopted in other countries. It therefore remains for the near future to decide what the shipbuilding programmes of other countries will prove to be for the next financial year; but we shall be much surprised if the international situation will permit of any reduction in the British expenditure in 1912-13."

One of the most powerful lathes ever constructed is in use at the Darlington Forge Company, Ltd. Its massive double-slide bed, 61 feet 6 inches long, 16 feet wide and 27 inches deep, is built up in two lengths jointed down the center, with five longitudinal and several transverse box girders, and is so arranged that an additional length can be easily added later. The lathe, which was built by Hulse & Co., Ltd., of Salford, will admit work 40 feet 6 inches long and 13 feet 4 inches diameter between centers. The fast headstock has two changes of double and two of quadruple machine-cut forged steel gearing, the changes being readily effected by means of racks and pinions. The spindle is 19 inches in diameter by 27 inches in length in the front bearing, and 15 inches diameter by 22½ inches in the back bearing. A large ball bearing is fitted to take the end thrust. The machine is driven direct through machine-cut double-helical forged steel gearing by a 100-brake-horsepower motor, having a speed variation of 3 to 1, mounted on the foundation plate at the front of the headstock. The keys on the shafts in the fast headstock are forged solid with the shaft, and all the sliding wheels are fitted with two keys. The face plate chuck is 12 feet in diameter, cast in one piece, bolted to a large collar forged on the spindle nose. The movable headstock has a forged steel spindle 12 inches in diameter. Four independent sliding carriages are provided, two at the front and two at the back, with transverse slide and extra holding-down strip. Each is fitted with a rotating nut and reversing gear, swing frame and machine-cut steel change wheels, these latter not only imparting the various rates of feed longitudinally for sliding or screw-cutting, but transversely for surfacing. Rotary motion is transmitted by means of longitudinal shafts driven from one of the quick-running shafts on the fast headstock through two changes of spur gearing, means of hand adjustment being also provided. The sliding carriages have a quick-transverse motion in both directions, driven direct from a 20-brake-horsepower constant-speed motor self-contained with the lathe. The range of spindle speeds is from 0.4 to 30 revolutions per minute.

When writing to advertisers, please mention International Marine Engineering.

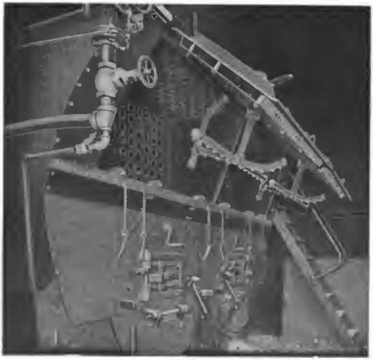
A NEW DESIGN of crane panel has been introduced by the Electric & Ordnance Accessories Company, Ltd., of Aston, Birmingham. Although these panels are of particularly substantial construction, both electrically and mechanically, they are considerably smaller and lighter than panels of the usual construction. The panels consist of a double-pole, quick-break main switch, with three or four double-pole branch fuses, enclosed in a cast iron case, which is provided with lugs for fixing. The main fuses are mounted on the movable switch arm, so that they can only be renewed when the switch is in the "off" position. Pilot lamps are mounted on the top of the case to indicate when the motors are entirely disconnected from the mains; connections for an inspection lamp are also provided. The panels are supplied to control one, three or four motor circuits, dealing with currents ranging from 50 to 400 amperes at pressures up to 600 volts.

AN APPARATUS which has been brought to Great Britain by Mr. Victor Nightingall, an Australian inventor, is designed to enable communication to be established by night between ship and shore or ship and ship by means of light signals according to the Morse code, even though those working it are not adepts in that code. For this purpose the ship is provided with a number of metal plates, each representing a letter of the alphabet, which can be fixed to a wheel forming part of the apparatus, and which, when the wheel is rotated, by means of suitable projections close the circuit through an electric lamp, and thus cause it to flash out the dots and dashes corresponding to the letters. To use the apparatus the sailor consults the international signal book, picks out the letters which stand for the message he wishes to send, fixes the corresponding plates on the wheel, and pulls a lever which both sets the wheel in rotation and switches on the current to the lamp, either from the ship's dynamo or from a battery. The apparatus then continues to send the desired message automatically without further attention until it is stopped. As the signals are shown comparatively slowly, and are repeated at each revolution of the wheel—or oftener if duplicate sets of plates have been fastened to the circumference—any one on another ship ought to be able to decipher them by reference to a Morse alphabet; and then, having made out the letters, whatever his nationality, he has only to consult his international signal book to discover the meaning of the message.

