No. 4. Vol. 2. ONE SHILLING NET. April, 1903.

EDITORIAL & PUBLISHING OFFICES, CLUN HOUSE, SURREY STREET, STRAND, LONDON, W.C.

PARIS—22, Rue de la Banque. ST. PETERSBURG—14, Nevsky Prospect. UNITED STATES—Subscription News Co., Chicago. International News Co., N.Y. BERLIN—5, Unter den Linden. CHINA & JAPAN—Kelly & Walsh, Ltd. VIENNA—7, Kumpfgasse. SOUTH AFRICA & AUSTRALASIA—Gordon & Gotch. CANADA—Toronto News Co. Montreal News Co.

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No. 4. **APRIL, 1903.** **Vol. II.**

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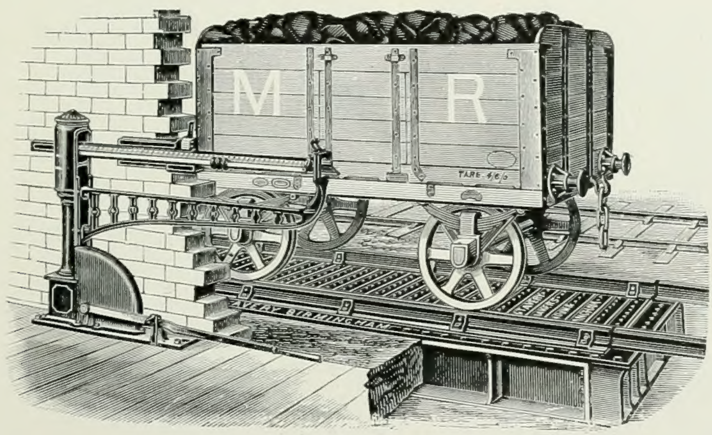

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(*Continued from Page 2.*)

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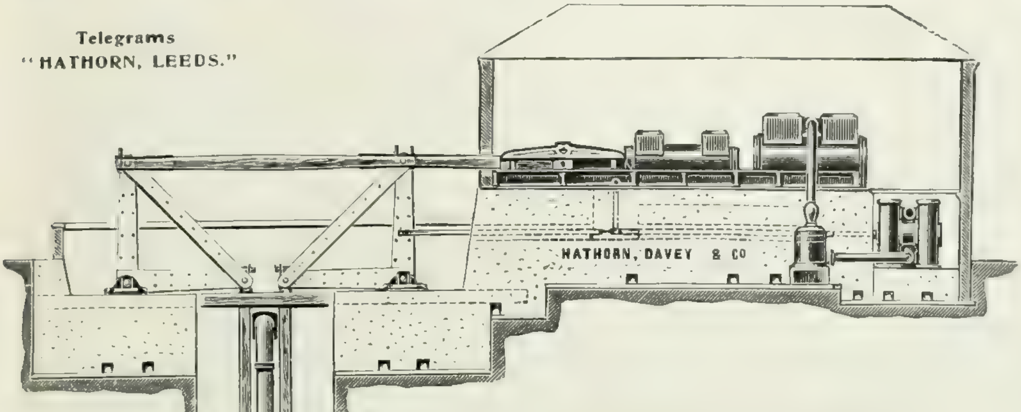

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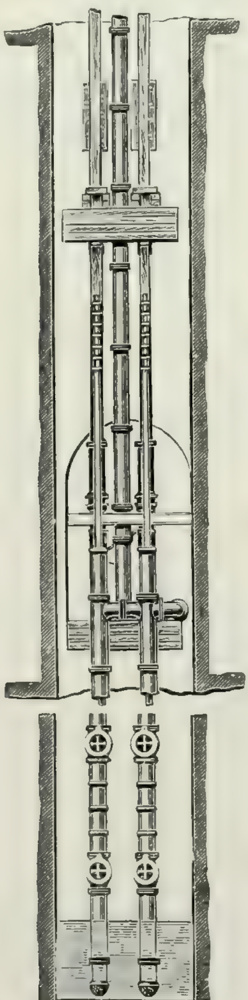

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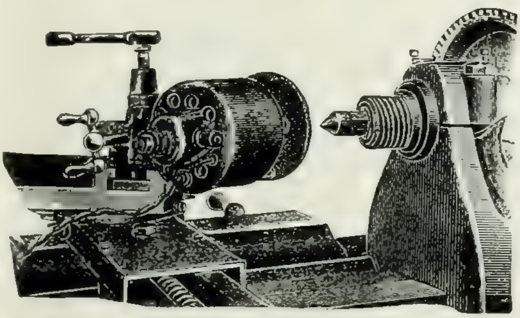

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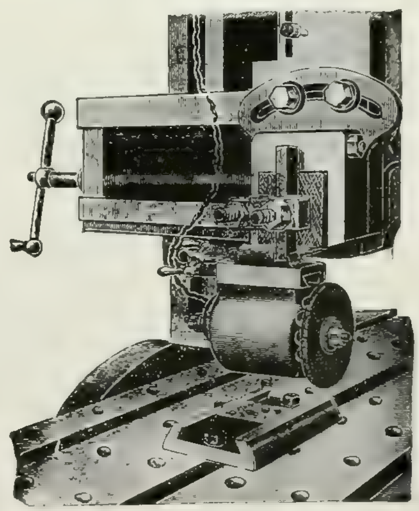

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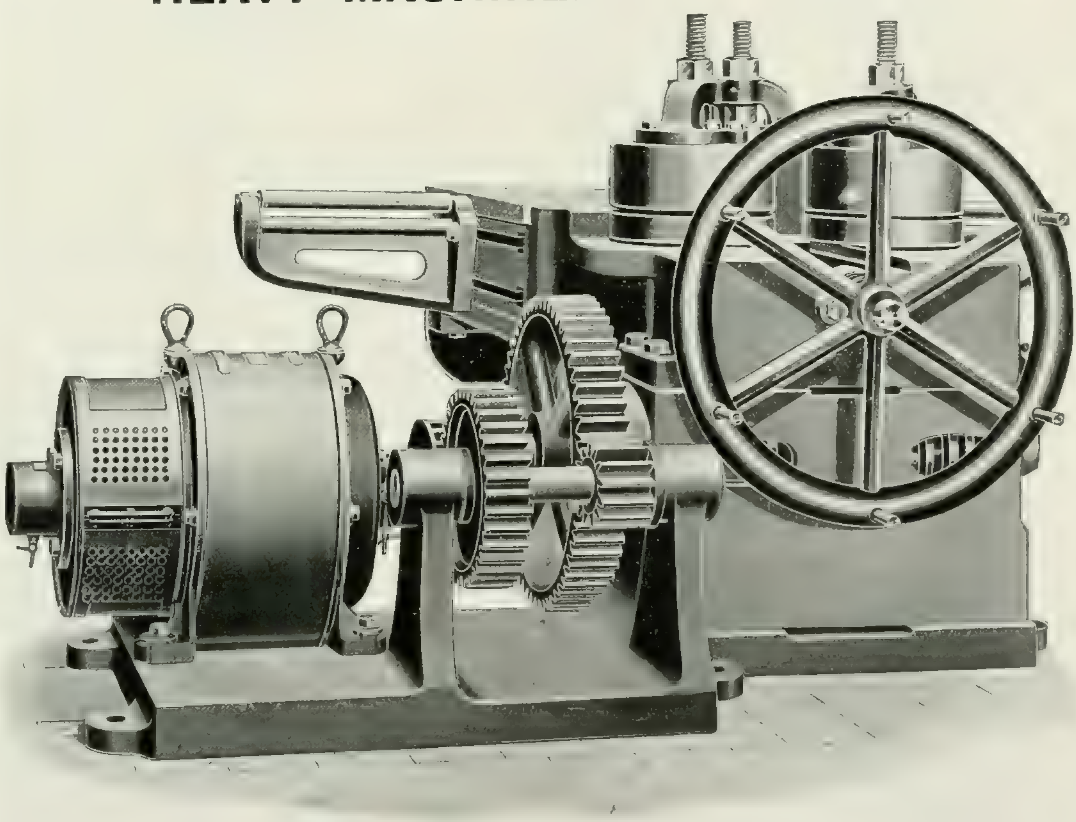

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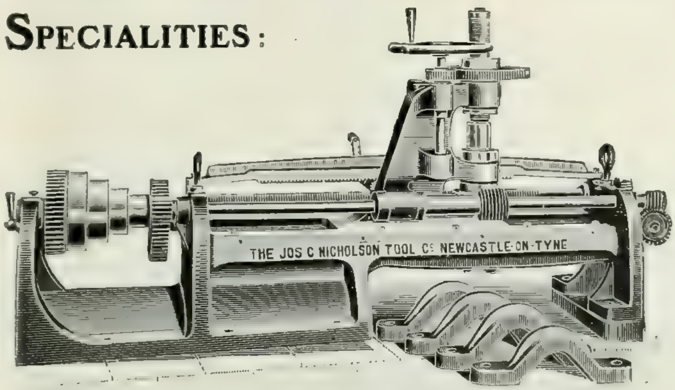

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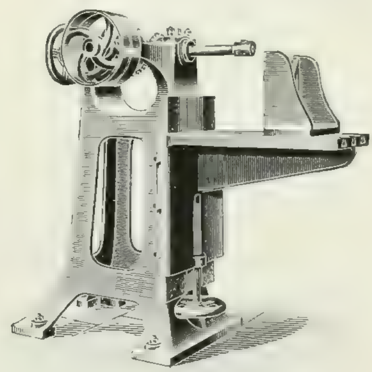

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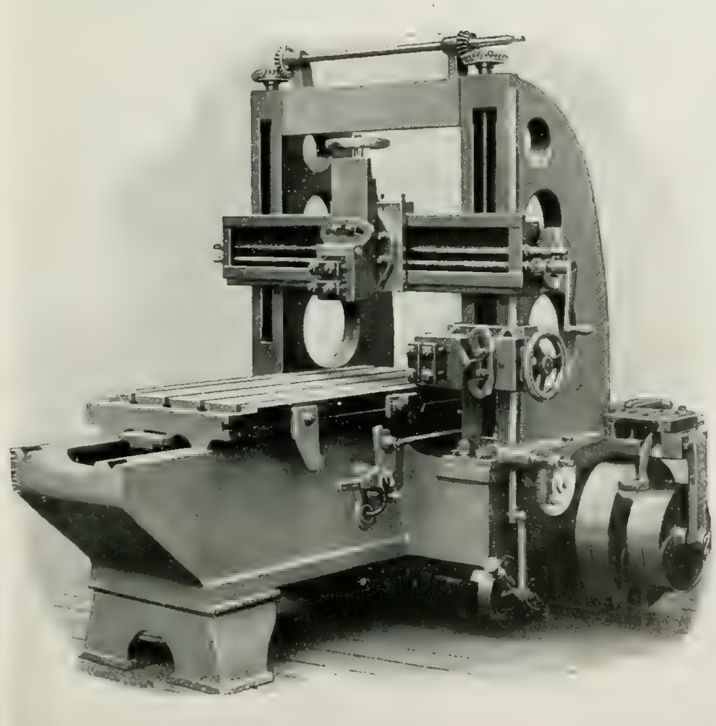

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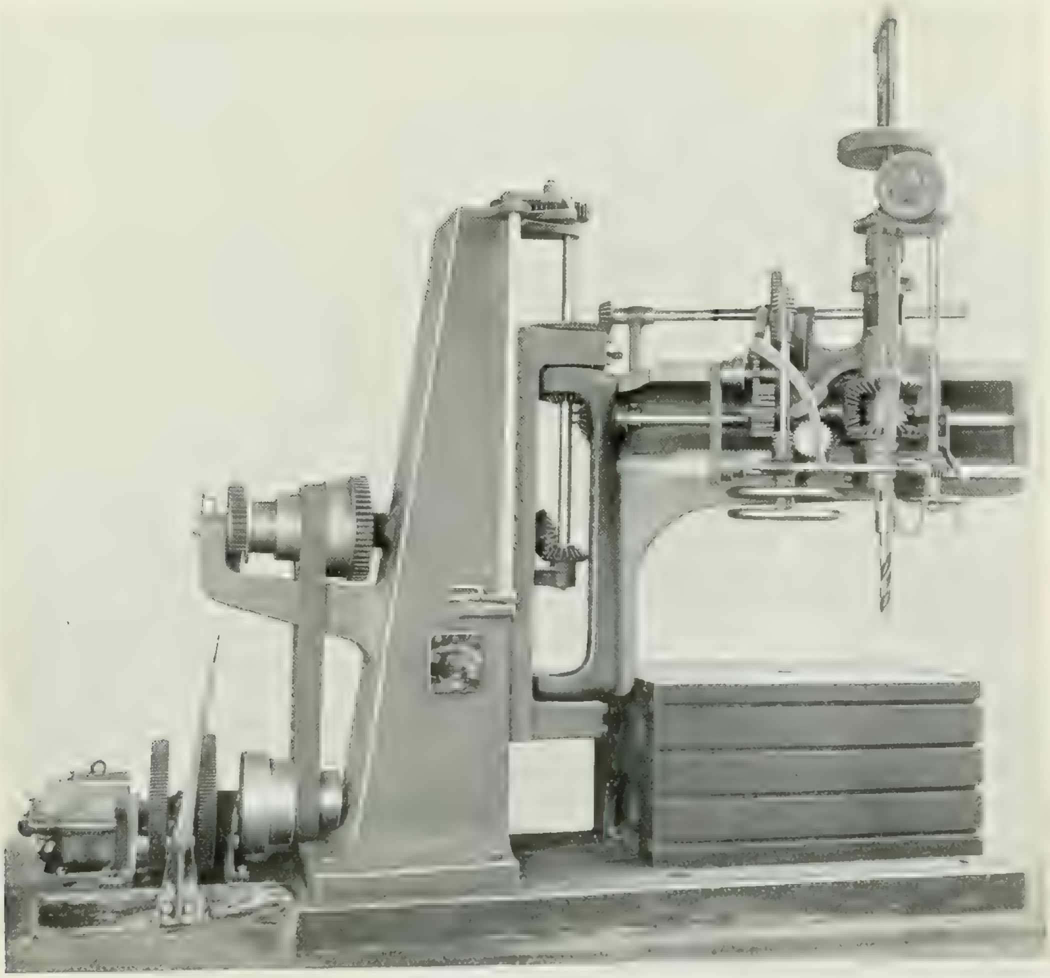

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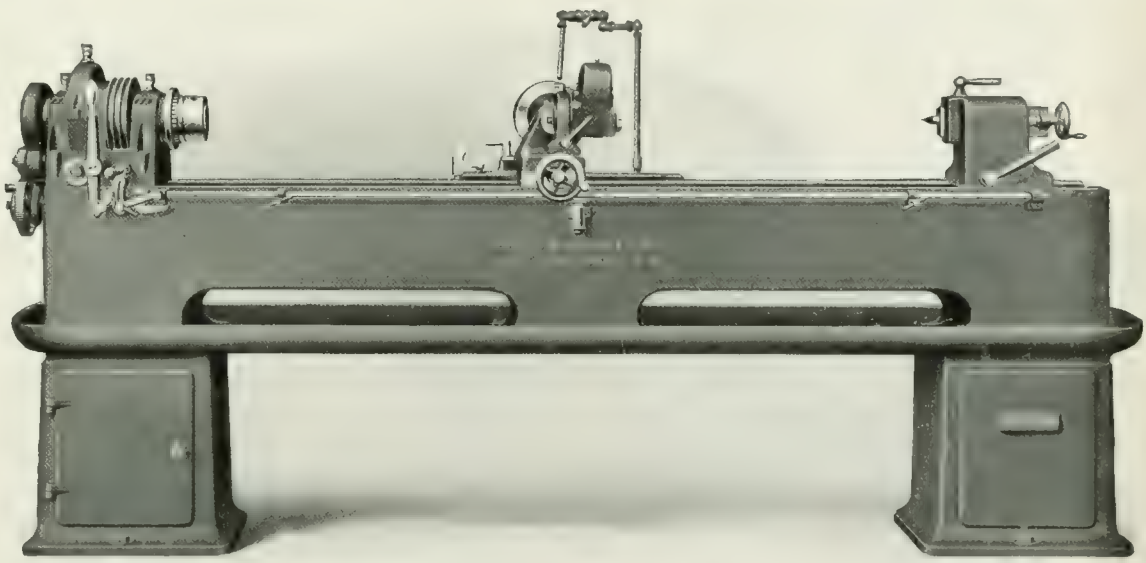

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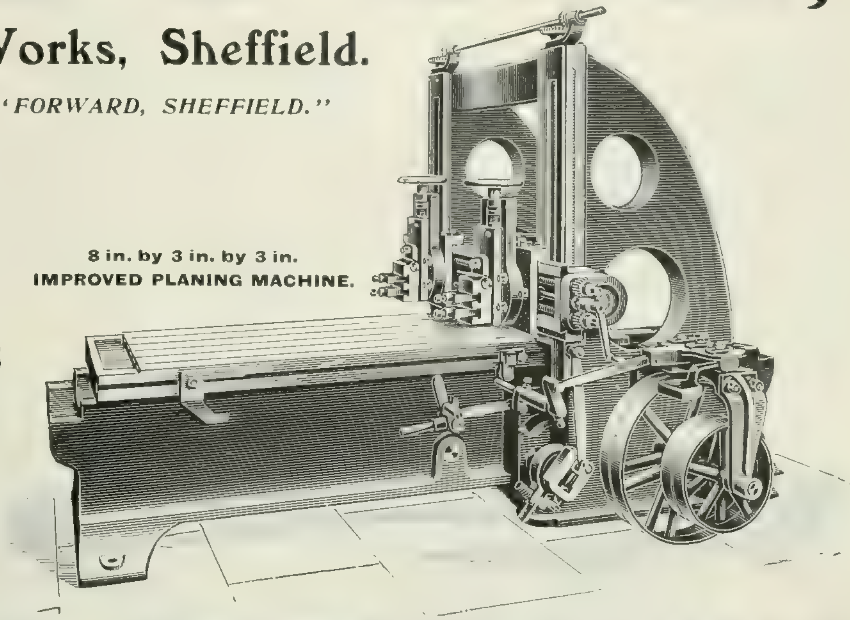

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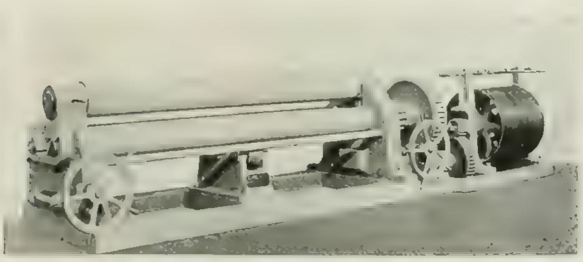

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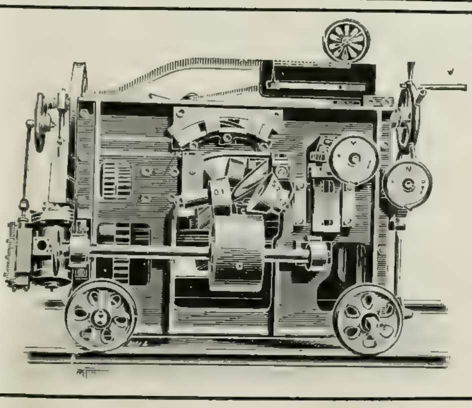

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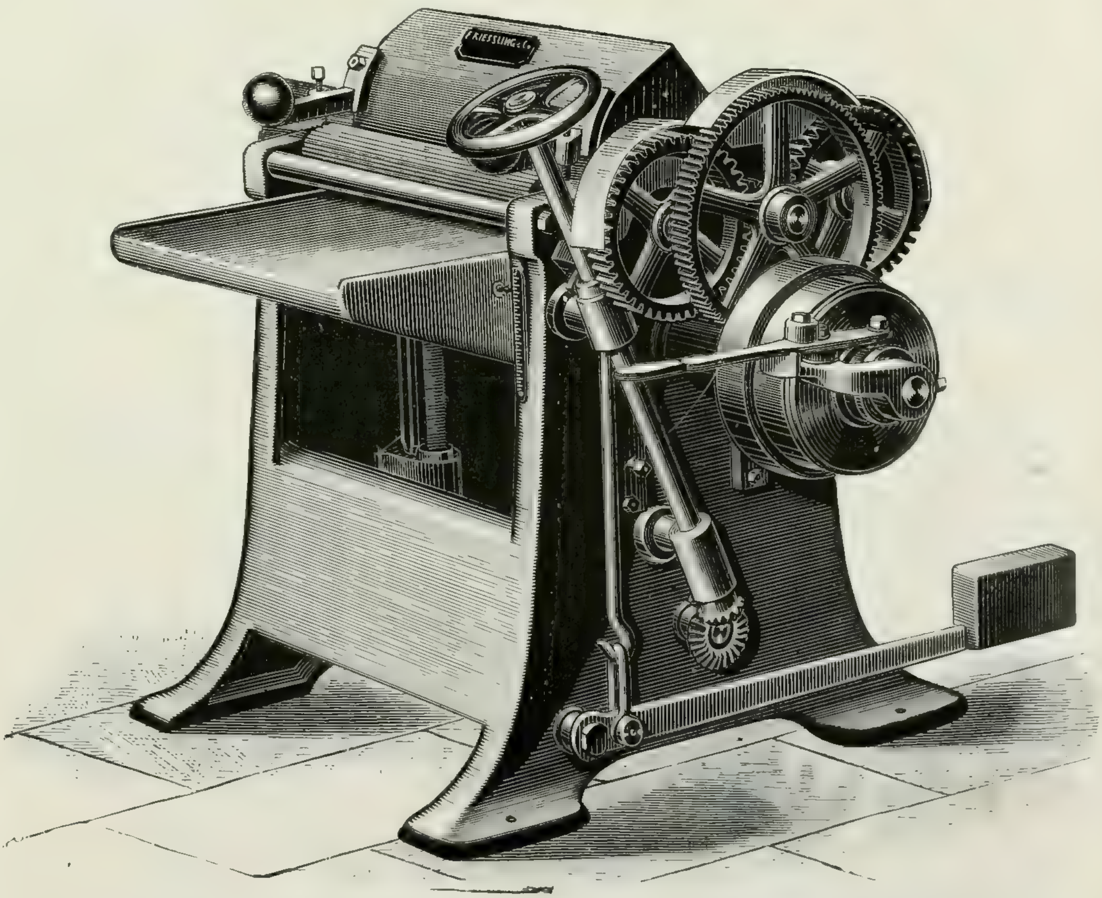

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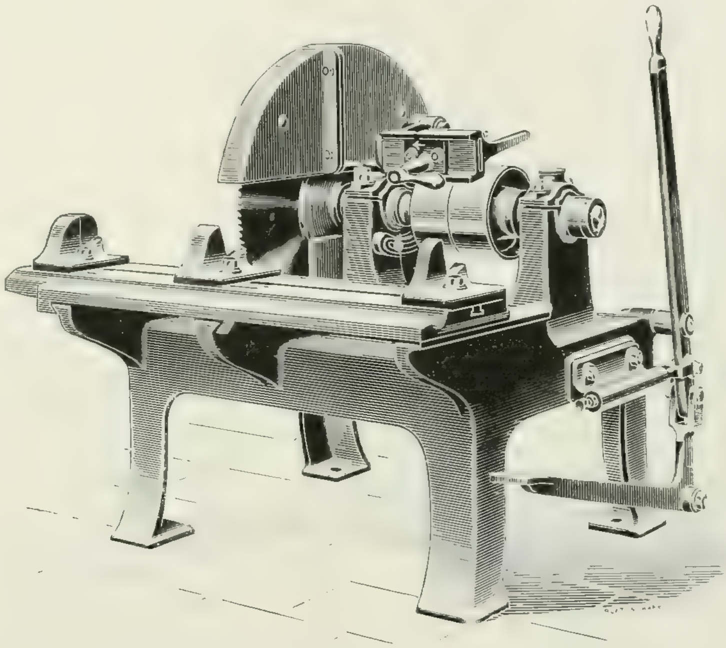

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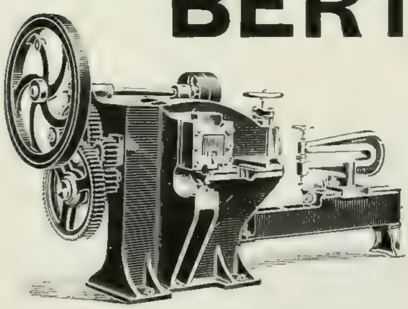

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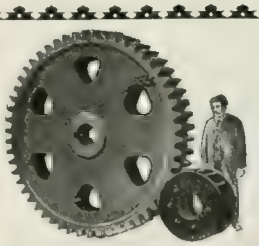

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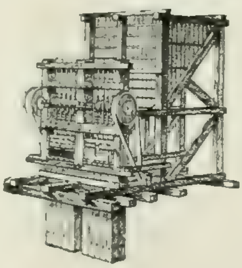

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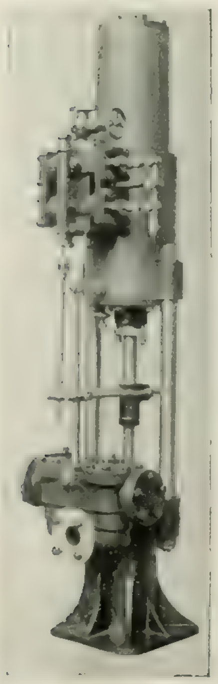

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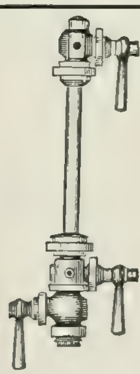

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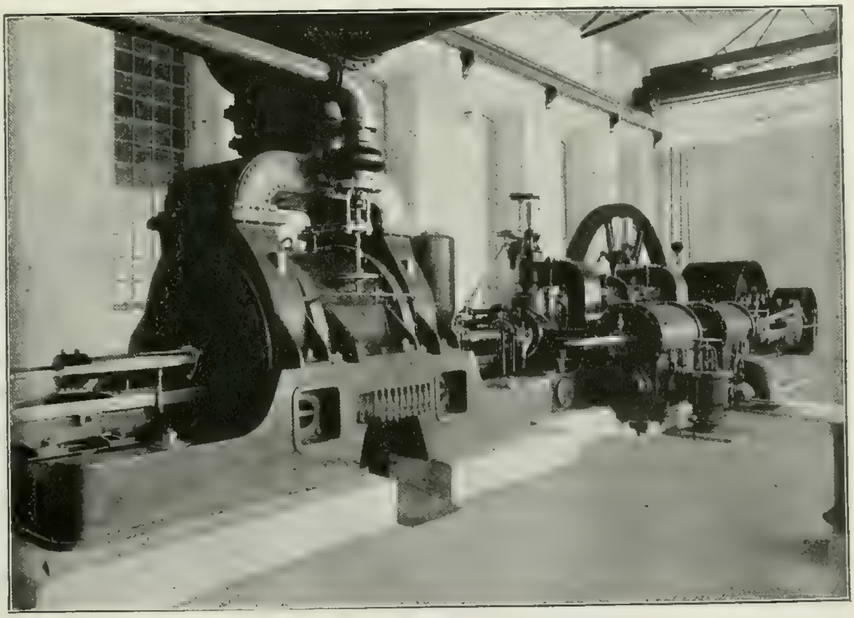

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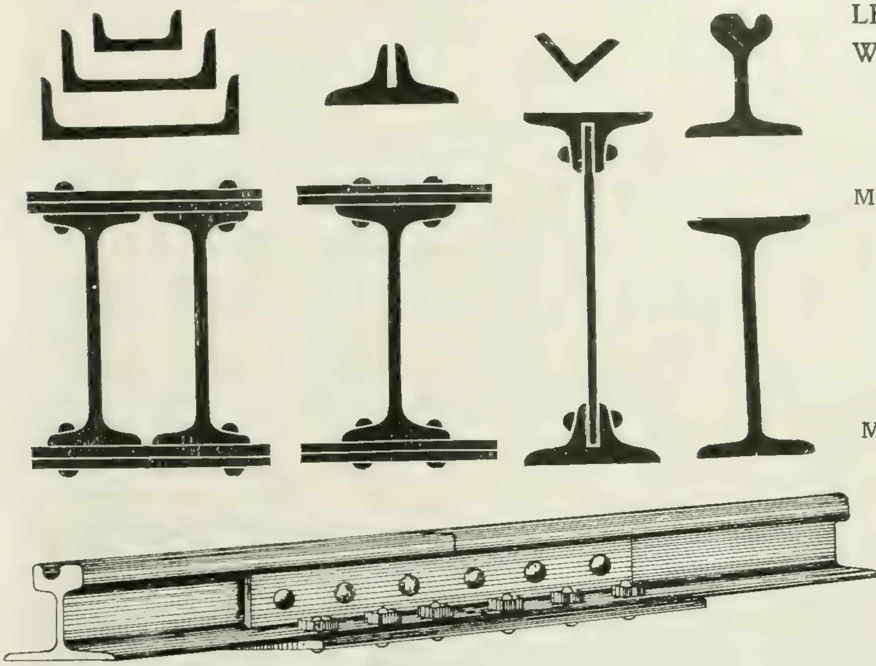

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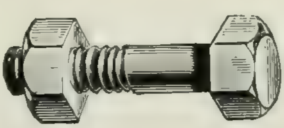

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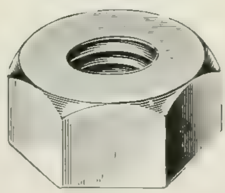

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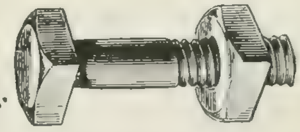

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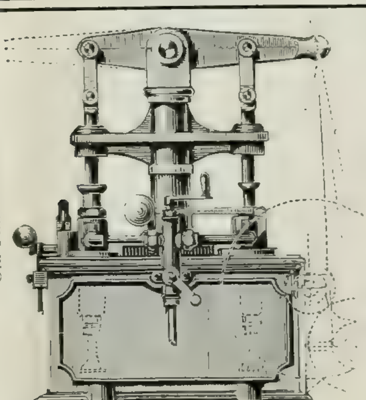

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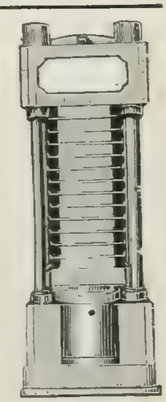

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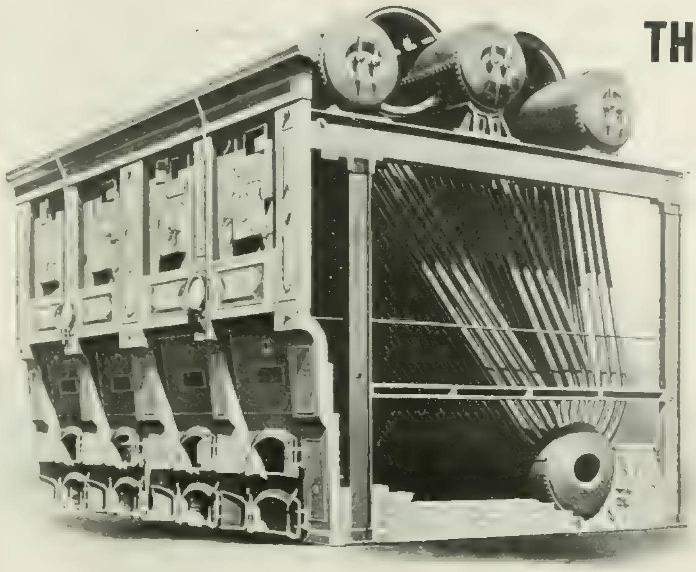

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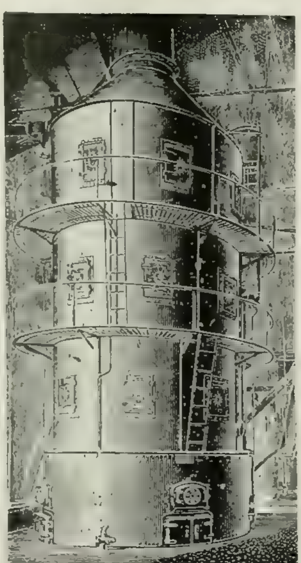

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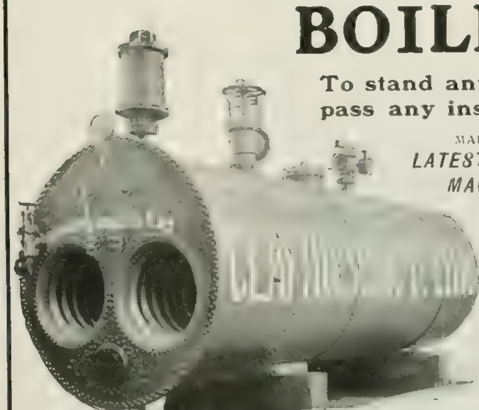

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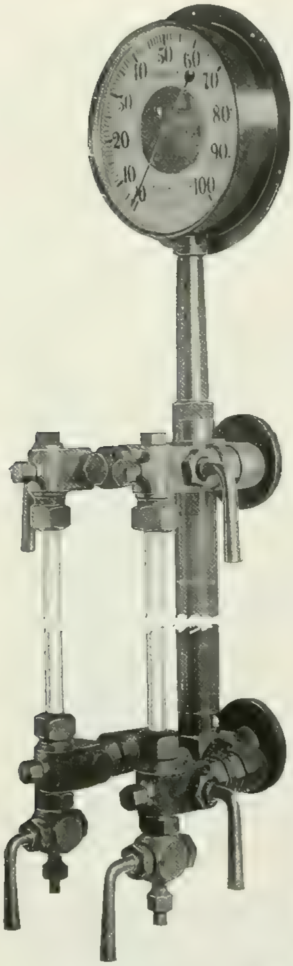

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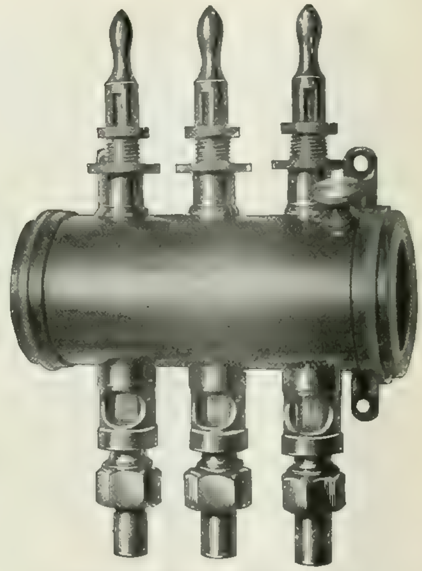

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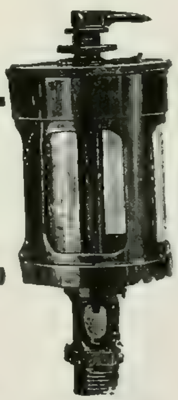

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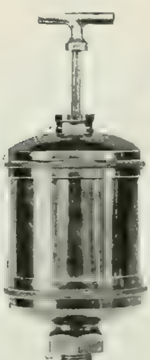

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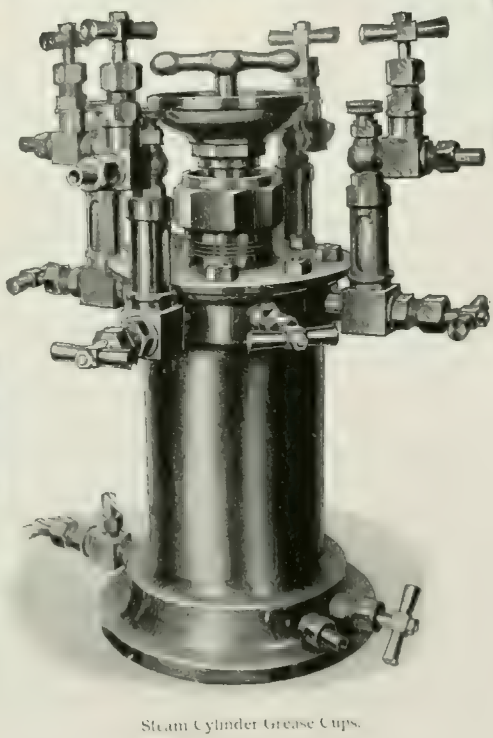

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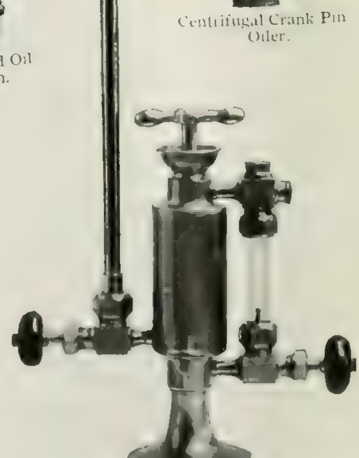

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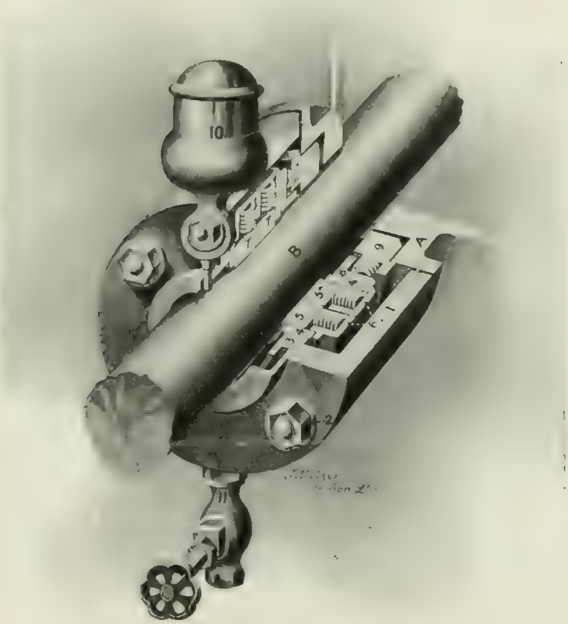

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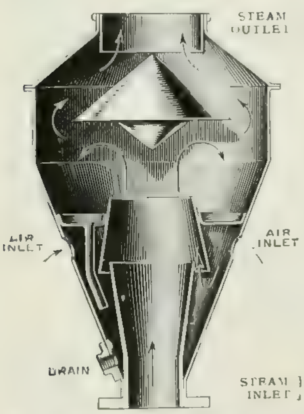

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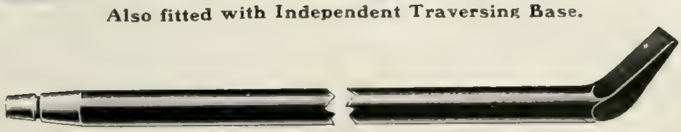

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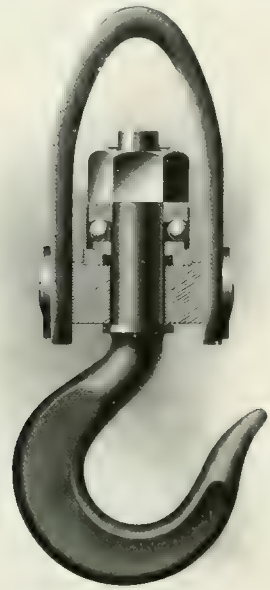

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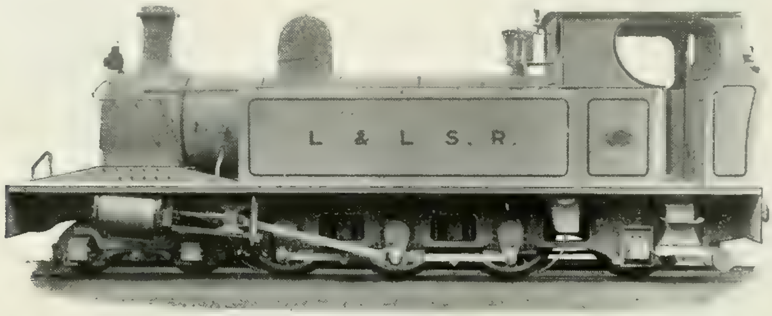

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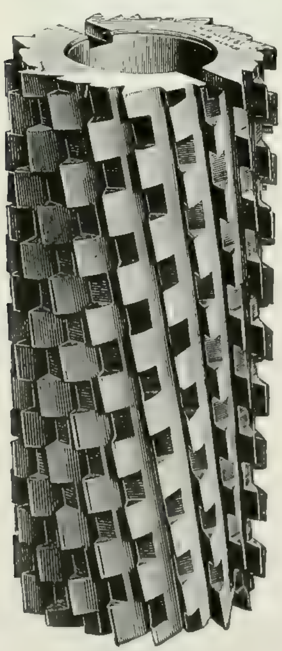

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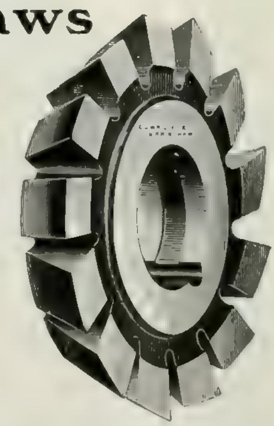

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An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. II. LONDON, APRIL, 1903. No. 4.

THE "PROTECTOR" RUNNING AT FULL SPEED.

AN UNDER-WATER AUTOMOBILE.

THE NEW AMERICAN SUBMARINE TORPEDO-BOAT "PROTECTOR."

BY

HERBERT C. FYFE, Author of "Submarine Warfare."

Mr. Fyfe gives a detailed account of the "Lake" submarine torpedo-boat, and discusses its efficiency as compared with the Holland type.—EDITOR.

THE launch of the submarine torpedo-boat *Protector* at Bridgeport, Conn., U.S.A., the other day, is a very interesting event in the story of under-water navigation. The *Protector*, the invention of Mr. Simon Lake, is an entirely new type of craft, and differs very materially from every other submarine boat ever constructed.

Mr. Lake believes that under-water vessels have a very useful future before them, both from a peaceful and from a war-like point of view, and already his submarine wreck-raising boat has performed valuable service in wreck recovery, raising coal from sunken barges, and similar work.

THE "ARGONAUT."

Mr. Lake commenced the study of submarine navigation nearly twenty years ago, and he claims that he has travelled greater distances under water than any other builder on either side of the Atlantic. The first practical and successful boat built by Mr. Lake was the *Argonaut*, and she has proved the practicability of this type of vessel for commercial purposes. She can remain for days under the surface; she can steer as correct courses beneath the waves as on the surface; she affords the crew the same comfort as when on the surface, with ample sleeping and cooking facilities, and she

THE NEW SUBMARINE JUST BEFORE LAUNCHING.

has means of enabling divers to enter and leave the hull by an open door through which no water can possibly enter.

The *Argonaut* is now in the possession of the Lake Submarine Company of New York. She is 66 ft. long and 10 ft. beam and of about 120 tons displacement, and has travelled thousands of miles under her own power along the coast, and in the Chesapeake and Delaware Bays and Long Island Sound. She has been in use over three years, and during all her cruises has never been compelled to take a tug boat owing to any breakdown of her machinery. At the present time she is engaged with the Sound and Coast Wrecking Company in their salvage operations in Long Island Sound.

TRAVELLING ON THE FLOOR OF THE OCEAN.

The main feature that distinguishes the "Lake" type of submarine is the power of travelling on the floor of the ocean. For this purpose they are fitted with wheels, and when on the bottom they run along the sea-bed just as a carriage rolls along a high road.

Mr. Lake declares, in a recent pamphlet, that travelling on the bottom is the most simple, safe and reliable method known of under-water navigation, and his boats differ from the "diving torpedo-boats," owned by Great Britain, France and the United States in that they go under *on an even keel* and can rest on their wheels when on the sea floor. Mr. Lake says that several boats of the diving type have taken head-first dives to the bottom, throwing their crew down into one end of the craft.

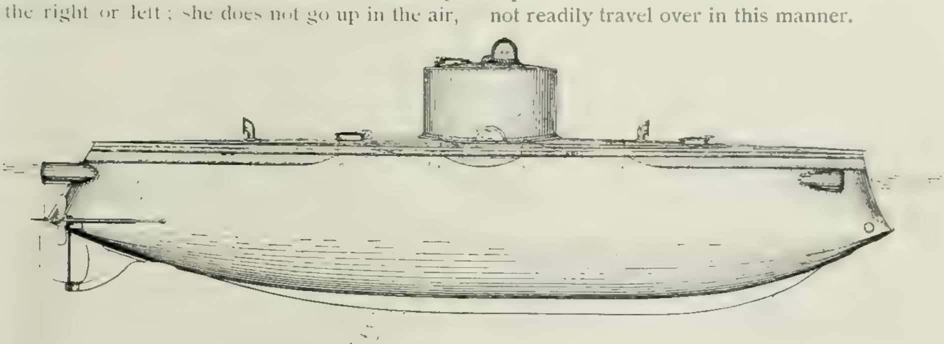
All mariners know (he remarks) how difficult it is to steer an absolutely straight course on the surface; then *how much more difficult* is it to steer a straight course beneath the waves? On the surface the vessel can only swing to the right or left; she does not go up in the air, because she is held to one plane (the surface of the water) by her weight; neither does she go down, because she is held to the same plane by her buoyancy, therefore the rudder is able to control her. But below the surface all these conditions are changed; every wave imparts an up and down motion to the particles of water beneath it, and consequently affects the course of the submarine vessel. Currents run in a variety of directions, and as soon as the screw or propelling mechanism starts in motion, it affects the equilibrium and trim of the boat. If one of the crew move forward or aft, the trim is affected, and all these things tend to elevate or depress the bow of the boat or affect her course, and as she can go either to the right or left, or up or down, or, indeed, in any direction, there is scarcely any limit to the difficulty of holding her securely to an appointed course under the surface of the water. Either she will be ducking down and running her bow into the bottom of the sea, or bobbing up again to the surface.

At the best, a vessel navigated in this manner is much like a vessel in a dense fog, and it is necessary to come to the surface frequently to correct her course, and thereby expose her presence to the enemy.

The "Lake" type is *not* subject to the above difficulties. When travelling on the bottom she has no perfect trim or equilibrium to maintain, as she can travel when resting on the guide wheels with a weight varying from one pound to two thousand pounds or more (according to the conditions of the bottom), and she is so proportioned that the entire crew can move from one end of the vessel to the other without materially disturbing her trim, great longitudinal stability being one of the features of the type. She can run more accurate courses than a surface vessel, because she is running over a medium, the bottom, which is not constantly changing like the surface waters; currents do not drift her out of her course, and when the propelling machinery is stopped she is always anchored.

The wave motion does not affect her, as means are provided to compensate for the lifting effect of the ground swell at sea, so that in practice travelling on the sea bottom has been found to fairly compare with travelling over an asphalt pavement in a pneumatic-tired vehicle.

In travelling in this manner there is no danger of failure of some of the diving machinery, which might cause a head-first dive to the bottom, and in all our experience we have never found a bottom that we could not readily travel over in this manner.



MODEL OF "PROTECTOR," SHOWING WHEELS FOR RUNNING ON THE SEA BOTTOM.

LAUNCH OF THE "PROTECTOR" AT BRIDGEPORT, CONNECTICUT.

It is quite true that some of the earlier submarines were very erratic in their diving, and showed a desire to run their noses into the bottom or to stand up on their tails and shove their bows out of the water. The new *Holland* type, the new "Vickers-Admiralty" type, and the French submarines and submersibles are all "diving boats"; that is to say, when their ballast tanks are full, and they are running awash, they are submerged by means of horizontal rudders which send them down an inclined plane. When the requisite depth is reached they are brought up again on an even keel, either by hand or by means of a hydrostatic valve, a pendulum or some other mechanism acting on the horizontal rudders.

No difficulty appears to be experienced with the modern diving boats, thanks to the ingenious appliances with which they are fitted.

NAVIGATION AT A GIVEN DEPTH.

The "Lake" boats need not always run on the ocean bed, but can be navigated at any predetermined depth between the surface and the bottom. In this position the depth of submergence is maintained nearly constant by means of hydroplanes, one or more on each side of the vessel. These hydroplanes, or horizontal rudders, are controlled automatically, and the boat in submerging always maintains a level keel.

The method of submerging by the side vanes of hydroplanes is as follows: water ballast is taken in to bring the boat to the "awash" condition. The vanes are then turned downwards and the water flowing against the upper portion of the planes forces the structure beneath the surface until the required depth is reached, when the "automatic depth regulator" causes the planes to oscillate as required to constantly maintain that depth.

THE "PROTECTOR."

We may now give some account of the latest "Lake" boat, the *Protector*.

The *Protector* has been built as a speculative venture, by the Lake Torpedo-Boat Company, of New York City and Bridgeport, from the designs of Mr. Simon Lake.

The following is a comparison between the "Lake" and *Holland* boats represented by British Submarines Nos. 1 to 5, and the United States boats, *Adder, Porpoise, Pike, Shark, Grampus, Moccasin* and *Plunger*.

	"Lake" Boat.	*Holland* Boat.
Length over .	65 ft. ...	63 ft. 4 in.
Beam ...	11 ft. .	11 ft. 6 in.
Displacement afloat ..	115 tons .	105 tons
Surface buoyancy ...	55 tons	15 tons
H.p. of gasoline engine..	250	100
H.p. of batteries... ...	75 for 4 hours	70 for 4 hours
Screws .. .	2	1
Depth of submersion ..	150 ft. ...	150 ft.
Armament	3 Whitehead torpedo-tubes	1 Whitehead torpedo-tube
Fuel-carrying capacity...	1,400 gallons...	850 gallons
Speed on surface	10 to 11 knots	8 to 9 knots
Speed submerged .	7 knots .	7 knots

The *Protector* is 65 ft. long, 11 ft. beam, and displaces in light condition 115 tons. She is ship-shape instead of cigar shape. On the surface she is driven by a gasoline engine of 250 h.p., and submerged by an electric motor of 75 h.p. for four hours. The gasoline is carried in tanks in the superstructure, and entirely outside of the living quarters in the boat, so that if it escaped it could not injure the crew. In the *Holland* boats it is carried in the interior of the shell. Twin screws are employed, and it is claimed that in manœuvring the operator has better control of the boat than if there were only one screw. The hull has sufficient strength to submerge 150 ft. The armament consists of Whitehead torpedoes, and there are three torpedo expulsion tubes, two at the bow and one at the stern; in the *Holland* craft there is only one expulsion tube, forward.

The *Protector* carries three 18-in. Whitehead torpedoes, while the *Holland* boats each carry five torpedoes.

The vessel will be surprisingly speedy in its changes of station. To change from ordinary cruising condition to that of deck awash will require but three seconds, and an equal interval will suffice for submergence from the awash condition to the exposure of only the sighting hood.

THE SUBMARINE TORPEDO-BOAT "PROTECTOR" ON THE STOCKS, SHOWING SIDE RUDDERS AND TWIN SCREWS.

Complete submergence may be accomplished in less than a minute. The *Protector* can, if desired, be sent to the bottom without any interruption of the operation of the batteries; but in all probability the plan to be usually followed will provide for the stoppage of the machinery. The actual descent will be accomplished either by the admission of water to the tanks or by drawing the vessel down by the use of wire cables attached to two anchors, previously lowered to the ocean bed from anchor wells in the bottom of the boat. These anchors serve a double purpose, inasmuch as they, as well as a large section of the keel of the vessel, may, in the event of accident, be cast adrift; the boat thus lightened will, of course, rise to the surface.

UNIQUE FEATURES.

The most striking feature of the "Lake" type of submarine boat is found in its equipment for travel upon the bottom of the ocean, as above described. For this purpose it is fitted with two large iron wheels which are fitted on the keel line, one in advance of the other, and which may be raised or lowered at will. The propellers push the boat forward just as when she is afloat, but the wheels tend to keep the vessel upon a straight course, once the bearings have been taken.

The wheels are 3 ft. in diameter with 9-in. face, and are constructed of cast iron. The bottom reached, the submarine rests on the two wheels and becomes in reality a "submarine automobile."

The *Protector* is also fitted with several other adjuncts which have not appeared in any other submarine craft, among these being a device which indicates exactly the distance travelled on the bottom, and a telephone equipment which enables persons on the submerged vessel to communicate with those on shore. This would, of course, prove of advantage in war operations. The lines of the hull are such as to give the vessel a great reserve of buoyancy in every condition save that of total submergence upon the bottom, and this ability to secure absolute horizontal stability without imposing other than a reasonable movement of weights therein will, it is claimed, enable the new-comer in the submarine field to be readily controlled in rough weather.

SUBMERGING THE "LAKE" BOAT.

In its method of submerging the "Lake" boat differs from the *Holland*. The first operation, viz., the admission of water-ballast to bring the vessel to the awash condition, is common to both. The *Holland* is steered below at an angle by the horizontal rudders at the stern, whilst the "Lake" is submerged on an even keel by the manipulation of four "hydroplanes" or horizontal rudders, two of which are carried on each side. This is the method of submersion when under way. When stationary, however, another method is employed. Two heavy weights are lowered to the bottom, each weighing 1,000 lb. The winding mechanism is put into operation, and the boat is hauled down to the bottom. Then the weights are hauled in, and enough water ballast is admitted to keep her from rising to the surface.

The fuel carrying capacity is 1,400 gallons, the speed on the surface is estimated at ten to eleven knots, and the submerged speed is estimated at seven knots for three hours continuously. The radius on the surface is over 1,500 miles. The storage batteries can be re-charged by the gasoline engine which drives a dynamo.

An automatic drop keel is carried, and there are other automatic features to prevent the craft submerging below a safe depth.

There are ample officers' and crews' quarters, with cooking and sleeping facilities, and there is provision for the escape of the crew in case of partial disablement of the vessel while submerged.

THE DIVING COMPARTMENT.

A great feature of the "Lake" boat is the diving compartment, located in the bow of the boat. It is a room about eight feet long with a door that opens outward into the sea. An air-lock connects the diving compartment with the living quarters when the captain desires to send a man out. He enters this compartment, closes the door, and opens a valve which admits the compressed air until the pressure of the air in the diving compartment equals the pressure of the water at whatever depth the boat happens to be. There is a duplex gauge in the compartment with a red and a black hand. The black hand shows the water pressure outside, and the red hand shows the pressure of air inside the diving compartment. When the two hands are together this indicates that the pressure of the water outside and the air pressure inside are equal. Then the door can be opened, and the water will not come in. The diver who leaves the boat can pick up and cut cables and can do mining and counter-mining work. The *Holland* boats, it may be added, are not provided with diving compartments.

Rear-Admiral Melville has said :—

From a careful study of the plans of the "Lake" and *Holland* boats I cannot see why the "Lake" boat will not do everything that the *Holland* does, and, in addition to that, it could be used for mining and counter-mining purposes, for cutting cables, and for other submerged work. Mr. Lake contends that it is possible to travel on the bottom anywhere on the United States coast from Maine to Mexico, and within bombarding distance of the coast cities. The *Argonaut* has travelled over bottoms so soft that divers would sink up to their waists in the mud when sent out on the bottom. Yet she rested so lightly on her wheels they did not sink into the mud over six inches.

This kind of bottom is, however, found only in inland waters. On the bottom of the Atlantic it is almost as hard and as smooth as macadamised pavement, and this is the general condition of ocean bottoms adjacent to coast lines. The American coast is an excellent locality for wheeling along in this manner, and the distance from the shore that one can travel in depths less than 150 ft. varies from 15 miles off Cape Hatteras to 75 miles in other localities—ample in all cases to prevent a blockade of any of our seaports.

The air tanks charged at a pressure of 2,000 lbs. to the square inch are capable of supplying sufficient air to enable a crew of six men to remain submerged for sixty hours. The sleeping quarters consist of seven folding berths, similar to those found in American sleeping cars.

During the recent meetings of the Special Submarine Committees of Naval Affairs, both of the United States House of Representatives and of the United States Senate, a good deal of evidence was given respecting the "Lake" type. The opinions of the *Protector* which were given by various naval authorities were in many cases very favourable.

Lieut.-Commander John R. Edwards, United States Navy, in his evidence, said :—

In my opinion the "Lake" boat will be shown before the end of the year to be a far superior craft for naval purposes to the *Holland*. Her superiority will not only rest in special contrivances that are fitted in the boat, but in the manner in which her propelling and other contrivances have been installed.