JNO. HY. ANDREW & COMPANY, LTD., of Toledo Steel Works, Sheffield, recently appointed Bernard Holland & Company, of 17 Victoria street, S. W., to act for them in London and district so far as the British government departments, railway companies, engineers, shipbuilders, contractors, etc., are concerned.

OIL ENGINES which have been recently constructed by William Beardmore & Company, of Glasgow, include a 45-horsepower crude-oil engine for a steel fishing vessel which has just been constructed at Amsterdam; a 38-horsepower auxiliary paraffin engine for a schooner trading in Australian waters, and a crude-oil engine of 45 horsepower for the Crown Agents for the Colonies. In addition they have built for the Irish Congested Districts Board two motors—a 60-horsepower crude-oil engine and a 38-horsepower paraffin engine. They have also supplied a 120-horsepower crude-oil engine for a new yacht to the order of the Marquess of Graham.

THE BRITISH OXYGEN COMPANY, LTD., state that they have decided to erect an oxygen factory in Sheffield, where they consider the growing demand for oxygen in connection with metal cutting warrants this extension. When the Sheffield plant is completed the company, which in 1908 had only three factories (London, Birmingham and Manchester), will possess eight factories in the United Kingdom, all situated in centers where the demand for oxygen is important—at London (Westminster and Greenwich), Birmingham, Cardiff, Manchester, Sheffield, Newcastle and Glasgow. These extensions are entirely due to the demand for cheap oxygen in connection with oxy-acetylene welding and oxygen metal cutting. In view of the heavy freight charges on gas cylinders conveyed by rail, it is obvious that local sources of supply must tend to reduce the price of oxygen to the consumer. All the company's plants are of the modern liquid air type, producing oxygen of a high degree of purity, and when the Sheffield plant is in operation their total output will be about 300,000 cubic feet a day. This supply is largely in excess of the present demand, but it is anticipated that this quantity may ultimately be required if the use of oxygen for metal cutting extends. The present average price of oxygen, supplied in cylinders, for industrial purposes is about £2 per 1,000 cubic feet, but reductions are expected if the demand increases.



"Diamond" Front End Marine Soot Blower

With Smoke Box Doors Open and Showing How the Entire Mechanism is Withdrawn from Smoke Chamber.

It Costs Money to Force Heat Through Soot

A one-tenth inch coating of soot on your boiler flues resists heat to a greater degree than a full inch of asbestos. You would not think of running your boiler with the tubes wrapped in asbestos. And yet a slight coating of soot causes the loss of more heat—and the waste of more fuel—than does asbestos.

This "Diamond" Soot Blower

Keeps the Tubes Free of Soot—Cuts Down Your Fuel Bills—Doubles the Efficiency of Your Boiler

Send for copy of New Circular Just Issued

"Diamond" Power Specialty Co.

58 First Street, Detroit, Mich.

THE DIAMOND BLOWER COMPANY
75 b Queen Victoria St., London, E.C., England

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MARINE SOCIETIES.

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
814 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

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An international exhibition of non-ferrous metals is in course of arrangement by Mr. Fred. W. Bridges (organizing manager), under the presidency of Sir Gerard A. Muntz (president, Institute of Metals). The Royal Agriculture Hall, Islington, has been booked from May 6 to 18, 1912. Judging from the experience which the organizing manager has gained in previous exhibitions he has been connected with, and the results achieved, the success of the exhibition now being organized is assured.

The works and business of the Société Escaut et Meuse at Val Benoit, near Liege, have been transferred to a new company formed with the co-operation of the Société Cockerill and the Société d'Ougrée-Marihaye, under the name of Société des Usines à Tubes de la Meuse. This company, with a capital of 5,500,000 francs, will engage in the manufacture of iron and steel tubes and accessories of various kinds.