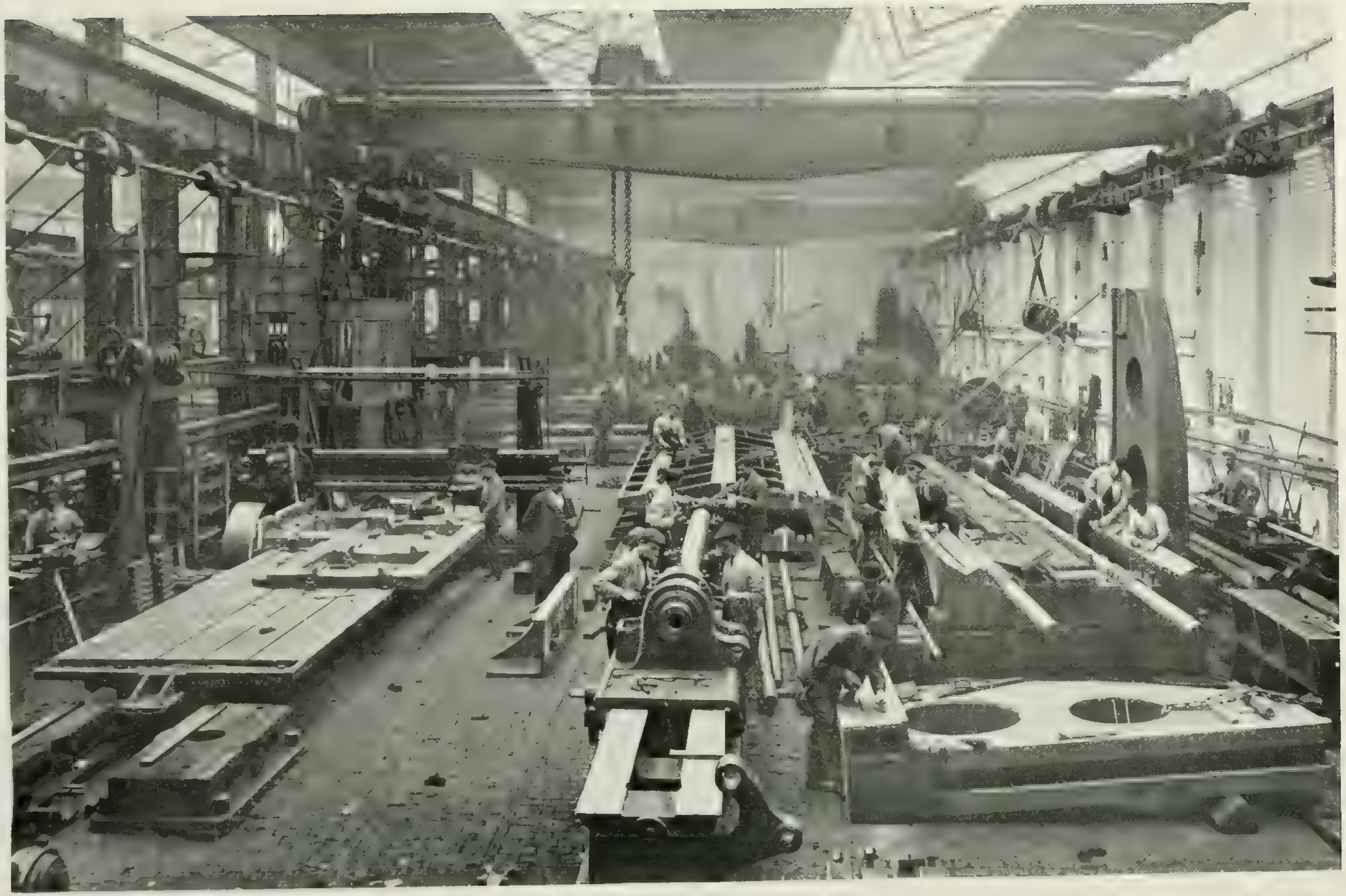
Rear-Admiral Charles O'Neil said that, in his opinion—

The *Holland* boat did not fulfil all the necessary requirements of an efficient instrument of warfare. He believed that the science of submarine or sub-surface navigation was yet in its infancy, and that considerable further development must take place before it could with propriety be said to have passed beyond the experimental stage. Apparently the *Holland* boats had about reached the limit of development to which boats of this type were susceptible, and if we were to progress in the art, efforts should be made to produce or to encourage others to produce submarine boats having fewer limitations than the *Holland* boats, and this could only be done by throwing the door open to other inventors.

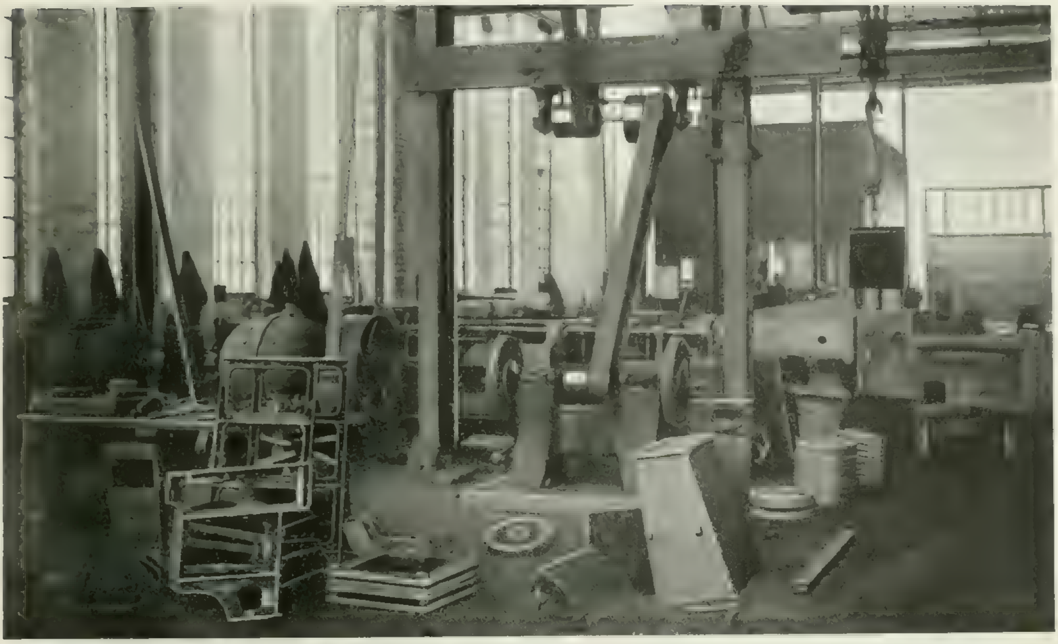
The United States Navy Department is going to carry out a series of exhaustive trials with the *Protector* in order to arrive at some conclusion respecting its capabilities.

Although the *Argonaut* was designed for peaceful purposes, Mr. Simon Lake made application during the Spanish-American War for her to be allowed to disconnect, by stealth, some of the torpedoes in the mine fields abreast Fortress Monroe, Virginia. Permission was refused, but Mr. Lake was determined to show the United States naval and military authorities of what his vessel was capable.

Taking his bearings when about three miles distant, the Commander of the *Argonaut*, one afternoon, submerged the boat until the sighting hood on the conning tower was just above water, while the ventilating pipes which the boat then carried were high above the surface. It was nearing sunset when he started, and a short while afterwards the sun dipped and the searchlights on the fort began to sweep the whole area of approach, but while the lights picked up every ordinary craft of any size whatever, they quite failed to discover the approaching *Argonaut*. After an hour's run she stopped right in the midst of the vessels, rose to her cruising trim, and anchored right under the fort's guns. The military authorities were thoroughly surprised. A day later the *Argonaut* submerged at the same spot and cruised around the bottom for some hours, and in that time the diver could easily have disconnected half the mines in the adjacent fields.



HEAVY TOOL BUILDING DEPARTMENT, AT THE WORKS OF MESSRS. GREENWOOD AND BATLEY, LTD., LEEDS.



DEPARTMENT FOR CLEANING CASTINGS, MESSRS. JOHN LANG AND SONS' FOUNDRY, JOHNSTONE.

THE LAYING OUT OF ENGINEERS' WORKSHOPS.

BY

JOSEPH HORNER.

* This article deals with the various shops and departments which form the separate units comprised in an engineer's works.—EDITOR.

II.

IN order to understand the lay of engineering works it is necessary to be familiar with the several units which are comprised in them, because the relations of shops should be governed by the nature and sequence of the industries which are carried on in those shops.

OFFICES AND SHOPS.

Factories include offices and shops, and though these are intimately connected, they are nevertheless more widely differentiated than the various shops are from one another. Each is a world in itself, and each requires management of a different order from the other.

THE OFFICES.

These include two main departments—the commercial, and the designing and drawing offices, each being under different management. The commercial is controlled by one of the principals, who seldom attempts to take any active participation in the conduct of the works. Or, in the big companies, a confidential secretary, possessed of much technical knowledge, and wide experience has charge of it. Under him are the clerks of the several sub-offices, through whose books pass all orders for materials and stores, all the work undertaken by the firm, its income, expenditure, correspondence, and so forth. All the work done here is purely commercial, unless the estimating department is included in it. This, however, is properly a branch of the drawing office.

THE DRAWING OFFICE.

This is in charge of a chief draughtsman, who occupies a very different position in some works

* The first article of the series appeared in PAGE'S MAGAZINE for March.

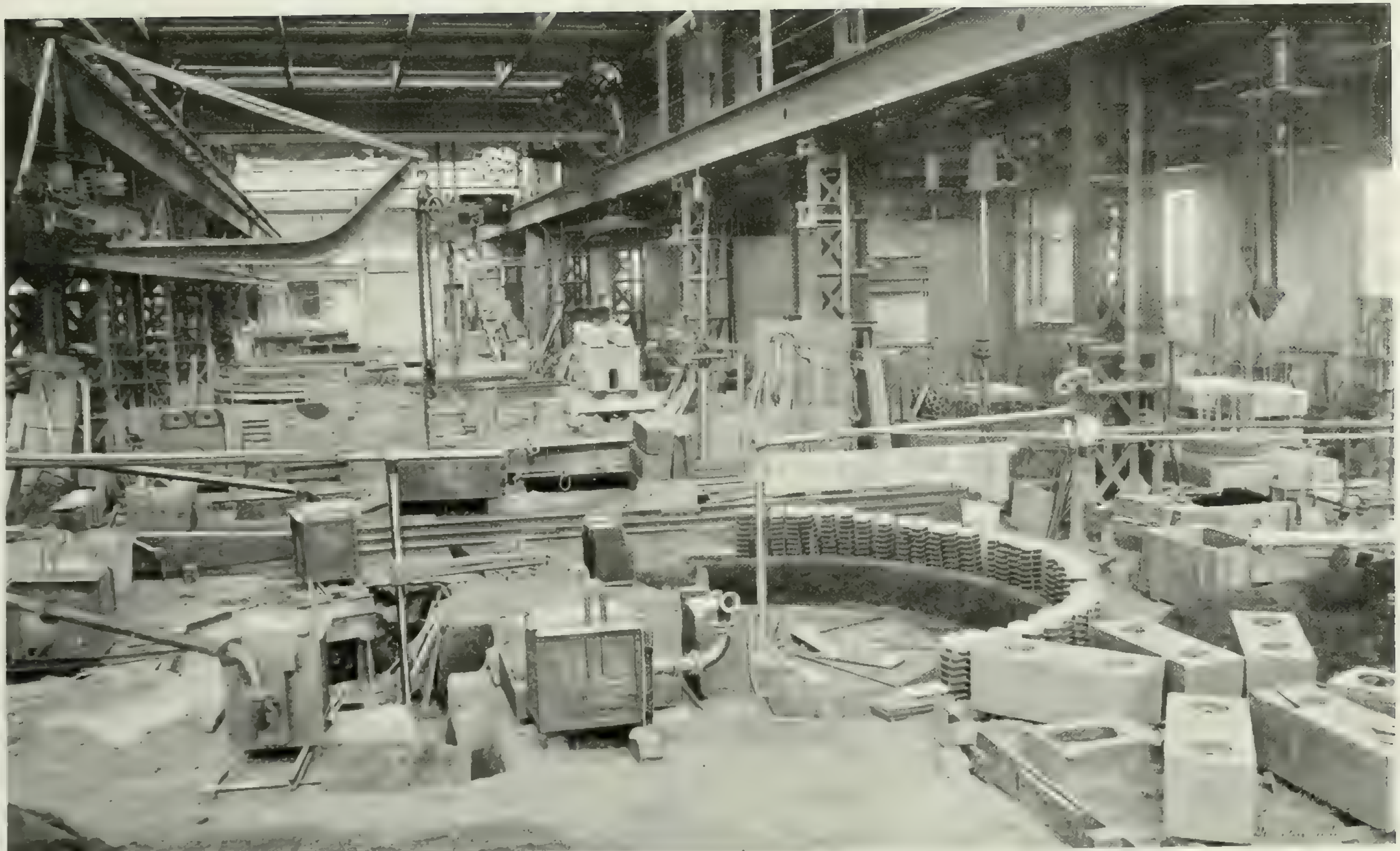


Photo by C. Stephen, Winterthur.]

A VIEW IN THE SULZER HEAVY FOUNDRY, SHOWING IN THE FOREGROUND PORTABLE HOT BLAST-FURNACES FOR DRYING MOULDS, AND TRAVELLING JIB CRANE ON THE LEFT.

than in others. If he is an office man merely, with little or no shop experience, he holds a position inferior to the works manager, whose practical knowledge is necessary to check the office designs. If he is a shop man as well as a draughtsman the situation is reversed, and he will often exercise a strong control over the works manager, or may even combine the two posts. Between these extremes all grades exist in the positions occupied by head draughtsmen.

Those who work under the chief, include men who can design, and those who cannot—copyists and tracers merely. In large factories the work of drawing is often subdivided between two or more offices. This occurs when a firm produces several specialities. Such a separation permits of that subdivision of tasks which is carried on to a larger extent in the shops. Each sub-office is then in charge of a leading man, but all are usually under the control of the chief draughtsman.

An important appanage of the drawing office is the printing room. The growth of sun prints has been a marvellous one. They have taken the place of drawings on cartridge paper, of tracings unmounted, and mounted; and they are blue, brown, or white, the latter permitting of colouring like drawings. Within the last few years the cylinder printing machine, illuminated with an arc light in the centre, has done away with the delays due to cloudy weather, and in winter. And prints can, of course, be made at any time—in the night if necessary.

THE ESTIMATING OFFICE.

This should always be, and generally is, a department of the drawing office, rather than of the commercial offices. The reason is, that estimates are based primarily on the quantities taken out on the drawings, and in the largest proportion of cases on drawings and specifications that are invitations to tender only. The quantities and weights for these have to be got out in the drawing office, or by a technically trained staff of clerks. Such estimating as is done on the commercial side is based on work that has been already carried through, and is obtained from the men's time sheets, and from the quantities charged in the shops. This can be transferred to the drawing office department more easily than the technical work of the latter can be assimilated by the book-keeping clerks.

OFFICE *versus* SHOPS.

The present tendency is to throw much greater responsibility and initiative upon the offices, and to exalt them to a more important position than was formerly done. The old office and the old staffs were very different from those which are found in advanced works to-day. The tendency is increasing also to make the offices the heart of the works, the pulsations from which shall control the life of every shop. The initiative of men and foreman has been greatly curtailed in consequence. Less and less of individual judgment and choice remains with the craftsman. This change involves a vast amount of clerical work, but the general judgment approves the change as an important element in that competitive production of which we spoke in the previous article. Increase of clerical work and centralisation has resulted in larger offices, located not in stuffy rooms in the midst of the shops, but in a separate block of buildings in telephonic touch with the offices of the foremen and managers throughout the works.

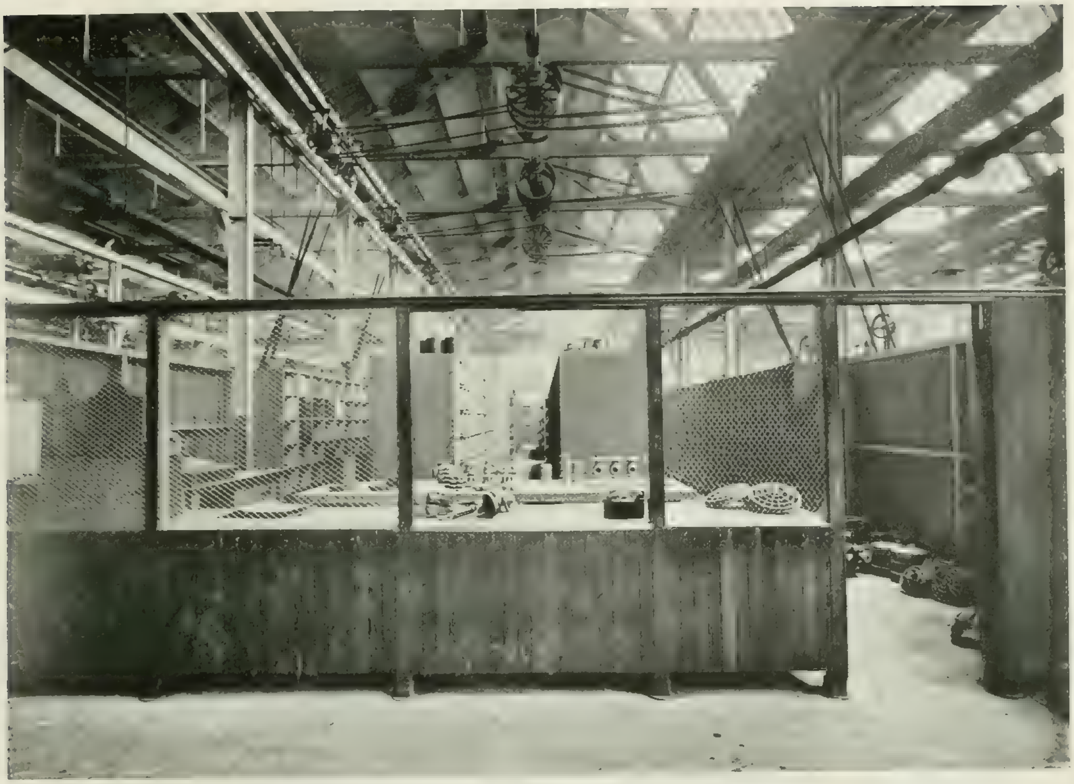
THE SHOPS.

The shops vary in two respects in different works—as, in the number of separate trades carried on in a works, and in their relative magnitude. These differences immensely modify the methods of laying out a piece of ground. Speaking generally, the essential shops in any self-contained engineers' works include a pattern department, a foundry, a smithy, a turnery and machine shop, a fitting shop, an erecting department, and a yard. But besides these many large works must include a boiler shop, a platers' shed, or shop, a coppersmiths' department, a whitesmiths' shop, testing department, and a paint shop. In some works also an electrical department is now included for the manufacture of dynamos, motors, and various fittings.

THE PATTERN SHOP.

In this department the patterns for foundry use are made, and generally also any models of machines which are required. The men use such tools as those which are employed in common wood working trades, including turners. They employ similar, but not identical methods of construction. But there the resemblance ends, because the work of the pattern-maker involves

ASSEMBLING DEPARTMENT, NATIONAL CASH REGISTER COMPANY, DAYTON, OHIO, U.S.A.



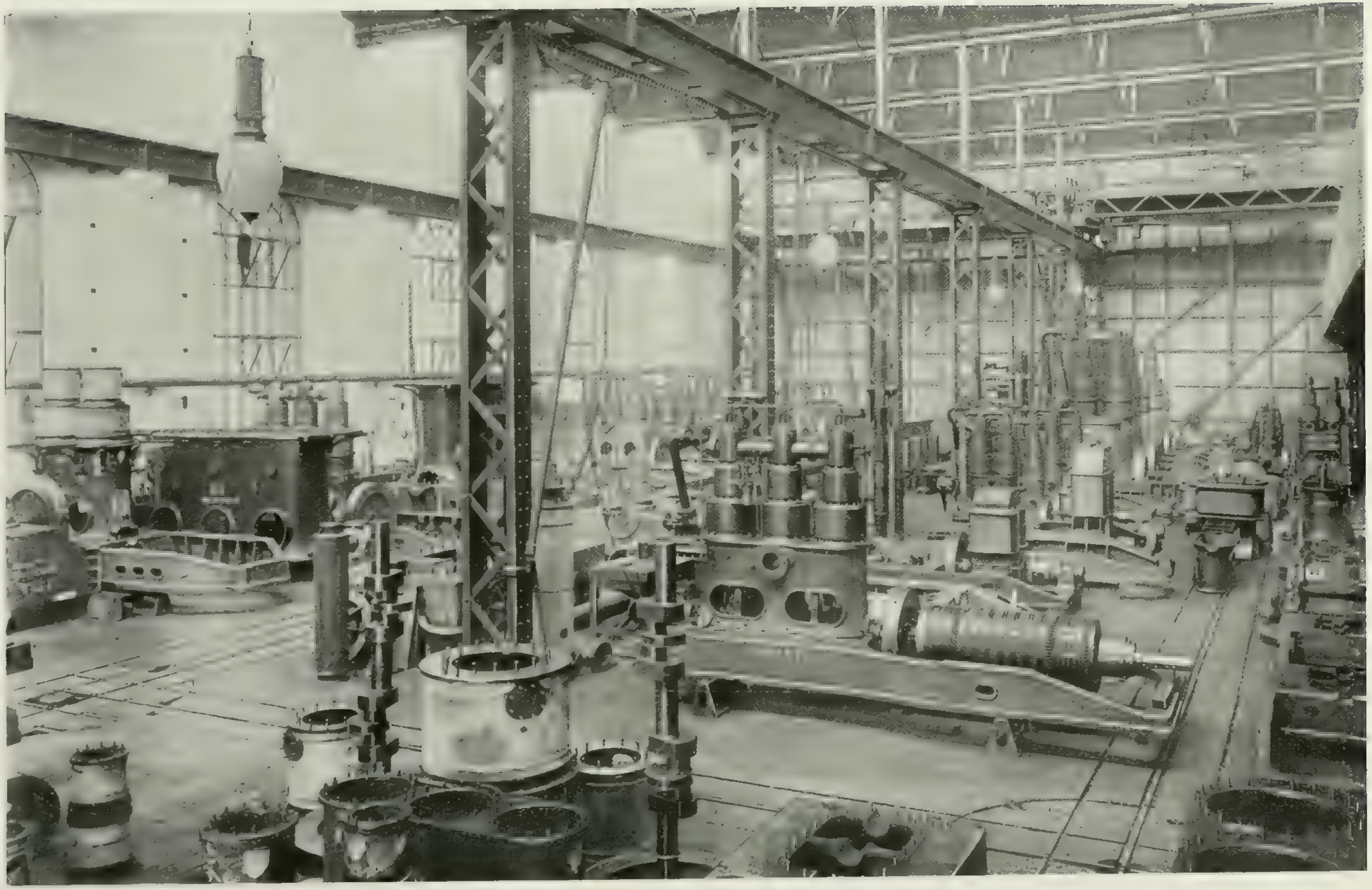
STORE FRONT IN THE MACHINE SHOP OF MESSRS. G. AND J. WEIR, LTD., GLASGOW.

a very intimate knowledge of the trade of the moulder, and also that of the general practice of engineering. Excepting in the work of roughing out stuff, there is little help to be obtained from machinery, so that benches, far more than machines, occupy this shop.

The pattern stores are generally of much larger dimensions than the shop, for few firms venture to destroy patterns until many years have elapsed since they appear to have outlived the demand for them. It is not unusual for stores to contain the greater portion of the patterns that have been constructed for thirty or forty years. Many of the largest patterns are not stored in buildings, but in open sheds; sometimes even in open yards. Though the pattern shop is not as a rule of large dimensions, its stores usually are. They should have at least from four to six times the capacity of the shop, and if they are ten times as large, so much the better.

THE FOUNDRY.

"The foundry" is a very generic term. It may mean a dark, dusty, tumble-down shed, where candles and lamps have to be used throughout all the winter's day. Or it may be as light and bright a building as an up-to-date machine shop. A foundry often includes brass moulding, as well as iron; machine, as well as hand work. In some shops the latter may be nearly displaced by the former. Further, the work may be all heavy, like marine work, or all light. Or the two classes may be carried on in various proportions. Or, again, loam moulding may be carried on most extensively, or green sand only, or chiefly. Lastly, very special classes of manufacture may be done, such as pipes, columns, ornamental castings, heating apparatus, stoves, and so forth, which lie outside what we are accustomed to see in general engineers' works. It is clear that all these modify the laying out of foundries very much.



A PART OF THE INTERIOR OF THE ERECTING SHOP OF MESSRS. WILLANS AND ROBINSON, LTD., RUGBY.

The fettling shop, or shed, is a building outside the foundry, and adjacent to it. Here all the castings are brought when roughly stripped of their sand, lifters, nails, etc., and here the fins and runners are chipped and ground off, and the sand thoroughly cleaned away. In a well-arranged foundry, doing a large volume of work, there is a good deal of machinery in this department, consisting chiefly of emery wheels, and tumbling barrels; in small foundries there is often nothing of the kind, but files, chipping chisels, and wire brushes chiefly.

THE CASTING STORES.

This should be a well fitted up building or buildings. Iron and brass castings are, if light, stored separately on shelves, but on the ground if moderately heavy. Massive castings are generally run at once into the portion of the works where they have to be tooled, or fitted, and erected. Or if stored, they are not as a rule covered in, but left on an area in the open yard, being protected first with a coating of boiled oil.

THE SMITHY.

A good many firms manage to get along without a foundry, putting their castings out. Some also, who cast their iron, put out their brass, and *vice versâ*, but few attempt to do without a smithy of some kind. The work of the smithy in a shop where specialities are not handled is all done on the anvil, with the aid of a steam, or other power hammer, by craftsmen. But little assistance is to be obtained from dies or stamps. The work thus comes out costly, though uniformity in dimensions is not secured thereby, and the cost of machining is increased. The work of the smithy is, therefore, broadly divisible into hand forging and die forging, and in proportion to the predominance of either of these will the lay out of the shop be modified. In some cases we see nothing but a row of forges, with a power hammer or two. In others there are rows of hammers, and heating furnaces, with pipes, flues, and auxiliary machines. The iron stores are adjacent to or within the smithy. The bars and rods are laid horizontally on racks, or allowed to stand perpendicularly.

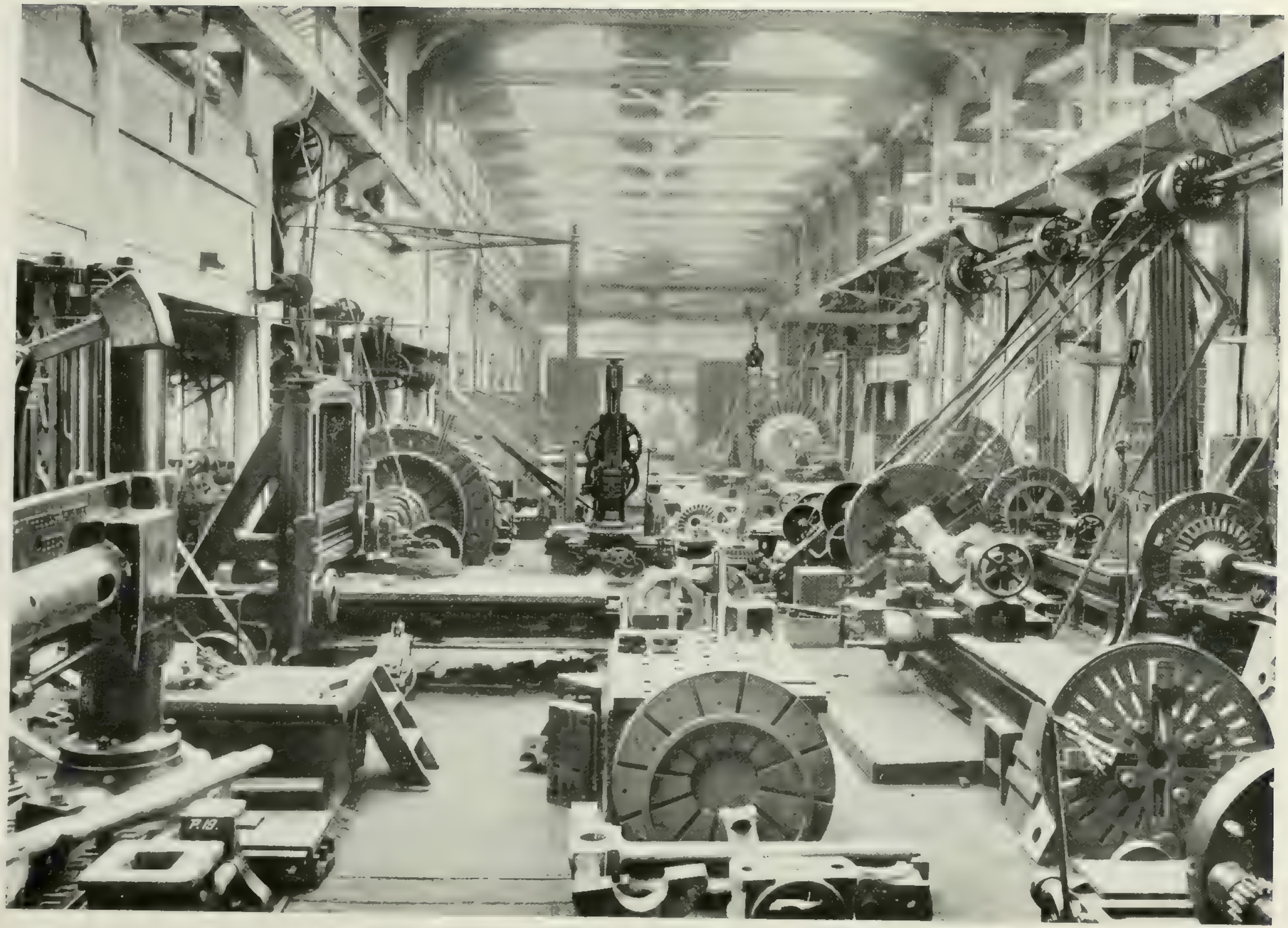
THE TURNERY AND MACHINE SHOP.

These departments take a first rank in most factories. They are, moreover, subject to greater diversities in arrangements, and more minute sub-divisions than either of the other departments; while the question of skilled and unskilled labour becomes a more burning question here than elsewhere, some few foundries excepted.

In the old days the turner was a man who did one of two things only. He worked a screw-cutting lathe, or a non screw-cutting tool, the first-named being considered the superior craftsman. Generally, too, men were kept mostly either on heavy or on light lathes. Automatic and semi-automatic turret lathes were scarcely seen in the shops. Circular work, moreover, all went to the lathes, nowhere else.

In a present-day well-equipped turnery, the old limitations have been invaded. A vast deal of work is now done on machines which require only the attendance of youths, and in which provision exists for ensuring the uniform accuracy of a score, or a hundred, or a thousand similar pieces, without the intervention of a skilled workman, armed with rule and calipers. Much screw cutting is now done without the calculations, the ability to perform which set a man above his fellows, and put a couple of shillings extra on his wages. The vertical lathe takes much from the horizontal face lathes. The milling machine takes a considerable volume of some classes of work from the lathes. And the greatest changes as affecting the laying out of a works are found in the increasing and careful subdivision of the turnery and machine shops, either in distinct shops, or on separate areas of the same floor. They are also found in the alterations in shafting and belting arrangements that result from the introduction of electric driving, and the laying down of power plants. Sometimes too, the system of lifting and hauling adopted involves changes.

As the weight of the machines used in different factories, or in the several departments of a single factory, varies, the question of the one floor, or of the storied system of building is often decided mainly in reference to the predominance of either type. This difference affects not only the mass of the machines themselves, but that of getting the work to and away from the machines, and therefore the hoisting and hauling tackle.



MACHINE SHOP OF MESSRS. J. AND H. McLAREN, LEEDS.

THE TOOL ROOM.

This is a small department, but one of great importance in a modern shop. It is the microcosm of the turnery and machine shop; containing its own lathes and other tools, hardening furnaces, grinders, vices, and the rest. It is the visible embodiment of the centralisation of responsibility which distinguishes the new from the old. The ideas of the individual workman are controlled from the tool room, while all the tool formation and construction is done here, instead of by the workmen, as heretofore.

THE STORES FOR FINISHED WORK.

These are an essential portion of a properly arranged factory. Into them all the separate pieces that go to make up a machine are sent from the lathes and various machines, and stored in sets. Thence they are booked out to the fitters, assemblers, and erectors, to be put together into their several machines. Orderly stores are a great factor in economical production. The heavier parts are generally stored in the shops in piles, adjacent to the erecting areas.

THE FITTING SHOP, AND ERECTING DEPARTMENT.

These two are often combined under one roof, the fitters' benches bordering the sides of the shops, the central areas of which are occupied with work in course of erection. Often the two classes of work are executed by the same set of men. But in massive work it is judicious to separate these tasks. The heaviest structures are often necessarily erected out of doors. Then portions of them may be partially fitted in the shops, and run out thus into the yard. This, for example, is the practice in building massive cranes.

The amount of room required for these departments, and their location, whether on a ground floor, or in stores, depends, as in the case of machines, on their mass and bulk. Light fitting and erecting can be well done in storied buildings, but the heavy kind requires ground floors. The fitters' benches may, when light work is being done, occupy as much space as the erecting areas; but in massive work the open areas exceed vastly the bench room required. A certain amount of mechanism and appliances is required in these departments, as emery wheels, surface plates, large straight-edges, pits over which work is built—such as marine and locomotive engines—and many cranes. The hoisting appliances are often wanted very powerful—travellers ranging from twenty to a hundred tons or more, besides a liberal allowance of wall cranes and pulley blocks. From these various causes the fitting and erecting departments may require a greater amount of space than the machine and turning shop, or much less.

THE BOILER SHOP, AND PLATERS' SHED.

All firms that build engines or steam cranes are almost compelled to include these departments, or endure vexatious delays due to non-delivery, if this work is put out. These are big departments, occupying a lot of room, all of which must be on the ground. The machines and the work handled are massive. To a certain extent the two departments are similar, since both deal with plates and riveting; and the two are, therefore, often combined under one roof, or under adjacent sheds. The same rolls, punching and shearing machines, plate edge planers, drills, riveting machines, templet shed or shop, compressed air or steam, or hydraulic plant will serve for both. These shops are an example of big areas with few men; in strong contrast with the light machine and fitting shops with small areas, crowded with men and lads.

The plate stores are adjacent to the plating or the boiler shops, or within them. Plates are often not stored in large quantities, the practice being to order the quantity wanted for a given job, and to stack them in the shop where the work is to be commenced.

COPPERSMITHS' AND WHITESMITHS' SHOPS.

These are chiefly found in works that deal largely in steam engineering, in brass finishers' work, in brewers' and sugar machinery. They are essential departments in the marine and locomotive works. They are never very large, neither is there so much machinery as there are appliances ;and small tools. Bending, raising, jointing, and brazing are the principal tasks done, and always by skilled craftsmen.

THE CARPENTERS' AND JOINERS' SHOP.

The carpenters' shop is a department, the importance of which varies with the nature of the work done by a firm. It is a very extensive one in locomotive and agricultural shops, and in some high-class stationary engine works, while in some shops it is nothing more than a department for the making of packing cases, and similar jobs. In large works the carpenters have their separate shop, and foreman. In small works they are often under the charge of the pattern foreman, and are located in his shop.

THE YARD.

The "yard" is an engineers' department of considerable importance. It includes a gang of labourers, many of whom are really trained handy men, of a different class from the loafers who gather round the gates for casual jobs. They are under a yard foreman, and have the handling of all heavy materials and goods that come into and are despatched out of a works. Besides this, they often render valuable aid in the erection of big work outside the shops, and are generally entrusted to dismantle, paint, and pack such heavy work as is erected in the yard.

THE TESTING DEPARTMENT.

This, as a separate department, is non-existent in works that deal with very massive machines and engines, because in these testing, when practicable, is done where the work is erected. But in the lighter class of engines, and in work also where electrical tests come in, a separate room or building is fitted up for the purpose. The dimensions of this depend entirely on the volume of work done. Thus, in the case of a firm making, say, gas engines, or dynamos, the room would be much larger than in one building large engines, because the numbers turned out per week would be much greater in the first than in the second. In the first instance, room is required for a number of engines to be tested, while in the second, one will be removed as fast as others are built.

THE ELECTRICAL DEPARTMENT.

Many firms have been adding this to their regular engineering work of late years, because they prefer to be independent of outside help in a section of manufacture, that is of ever growing importance. This may be a department that is entirely self-contained, or it may consist only of the electrical work proper, such as the winding and commutator, and brush making, and assembling. If it is an entirely self-contained department, it will include a full complement of machines and benches, comprising a turnery, machine shop and fitting shop, as well as the winding department.

THE POWER-HOUSE.

Until recent years few firms possessed a power-house, or building, in which the whole of the power for the works is generated, and whence it is distributed to all the shops. Instead of this, isolated engines were scattered about in the several shops, as they are still in the majority of works. The central power-house is the creation of electricity, since the distances across which the current can be transmitted in works counts for nothing. It includes boilers, engines, dynamos, switch boards, and in most instances accumulators, so that a certain amount of current may be available for lighting, etc., after working hours, when the engines may be stopped. A storage for coal is also essential, and some method of handling it by means of conveyors to the boiler is now considered important.

THE PAINT SHOP.

This ranges from the small shed or room in which paint is mixed, to the immense buildings of the locomotive shops, into which all the engines and rolling stock are run to be painted. Where there is no painting shed the work is done where it stands.

THE SHOP STORES.

This is the department in which all the light materials required for use in the works are kept. It is a most miscellaneous collection, and rivals in size and quantity many large retail businesses. None but those who are acquainted with the internal working of engineers' factories can form an idea of the varieties and quantities of stores used. These are kept under lock and key, in charge of a responsible clerk with a man and lad, and everything is charged out to the heads of departments, or to individual men. Generally, sub-stores are kept by the foremen of the shops for the use of their own men.

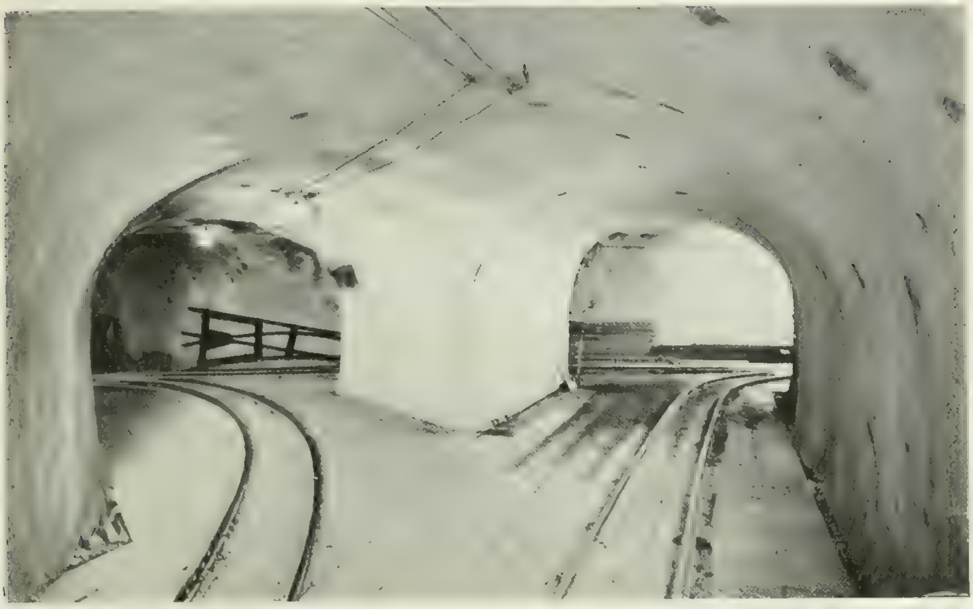


FIG. 12. THREE-WAY INTERSECTION AT CONGRESS AND FRANKLIN STREETS.

UNDERGROUND CONDUITS IN CHICAGO.

BY

GEORGE W. JACKSON.

The action of the State in monopolising the telephones and interfering with the application of electricity has thrown this country a generation behind most of the nations of the Continent and North America. A description, therefore, of a modern conduit system in one of the leading cities of the United States will be of considerable interest to our readers. This paper, originally read before the Society of Western Engineers, is now presented in article form with several unique photographs. It shows the scope, extent, and construction of the underground conduits of the Illinois Telephone and Telegraph Company in Chicago. The scheme provides for a telephone system composed of conduits and cables which will accommodate 100,000 subscribers.—EDITOR.

UP to the present time telephone companies in different cities have made a serious mistake by not building their conduit systems large enough to allow for reasonable expansion from year to year. In canvassing the situation for a new conduit system at Chicago for 100,000 telephones, and figuring on the space required, it was found that the space was not to be obtained immediately below the surface, on account of the present congested condition below the streets. An illustration of a cross section of our 6-ft. by 7-ft. 6-in. lateral tunnel is shown in fig. 1. This size conduit would only allow us to place enough cable for 25,000 telephones, coming in from one direction to a central exchange. The conditions as they now exist at the intersection of LaSalle and Washington Streets is shown in fig. 2. The space below the paving is almost completely taken up by water and gas pipes, sewers and conduits for other companies. It was ultimately found that the conditions of the soil underlying Chicago would admit of a deep tunnel conduit system being built without any danger to adjoining property, or interference with other corporation rights. After Mr. Wheeler had obtained the necessary

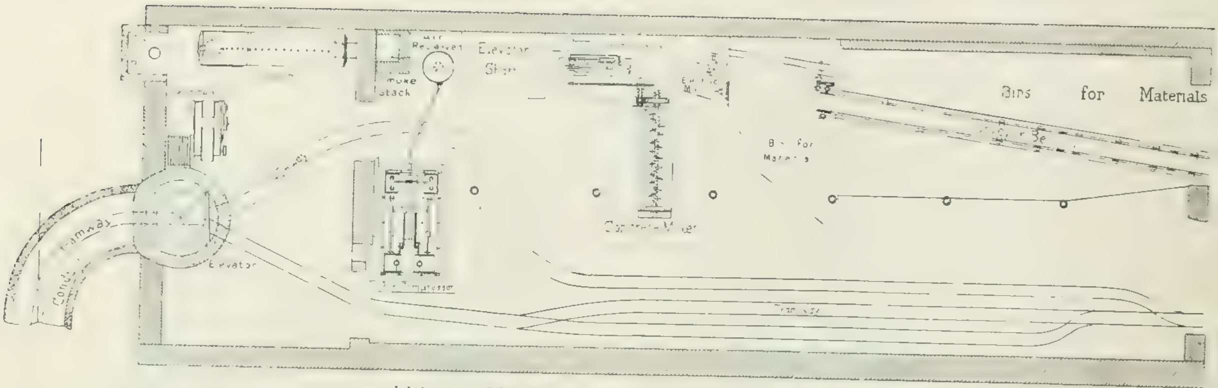


FIG. 3. GENERAL PLAN OF SHAFT NO. 1.

permit from the city authorities, work was started at the first shaft, or what is known as shaft No. 1. This is on the alley between Madison and Monroe Streets, west of LaSalle Street. Fig. 3 shows the location of the shaft, the air compressor, belt conveyor, concrete mixer, the elevator, elevator machinery and shaft.

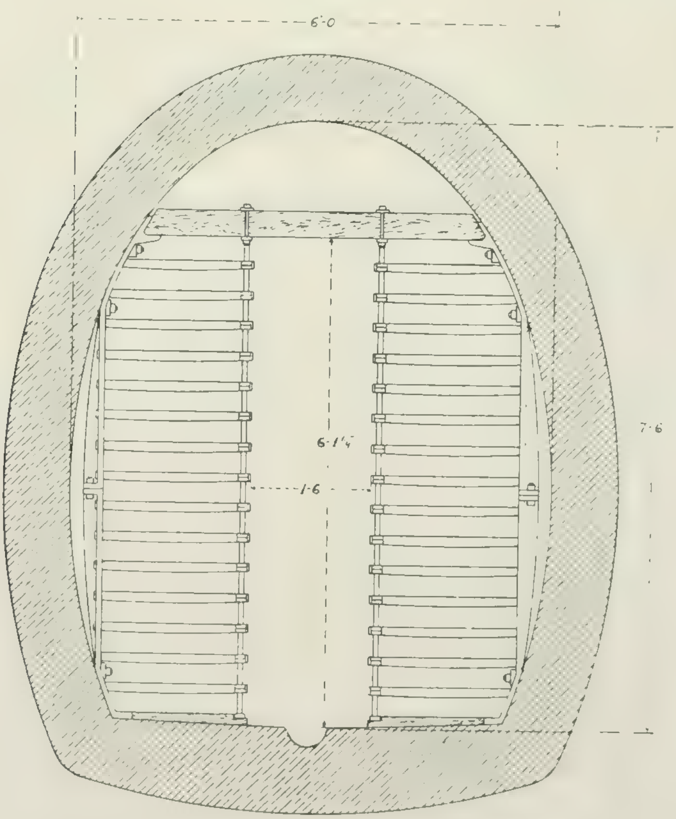


FIG. 1. CROSS SECTION OF LATERAL CONDUITS. Showing Racks for the Cables.

LOCATION OF SHAFTS.

It required considerable time and thought in locating our shafts, as we had to show property-owners that by the location of them we would in no way inconvenience their tenants. After locating shaft No. 1, we leased other basements for other shafts, which are located as follows :—

Shaft No. 2, on Dearborn Street, just north of the Fisher Building.

Shaft No. 3, at 113 and 115 Franklin Street.

Shaft No. 4, at State and Lake Streets.

Shaft No. 5, at Randolph and Clark Streets.

Shaft No. 6, at Harrison and Clark Streets.

Shaft No. 7, at State Street and Eldridge Court.

Shaft No. 8, at Congress and Market Streets. The location of these shafts, also shown on the plan of work as projected, was such as to allow us to proceed with the building of the conduits covering the down town district. The ultimate scope of our work is intended to extend on the south side to 71st Street, on the west side to Kedzie Avenue, and on the north side to Fullerton Avenue, it having been decided that the building of the conduits by tunnel methods would be the speediest and most economical. Extending from the tunnel system on the south, west and north, it is the intention to build side

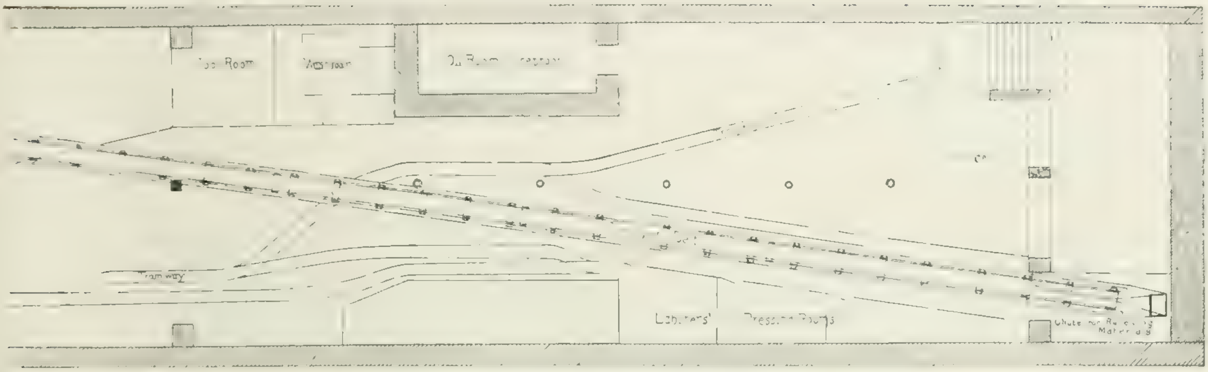


FIG. 3. GENERAL PLAN OF SHAFT NO. I.

branches covering the entire city. These side branches will largely be constructed by the method of tunnelling, as far as it is economical. From this system it is our purpose to construct a sufficient number of miles of tile conduit system in outlying districts, to reach all of the available territory and accommodate all classes of subscribers. In short, the purpose of Mr. Wheeler and the board of directors is to install a telephone in every residence, as well as in every business office and manufactory in Chicago.

NO ACCURATE MAP OF THE STREETS.

After having our plans approved by the proper city authorities, and shortly after starting with the building of the conduits, we found there was not in existence an accurate map of the streets. We decided that no further work could be done until such time as a new survey was made, and our engineering department was, therefore, called upon for a new topographical survey. A work which necessarily required considerable time, as it was impossible for our engineers to run lines until after the congestion of traffic was off the streets at night. We were thus compelled to run our lines after ten o'clock at night and before five o'clock in the morning. But in spite of the expense and delay involved, the results of the survey have amply repaid the company. This will be appreciated by engineers when I say that some thirty-eight different tunnel connections were to be made.

After the work had been checked and approved by the engineer appointed by the Department of Public Works, we were ready to proceed with the work in the down town district, but upon notifying the City Engineer, of this fact, we were informed that he would not allow us to proceed in the way provided for by the first permits that were granted, as he was of opinion that the number of manholes required on the streets would present obstructions to a subway, which in his judgment the city would some day build

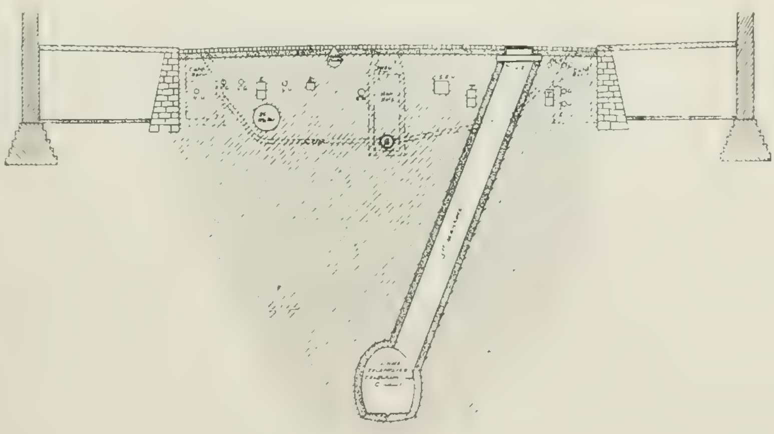


FIG. 2. CROSS SECTION OF STREET.

Showing the space below the pavement—occupied by Sewers, Water and Gas Pipes and Conduits—also showing the Lateral Conduit and Manhole Connection.

Permits, as originally granted the company, allowed us to build manholes as shown in fig. 2. His position was that he could not allow us to construct such manholes, and also that he believed we were too near the surface. This compelled us to adopt a method whereby the building of manholes would be obviated. After designing numerous cross-sections, and carefully figuring out what space would be required to accommodate our business, the size 12 ft. 9 in. by 14 ft. for the trunk lines was submitted for approval.

from the grade. At the present time we have completed about twelve miles of the lateral conduits. The annexed table shows the number of yards of stone, gravel, barrels of cement, and number of yards of excavation hitherto required.

INSTALLATION OF THE PNEUMATIC SYSTEM.

After satisfying ourselves as to the nature of the sub-soil, we settled upon the method for carrying out the work. Experience having taught me that the pneumatic system would be the most economical and safest, we adopted it.

WORK DONE AND RATE OF PROGRESS. SEPTEMBER 1, 1902

Total No. of feet constructed 61,726

WORK PER SHAFT.

Shaft	No. Feet	Working Days	Average Feet per Working Day
No. 1	18,730	294	63.1
No. 2	14,595	247	59.2
No. 3	2,464	118	20.5
No. 4	17,510	229	76.1
No. 7	1,244	63	19.4
No. 8	7,183	176	40.1

Average working days from all shafts 188

Average feet per day from all shafts 328

Total excavation from all shafts ..... 175,000 cubic yards

MATERIAL USED.

Cement ..... 90,000 barrels

Stone ..... 30,000 cubic yards

Gravel ..... 60,000 cubic yards

CONSTRUCTION OF LATERAL CONDUITS.

In going over the situation with the city engineer, he finally decided that a 12 ft. 9 in. by 14 ft. size could be permitted, this enabling us to lower the reels and cables from our warehouse down a shaft to the level of our conduit system, and to transport the car, reel and cable, as shown in fig. 4, through these trunk conduits around to the different lateral systems. By this method of lowering the reel and cable and transporting it through the trunk system, we avoided the building of manholes. It was understood that we would drop the roof of our 12-ft. 9-in. by 14-ft. tunnel so that it would not come any closer than 24 ft. 6 in. to the surface. In our original permits, as granted, we had the right to construct our conduit as close as 22 ft. 6 in.

While it was not altogether necessary for us to use this system, as the nature of the soil is such that it would stand without caving or swelling, we put in the pneumatic system more for the purpose of being protected from labour troubles, than anything else. With this system, if the men should go on a strike, one has no anxiety, as there is no danger, if the work is left for a time in an uncompleted state.

In installing our pneumatic system, airlocks were placed just outside the several shafts. These airlocks have iron doors with frames imbedded in the concrete, the locks being long enough to accommodate the work, in some cases as many as ten cars. I do not know that it is necessary to describe the operation of the airlocks in detail. Two airtight doors are used, one at each end of the lock. The locking-in process is effected by allowing the cars to enter through the outer door, and then the door is closed. The air under pressure is then admitted from the uncompleted tunnel, allowing it to flow into the lock, thus equalising the pressure in the lock with that in the tunnel; the inner door is then opened and the cars are run on to the headings. In locking-out again, the inner door is closed after the cars have entered the airlock, the valves opened at the outer door allowing the air to escape and thus equalising the pressure with the completed part of the tunnel (which is open to atmospheric pressure), after which the outer door is opened and the cars go on to the shaft.

FIG. 4. LATERAL CONDUIT UNDER CONSTRUCTION.

METHOD OF USING THE CONCRETE.

Fig. 4 shows the ground as excavated ahead of the completed conduit, after the mining has been done. The concrete is then placed in the bottom and thoroughly tamped, the lagging placed on top of the concrete, iron ribs made of channel bars being placed on the bottom, and lagging laid at the sides against these. These frames or ribs are made of 3-in. channel bars, and are placed three feet apart. After the ribs have been

FIG. 6. ELEVATOR HOUSE.
Used for lifting the excavated clay so that it may be dumped into waggons to be hauled away to the Lake Front.

FIG. 7 UNLOADING THE EXCAVATED CLAY AT THE LAKE FRONT.
Lifting away the side boards of the waggon bed.

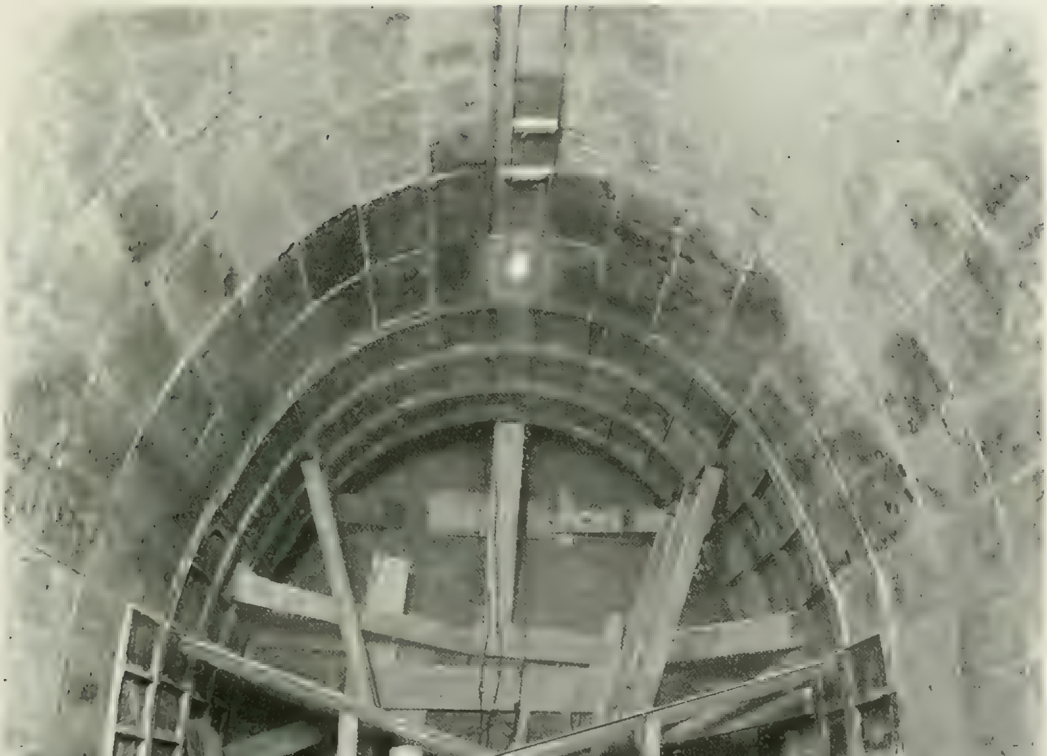


FIG. 5. VIEW OF TRUNK CONDUIT UNDER CONSTRUCTION.