For several years now, says the London correspondent of the *Manchester Guardian*, Norwegian companies have monopolized the whaling industry in the Southern Ocean largely by means of second-hand British steamers adapted for the purpose. Their efforts off the southeast African coast and in the vicinity of the South Shetlands have, I hear, been so successful that one or two British firms are about to embark in the business. A fleet of five vessels will leave the Tyne for Kergulen Island towards the end of next month, and all of them will be equipped with wireless telegraphy, while three will have Diesel engines as their motive power. One of these is the old Clyde-built barquentine *Sound of Jura*, which has been fitted with tanks for storing the oil. I hear also that a Liverpool firm is having three vessels built for the sealing industry off the Newfoundland coast, and they are to be supplied with internal-combustion engines.

A Barrow correspondent of the *Newcastle Daily Chronicle* states: "There are very bright prospects for the shipbuilding and engineering trades at Barrow, as it has been agreed upon that one of the two Turkish dreadnoughts shall be built by Vickers, Ltd., and the Admiralty Commission of Chili has recommended that the two Chilian dreadnoughts shall be built in this country by Armstrong's and Vickers, who in both the Turkish and Chilian negotiations have been working in combination. The Turkish warships are to be of 23,000 tons displacement, and the Chilian of 28,000 tons displacement. No British battleship has yet reached these dimensions. The guns with which these vessels will be mounted are of 14-inch and 15-inch calibre, respectively. Similar guns will be placed on modern warships now in course of construction. There is building at Barrow a Japanese battleship cruiser, which will be a better equipped vessel than even our battleship cruisers. There is also in course of building at Barrow a Chinese cruiser and other craft of up-to-date characteristics. The prospects are that shipbuilding and engineering at the Barrow yard of Vickers, Ltd., will be very busy for some years."

The trials of the Diesel engine of 1,000 horsepower for a vessel of the Woermann Line were completed recently at the Nürnberg works of the Maschinenfabrik Augsburg-Nürnberg. It is of the two-cycle double-acting type, running at 125 revolutions per minute normally. There are three working cylinders and three separate scavenger pumps in line with the working cylinders, and driven direct by an extension of the crankshaft. Air pumps for maneuvering and starting are driven by a separate motor. The floor space occupied by the scavenger pumps is very nearly equal to that taken by the working cylinders, and at first the engine appears to be somewhat larger than would have been expected; the over-all space occupied by the bedplate is about 25 feet by 9 feet, and the height from the bottom of the bedplate to the top of the working cylinders is about 14 feet or 15 feet. The arrangement for reversing, although complicated by the fact that the engine is double-acting, is comparatively simple. The cam shaft itself is turned through an angle of about 30 degrees, by which motion all the cams are set in their proper positions for running in the reverse direction. So easy is the manipulation that the engine is changed over from full speed ahead to full speed astern in less than ten seconds, which is rapid enough for all requirements. The scavenging air before passing into the working cylinders is cooled by being taken through a copper cylindrical vessel. The pistons and rods are oil cooled, the oil being itself cooled by circulating through a special cooler. The cylinders are cooled in the usual way by water. The Nürnberg firm have lately built a very large shop for the construction of Diesel marine engines, which is already well filled. Several 850-horsepower high-speed Diesel marine engines, running at about 400 revolutions per minute, are under construction or are completed for use in submarines. These have eight working cylinders and two air pumps on the same shaft in line. The scavenger cylinders are arranged directly underneath the working cylinders, and they have a stepped piston, the piston of the scavenger pump forming in reality the crosshead of the engine. These submarine engines are all of the two-cycle single-acting type, and are of very light construction. The frame and bedplate are built of manganese bronze. Engines are on order for the Dutch, German, Italian and the Austrian navies.