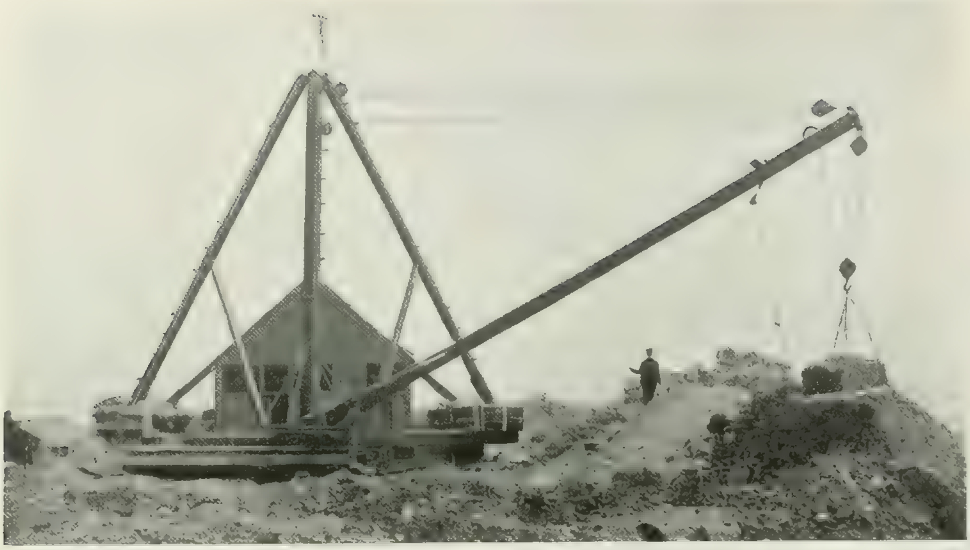


FIG. 8. WAGGON BED BOTTOM.
Swung round to dumping place, ready to spill.

FIG. 9. TRACKS AND MOVABLE PLATFORMS.
For dumping the excavated clay into scows in the river.

FIG. 10. LOADING SCOWS IN THE RIVER WITH EXCAVATED MATERIAL FROM SHAFT 8.

placed in position, the lagging of 2-in. plank is adjusted behind the ribs and the concrete thrown in behind the lagging in layers of six inches. As can be seen by the illustration (fig. 4), the use of concrete absolutely avoids any chance of settlement of the earth as the concrete is tamped into the entire space between the lagging and excavation. It makes no difference how irregular the digging or mining has been done, as every void is filled. This method of placing concrete is carried up until it reaches what is known as the key, as shown in fig. 4. As it is most important to have the key properly placed, it is built in sections of three feet, or, in other words, the key boards are only three feet long. These are also placed on the ribs, which are three feet apart. The concrete is then thrown in, and after three or four shovelfuls are thrown in, the concrete is rammed, care being taken that this is effected so that every void is filled. By this manner of working, any possible chance of the ground settling is avoided. In proceeding with the concrete work the face of the preceding day's work is cleaned, and a plaster coating of cement, made in proportions of one to one, of sand and cement, is plastered on the old work. This forms a seal, allowing the old work to have a bond with the new, and making it almost an entirely homogeneous structure.

In fig. 5 is shown some ribs and lagging which was used in the trunk system. Here the ribs are made of 5-in. channel irons, and the lagging plates are made of No. 12 steel. These steel ribs and lagging were used as an extra precaution on account of the extra weight of the concrete, as well as to allow the men to

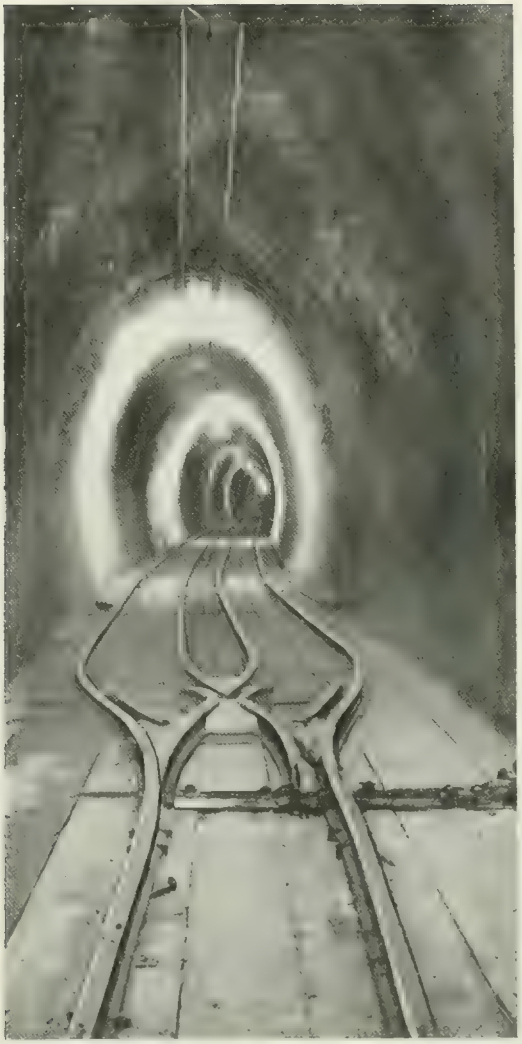


FIG. 13. VIEW OF 6-FT. × 7-FT. 6-IN. LATERAL CONDUIT. Completed and ready for inspection.

thoroughly tamp the concrete without having the work left in irregular shape.

Fig. 5 shows the trunk system with steel ribs and lagging in place. The walls of the 6-ft. by 7-ft. 6-in. lateral conduits are constructed with 13-in. bottoms and 10-in. walls of concrete. The trunk system conduits are constructed with 21-in. bottoms and 18-in. walls of concrete.

METHOD OF WORKING

The work was carried on by three shifts of men working eight hours each. The first shift of miners went on at four o'clock in the afternoon and worked until midnight; the second shift went on at midnight and worked until eight o'clock in the morning; the third shift, which was known as the concreting shift, went on at eight o'clock in the morning and worked until such time as they were "through." The work of the third shift was arranged in such a way that they would get through their work so that the miners could take up their duties at the regular time, 4 p.m.

The distance excavated by the two shifts of miners averaged about 21 ft. at each heading. Including all the different shafts, the number of working headings averaged about fourteen, and it required about twenty men to operate each heading. About 850 men were engaged on the tunnel construction, and about 600 other men were employed in the office forces, the hauling of gravel, stone, cement, and excavated material.

The cement used for the making of the concrete was American Portland (Atlas and Chicago AA). All tests of cement were made by the company, and each and every barrel was tested and subjected to a 14-days' test before being accepted and under very rigid specifications. Most of the concrete was made with the mixture of five parts of broken stone and screenings to one part of cement; but a large portion of the concrete was composed of mixed gravel and sand, which was used in the same proportions as broken stone, five parts of gravel to one of cement. This mixture of concrete was used on the straight work of the conduit. At the intersections, a mixture of four parts stone or gravel to one of cement was adopted.

In order to have everything run smoothly, it was essential to make provision for the prompt disposal of the material excavated. Some 900 tram-cars were built running on a gauge 14 in. wide, and a double track system was laid through the entire tunnel system. Experience has taught me that the most economical way of handling large quantities of material is to deal with it in small portions. For handling concrete and excavated material small cars were therefore used, 20 in. wide inside and 48 in. long. I believe the smallness of the cars was largely instrumental in successfully carrying out the building of the twelve miles of tunnel in the short space of time occupied.

METHOD OF DEALING WITH EXCAVATED MATERIAL.

The cars were hoisted by a power-driven elevator up the shafts to the second floor of the building, or to a head-house built on the curb line, and the material dumped into waggons standing on the street or alley. The dumping of excavated clay into a waggon is shown in fig. 6. Much of the material was deposited at the Lake Front, and for unloading the waggons a 10-ton stiff-leg derrick was installed. This first hoisted away the sides of the waggon boxes (fig. 7), and then hoisted the entire bottom of the waggon with its load. When this was swung round ready to dump, the chains on one side were unhitched and the clay dumped, as shown in fig. 8.

The reason I have touched upon this part of the construction is from the fact that it was imperative that this branch of the service should be kept in continuous operation while the miners were at work, as any delay in operations would have proved expensive. The hauling away of the excavated material was done mostly at night, between 5 p.m. and 7 a.m., to avoid interference with the usual street traffic. Another method that we adopted for handling the excavated material was, at what is known as shaft No. 8, which is located on the river at the foot of Market Street. At this shaft we constructed an incline from the conduit, and used an endless conveying chain with dogs, constructed in such a manner that they took hold of the axles of the cars and conveyed the cars up the incline to the surface of the ground. They were then run on the tracks to the edge of the river, and out on platforms extending over dump scows moored to the dock below.

Fig. 9 shows our method of movable platforms, which were erected so that they could be raised or lowered and not interfere with boats going up and down the river when not in use. The next illustration (fig. 10) shows the platforms being lowered down to the scow and the men about to dump the cars. This method of handling excavated material, was found to be very economical and did away with possible delay, besides increasing the capacity of the tunnel.

The illustration (fig. 11) shows the four-way intersection as built and located at Washington Street and Fifth Avenue looking east, and (fig.12) shows the three-way intersection at Congress and Franklin Streets. This intersection was built larger for the purpose of having more room in handling material at shaft No. 8. Its size is 7 ft. by 8 ft.

The illustration (fig. 13) shows a straight piece of 6-ft. by 7-ft. 6-in. lateral conduit, ready for inspection.

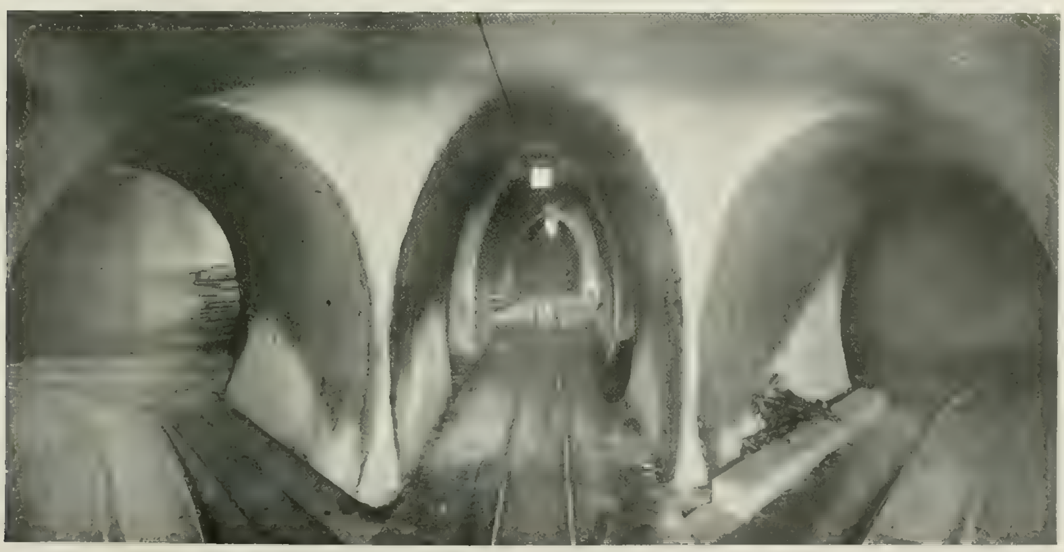


FIG. 11. FOUR-WAY INTERSECTION COMPLETED

OUR BIOGRAPHY OF THE MONTH.

PROF. JAMES ALFRED EWING, M.A., LL.D., F.R.S., M.Inst.C.E.,

Professor of Applied Mechanics and Mechanism in the University of Cambridge.

Photo by Lafayette, Ltd.]

PROFESSOR EWING, M.A., LL.D., F.R.S.

PROFESSOR EWING was born at Dundee on March 27th, 1855, being the third son of the Rev. James Ewing. He studied engineering first at the University of Edinburgh, under the late Professor Fleeming Jenkin, who, with Sir William Thomson (Lord Kelvin), was then in practice as an electrical engineer. Becoming a member of their permanent staff, he obtained practical experience of cable engineering extending over some years, and was also associated with the development of several of their inventions. Appointed, in 1875, Professor of Mechanical Engineering in Tokyo, Japan, it was for five years his interesting duty to take part in the intellectual awakening of the Japanese, whom he found most apt pupils. The Japanese professorship was relinquished in 1883, when Mr. Ewing returned to Dundee to take up the Engineering Professorship in the University College of his native town. In 1890 he was appointed to the Cambridge Professorship, which he still holds. Shortly after his appointment he induced the University to establish a Tripos in engineering, as well as to make provision for a laboratory, and has been highly successful at Cambridge in developing a large and active school of practical engineering. The laboratory, begun in a very small way, has now grown to a great size by the gifts of the Hopkinson family and other donors, and is still being extended.

Professor Ewing's experience as a teacher, ranging over twenty-five years, has rendered him an enthusiastic exponent of the laboratory method of teaching. He is himself an ardent experimentalist and author of many papers describing the results of his researches. His discoveries in magnetism were recognised by the award of a Royal medal in 1895. While in Japan he gave much attention to seismology, devising machines by which the earliest complete records of earthquake motion were obtained.

More recently he has taken up the microscope as an instrument of engineering research. He is well known as the author of several scientific works, and many of his instruments, especially his extensometer, hysteresis tester, and permeability bridge are familiar appliances in most laboratories.

Professor Ewing's services as a consultant are in frequent request. He served in 1901 with Lord Rayleigh and Sir John Wolfe Barry on the committee which settled the vexed question of vibration in the "Twopenny Tube."

He has been the recipient of many honours, including the degree of LL.D. from the Universities of Edinburgh and St. Andrews, and the Order of the Sacred Treasure from the Emperor of Japan.

NOTES AND NEWS.

Electrical Ore-Finding System.

OUR illustrations show the working of the Electrical Ore-Finding System, invented by Messrs. Leo Daft and Alfred Williams. The apparatus is stated to have successfully located lead and zinc ore in Wales, and hematite in Cumberland. As described by the inventors, the system consists of transmitting inductors, which deliver electric waves of a definite length extremely sensitive to the presence of minerals, and receiving resonators tuned to detect these waves and determine their characteristics.

The waves from the inductors are impressed upon the crust of the earth, in any desired locality, and are radiated to considerable distances, horizontally and perpendicularly. The area of the ground thus energised is increased or diminished at the will of the operator, irrespective of the prime energy used. Areas as small as 100 metres square, and as large as 30 square miles, or greater, are excited by one inductor.

DAFT-WILLIAMS ELECTRICAL ORE-FINDING APPARATUS.

METHOD OF USING THE APPARATUS.

The operator traverses that portion of the energised field to be explored for mineral, and constantly receives manifestations of the waves beneath. On approaching a mineral vein or lode the normal characteristics of the waves undergo a marked variation in intensity or direction (or both); the changes are heard in the resonators and readily interpreted. When the resonators are over the lode, the variation and intensity are greatest. Here some very specific changes abruptly take place, and by noting density of wave flux, rotation of path and discord or overtone of the waves, considerable information as to the depth, width and condition of the deposit is obtainable.

Veins or lodes which act as insulators, as compared with their enclosing rocks, are discovered with the same facility, the surface variations of the wave differing to a considerable extent.

Duplicate working is used where necessary. Two fields of force are focussed so that their waves will coincide, at a predetermined angle, on the area to be investigated for mineral. The phases of the diplex inductors are tuned to produce periodic harmonics.

Professor Hele-Shaw.

The excellent portrait of Professor Hele-Shaw, LL.D., F.R.S., which appeared in our March issue, was reproduced from a photograph taken by Messrs. Elliott and Fry.

London Transit through American Spectacles.

Mr. C. T. Yerkes, as the principal speaker at a dinner given by the Mayor of Kensington (Major Lewis Isaacs), said he had noticed in his many visits—and he had come to London for a great many years—the very bad condition of our intramural transportation. He had noticed that the people were herded together and had no opportunity of getting away from the centre; and he ventured to say that there were hundreds of thousands, if not millions, of people who did not get one mile away from their home from year's end to year's end. Their homes were located in very bad districts, the sanitary arrangements were extremely poor; and, in fact, in London to-day the conditions were worse than they were in any civilised city that he knew of; and there was no one who ought to appreciate that more than an Englishman. His plan, inaugurated years ago in the United States, was to build up the prairies outside Chicago. At the time he spoke of their railroads extended only five miles, and conveyed passengers just to the outskirts. They went on extending their lines until a man could ride 20 miles. He did it all for one fare. The labouring people going out on the prairie all inhabited little homes which were built by private enterprise, and they paid the owner and the occupier. The labouring man brought up his children in a proper manner.

Proceeding to advocate a similar extension of cheap transport for London, Mr. Yerkes said his idea was to make the fare 2d. for almost any distance. As far as tube lines were concerned, we must there have 2d. fares for almost the whole of the lines. Where one crossed the roads and had a change of stations there must be a free transfer at those points.

As far as he was concerned, it was not a matter of making money with him, though a great many persons thought it was. He could make more money by remaining in America; but he had got to the point where he did not care so much for that. He did want to accomplish something in London, however, if he was permitted to do so, in the direction of improvement of transportation.

In the *Daily Telegraph* Mr. Yerkes has replied to some criticisms on the above speech. The critic is evidently in favour of what he calls "working-class colonies," and Mr. Yerkes answers this by denying the practicability of placing the working people in colonies. There is no more reason why the working classes should be so placed than other classes. Placing together a particular class of people to the exclusion of others does not tend to improve the condition of society which is so necessary to making good citizens. In Mr. Yerkes's opinion, the mixing of the working people—the mechanics, labourers, clerks, and others who are compelled to work for their living—together would have much greater advantages than having them housed separately and distinctly. He further denies that he was in error when he said that the intramural transportation of London was poor, or that the outlying districts should receive more attention. Granted that the Great Eastern Railway has assisted in building up the suburbs, it seems to him there is plenty of room for improvement in other directions. Dealing with other criticisms, Mr. Yerkes states that a train of thirty cars, if necessary, may be hauled by electricity, but admits that the question whether the multiple-unit system of working will lead to really improved acceleration has yet to be proved.

The Defences of Port Arthur.

In a recent issue of the *Navy and Army Illustrated*, Mr. Alan H. Burgoyne, F.R.G.S., gives a striking account of Port Arthur, which is described as "well nigh impregnable as Gibraltar, both landwards and from the sea. The site of the old Chinese city is rapidly becoming a mass of barracks, and the extensive military works at present being carried out on all the surrounding heights testify to Russia's firm intention to retain Port Arthur for all time.

"The defences of the adjacent coast are remarkable, and extend in the northern direction for a distance of forty versts, whilst to the south the sea-line is fortified along twelve versts. These fortifications take the form of earth batteries, and mount either three or four heavy guns each; the approach to them on the land side is made impossible by the erection about the bases of the hills on which they are situated, of stout fences, or, in many cases, castellated walls, with sentries placed in profusion around them to prevent any inquisitive stranger from approaching too near. These two long lines are joined by a circle of forts surrounding the town and surmounting the tops of the hills which are scattered over the country. The huge, scarcely finished, fort commanding the entrance has just received four new 63-ton breech-loading cannon on fortress mountings, whilst on the side towards the sea, and halfway between the crest of the hill and the water level, are two batteries of small quick-firers, with a torpedo and search-light station, the combination making the success of an attack by torpedo vessels highly problematical.

"As one enters the harbour a large semi-natural breakwater is seen on the left, enclosing a fine bay of about two miles in length by one mile in breadth. On this is placed a battery of seven 5·5-in. Canet quick-firers, at an elevation of not more than 10 feet from the mean sea-level, thus efficiently protecting the inner harbour and basin from any torpedo craft that might by chance have escaped the fire of the outer batteries."

Electric Transmission Plant at Pochin Colliery.

(Continued from last month.)

The electric motors for driving the haulage gears (both main and tail, and endless rope) are all of 55 e.h.p., of the three-phase type, at 500 volts, but the motors are capable of working up to 100 h.p., at a speed of 590 revolutions per minute. Each motor is complete with slip rings which are totally enclosed for protection against gas, and with oil-filled controllers. The motors are placed behind the haulage gears, and driven by means of cotton ropes 1 in. diameter.

The electric lighting installation includes a horizontal single cylinder engine which is fitted with automatic trip expansion gear, and is of the following dimensions and power: Diameter of cylinder, $9\frac{1}{2}$ in.; length of stroke, 20 in.; diameter of flywheel, 6 ft.; face of flywheel, 10 in.; revolutions per minute, approximate, 120 in.; steam pressure per square inch, 120 lb.; brake horse-power, 40 lb. This engine drives by belt on to the lighting generator, which is of Scott and Mountain's continuous current two pole type.

The colliery is lighted above ground and underground by about 150 16-c.p. incandescent lamps.

The whole of the new plant described and illustrated in this and the previous number has been constructed for the Tredegar Iron and Coal Company, Ltd., by Messrs. Ernest Scott and Mountain, Ltd.

New Winding Plant at Sandwell Park Colliery.

After a thorough investigation of current English and Continental practice, Messrs. Fraser and Chalmers, Ltd., have been asked to supply Corliss Winding Engines for the Sandwell Park Colliery, and Earl of Dudley, Baggeridge Sinking, in the South Staffordshire district. These winding engines are of 3,000 h.p. each, will be duplicates of each other, and will be among the largest colliery winding engines in the country. The duty of each will be 3,000 tons per day of eight hours, from a depth of 600 yards. The coal per trip which will be wound will be $7\frac{1}{3}$ tons, and the engines will eventually run condensing with 150 lb. initial steam pressure. The engines will be of most economical type, and will be fitted with Fraser and Chalmers' standard Corliss cut-off gear, and Whitmore safety brake. It is expected that the first of these winders will be running in about a year's time.

Bogie Mineral Waggons for the North-Eastern Railway Company.

Recently, there left the Leeds Forge Company's sidings at Armley, the longest train of high capacity bogie mineral waggons that has ever travelled in the United Kingdom. It consisted of twenty-five waggons, each with a capacity for carrying 40 tons of coal, and weighing only 16 tons; thus the train, which was constructed for the North-Eastern Railway Company, when fully loaded, would carry 1,000 tons of coal; the tare weight, or non-paying load, being only 400 tons, and the total length of the train only 975 ft. exclusive of engine and brake van. "This," writes a correspondent, "is a great advance on the older type of railway waggons now generally in use. To carry the same quantity of coal in the latter at least 100 waggons would be required, and the tare weight, or non-paying load of these, would be at least 625 tons, or 56 per cent., heavier than the bogie waggons, while the length of this number of four-wheeled waggons would be 1,900 ft., or about double that of the train of bogie waggons, consequently two trains would be required; whereas the bogie waggons of the same carrying capacity were taken in one train. The tare weight, or non-paying load, in the case of the bogie waggons, is only 40 per cent. of the paying load, and there are only one-fourth the number of waggons to deal with; whereas in the case of the four-wheeled waggons the non-paying load is 62 per cent. of the paying load. There is another great saving in connection with the high capacity waggons, which are of the self-emptying type. They are so arranged that by pulling two hand levers through an angle of 120 degrees the whole of the contents of the waggon are discharged between the rails upon which the waggon rests, and shoot down into the hold of the vessel, at the rate of one ton per second; further, the doors can be operated from either side of the waggon, so that to discharge 1,000 tons of coal, only fifty levers have to be pulled over, whereas in the four-wheeled waggons of the same capacity, 400 doors have to be let down and lifted up again, and fastened by hand.

"The waggons are constructed throughout of pressed steel, each being strong enough to carry a load of 100 tons without injury. Indeed, one of the waggons has been loaded with 40 tons of coal, and upon this was placed 60 tons of pig-iron, which load remained on the waggon for thirteen days. It was afterwards shunted before being discharged, but no injury whatever was done to the waggon, thus showing the great strength of this form of construction. It appears that the North-Eastern Railway Company recognise the advantage to be gained by the adoption of high capacity bogie waggons. I believe these waggons are the finest yet constructed, and that nothing in the United States or any other country can approach them for finish, strength, and low tare weight."

Polyphase Electric Driving.

Messrs. T. Harding, Churton and Co., of Atlas Works, Leeds, have recently discarded the gas engines by which their works were formerly run, and put down two-phase motors instead to do the work, the current being obtained from the Leeds Corporation Supply mains. The motors are of Messrs. Churton and Co.'s make, and are of various powers, constructed for a two-phase, 200 volt, 50 service. The installation has proved very successful, and it is expected that the marked economy which has already been effected will be still further increased as the power is further subdivided.

A LONG TRAIN OF HIGH CAPACITY BOGIE MINERAL WAGGONS.

Blast Furnace Improvements for Dusty Ores.

Mr Linn Bentley, of the Columbus Iron and Steel Company, Columbus, Ohio, has designed a blast furnace improvement designed to aid in the handling of flue dust. The inventor refers to its object and its construction in these terms :—

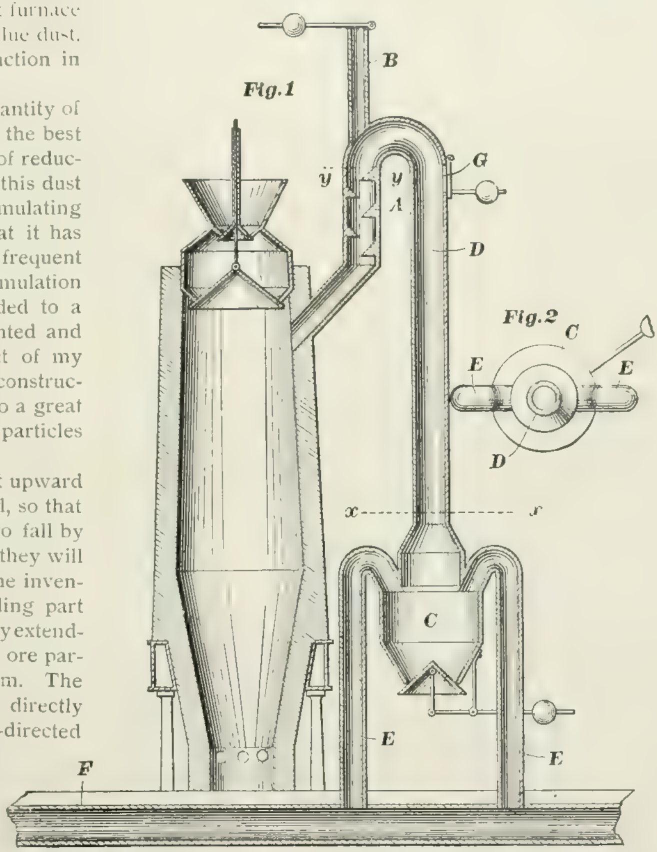
"In most iron ores there is a considerable quantity of fine dust or particles of ore deemed to contain the best and purest metal, and heretofore in the process of reducing ore in a blast furnace a large proportion of this dust has been blown out through the downtake, accumulating in and choking the flues to such an extent that it has been necessary to shut down the furnace at frequent intervals to remove the accumulation. This accumulation is often lost or wasted, because when it is added to a charge the ordinary quantity of dust is augmented and the trouble in the flues aggravated. The object of my invention, therefore, is to provide an improved construction of gas-flue or downtake that will prevent to a great extent, if not entirely, the escape of the ore particles through the downtake.

"In my improvements the downtake leads first upward from the top of the furnace and then downward, so that there shall be a tendency of the ore particles to fall by their own weight back into the furnace, where they will be reduced along with the rest of the charge. The invention also consists in providing the upwardly leading part of the down take-flue with substantially horizontally extending obstructions or baffles, against which the ore particles strike and are deprived of their momentum. The invention also consists in providing a 'bleeder' directly above and in line with the axis of the upwardly-directed part of the downtake, so that the ore particles rising in it will fall back into the furnace through the said upwardly leading portion.

"The invention further consists in a peculiar construction of dust-catcher whereby most of the metallic and other dust that does get around the bend in the top of the flue may be detained and removed."

The illustration shows a central vertical section of a blast furnace with the attachment referred to. Fig. 2 is a section of the dust trap. D is the flue, or downtake, for carrying off the gases. In the upward extension of the flue are baffles, as at A, preferably having their upper sides inclined, so that the particles dropping or lodging thereon shall tend to roll off and fall back into the furnace. B is a valved vent or bleeder, to let out gas should the pressure become too high for safety. This bleeder is located above the upwardly leading part of the downtake, so that particles of dust entering or lodging therein shall fall back into the flue and furnace.

The dust trap comprises a chamber, C, into which the upper end of the downtake discharges, the discharging end of the downtake being shown to be somewhat enlarged, but of smaller diameter than that of the chamber, so that the branch flues, E E, forming a continuation of the downtake, can lead upward out of the upper end of the chamber C. Thus the discharging end of the flue is practically in the same horizontal plane as the induction end of the flues E E, and particles dropping into the trap can hardly be carried upward through the flues. The lower end of the dust-trap is provided with



a bell-valve, which may be operated at any time to discharge the accumulation in the trap. The flues E E communicate or discharge into the ground or other flues F, and the gases from the furnace may be conveyed to any place where it may be desired to utilize them—for example, as fuel for stoves or boilers. The flue can also be provided with a safety-valve to give vent in case of explosion in that part of the downtake. With this construction the valuable metallic dust heretofore wasted is saved and much annoyance and loss of time due to choking of flues avoided.—The Iron Trades Review.

Lord Selborne on his Scheme.

The advantages of the new naval scheme were forcibly stated by Lord Selborne in the course of an address on Imperial Defence, to the South St. Pancras Unionist Association. He remarked that the two great pillars of imperial stability on which this country rested were the maintenance of its credit and the strength of its Navy. Proceeding, he said :—

"You have also to take into account the quality of the ships, the manner in which they are found and equipped, and the quality of the officers and the men who man them. It is in connection with the quality of those officers that I would very briefly allude to that scheme of entry and training of the officers of the Navy to which Captain Jessel has referred. You may remember that the object of that scheme, which comes into force this year, is that henceforth all the officers of the Navy who are essential for the fighting of a ship in action, be they what are known as the executive officers or engineer officers or Royal Marine officers, enter as boys into the Service in the same way, and enjoy the same training ashore and afloat up to the age of twenty, and then branch off into their different spheres and become specialized in their own particular lines. What is the main point in connection with this scheme, great change as it is, that I want to impress upon my country? It is this, that the whole character of the modern battleship and the modern fleet has changed; that you are dealing with one of the most complicated collections of machinery in every form which the world contains. A battleship is propelled by machinery, everything on board her is moved by machinery, she is steered by machinery, her guns are adjusted by machinery. Is it right that the largest proportion of the fighting officers of the Navy should be trained so as to remain in comparative ignorance of the mystery of machinery? If anybody put to you the question whether it was right that the naval officer of the future should know comparatively little of navigation you would laugh and say 'What else is he there for?' If it were put to you that the naval officers of the future should remain in comparative ignorance of gunnery you would again laugh, as the whole purpose of the ship is that at a given moment the guns should be fought in such a way that the enemy's ships should be defeated. Is it not equally impossible to defend the position that the naval officer of the future should not have the general knowledge of machinery and of the craft of the engineer as he has now of the craft of the navigator or of the gunner? (Cheers.) Just as now every naval officer can take the place of the specialist gunnery officer or the specialist torpedo officer, in themselves really only engineers of a very particular kind, just as on occasion he can take their place or that of a navigating specialist, will every naval officer be so trained that on occasion he can take the place of the specialist engineer officer. You will see what an added strength to the Navy it will be when all these officers are competent to take up and carry on each other's duties—what an influence that will have on the expansion of the fleet, on mobilization, and how much greater power of offence it will put into the hands of the Admiralty of the day. You need not fear that the specialist engineer officers will be inadequately trained. Every one of them, in common with his shipmates of the other branches, having had a thoroughly sound engineering education so far as it affects the Navy, will then pass on to his specialist education, and there will be no young engineers in the whole of the country better equipped for the work they have to do than the naval engineers of the future. One word more, and I have done. Questions have been asked as to what the future of these different branches of naval officers and marine officers will be. Whether they will every one of them, having had a common training up to the age of twenty, for ever then pass on in separate lines. As I have already said in public, the present Board of Admiralty have carefully left it open for a future Board, actuated by experience, to make a decision in this matter of *personnel*. I have no more doubt than that I am standing here, that the scheme will work out so that all these branches of the naval service will, throughout the career of the officer, be interchangeable; that not only will the same promotions be open to the officers of all those branches, but every appointment for which an officer by his capacity and merit may prove himself to be fitted will be open to him, no matter to which branch he belongs; and that therefore, eventually, not only in the early entering and training, but from the moment of his early training as a child to the moment of his retiring after years of service to his country, the essential and complete unity of the naval service will be preserved." (Loud cheers.)

Proposed New Docks for Gibraltar.

A Blue Book has been issued containing the report on the proposed eastern harbour and dock at Gibraltar by Captain T. H. Tizard and Mr. William Shield. The Commissioners state that, having carefully considered all the conditions affecting the construction of an eastern harbour and dock at Gibraltar, they are of opinion that such a work is quite feasible, and that a scheme which they indicate by means of a drawing accompanying the report would be suitable.

The work consists generally of :—

(1) A main or outer breakwater, 11,000 ft. in length, with a span 300 ft. long projecting from it on its landward side at a point 1,000 ft. from its eastern termination.

(2) A southern breakwater, 1,800 ft. in length.

(3) A graving dock, 700 ft. long, with an entrance 95 ft. wide, and a depth over the sill of 38 ft. at low water.

(4) Quays and quay walls to the southward of the proposed dock.

(5) A tunnel through the span of rock which juts out between the Monkey Cave and Monkeys' Alameda.

(6) The enlargement of the existing tunnel.

(7) Additional workshops, sheds, dwellings, water supply, and other accessories.

The cost of the works recommended, and the time required for their construction, can only be approximately estimated at the present stage; but it is estimated that, after making due allowance for contingencies, the works could be constructed for £6,500,000, and could be completed within ten years from the letting of the contract.

"WIRELESS" TELEGRAPHY.

BY

ED. C. DE SEGUNDO, A.M.INST.C.E.

The author discusses the present position of cable and "wireless" telegraphy from a commercial point of view, and desires us to state that the following remarks apply solely to the probability of existing long distance submarine cables being superseded by any wireless system of signalling, and must not be taken to detract in any way from the splendid work which Sir Oliver Lodge, Mr. Marconi, and others, have done, and are doing, in connection with wireless telegraphy, for which there is undoubtedly a large field in directions specially suited to the conditions involved.—EDITOR.

ABOUT a year ago the detection on one side of the Atlantic of an electric oscillation set up on the other struck terror to the hearts of shareholders in cable companies, who deemed that in consequence the days of submarine telegraph companies were numbered. They consequently rushed incontinently to sell their shares, not realising that in so doing they were playing into the hands of certain financial groups, whose avowed business is to aggravate the effect of any circumstance calculated to affect the value of the shares of any company adversely, by selling shares in that company (which they often do not even possess) in order to unduly depress the market price, and thus frighten genuine holders into realising, so that the shares can be bought back at a lower figure than that at which the financial groups in question sold.

A WAVE OF DEPRESSION.

The following table will give some idea of the depreciation in the value of telegraph companies' shares at the beginning of the year 1902, caused by the fear of wireless competition :—

Stock.	Highest, 1899.	Highest, 1900.	Highest, 1901.	January, 1902.
Anglo-American Telegraph Ordinary	69	67½	59½	48½
Anglo-American Preference Ordinary ...	120¾	117¾	102	90½
Anglo-American Deferred Ordinary ...	18¾	17¼	11¾	8
Direct U.S. Cable	12¼	12½	11½	10
Eastern Telegraph ...	188	159	151	130
Eastern Extension Telegraph	18¾	16½	14¼	13

Although at the time of writing, the prices of the shares have recovered considerably, the present figures are much below those at which these shares stood for many years prior to the fateful projection of the letter "S" in the Morse code across the Atlantic.

That considerable uneasiness is still felt by shareholders in cable companies is evidenced by the questions asked at meetings of the telegraph companies, and it must therefore be of importance to not a few, and of interest to a large number of people, to determine whether the submarine cable is destined to become a relic of the past, and, if not, whether it will, or may, be superseded in any degree by the wireless method, and, if so, to what extent.

To prophesy would be easy; to quote the views of the Chairmen or of the Engineers of either cable telegraph companies or wireless method companies would be unconvincing. I propose, in the following lines, to refer to facts and to quote only such expressions of opinion as are uninspired and impartial, so as to enable readers to form their own conclusions as to the probable influence of wireless telegraphy upon future submarine cable work.

It is fair to assume that a number of my readers will be non-technical men, and therefore it has been suggested to me that a reference to the principles underlying "wireless" systems of telegraphy will not be out of place.

First of all, let me anticipate the objection of the hypercritical reader that the term "wireless telegraphy" is scientifically inaccurate. I agree that such is the case, but the words "wireless telegraphy" convey my intended meaning sufficiently well, and, indeed, such a term is now universally recognised as applying to all systems of electric signalling in which no *intervening* wires are employed.

THE ESSENTIALS OF "WIRELESS" TELEGRAPHY.

My next step will be to try to indicate the means by which the effect of an electric oscillation travels over from one side of the Atlantic to the other. Whatever system be employed, some vehicle must exist by means of which the transmission of the electric impulse is effected. In ordinary systems the vehicle is a visible copper wire. In wireless methods the vehicles although invisible, is none the less a physical entity. To grasp this, one must first realise that there is no such thing as an absolute void. We are accustomed to demonstrate the elementary principle of subtraction to Smith minor by saying to him, "If you have two apples, and Jones major takes them away from you, what is left?" and Smith minor naturally replies, "nothing." He is quite right in a sense. Nothing of the nature of an apple remains, but *something* that existed in that particular portion of space occupied by the two apples continues to exist irrespective of the fact that the two apples have been annexed by Jones.

There is no such thing as *nothing*. Even in a perfect vacuum there would still be *something*, which scientific men have the strongest possible reasons for believing exists throughout space, is indestructible and unproducible. This something is called, for want of a better name, the luminiferous ether, or, shortly, ether, and is considered to pervade the whole of space, that is to say, to exist even in the space separating one ultimate particle of matter from the contiguous particles which form terrestrial solids, liquids, and gases.

The following experiment, which can be carried out by any one of my readers, shows that light and sound are propagated through different media. Take a loud ticking clock to the laboratory of any professor of physics with whom you may be acquainted. Place it under the glass receiver of his air-pump and then pump away from around the clock all the air you can. As the exhaustion of the air proceeds the ticking will become fainter and fainter, till at last you will hear nothing, but the clock will, of course, continue to go. Now, you cannot *hear* the ticking, but you can *see* the clock, which shows that although the vehicle for the sound waves has been removed, the vehicle for the light waves remains. This vehicle which exists in vacuo has therefore been termed the luminiferous, or light-carrying ether. It may incidentally be mentioned that it is a merciful dispensation of Providence that the luminiferous ether does not convey sound, for were this the case we might constantly be subject to serious disturbance by the noise of the stupendous convulsions of Nature taking place in the solar system, even as magnetic disturbances caused by volcanic and other eruptions in the sun are appreciated by the more delicate electric measuring instruments in use on the earth.

To give some idea of the wide range of vibratory motion, it may be mentioned that the lowest sound that the average human ear can appreciate is produced by sixteen vibrations per second, and the highest by forty thousand vibrations per second. Sounds whose rates of vibration are higher than this, are inappreciable to the human ear. This shows that a sound may be too shrill to be heard, which I think will be a novel idea to some of us. Yet, if we reflect a moment, we will remember that on occasions, certain of our friends have been able to hear the cry of a bat, while others have said they never heard a bat cry. This is a well-known fact, the reason of which is simple ; the "wave-velocity" so to speak of the bat's cry is in the neighbourhood of the extreme upper limit of sensibility of the human ear.

Between the wave velocities constituting sound and those which are appreciable by the eye as colour there is a huge gap. The ultra red rays have something like 100,000,000,000,000 vibrations per second—and in between these are to be found the Hertz waves with a frequency of approximately 230,000,000 vibrations per second, which are utilised for the purpose of projecting electric oscillations to a distance. It must be remembered that certain electro-magnetic waves of induction are propagated through the ether, and are not influenced in the slightest by solids, liquids, or gases.*

The principles involved in "wireless" telegraphy have been known for a number of years. In 1882 Sir William Preece conducted some completely successful experiments in the transmission of signals without intervening wires over a distance of eighteen miles. We must also not forget the experiments of Morse in America, who some forty years ago indicated the means whereby "wireless" telegraphy might be accomplished. Lindsey—whose labours in this field were also of no little importance—indicated another direction in which signals could be exchanged without intervening wires. His system, however, utilises the difference in conductivity of two media, namely, earth and water, and must, therefore, not be confounded with the methods we are now discussing, whereby electric oscillations are projected through the ether by the utilisation of inductive effect. It is, however, of interest to refer to Lindsey's work, as his ideas have taken concrete shape in a system devised by Mr. Willoughby Smith, which is still in operation. The fundamental principles upon which all so-called systems of wireless telegraphy are based is as follows : An electric disturbance of sufficient strength and of a suitable nature is set up at one point, and this disturbance travels (like the ripple on a calm sheet of water caused by a stone falling into it) through space through the medium of the ether, and enables a suitably arranged receiving apparatus at another point to reproduce—although in a proportionately faint manner, according to the distance traversed—the starting and stopping of the original impulse. We have likened the transmission of the electric impulse to the ripple caused by a stone dropped into a sheet of still water. This is not quite accurate ; the inductive effect extends in all directions from the point at which it was produced—that is to say, in continually increasing spheres of influence. This is an important point in wireless systems, and will be referred to later on.

* We are quite in the dark, and probably shall remain so, as to why certain wave lengths can pass through solids while different lengths are unable to do so, and why, again—as in the case of the X rays—flesh and blood offer no resistance to the passage of these rays, whereas they are intercepted by bony tissue. The fact remains that such is the case, and at present that is all that can be said about it.

Before going further, I would just like to say that I am refraining from all eulogistic reference to the labours of the numerous workers in this field, because in the first place any tribute of mine could not add to the appreciation which has already been expressed by abler pens ; and, secondly, because to do justice to the many who have worked in this field would require a volume in itself. The discoveries upon which wireless telegraphy is based are numerous, and, indeed, wonderful, but they have been chronicled long ago, and the object of my paper is to consider the probable practical value of the wireless system from the cold and uncompromising point of view of commercial and pecuniary advantage.

COST OF THE "WIRELESS" METHOD.

The cost of establishing communication on the wireless method is, of course, extremely small compared with that by a submarine cable. The cost of a submarine telegraph cable, including manufacture and laying, is approximately £225 to £250 per nautical mile. This is an average figure, and, of course, may be greater or less, according to the special conditions aimed at (such as, for instance, high working speed), and the life, as far as present experience enables us to judge, may be from thirty to forty years. In the wireless method no cable is used between the transmitting station and the receiving station, thus enormously reducing the capital outlay.

The cost of energy for transmitting the necessary electric impulses on the wireless method is, however, very much greater than in the case of the direct conductor method. It is at present impossible to estimate very accurately how much greater, as such items of information are very jealously guarded by "wireless" companies, who naturally enough are labouring hard to reduce working costs, and therefore are anxious not to give themselves away. Mr. William Maver recently stated that about 150 watts were used for the transmission of the necessary impulses from a Marconi transmitter over a distance of about 186 miles. Comparing this with the expenditure of energy necessary to operate an ordinary telegraph relay over a similar distance, he stated that the latter would require about three watts, so that the wireless method required fifty times more energy than the ordinary telegraph method. Assuming that the energy required will vary as the square of the distance, it would require roughly

$$\left(\frac{2{,}600}{186}\right)^2 \times 150 \text{ watts, or about 40 h.p.,*}$$

to project the electric impulse across the Atlantic. Assuming other things to be equal—that is to say, that the wireless method is brought up to the same degree of efficiency as the cable method in point of speed, reliability, etc.—there would naturally be a limiting distance at which the extra cost of working on the wireless method would equal the interest on the first cost of the cable, together with the cost of maintenance and repairs. In the present state of our knowledge of the cost of wireless telegraphy, it is quite impossible for us to say what this limiting distance would be, but we can only assume for the moment from Mr. Marconi's unequivocal utterances as to the rate at which his company will shortly be prepared to transmit messages from London to New York, that the distance across the Atlantic is well within this limiting distance, and this certainly appears probable.

* The question of power is not an important one from the point of view of cost of working, unless it should very greatly exceed this.

CRUX OF THE PRESENT SITUATION.

We have assumed above that in point of reliability the wireless method has been brought to the same degree of efficiency as the direct cable method. This, however, appears to me to be the crux of the whole situation, and while it would be unwise to suggest that it could never be attained, it is safe to say that up to the present it has not been attained.

One of the chief difficulties, in fact *the* main difficulty from a commercial point of view, that has to be contended with in the wireless method is to find means to enable two parties to communicate with each other without fear of their message being overheard or intercepted, and also to prevent a third party from making communication between any two parties impossible by simply working his own apparatus, and thus rendering the other parties' signals unintelligible. Although it has been stated by the Wireless Telegraph and Signal Company, Limited, in reference to the installation between the East Goodwin Lightship and the South Foreland Lightship (*Times*, February 24th, 1900), that between December 29th, 1898, and February 14th, 1899, there had not been a single flaw or hitch, and that night and day, in fog, storm, and thunderstorm no difference had been found in the working of the system, we are still —in February, 1903, or four years later—no further advanced as regards the application of the wireless method as a practical commercial undertaking.

Sir William Preece has characterised the methods of the Wireless Telegraph and Signal Company (*Journal of the Society of Arts*, May 5th, 1899) as "mysterious" and "inscrutable."

In the leading article of the issue of the *Electrical Review* of January 24th, 1902, comment is made upon the fact that although the Post Office had been informed that the Wireless Telegraph Company could communicate Sark with Guernsey, they had not done so, and, further, that for nearly two years after its practicability was confirmed, not one single commercial circuit existed.

The *Electrical Review* goes on to point out that in the House of Commons' Report of the *Times* of July 23rd, 1901, Mr. Henniker-Heaton, M.P.—then a director of Marconi's Wireless Telegraph

Company—asked the Secretary of the Treasury, as representing the Postmaster - General, "whether anything was being done to connect by telegraph the Island of Sark with Guernsey, and whether he proposed to continue the policy of his predecessor of refusing an offer of Marconi's Wireless Telegraph Company to connect Sark with Guernsey by wireless telegraphy without any expense whatever to the Government." The reply was, that "the Postmaster-General had no reason to suppose that the Marconi Wireless Telegraph Company were prepared to maintain permanent telegraphic communication between Sark and Guernsey without charge, and it was, of course, permanent communication that was required." The comment of the *Electrical Review* was, "if such differences and contradictions arose in regard to a short span of the Channel Islands, what are we to expect from an exploit across the Atlantic?"

Up to the present Mr. Marconi has not published any results which would lead us to suppose that the practical realisation of his views as to long distance wireless telegraphy is imminent. Had the advocates of wireless telegraphy contented themselves in the past with expressing their confidence in the ultimate realisation of their hopes, the significance of the non-fulfilment thereof would be comparatively small, but in a paper read by Mr. Marconi to the Society of Arts—May 17th, 1901—he states that his efforts to secure syntony, or the means of preventing interference by other transmitters, or interference with other receivers than the particular transmitter and receiver engaged in the transmitting of a message, were "crowned with complete success," and Mr. Marconi further stated that "a very great number of non-interfering stations can now be worked in the immediate vicinity of each other." On the other hand, Professor J. A. Fleming expressed the opinion (*Times*, April 3rd, 1899) that "wireless telegraphy will not take the place of telegraphy with wires." So far Professor Fleming is "on top."

Although wireless telegraphy has not yet borne out in practice the published convictions of its advocates—in spite of the fact that some time has elapsed since statements were made that the system had been perfected, and so forth—it does not, of course, follow that improvements will not be attained in the future, but it would appear that the very principles involved in wireless telegraphy militate against the probability of the same degree of reliability, secrecy, and speed being attained with which Atlantic cables are now being worked. It must, further, be recollected that the advent of a possible rival will stimulate telegraph engineers to still further improve the telegraph service. Within the last three years cables have been laid across the Atlantic capable of transmitting 600 letters per minute, representing an important advance upon the speed hitherto possible. If we admit the possibility of great improvements in the wireless system, it is surely competent to extend the same latitude to submarine telegraph engineers.

The main obstacle in the way of long distance wireless telegraphy on a commercial scale is the non-success so far of any attempts to prevent the interference of neighbouring transmitters, and when one considers that the waves of influence radiate in all directions from the point at which the electric impulse is produced, and when, further, one remembers that electric oscillations have to be used which of necessity must be capable of propagation through space, irrespective of intervening solids or liquids or gases, it will be seen that any attempt at screening or directing these waves must of necessity be unsuccessful, and that the only hope lies in the syntonisation or attuning of corresponding transmitters and receivers. The practical difficulty of effecting this when transmitting and receiving stations are multiplied, as, of course, they would have to be were the system to come into general use, will at once be realised.

It seems unnecessary to dive into the more technical issues involved.

THE FUTURE.

There can be no doubt that many advantages exist in the wireless method, as compared with the cable method. No doubt, also, many of the technical difficulties now existing in connection with the construction and working of the transmitting and receiving instruments and accessory apparatus will be overcome, but two things cannot be altered; first, the nature of the vehicle for the transmission of the electric impulse, namely, the luminiferous ether; and, secondly, the laws governing the conditions set up by the production of the necessary electrical oscillations. It is impossible to direct and control the electric impulse produced in the wireless method with the same accuracy as is achieved by the direct conductor method in the case of a submarine cable. In this connection it may be interesting to quote the following paragraph which appeared in the *Globe* of February 13th, 1903 :—

> It came to our ears a considerable time ago that Marconi messages could be tapped, but it was only after Mr. Neville Maskelyne had published actual results of tapping, with specimens of the messages, that we referred to the matter. According to recent interviews with Marconi, given in the newspapers, he admits that his messages can be tapped over their radius of transmission —that is to say, the area of a circle of that radius, and also that he has not yet succeeded in tuning or syntonising his messages, but expects to succeed.

In the *Electrical Review* of February, 27th, 1903, an extract is given from the Report of the French Budget Sub-Committee on Posts and Telegraphs, prepared by Mr. Marcel Sembat. The Report states that " means of rendering wireless messages exchanged between various stations independent of one another has not yet been found. It is sufficient for us in this connection to reproduce the conclusions of a recently published work by two engineer officers—Commandant Boulanger and Captain Ferrié—who have specially interested themselves in this question. Communications by wireless telegraphy give no security in the present conditions, because a receiver could not be protected against atmospheric influences, nor against an energetic transmission made even at a considerable distance, by a station other than that with which it is wished to correspond. It is impossible to forecast, at present, the means of remedying this inconvenience. The applications of wireless telegraphy can only be limited, and they cannot replace the methods of communication employed up to the present in military telegraphy. . . . Nobody is ignorant of the fact that the exchange of wireless telegrams is more difficult on land than by sea, the smallest accident on land weakening the Hertzien waves. It has been remarked in a precise manner that these waves are transmitted more distinctly if the transmitting station and the receiving station are placed before a sheet of water of some extent. . . . To sum up, it seems that the augmentation of the strength of the currents used will increase the range of transmission, but so long as the means of ensuring the secrecy of the correspondence exchanged remains undiscovered, and no remedy has been found for the difficulties arising from the super-position of signals and atmospheric disturbances, this means of transmission cannot supersede the means of transmission employed up to the present. The first service which this new application of science can render in its present condition consists in the possible exchange of communication between the coast and vessels at sea, or neighbouring islands, or between the vessels themselves."

Reference may also be made to the report prepared by Sir William Preece at the request of the Chairman of the Eastern Telegraph Company, which was quoted at length at the recent general meeting of that company.

Lord Kelvin, who is in the front rank of experts in submarine telegraphy, tells us that in his opinion the property of the submarine cable companies will not be in the slightest degree injured by the greatest success possible by wireless telegraphy.

It is, however, unnecessary to multiply instances. The concensus of opinion amongst men of undisputed scientific attainments in the field of physics and telegraphy practically amounts to this, that the failure to ensure secrecy and non-interference is in the present state of our knowledge an apparently insurmountable obstacle to the successful competition of wireless telegraphy with long distance submarine cable work.

The foregoing remarks are intended to apply solely to the influence of the wireless method upon the value of telegraph companies property, and there is nothing in what has been written above that is inconsistent with the statement that undoubtedly there are many useful and profitable applications for wireless telegraphy, and that there is no reason why wireless telegraph companies should not have a prosperous future before them in the particular fields of commercial activity suited to their peculiar methods.

AND ORGANISATION.

BY

D. N. DUNLOP.

The author indicates the lines on which, in his experience, the important question of labour should be dealt with in factories. Some significant examples are given.—EDITOR.

SECOND SERIES.—I.

THE PROVISION OF LABOUR (GENERAL).

THE importance of the provision of labour in the organisation of the factory cannot be over-estimated; it forms, as we have seen in past issues, the principal factor in the cost of production, while we cannot afford to disregard the influence of the quality of labour on output.

CHIEF ASSETS OF LABOUR.

In considering the provision of labour from the point of view of its value to the employer, we find the following assets pre-eminent :—

(1) The innate worth of the man.
(2) Training.
(3) Such qualities as experience and skill, self-dependence, and enterprise.

Among the means of promoting quality in labour which rest with the employer are the following :—

(1) Discipline.
(2) The promotion of moral and physical well-being.
(3) The encouragement of *esprit de corps*.
(4) Co-operation in management.
(5) The cultivation of good relations with the employer.
(6) Philanthropy.

TREATMENT OF WORKMEN.

Nothing pays better in the management of labour than a judicious mixture of philanthropy, justice, and discipline.

The absence of one unit of labour from his post, even for an hour, may put the whole machinery out of gear. Experience teaches that no employer of labour on a large or small scale can afford to provoke discontent or indifference.

Ordinary labour is easily procured, but the firm whose considerate treatment of employees, coupled with good wages causes keen competition for vacancies can pick and choose, and is bound to secure the best labour. An employer who gives his men nothing except wages can expect to receive nothing more from them than the working of so many hours. To increase the output and decrease the cost of production, however, the intelligent and sympathetic co-operation of the workers is required. How may this best be enlisted ?

TRAINING.

Integrity, ability, and faithfulness are the chief attributes the manager looks for in his men ; if they are alert as well, so much the better.

The workman's training has been considered of more vital importance in America and in Germany than in England, where a technical and practical training is not so easily attained and the workman, therefore, rarely starts so thoroughly equipped for his work or for advancement in his craft or trade. This subject will receive further consideration in the next article. The new school of technology recently opened in Manchester, with day and evening classes and facilities for acquiring not only theoretical but practical knowledge, will, no doubt, prove of the greatest importance to the engineering industry ; it is a step in the right direction, and similar institutes should exist in all our large manufacturing towns. The Manchester School of Technology will create engineers, chemists, etc., and experts in all branches, but it does not help the average workman in the factory or artisan. Now that the Trade Guilds are things of the past in England and have been replaced by Trades Unions, the dignity of the craft is disregarded ; quality in workmanship goes for little with the Unions. We want corresponding advantages placed within the reach of our lads, so that if they be ambitious and enterprising they may be enabled to become past masters of their craft or trade.

Experience, skill, self-dependence and enterprise are good *climbing* qualities, and to see them appreciated and rewarded is an incitement to less well-equipped workmen to endeavour to acquire them. This leads us into the province of the employer and we will now consider those methods which tend to improve the quality of labour in the factory.

INSPIRING CONFIDENCE.

The first step is to inspire confidence in the organisation and to establish good relations between employer and employed. This cannot be done in a moment. Let the workman feel sure of being treated with perfect justice and make him realise that in return for good wages nothing short of his best endeavour will be accepted ; that the master intends to have the work done in his own way and to have his rules obeyed.

To demonstrate your good intentions towards the men, adopt all possible methods for increasing their comfort and happiness, and for improving their mental, moral, and social condition ; in doing this you create a bond of sympathy and inspire feelings of loyalty. Nor must the physical needs of the man be forgotten ; provide good ventilation, sanitation, plenty of windows to admit the sunlight, and a liberal sufficiency of arc lamps and incandescent lamps throughout the works ; maintain an even temperature in the workshops, and give every facility and encouragement to the men to practise personal cleanliness. The good works of a successful and philanthropic employer are not limited by the walls of the establishment, they extend beyond into the homes and home life of his employees. How this is accomplished may best be told by citing a few examples. The Westinghouse firm is proverbial in this respect and so is the National Cash Register Co. In the new works of the British Westinghouse Co., at Trafford Park, Manchester, the ventilation system is completed ; the pure air admitted is heated in winter by passing over a steam coil, while in summer the bad air is expelled and fresh air takes its place.