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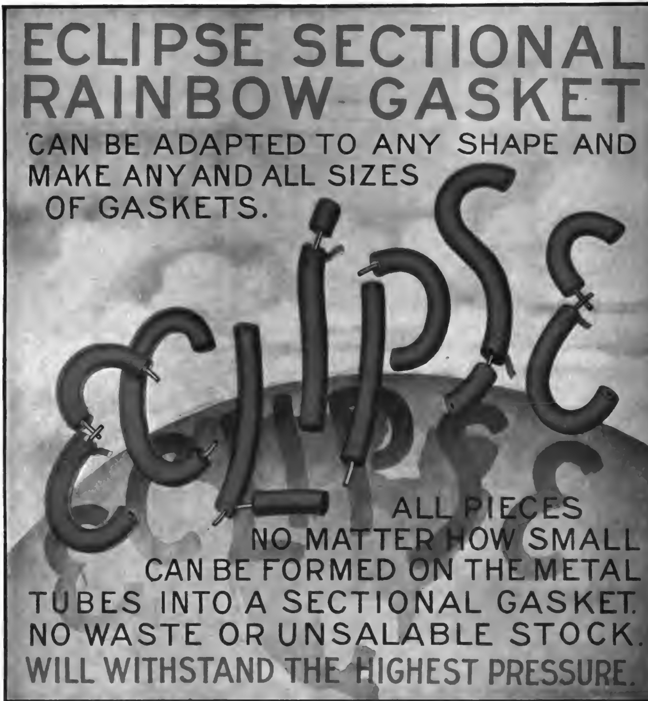

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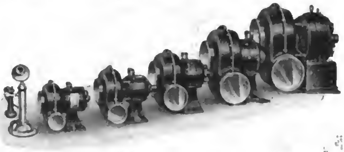

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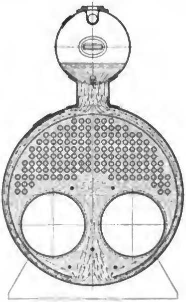

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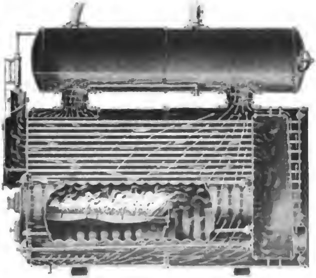

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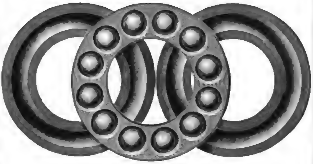

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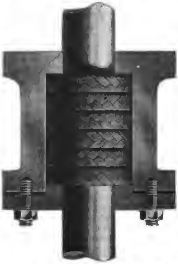

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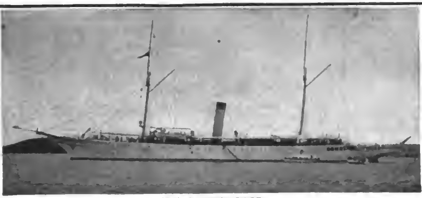

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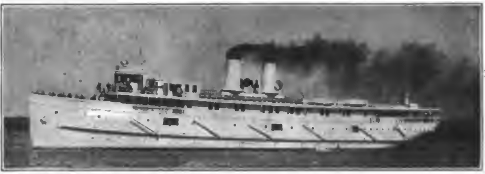

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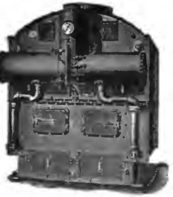

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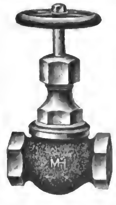

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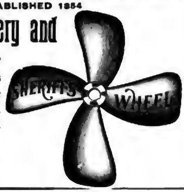

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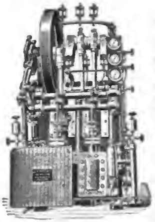

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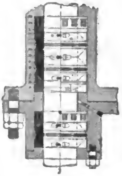

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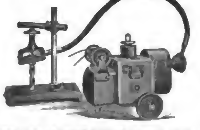

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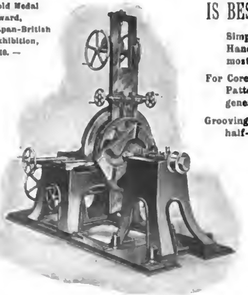