VALUE OF CLEANLINESS.

Lavatories are provided on an extensive scale ; there are 600 wash-basins in the machine shop alone for the workers, who have, besides, clothes lockers, and a dining-room for their own use. Electric light (at a cost of from 6d. to 9d. per week) and fuel gas for cooking will shortly be provided at a cheap rate.

This persistent insistence on cleanliness—which is also a prominent feature at the works of the National Cash Register Co., where baths are not only provided, but time also, at the expense of the employer—has a beneficial effect in the worker's homes, for the self-respect induced by the order and cleanliness during working hours will not tolerate dirty, untidy homes, and slovenly habits. The same results are observed with regard to the sound moral tone and good discipline at the works.

FOR WOMEN WORKERS.

In factories where women are employed, much can be done to lighten and brighten their lives and to keep them healthy, therefore fit for work. Just as a machine will not work without oil or a boiler without fuel, so the bodies of the factory girls require proper nourishment. The President of the National Cash Register Co. observed a girl warming up coffee over a radiator one day, and on inquiry found that with a lump of bread it constituted the sum total of food upon which she was to sustain her energy for the day's work. He resolved henceforth to provide a luncheon room for the women, and hot coffee, and later he was able to supply a lunch of coffee or tea, bread and butter, soup, beef, and vegetables for 2½d. He found himself more than repaid for looking after the welfare of his employees by their intelligent and willing co-operation.

CO-OPERATIVE MANAGEMENT.

Co-operative management has recently received much attention in America and many firms have adopted it and found the results encouraging and satisfactory. Committees are formed in all departments drawn from superintendents, foremen, and employees, the latter being chosen from the rank and file for their fitness to serve on the committee; they meet daily during the lunch hour or after work is over (at the firm's expense) and report to the General Management Committee on the work and organisation of their department.

FOSTERING ESPRIT DE CORPS.

There are committees to look after office detail, mechanical and building departments, sanitation and cleanliness, advertising, shipping and sale departments, repairs, etc. The employees are thus brought to feel that it is "our business" and are actuated by a strong *esprit de corps*, one of the most powerful and valuable motive springs of any organisation, which, besides, enables the employer to maintain a perfect system without coercion. Fines for slight infractions of rules become unnecessary; it is better to dismiss an employee who is habitually careless and indifferent than to levy fines. The Westinghouse firm was among the first to realise that those who are actually engaged in the work of production or in one of its processes, often make the most valuable suggestions for improvements in the machinery, the tools, or even in the system of management. These improvements generally result in a saving of material and expense. One workman was actually found to suggest a device whereby his own labour was rendered unnecessary. At first the men objected that it would be useless for them to make suggestions, as they would never reach their employer's notice. Many firms, to obviate this difficulty, provide suggestion and grievance boxes, kept locked, into which the men drop the slips of paper containing suggestions or complaints duly signed, and these are collected daily by the employer or manager's secretary, and taken direct to his office, where they receive immediate attention. Prizes are offered for the best suggestions; this prevents stagnation and torpidity, and many owe promotion from the ranks to the intelligence and interest thus awakened in them by the consideration and encouragement of the employer.

These methods, which perhaps cost the firm a large sum annually, may be regarded as a safe investment, and one more effectual and beneficial in its results than many systems of bonus, premium, or profit-sharing, for these appeal less to man's nobler and finer instincts and nature.

LABOUR-SAVING MACHINERY.

Great prejudice exists in most workshops in Great Britain against labour-saving machinery, which, it is asserted, is a menace to the interests of the working man; it is worth while to take the trouble to eradicate that idea which is entirely false. The effect of labour-saving machinery is to raise the price of labour and to lessen the cost of products; the prejudice is on a par with the principle inculcated by Unions—that men should not do more than a certain fixed amount of work per day in order that sufficient employment may be found for the many. Work creates work—the greater the output of the factory the more work there is to be done and the greater the need of expansion in plant and establishment. The man who spends his life in accomplishing one process becomes a mere machine with no prospect of advancement. Is it not a thousand times better to invent a machine to do his work in one-tenth the time and to set him to mind it? If he has a spark of intelligence in him it stands a chance of being awakened, and before long he will be promoted to a more complex machine. The introduction of labour-saving appliances into a factory, besides increasing the dividends, turns machines into men instead of turning men into machines; it energises and humanises and sharpens men's wits.

In the opinion of the writer it is by some such methods that the labour problem will best be solved. The recognition of employees, as human beings who have their aspirations, their cherished ideals, and their lives to live just as their chiefs have; the elevation of their surroundings and the prospect of advancement through self-culture and interest in their work—these things will in time solve the problem.

WATER-TUBE *v.* CYLINDRICAL BOILERS.

BY

BENJAMIN TAYLOR.

In the October number of PAGE'S MAGAZINE, this subject was discussed from a naval and an engineer's point of view. Following up that discussion, the writer gives a further account of the experiments of the Boiler Committee, whose investigations did not cease with the 1902 trials.

ALTHOUGH boilers for the warships now being built have been ordered in conformity with the advice of the Boiler Committee, that Committee is still earnest and active in pursuit of further knowledge. It is composed of engineering and shipbuilding experts, and is presided over by Admiral Domville. Among the recent experiments were some extremely interesting trials of H.M. sloops *Espiegle* and *Fantome*, and H.M. torpedo gunboats *Sheldrake* and *Seagull*, the details to be drawn from the reports of which are of the greatest interest to all concerned in the production and utilisation of steam power. One of these sloops and one of the gunboats are fitted entirely with Babcock and Wilcox boilers, viz., the *Espiegle* and the *Sheldrake* ; while the sloop *Fantome* and the gunboat *Seagull* are fitted with Niclausse boilers. As these are all small vessels, the installations are necessarily small —but they were the only vessels in the British Navy so fitted, and available for competitive comparison. Therefore, the Boiler Committee took them in hand and put them through a long succession of trials and tests.

The result has been to prove that the power required was on the whole obtained more readily from the Babcock and Wilcox than from the Niclausse boilers. This was particularly the case in the full-power trials of the *Sheldrake* and the *Seagull* ; but the heating surface of the former's boilers is 15 per cent. greater than that of the latter. The trials were completed in each ship without any defects being developed in the boilers themselves, but the boilers were not thoroughly tested as to their freedom from developing defects while being used on actual service.

In the case of the sloops, the Niclausse boilers gave wetter steam than the Babcock and Wilcox boilers. The steam collector of each of the Babcock and Wilcox boilers of the *Espiegle* is 3 ft. 6 in. internal diameter by 9 ft. 6 in. long, while that of each of the Niclausse boilers of the *Fantome* is 2 ft. $7\frac{1}{4}$ in. internal diameter by 5 ft. 11 in. long. Thus, the area of water surface is about 130 square feet in the *Espiegle*, and about 60 square feet in the *Fantome*. The steam space in the boilers of the *Espiegle* is about twenty-seven times that in the *Fantome*. The boilers of the *Fantome* were fitted with small steam domes, but it does not appear that these were sufficient to compensate for the very great proportional reduction in water surface and steam space. The steam obtained from the *Sheldrake's* boilers showed about 4 per cent. of wetness on each of the short trials, and the installation of the boilers of that ship is such as to render the probability of wet steam being given off much greater than in the case of the boilers of the *Fantome*. The *Sheldrake's* boilers have small generating tubes and only one return tube for each header ; while the *Espiegle's* boilers have large generating tubes and two return tubes to each header, in addition to a baffle plate over the ends of the return tubes in the steam collector.

In the case of the *Seagull*, it was found that the steam used during the 1,000 h.-p. trial was practically dry, but on the full-power trial there was a wetness of over 3 per cent., and in this case also the steam collectors are small, being only 2 ft. $7\frac{1}{2}$ in. diameter.

The installation of machinery fitted with the Niclausse boilers showed smaller loss of feed water than the similar installation fitted with Babcock and Wilcox boilers. This was specially noticeable on the coal-endurance trial of the *Fantome*, in which the evaporators were not used throughout the trial, although on a similar trial of the *Espiegle* it was necessary to use one evaporator for fourteen out of the ninety hours of the trial.

The inferior efficiency of the boilers of the sloops on the coal-endurance trials, as compared with that found on the shorter trials, was to a great extent due to the necessity for cleaning the fires. When the results obtained for the first eight or sixteen hours of each coal endurance trial are examined by themselves they reveal figures very nearly the same as those obtained on the short trials at about the same horse-power—that for the *Espiegle* being 1·88, and that for the *Fantome* 1·91 lb., of coal per horse-power hour for the first sixteen hours respectively, as against 1·86 lb. in each ship on the short trials. The long trials of the gunboats did not show any material difference in economy from the short ones, which may have been due to the stoppages in these trials from fog and other causes, which had practically the effect of converting the trials into a series of short ones.

The boilers of the sloops were built in 1901, and those in the torpedo gunboats were built in 1897. Comparing the efficiencies of the earlier and later Babcock and Wilcox boilers, the maximum efficiency of the boilers of the *Espiegle* reached 73·2 per cent., as against 66 per cent. in the *Sheldrake*, an improvement of about 11 per cent.; and the average efficiency in the *Espiegle* is 67·8 per cent., as against 63·1 per cent. in the *Sheldrake*, or an improvement of 7 per cent.

With regard to the Niclausse boilers, the maximum efficiency in the case of the *Fantome* was 69·8 per cent., as against 66·9 per cent. in the *Seagull*, an increase of about 4 per cent.; and the average efficiency in the *Fantome* is 63·4 per cent., as against 63·2 per cent. in the *Seagull*, or practically the same. The results with the Babcock and Wilcox boilers show that the large tube boilers, as fitted in the *Espiegle*, are more efficient than the small tube type as fitted in the *Sheldrake*. The arrangement of heating surface is the same in both the earlier and later boilers of the Niclausse types.

The boilers of the *Sheldrake* are not fitted with furnace gas baffles. The baffles in the boilers of the *Seagull* are similar to the modified baffles of the *Fantome*. In the boilers of the *Espiegle* two sets of vertical baffles are fitted, which make the masses rise at the back of the furnaces among the back ends of the tubes, then fall again among the tubes about half-way along their length, and rise again among the front ends to the uptakes. A similar arrangement was fitted in the *Martello*, but in this vessel these baffles have recently been removed and the area of outlet at the uptakes restricted, in consequence of the difficulty experienced in cleaning the boilers with the baffles in place.

On the long trials of the *Espiegle* and *Fantome* it was found that the boiler feeding in these ships could be easily regulated by hand. This is a distinct advantage possessed by Babcock and Wilcox and Niclausse boilers; but it will no doubt be found that automatic feed regulation will be a valuable adjunct in similar boilers in large installations.

The automatic feed regulators fitted in the *Fantome* worked throughout the trials without giving any trouble. Those fitted in the *Espiegle* were not so satisfactory, as they occasionally stuck, and allowed the water in the boilers to fall below the proper working level before opening, or allowed too much water to enter the boilers before they closed. The feed regulators of the *Sheldrake* and of the *Seagull* also required attention at times.

The space occupied by the Niclausse boilers in the *Fantome* is considerably less than that occupied by the Babcock and Wilcox boilers of the same power in the *Espiegle*, although the grate surface and heating surface are nearly alike; but the results indicate that this advantage has been obtained at the expense of some other advantages.

The boiler-room weights of the *Sheldrake* are about 8 per cent. less than those of the *Seagull*, although the *Sheldrake* has 15 per cent. more heating surface. This is partly accounted for by the fact that the boiler tubes of the *Sheldrake* are small in diameter ($1\frac{3}{8}$ in.), giving a large heating surface for a small weight, and also by the fact that the *Seagull* has six boilers against four in the *Sheldrake*.

In the case of the sloops the Babcock and Wilcox boilers are 25 per cent. heavier than the Niclausse boilers. The fire-grate and heating surface of the boilers of the *Espiegle* are slightly greater than those of the *Fantome*. The generating tubes in the boilers of both ships are of practically the same diameter, so that neither type of boiler has any advantage in obtaining a larger amount of heating surface on reduced weights by the use of smaller tubes. A large portion of the excess of weight is due to the fact that the steam collectors of the *Espiegle* are considerably larger than those of the *Fantome*, not only increasing the weight of the boilers themselves, but also of the water contained in them.

On a previous occasion the Boiler Committee named several defects which are peculiar to the Belleville type. These include the corrosive decay of the baffles in the steam collectors, and of generator and economiser tubes, now greatly reduced by the use of lime and zinc; but great care has to be taken to prevent choking of the water-gauge connections in consequence of the free use of the lime. The next is the rapid wear of the working parts of the automatic feed apparatus, and the non-return valves in the down-take pipes. The third is the melting of fusible plugs owing to uncertain circulation; the fourth is the deposit in the tubes about the water line, but specially in the wing elements, due to impure feed-water, and involving failure of the tube; and a fifth is the excessive expenditure of coal and of fresh water for boiler feed make-up, as compared with vessels fitted with the cylindrical boilers.

It is indicated that, as compared with the cylindrical boiler, satisfactory water-tube boilers in warships should possess the following advantages:—Less delay in steam raising; less liability to damage if the boiler be struck by a projectile; greater ease of repair and renewal of parts; less weight for the power generated considering the weight of the boiler installation only; ability to carry a higher steam pressure; and greater fire-grate area for the same floor area, with consequent less forcing for full power. These advantages are possessed to a considerable extent by the Belleville boiler, and on the first competitive trials of the *Hyacinth* and *Minerva* the Belleville boilers proved more efficient, as regards evaporation, than the cylindrical boilers as originally fitted, but after the retarders were fitted in the latter, the efficiencies were nearly equal. The long runs to Gibraltar and back last year proved that in several respects, notably in the loss of feed-water and in economy of coal consumption, as well as in the immunity from accident during ordinary working, the cylindrical boilers were considerably superior to the Belleville.

In the British merchant fleet the Babcock and Wilcox boiler alone is in use in ocean-going steamers. In the United States merchant marine the same type of boiler is stated to be used to a small extent, principally in ships plying on the Great Lakes. Niclausse boilers are installed in two large ships of 15,000 h.p. In France, Belleville boilers have been working in vessels of the Messageries Maritime Cie for many years. The French Transatlantique Company have fitted two small vessels, one with Belleville, and the other with Niclausse boilers, for comparative trials. In the German Navy, the Dürr boiler has been adopted for large cruisers, while a combination of cylindrical and small-tube types is retained for battleships; but small-tube boilers are exclusively used only in the small cruisers. In the Dutch, Austrian and Swedish navies, the Yarrow boiler is very largely in use. In the American Navy many Babcock and Wilcox boilers are in use, although recently Niclausse boilers have been ordered for four of the largest ships.

The following is believed to be a complete list of all the vessels in the United States and British Navies at present fitted, or about to be fitted, with the Babcock and Wilcox boilers :—

Type	Name	I.H.P.	
Gunboat	Annapolis	1,300	United States Navy.
,,	Marietta	1,300	,,
Monitor	Manhattan	1,500	,,
,,	Mahopac	1,500	,,
,,	Canonicus	1,500	,,
,,	Wyoming	2,400	,,
,,	Amphitrite	2,400	,,
Cruiser	Chicago	5,000	,,
,,	Atalanta	3,000	,,
,,	Alert	1,560	,,
,,	Cincinnati	8,000	,,
,,	Tacomi	4,500	,,
,,	Chattanooga	4,500	,,
,,	Galveston	4,500	,,
,,	Raleigh	7,040	,,
,,	Denver	4,500	,,
,,	Des Moines	4,500	,,
,,	Cleveland	4,500	,,
,,	California	23,000	,,
,,	South Dakota	23,000	,,
,,	Milwaukee	21,000	,,
,,	St. Louis	21,000	,,
,,	Maryland	23,000	,,
,,	West Virginia	23,000	,,
,,	Charleston	21,000	,,
Battleship	Nebraska	19,000	United States Navy.
,,	Rhode Island	19,000	,,
,,	New Jersey	19,000	,,
,,	Connecticut	16,000	,,
,,	Lousiana	16,000	,,
Torpedo gunboat	Sheldrake	3,500	British Navy.
Sloop	Espiegle	1,400	,,
,,	Odin	1,400	,,
Cruiser	Challenger	12,500	,,
,,	Hermes	10,000	,,
,,	Cornwall	22,000	,,
,,	Argyll	16,800	,,
,,	Black Prince	18,800	,,
,,	Duke of Edinburgh	18,800	,,
Battleship	Queen	15,000	,,
,,	Hindustan	14,400	,,
,,	King Edward VII.	10,800	,,
,,	Dominion	18,000	,,
,,	Commonwealth	18,000	,,

A French Committee also has been investigating the question of water-tube boilers for large ships of the French Navy, and whether large or small-tube boilers should be used. They are considering apart from the engineering experts of the British Navy, who consider that small-tube boilers should not be fitted, as the rate of wear is considerably greater than in large-tube boilers, and is suitable only where weight is limited, and high speed a first consideration. The French Committee have decided that no small-tube boilers should be fitted to cruisers or battleships, and that in future designs, the allowance of grate area should be such that, at full power, the coal consumption should not be greater than 22½ lb. per square foot per hour, but that there should be a trial of considerable duration with three-fourths of the boilers burning 30 lb. of coal per square foot per hour. Thus, should occasion arise, when one-fourth of the boilers were put out of action, the others could be pressed to supply the volume of steam necessary to give full power.

Of the four British cruisers of the *Drake* class, the *Good Hope* consumed most coal per square foot of grate (26·2 lb. per hour), while at three-fourths power the rate was 17·3 lb. per hour. The *Bedford*, of the *County* class, burned about 30 lb. per square foot of grate per hour on the full power run, and at three-fourths power nearly 20 lb. The Belleville and Niclausse boilers have been ordered for the new French ships, and the Minister of Marine has given instructions that the other suggestions of the Committee should be acted on.

There has been, however, in France. considerable opposition to the proposal that only large-tube boilers should be fitted to battleships and armoured cruisers, and since the report a vigorous campaign has been in progress to prevent such a decision from being carried into effect. The Minister of Marine stood firm, and declared that the engineers in the fleet are at one with the Committee in their recommendation. It is pointed out that experience has shown that the small-tube boiler, while it may give a higher evaporation per square foot of surface, involves a larger coal consumption per unit of power, and makes repairs and cleaning more difficult than with the large tube boilers. The cases of the *Jeanne D'Arc*, the *Jurien de la Graviere*, and the *Chateau Renault* are cited in support of these general conclusions. It has, therefore, been decided that the Niclausse boiler and the Belleville boiler—the latter without economisers—will be used in all the large French warships now being built, and it has further been decided that on the full-power trial the rate of consumption shall not exceed $22\frac{1}{2}$ lb. of coal per square foot of grate. On a subsequent trial, with only three-fourths of the boilers in use, the rate of consumption is to be $30\frac{3}{4}$ lb. per square foot of grate per hour. The latter is a rate usually approached in the high-speed cruisers of the British Navy, the *Bedford*, for instance, having burned 29·5 lb. per square foot of grate at full power, and about 20 lb. per square foot at three-quarter power, while the *Leviathan* burned 26·2 lb. per square foot at full power, and 17·3 lb. per square foot at three quarter power.

As the question of coal consumption is so important, it should be noted with regard to the trials by the British Boiler Committee described above, that hand-picked Welsh coal was used in all cases, except in the coal endurance trial of the *Sheldrake*. The coal varied in quality, and at times contained a considerable quantity of ash and earthy matter. The stokehold plates were swept clean at the commencement, and at the end of each trial, and the fires were examined at these times. For the coal endurance trials of the *Espiegle* and *Fantome* eighty-five tons of coal were put into bags holding 70 lbs. each, and these, carefully tied up, were stored in the bunkers. The coal packed in the bags was used during the period of the trial only, and the bags were tallied as taken from the bunkers; twenty-one tons of coal were carried in a separate bunker as an emergency reserve, and for use before and after the trials. On all the other trials the coal used was brought from the bunker doors to the fires in buckets, every bucket of coal being carefully weighed and brought to a particular amount. The periodical records showed the amount of coal taken from the bunkers and weighed on to the floors exactly as tallied, but these figures do not represent the actual amounts burned in the periods, as the floors were only cleared at the beginning and end of each trial. Pieces from the coal about to be fired were taken off the stokehold floor at frequent intervals during each trial and put on one side. These were mixed together after the trial, and about two cwt. of the coal so mixed was sent for analysis. This amount was carefully ground and mixed to obtain the sample from which the analysis was made. In each case the determination of the thermal value of the coal was made in a bomb calorimeter, using compressed oxygen. The ash and moisture were also determined. The samples taken and analysed were fair considering the coal used.

WORKSHOP PRACTICE

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

A MASSIVE TURRET LATHE.

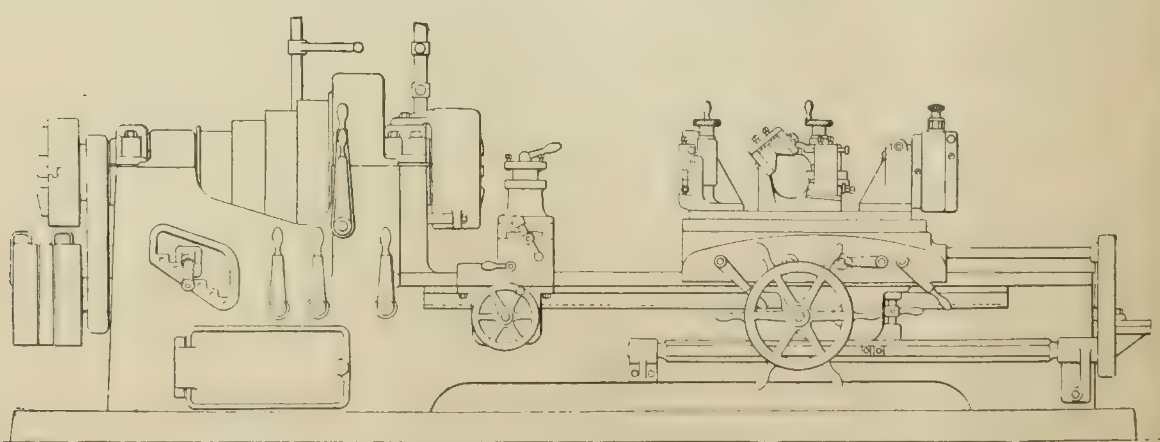
MESSRS. H. W. WARD AND CO., of Birmingham, have just introduced a new turret lathe—the largest of this type of lathe yet manufactured, since it takes a bar 5 in. in diameter by 48 in. long. It is designed for marine work, such as the bolts of heavy connecting rods, the coupling bolts of propellor shafts, pins for derricks, and massive forgings. It weighs 12 tons. The bearings for the live spindle measure 8½ in., and 7½ in. diameter at front and back respectively. The cones take a 5-in. belt. The back gears give two ratios—namely, 8 to 1 and 24½ to 1. They are engaged and disengaged by friction clutches, operated by levers at the front of the headstock. Three steps on the cone, two back gear speeds, and two speeds on the counter provide 18 rates of revolution. A four-jawed chuck in front grips the work, and a self-centring chuck at the rear steadies it.

The turret turntable is 3 ft. in diameter, and, being so large, is revolved by power by a movement of the lever at the front of the saddle. The turret feeds provide independently for traversing and screw cutting. The traversing shaft is placed in the centre of the bed. Steel wheels engage with steel racks laid along each side of the bed, giving a central thrust to the turret slide. A quick power traverse is provided, both towards and away from the headstock. The turret feeds allow of twelve changes, ranging from 10 to 216 revolutions per inch of traverse. An independent lead screw permits of the cutting of English, or metrical pitches. Screwing and turning feeds cannot be engaged at the same time. A reversing motion permits of cutting in either direction. The tools swing in holders which permit of definite adjustments for diameter, and are opposed by adjustable steadies. A bracket carries a die head to cut threads from 2 in. to 4½ in. in diameter.

A cutting-off rest is fitted to an independent carriage, it has a square turret carrying four tools, and can be used for forming. The provisions for lubrication are perfect, including a powerful pump and sud tray, and protecting hoods are fitted where desirable.

NEW GEAR CUTTERS.

Mr. Oscar J. Beale, the gear wheel expert of the Brown and Sharpe Company, has designed a bevel wheel cutting machine of the generating type, which, as a piece of marvellous ingenuity would be hard to beat. One of the



HEAVY TURRET LATHE BY MESSRS. H. W. WARD AND CO., BIRMINGHAM.

remarkable signs of the present development of bevel gear cutting machines of the last few years, is the partial supersession of machines using rotary cutters by those employing tools controlled by a former, or enlarged copy of the tooth to be cut. Another significant fact is the partial displacement of these last by machines of the generating type, some of which employ cutting tools of circular form to produce teeth of perfect shapes, without the use of a former. The principle which underlies these is that the cutter represents the tooth of a crown wheel, which cuts correctly a gear of any size, by rotating and rolling the blank past it, in the relations which would exist in finished gears. Such a method is applicable to single curve teeth only, and the cardinal setting whioh determines the mutual relations of such gears is the angle of obliquity of the path of contact between mating gears.

In the machine above referred to, the cutting is done simultaneously on the opposed faces of two adjacent teeth in a peculiar manner. Two milling cutters, set at an acute angle, and with inserted teeth, have their teeth freely interlocking, so that each occupies the same tooth space at one time, and each cuts the tooth face opposite to that which is being produced by the other. The angle of obliquity of the path of contact is given by the inclination imparted to the arbors of the cutters. Provision is made in the machine for the exact adjustment of this, and also for a slight adjustment bodily of the cutters to and from each other, the object of this being to permit of the use of a single pair of cutters for a limited range of pitches.

The rolling feed of the wheel blank past the cutters is imparted wholly to the blank, so that the cutters rotate on fixed centres. Such being the case, there is a very slight concavity left in the bottoms of the teeth, as in the teeth of the Rice machine, first exhibited at Paris in 1900. The Beale machine, in common with all others of generating type, involves very complicated mechanism.

The practice of gear-cutting has advanced a great deal if we go back, say only half-a-dozen years. It is also having the effect of bringing the involute tooth into increasing use, because double curve teeth cannot be produced by methods of generation. They must be obtained by rotary cutters, or by planing methods, in which a former tooth is employed. The demand for perfect gears has been strengthened by the motor car, and electrical industry, and there is much high class machinery in which quiet and smooth running is an ideal which cannot be attained, unless wheels are absolutely accurate, using the word in its shop sense. The continual improvements which are now being effected in wheel-cutting machines both supply and increase the demand for perfect gears.

A NEW GOULD AND EBERHARDT MACHINE.

The unmistakable general tendency at the present time is in the specialisation of machine tools, in the diminution of separate functions, and the limiting of their operations. Yet there are examples of the opposite kind. One, of these is a new Gould and Eberhardt gear-cutter, built in many respects on the model of their automatic spur-gear cutting machines, but so modified that it will produce also spiral and worm wheels. The change is mainly effected at the cutter head, which swivels on a circular base for adjustment of the angle of the cutter. The cutting of spurs and spirals is semi-automatic, the indexing for pitching requiring the intervention of the attendant. The hobbing of worm wheels is done entirely automatically.

A DRAW STROKE SHAPER.

The Colburn Company, whose keyseaters have become familiar in English shops, have now brought out a vertical shaper with a draw stroke. It is a departure which is likely to exercise a modifying effect on this class of tool. The Morton was probably the first innovation of this kind, about 1894. A draw stroke tends to hold the work down, instead of trying to lift or tilt it, as in the ordinary shaper. In a vertical shaper, the chips fall away at once, in the common type they remain on the work. The ends of very long pieces cannot be tooled on an ordinary shaper, though its capacities are often increased by having a pit in the floor in front. There is no limit to the length which can be brought to a vertical tool, just as in a slotter.

In this new machine the ram is rack driven, and its weight and that of the tool holder is counterbalanced by a weight suspended inside the frame. The tool holder swivels, and lifts on the return stroke. The work is held either on a tee-grooved table, or in a vertical vice on a housing bolted to the table. The jaws measure 18 in. by 6 in., and open 16 in. The usual tappet motions for shifting the belt are included.

A NEW HIGH SPEED LATHE.