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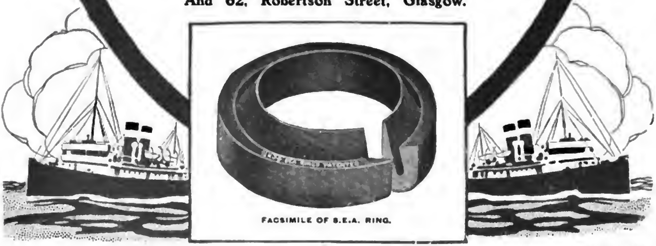

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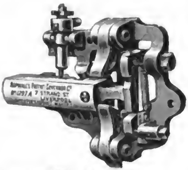

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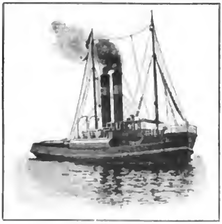

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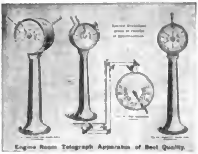

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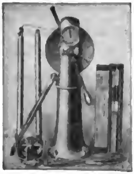

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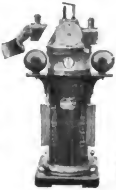

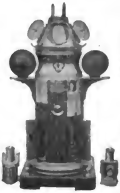

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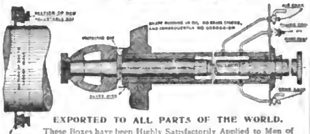

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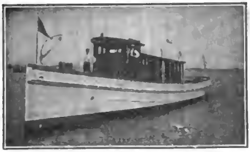

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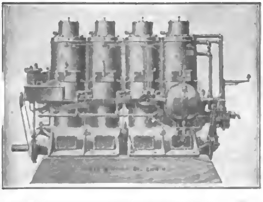

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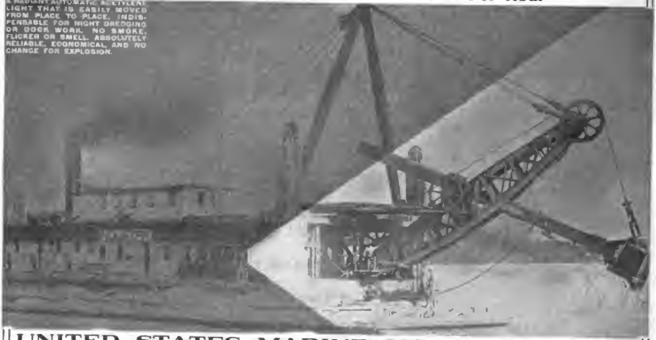

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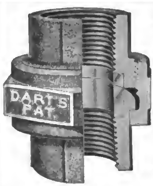

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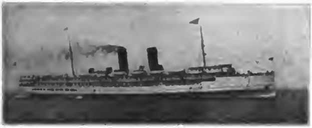

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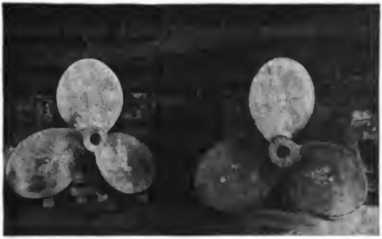

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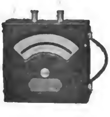


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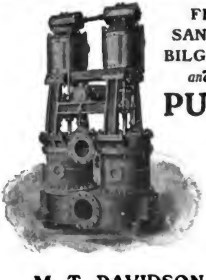

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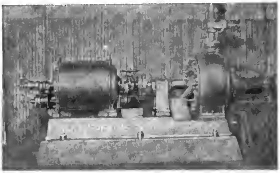

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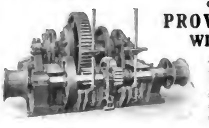

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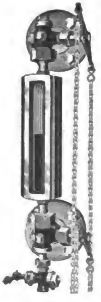

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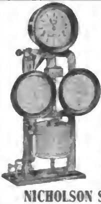
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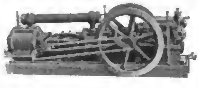
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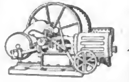
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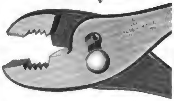

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