The lathes of John Lang and Sons, of Johnstone, are well-known, and highly appreciated. This firm has for some time past practically given up the general manufacture of tools, and specialised in lathes. The last addition is one for the high speed steels, the noteworthy feature being the large size of the driving cones, as compared with ordinary practice. On their 12½-in. centre lathe, the stepped cone measures 30 in. on its largest step, and 20 in. on the smallest. With a back gear reduction of 6 to 1, and the belt on the large step, a steel shaft is reduced from 6 in. to 5 in. diameter at a surface speed of 60 ft. per minute, the feed being ⅛ in.

THE METRIC SYSTEM.

Skirmishing has again been going on around the metric and duodecimal systems. The question affects machinists and engineers far more than it does the man in the street. We could afford to push aside all arguments that are adduced in its favour were we manufacturing without rivals. But with Germany, France, Belgium, and Switzerland using the metric system we no longer occupy the impregnable position our fathers did. América alone keeps us company in this matter, and we do not know how long that may last.

Several leading firms already employ the metric system. A far greater number work by it in fulfilling foreign orders. Many of the machine tool makers find it necessary to put metric screws to lathes, alternatively with those on the inch basis. There are few, if any measuring instruments now that are not made on both systems. Rules, micrometer calipers, vernier instruments, have millimetres and inch divisions separately, but frequently on the same tool. Gauges of all kinds are made in the two systems, as are also drills, and reamers, and taps. The subdivisions of vulgar fractions are terribly tantalising. When divided minutely, the bother is that all the numerous broken portions cannot be included on an ordinary rule, hence the reason that the English workmen is always using the terms "full" and "bare," and their equivalent expressions, and getting abused for doing so. To avoid this, rules are made with a large range of fractions. But the uniformity of the millimetre is much to be preferred.

THE DRYING OF FOUNDRY MOULDS.

The drying of moulds on foundry floors is a department of work which is undergoing a change. In the old methods the "devil," or open fire of coke, was the method. It still retains its place probably in more than 90 per cent. of our shops. The objections to its use are the sulphurous fumes which it gives off, its inefficiency and wastefulness, and the ashes which it leaves behind in the mould, to be cleared away subsequently. In the smaller moulds heaters are frequently used, consisting of chunks of iron made red hot, and suspended in the mould, or supported in it. This is cleanly, but not fully efficient.

These devices are inferior to the newer ones in which portable stoves are employed, by which a current of hot air is directed into the mould. These not only suit the floor work admirably, but they render unnecessary the sending of a large quantity of small work into the drying and core stoves. Here, as in other departments, it is often cheaper to bring appliances to the work than to take the work to them. It is particularly the case with moulds, in which there is more or less risk of disturbing the sand in the act of lifting and hauling them about. In some instances portable stoves are used, fed with gas; in others flexible pipes. In the Sulzer Foundry cold air is brought through pipes under pressure into the stoves, within which fires are lighted. The air, being heated there, is conveyed to the inside of the moulds by tubes. In another design a stove is slung over the mould, and a down draught is created into the mould, instead of using a pipe.

In many cases the cost and trouble of drying moulds have caused preference to be given to the employment of green sand. But this is unsuitable for a large proportion of foundry work, and even then skin drying is frequently necessary and desirable. Loam moulds and work in dry sand must always either be put into the stove or dried *in situ*. The question of the use of mechanical drying appliances is, of course, of greater importance in shops that deal with these classes of work than in those moulding small and light articles. In the heavy shops they assume great economical importance.

SPIRAL CRANE DRUMS.

The extended use of wire rope has had the effect of modifying the designs of crane drums or barrels. Instead of the plain drums that were used for chains, grooving is required for rope. The grooving is variously done, being either cast, or cut in a lathe. All, or nearly all the earlier ones had cast grooves. These can be moulded on end, or horizontally. The spirals can be struck directly with boards in either method. When moulded horizontally, the smaller drums are often made from loam patterns, also having their spirals swept up with boards. In some cases grooves are made with cores, but it is a slow and unsatisfactory method, because the joints show in the castings. It is rather a cause for wonder that more spiral drums are not cast, because it is not difficult to cast them truly and cleanly by the methods above named; and to cut them, when of large diameter, is costly. When cut they are done in a screw-cutting lathe, and this is a growing practice for the best cranes, more especially electric travellers and others in which high speeds are reached, and in which the most accurate grooves are essential to smooth working. There is no objection to cutting drums, say, of less than about 2 ft. in diameter, but when over that size it is cheaper to cast them.

BRITISH AND AMERICAN RAILWAY METHODS.

OFFICIAL REPORT TO THE BOARD OF TRADE.

BY

LIEUT.-COLONEL H. A. YORKE, R.E.

LIEUT.-COLONEL H. A. YORKE'S report to the Board of Trade on his recent visit to America is now at the disposal of the country, and merits the earnest attention of all who are in any way interested in the efficient organisation of railways.

As chief inspecting officer of railways to the Board of Trade, Lieut.-Colonel Yorke had exceptional facilities to enable him to arrive at correct conclusions with regard to the value of American railway methods as compared with those in vogue in this country; in fact, the report may be said to resolve itself into comparison between the railway methods of the two countries. Happily the commissioner found no wholesale condemnation of English methods necessary. In some respects, indeed, it appears that we can give points to America, while in others it is shown that the very dissimilar conditions prevailing in this country would render nugatory the introduction of certain American railway improvements.

Lieut.-Colonel Yorke directed his attention chiefly to the construction and equipment of (1) steam railroads, (2) surface lines or tramways, (3) subways and elevated railways, (4) high-speed electric inter-urban railways; but, incidentally, he saw many other things of interest, and the report will be found of the greatest practical interest and utility to railway men.

We here reproduce Lieut.-Colonel Yorke's conclusions on steam railroad matters.

CONSTRUCTION.

There is a fundamental difference between the modes of construction of English and American railways. In England the bull-headed rail resting in cast-iron chairs is almost universally adopted for lines of heavy traffic. In America the T-rail or (as it is sometimes called in England) Vignoles rail is invariably employed, the rail being secured to the sleepers or ties by means of ordinary spikes. The Americans claim that their permanent way is easier and quicker to lay, cheaper to maintain, smoother to run over, and as durable as the English type. As regards weight of rails there is not much difference between the two countries, the American engineers having now adopted 100-lb. rails, with a base 6 in. wide, as their standard for heavy lines, as against rails of 80 lb. and 85 lb. which were formerly employed. Of course, there are in the States many lines with rails lighter than any of the above, but I am now referring only to the more important lines, on which heavy rails are found to be necessary. In England the weight of rails for main lines now varies from 85 to 103 lb., *e.g.*, those used by the London and North-Western Railway Company weigh from 90 lb. to 103 lb.; by the Great Western Railway Company from 92 lb. to 97½ lb.; by the Great Northern Railway Company 92 lb.; and by the London and South-Western Railway Company 85 lb. The English railway chair weighs from 40 lb. to 54 lb.

In America the number of sleepers or ties is greater than in England, but the difference between the practice of the two countries is not so great as is sometimes supposed. In America the average number of ties employed with heavy rails is 14 or 16 to a 30-ft. length of rail, and 18 with light rails of the same length. In England the number of sleepers used is 12 to a 30-ft. length of heavy rail. The average dimensions of an American tie are 8 ft. long, 8 in. wide, and 7 in. deep. For a 30-ft. length of rail, with 14 ties, this gives a bearing area as between the ties and ballast of 74·6 sq. ft., and with 16 ties, 85·3 sq. ft.

The dimensions of an English sleeper are 9 ft. long, 10 in. wide, and 5 in. deep. This gives a bearing area for the same length of track of 90 sq. ft. The advantage in this respect is therefore with the English practice.

Again, as regards the bearing area of the rails on the ties, the American method with 14 ties gives 14 by 6 in. by 8 in. = 672 sq. in. for one 30-ft. rail, or with 16 ties, 768 sq. in. The English chair for heavy rails has a base of 105 sq. in., so that 12 of these give a total area of 12 by 105, or 1,260 sq. in. Here again the advantage is with the English method.

It must, however, be noted that the American ties are of hard wood, such as oak or chestnut, and are therefore better able to resist the pressure of the rails than the English sleepers of Baltic timber.

The lateral support afforded to the rails by the English chair is of the greatest value, especially on curves, and in America the absence of chairs renders it necessary to use rail braces, which are of the nature of small steel brackets, or struts, to support the rails at any place, such as a curve or switch, where there is much lateral pressure. It is also usual in many places to employ bearing plates, or tie plates, between the rails and the ties so as to increase the bearing of the rail on the tie and to afford mutual support to the spikes. The effect of these tie plates, however, is to shear off the heads of the spikes. The fact that these additions are found to be necessary, shows that the American mode of construction is lacking in certain elements of stability, which are inherent in the English type of permanent way.

The Americans do not place their rail joints opposite each other as we do in England, and there is a good deal to be said in favour of the American practice in this respect. The joint is admittedly the weakest part of the permanent way both vertically and laterally, and it can hardly be doubted that it is an advantage to make the rails break joint, so that the weak spot on one side of the track shall be supported by the continuous rail on the other side.

Perhaps the detail most open to criticism in the American permanent way is the use of spikes, in the place of screws or fang bolts, to fasten the rails to the ties. These are constantly working loose, and then have to be driven home again. When this process has been often repeated, the holding power of the spikes must be diminished. But with hard wood ties, this defect is not so serious as it would be with the soft wood sleepers used in England. In fact, hard wood seems to be essential for the American style of permanent way. If this be so, there would probably be no economy in England in adopting American practice, for the extra cost of the ties would more than balance any saving due to the omission of chairs. The American road would, I consider, be vastly improved if some form of fang bolt with rail clips were used instead of spikes for fastening the rails to the ties.

As to the cost of maintenance, I cannot help thinking that the English method must give the best results, but many factors, such as the difference in the prices of labour and materials, and in the nature of the traffic, have to be taken into account.

The ballasting of the heavy lines in America, so far as I saw them, is as good as anything to be found in England, and there is no doubt that as a rule railway travelling in America is smooth and quiet, a feature which, though partly due to the road, may be also partly attributable to the invariable use of long and heavy bogie coaches.

Movable frogs or crossings are largely used in America, and give general satisfaction. In England they are almost unknown, though the London and South-Western Railway Company are now experimenting with them. Their advantage is that they abolish gaps in the rails, and therefore enable crossings to be laid with much flatter angles than are possible with fixed crossings, besides affording smoother running. They are not unlike a combination of facing and trailing points, and are operated by levers in a signal cabin, and should be interlocked with the signals. As they are heavy and require a considerable force to operate them, they are specially suitable at places where a power plant has been installed for operating the points and signals.

Spring frogs are also common, but opinion is divided as to their merits. Some engineers assured me that they had no trouble with them, while others say that the springs are liable to break, and that under such conditions they may cause a derailment.

INCHOATE CONDITION OF SIGNALLING.

Signalling in America is in an inchoate condition, there being no uniformity of practice throughout the country. Some portions of the principal railroads are fully signalled, but on many others hardly any signals are used, and even where signals are used, their shapes, colours, and meanings vary upon different lines. Signals are divided into various classes in a manner unknown in England, such as automatic signals, interlocking signals, telegraph block signals, train order signals, etc. Similarly with block working, only about 25,000 miles out of a total mileage (measured as single track) of 200,000 are at present worked in America on the block system, but its use is being gradually extended. Block working, however, is not so strictly interpreted as it is in England ; two or more trains are constantly permitted to be in the same section at the same time, and trains are allowed under certain conditions to travel in either direction on either track, even where the lines are doubled or quadrupled. On two occasions it occurred to the train in which I was travelling to be switched across from the proper track to the wrong track, without any halt, and without any formalities other than the handing to the driver or conductor of a train order, giving him instructions to travel on the wrong track, regardless of opposing trains. On both occasions we travelled in this way for several miles at a high rate of speed, there being, of course, no signals for the guidance or control of the train. Such a mode of working must be dangerous, as the least misunderstanding between the men who give and receive the train order, or any negligence on their part must lead to an accident.

Single lines, which form the bulk of the railroads of America, are operated almost entirely on the "train order" system, no train staff or tablet being used as in England, there being no less than thirteen standard forms of "train orders" in use. The train order system was tried in England, and has long ago been abandoned as troublesome and dangerous, and I believe that the American train service would be probably conducted with greater punctuality and economy and certainly with greater safety, if the electric staff or tablet system were introduced on the single lines.

AUTOMATIC METHODS.

For some time past American railroads have been using automatic signalling, about which a great deal has been recently said in England. The main (four track) lines of the Pennsylvania railroad between New York and Pittsburg are signalled in this fashion, and so are parts of several other railways. The New York Central Company are also about to adopt it in the neighbourhood of New York, and its use will doubtless extend. Recently in England the London and South-Western Railway Company have equipped a section of their line between Grateley and Andover with automatic signals, and preparations are also being made on the North-Eastern railway for testing this mode of signalling.

The most modern and satisfactory mode of applying the system is by means of a "track circuit." A low tension current flows from a battery along one rail of the track through a relay, and back to the battery along the second rail. The relay makes and breaks a local circuit, which by means of electro-magnets controls the mechanism, electric or pneumatic or whatever it may be, for operating the signals. When the current is flowing along the line the relay completes the local circuit, and signal is held "off." When, however, an engine or vehicle with metal wheels and axles is in the section a short circuit is established in the track circuit, the relay becomes inoperative, the local circuit is broken, and the signal returns to danger. By insulating the rail joints at intervals, the line is divided into sections, to each of which a separate current is supplied, and signals are placed at the commencement of each section, by means of which the driver of an approaching train is informed whether the section ahead is clear or not. It must be borne in mind that a fundamental difference exists between "manual" signals, and "automatic" signals, in that the former have human agency and human intelligence behind them, and convey a direct order to a driver as to what he is to do, whereas the latter merely tell him the line is clear for a short distance ahead.

In America the sections for this system of signalling vary in length from about 700 yards to 1,300 yards, the average being 1,000 yards. As at the commencement of each section two signals (a home and a distant) are erected for each line of rails, signals become exceedingly numerous, and whereas the signals on American railroads have hitherto been too few, there is now a risk of their becoming too many. Block working, at any rate in England, means the maintenance of an adequate interval of space between two trains travelling on the same track. Goods trains of great length are now coming into use, and they are not infrequently as much as 800 yards long. With trains of such dimensions the interval of space between two trains may, if block sections are only 1,000 yards long, be as small as 200 yards, which, except at very low speeds, cannot be regarded as adequate. Again, the number of block sections into which a line requires to be divided depends on the number of trains which it is desired to pass over it in a given time. With block sections of 1,000 yards, and trains running at 60 miles an hour, the interval of time, or, as the Americans call it, the "headway" between them may be only 34 seconds, which is clearly impracticable and dangerous. Even at a speed of 20 miles an hour the headway may be only 1 minute 42 seconds, and at 10 miles an hour, 3 minutes 24 seconds, and as it can only occur at starting points or at terminal stations that it is necessary for trains to follow each other at such brief intervals as these, it is difficult to see the advantage of such very short sections in other parts of a line, where trains have to travel at speed, and where fast trains are mixed up with slow. Signals placed at such short distances apart are more likely to be confusing than helpful to drivers, whose confidence when running at speed must also be lessened by the shortness of the block sections. The only reason that I have been able to discover for the introduction of such short block sections, is that "track circuits" do not work well on sections of greater length, but it is difficult to believe that this defect cannot be remedied.

THE FOG DIFFICULTY.

A difficulty arises in England in connection with such signals, and that is how to deal with them in time of fog. In America fogs are said to be rare—at any rate no special precautions are taken to meet such an emergency. But here it will be as necessary to provide means for "fogging" automatic signals as any other signals. Men for the purpose will be difficult to find, and if mechanical means are adopted for the purpose, the complication and weight of the signals will be increased, and the mechanism will be more liable to fail. The effect of climate and of weather upon automatic signals in England has yet to be ascertained, and it must be remembered that a signal which fails at any time to give a correct indication is likely to be a source of danger. Probably the greatest risks are to be anticipated from snow, frost, and lightning, any one of which may, under certain conditions, cause a signal to remain at "all right," when it ought to be at "danger." Should that happen, a most serious condition of affairs would exist, the results of which might be disastrous. Even under normal conditions the reliability of automatic signals depends on the most careful and trustworthy maintenance. In America, it is said that the failures, as a rule, result in a signal remaining at "danger" when it ought to be at safety, and as this would be likely to cause delay to the traffic, drivers are instructed, when they find such a signal at danger, to bring their trains to a stand, and then to proceed forward at caution, without waiting for the signal to be lowered. This rule may be unavoidable, but it is easy to see that sooner or later it must result in two trains being in the same section at one and the same time, which defeats the whole object of block working. Telephonic communication is usually provided, telephones being placed on every second or third signal post, so that in case of a breakdown, the trainmen can communicate with the nearest signal box.

In England the problem is further complicated by the existence of numerous industrial sidings on the main lines, the points and signals of which must necessarily be interlocked with the automatic signals, and require human agency to operate them.

There is something attractive about the term "automatic signalling," and the conclusion is sometimes hastily arrived at, that its adoption will immediately effect increased safety, greater economy and simplicity of operation, a reduction of expenses, and larger dividends. But the cost of installing a system of automatic signalling is great, involving as it does the erection of a power plant, electric or pneumatic, to supply the power for operating the signals, the laying of pipes, conduits, or cables for the entire length of the line for conveying the power to the signals, the provision of numerous wires, batteries, and relays for controlling the power, and the erection of a great number of signals, and the bridges or posts supporting them. Moreover, if the system is to take the place of an existing installation of manual signals, it is to be remembered that the whole of the latter has to be "scrapped." A considerable advantage, such as a large saving of wages, and a largely increased capacity of the railway must therefore be assured in order to justify the outlay.

SPECIAL AND PECULIAR RISKS.

Automatic signalling does not of itself introduce greater safety of operation. It is merely a labour-saving device. No doubt it eliminates the risks due to mistakes of signalmen, but it introduces other risks peculiar to itself, due either to inefficient maintenance, to failure of the mechanism, to weather, and to accidents of various sorts. Moreover, the chief object of a system of automatic signalling must be to enable more trains to pass over a given section of the line in a given time, and more trains under such conditions necessarily involve increased chances of accident.

From what has been said it will be seen that the whole question of automatic signalling requires to be further considered before its applicability to main lines in England can be thoroughly ascertained, and the results of the trials of the system upon the London and South-Western and North-Eastern Railways will be of the greatest value in the investigation of the subject.

But in "tubes," subways, tunnels, and especially on electrically operated railways, on which speeds are uniform, junctions and sidings are few and far between, sections short, and which are self-contained, automatic signalling will undoubtedly prove exceedingly useful, and some of the railways in London now being equipped for electric traction are to be signalled in this fashion.

POWER WORKING OF POINTS AND SIGNALS.

The application of some form of power, pneumatic or electric, to the operation of points and signals, is becoming a common feature in America at places where large signal cabins are necessary. Such installations possess many advantages, reducing the physical labour to a minimum, and rendering it possible to employ fewer men. They also economise space and abolish all rods and wires from the station yards. The chief, if not the only, objection to them is their cost, which in the first instance is much greater than that of an ordinary manual plant, and it is simply a matter of calculation whether at any particular place the economies to be derived from such an apparatus balance the initial cost. There are two systems in general use, viz., the electro-pneumatic and the low-pressure pneumatic. In the former the movement of the points or signals is effected by air at 75 lb. pressure, which is admitted to cylinders containing pistons connected to the switches (or signals) by means of valves which are controlled by electric currents. In the latter the mechanism is operated by air at 15 lb. pressure, the valves being controlled by a secondary air supply at 7 lb. pressure. In England a large installation of a similar nature has lately been erected by the London and North-Western Railway at Crewe, in which the motive power, as well as the controlling agency, is electricity. The North-Eastern Railway and Lancashire and Yorkshire Railway Companies are at the same time about to test the electro-pneumatic system, and the London and South-Western Railway Company are trying the low-pressure air method. It will, therefore, soon be possible to compare the results obtained by these three systems.

ROLLING STOCK.

Probably the feature of American railways which at first sight makes the most impression on a stranger is the colossal size of the engines and cars employed thereon, and to this is due much of the correspondence which at intervals fills the columns of the papers concerning American methods of handling traffic. There is no doubt that the engines are very big, some of them standing 16 ft. high above rail level, and many more of them 14 ft. 6 in. and 15 ft. Such engines have great power and are able to haul trains of great weight and length. In the early days of American railroads over-bridges and tunnels were almost unknown, and now that such are being constructed, they have to accommodate themselves to the rolling stock, instead of the rolling stock to the bridges, as in England. In America over-bridges are built 18 ft. above rail level, whereas in England the height of such works is, as a rule, only 14 ft. 3 in. above the rails. Moreover, on double lines in the States the space between the tracks is 7 ft., against 6 ft. in England. It can, therefore, be understood that what is possible in the one country is impossible in the other, and we can never hope in England to equal America in the size of our engines or cars.

GOODS TRUCKS.

A great deal has recently been said about the long freight cars used in America, and English railway managers have been criticised for not adopting cars of equal dimensions in this country. I think some misapprehension occasionally arises on the subject. The important factor in the case is not the length of the car, but the carrying capacity of the car in relation to its weight. American freight cars are all carried on bogies, and, as a rule, there are eight wheels to a car. Their carrying capacity varies from 30 to 50 tons, and their "tare" weight from 15 to 20 tons. One of the most popular forms of car at the present time appears to be the 50-ft. steel-framed car, with a capacity of 50 tons (of 2,000 lb.) and a tare of about 20 tons, the total weight per axle being 17 tons 10 cwt. So long as these proportions are adhered to it makes no difference, so far as the cost of transportation is concerned, whether the load is carried in one car with eight wheels or in two cars with four wheels each. That is to say, the result will be the same if, instead of one car of the size and weight mentioned, two cars are employed, each with a capacity of 25 tons and a tare of 10 tons, and each having four wheels. Not all the cars in America offer such favourable conditions as those just mentioned. The box cars have as a rule a carrying capacity of 30 to 40 tons and a tare of 16 to 18 tons; the paying load in these cases having a less proportion to the dead load than is the case with the 50-ton cars.

There are serious difficulties in the way of introducing for general service in England waggons of great length. The sidings, goods sheds, weighbridges, turntables, coal tips, screens, etc., are, as a rule, quite unsuitable for waggons of the dimensions named, to say nothing of the usual conditions of trade which are based on the present style of vehicle. It is sometimes suggested that English companies should forthwith reconstruct the whole of these works and appliances, but no one has as yet estimated what the cost of such alterations would amount to. It is probably incalculable, and the question arises, whether, after all this vast expenditure had been incurred and the whole trade of the country had been disorganised during the transition period, the saving in handling the traffic would pay the interest on the outlay.

The four-wheeled waggon will, therefore, in all probability remain the standard waggon of the country, and economy is to be sought in improving the design of such waggons and increasing their carrying capacity in relation to their tare, rather than in introducing waggons of greater length.

There is no reason why this should not be done; in fact it has already been accomplished on some railways. Both the London and North-Western Railway and the Great Western Railway Companies have lately built four-wheeled waggons, having a capacity of 20 tons, and a tare of about eight tons, which gives the same proportion of paying load to dead load, as an American car of 50 tons capacity.

Another argument against the employment of very long cars or waggons is, that in the case of a derailment or collision the results would be more serious, and the removal of the wreckage would be a much more difficult operation than at present.

There is also the difficulty to be considered due to the private ownership of the bulk of the waggons used upon English railways. This, though serious, need not, perhaps, be regarded as insuperable, as if the railway companies throughout the Kingdom were unanimous in adopting waggons of a new design, means could be found, perhaps with the assistance of the legislature, either to abolish privately owned waggons, or else to compel the owners thereof to adopt whatever type of waggon was found to be beneficial to the trade of the country.

It is not suggested that long waggons will never be used, as it is evident that for some purposes such waggons are desirable or even necessary. But for ordinary trade purposes in this country the four-wheeled waggon, of improved design and increased capacity, is, I believe, the best suited.

The wheels of American cars, both passenger and freight, are smaller than those used in England, being only 33 in. in diameter, instead of 36 in. as in England. It seems worth consideration whether 33-in. wheels might not with advantage be introduced in England for goods waggons. This would enable an additional depth of 3 in. to be given to the waggons, thereby increasing their capacity without adding to their height. and would at the same time lessen their weight, and effect some economy in their first cost. All the wheels of American freight cars, and occasionally also of passenger cars, are of cast-iron with chilled rims. They are not turned in a lathe or machined in any way, but are used just as they come from the foundry. When the wheels are worn out the manufacturing company takes them back at a fixed price, breaks them up, and recasts them. The net cost of such wheels to the railway company is, therefore, very small. Recently fractures of these cast-iron wheels have increased in number, and it is a question whether, as at present made, they are suitable for the increased loads put upon them by the introduction of heavy cars. Improved modes of manufacture may overcome this defect, or wheels with cast-iron centres and steel tyres or wheels wholly of steel may become necessary.

COUPLINGS.

The law of the American Congress relating to the use of automatic couplings and air brakes on all freight trains engaged in inter-State commerce came into full force on the 1st August, 1900, and the fifteenth annual report of the Inter-State Commerce Commission, published in 1902, is a highly interesting document. From this it appears that the coupling mechanism is still far from perfect, especially in regard to the uncoupling attachments. Another "common defect in couplers, and one which is the cause of much trouble and expense to the railroads, is the breakage of the 'knuckle.'" The Commissioners are evidently not satisfied with the couplers as at present used, for the report says, "it will be seen that the needs of the future, in respect to couplers, may be described under the heads of strength, simplicity, and finish."

AIR BRAKES.

The same report contains some severe criticisms on 'the present condition of the air brakes on the freight cars of the country, the lack of thorough training and discipline of the men in charge of trains, and the insufficiency of the forces assigned to inspection and repair"; the result being that "some companies, more particularly in the east, are still controlling trains on steep descending grades by the use of the hand brakes." This is in accordance with what I saw on the Pennsylvania Railroad, where numerous heavy coal and goods trains were being taken down the Horse Shoe incline by means of the hand brakes, the brakesmen having, in consequence, to run about on the roofs of the cars while the trains were in motion, a practice which is highly dangerous and a fruitful cause of accident to the train men. One reason assigned for this non-use of the air-brake on such inclines is that the driver may, by repeated application and release of the brakes, exhaust all the air in the air reservoirs. It then becomes necessary for him to re-charge them, and the doing so releases all the brakes, during which time the train may gain a dangerous degree of speed, and get beyond control. To overcome this difficulty "retaining valves" have been introduced for partially controlling the air pressure in the brake cylinders during the process of recharging the reservoirs. These retain a pressure of 15 lb. in the cylinders during the time that the reservoirs are being recharged, and are described in the report already alluded to as "a device for more efficiently and safely controlling the speed of trains on steep, descending grades." "While under favourable conditions the air brake is efficient without this auxiliary, its use is a valuable additional safeguard, and on very steep grades it is a necessity."

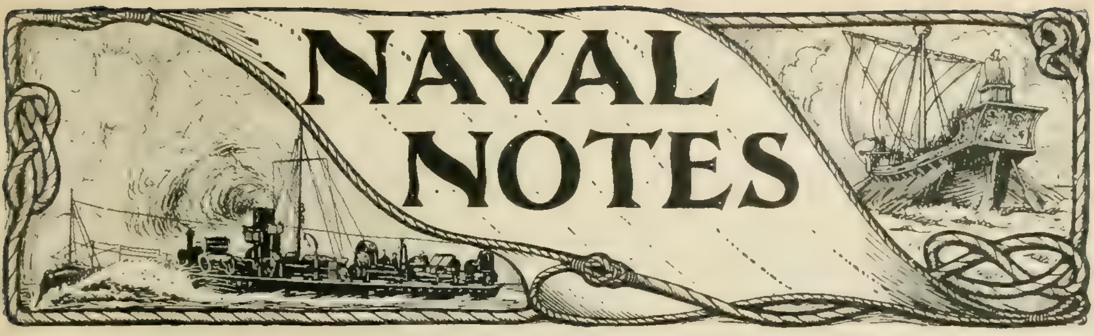
Unfortunately, the handles for operating these retaining valves are on the roofs of the cars, so that their use still renders it necessary for the train men to be above. As the number of bridges over the railroads is increasing, the danger to the men on the tops of high cars becomes greater, and a primitive arrangement for their protection is a common feature on American railroads. This consists of a rope supported on posts and stretched across the tracks on either side of an overbridge. From this rope depend short vertical lengths of thinner rope at close intervals, their lower ends being about the level of the underside of the bridge. The idea is that a man on the top of a high car would be struck by one of these ropes, and warned of the neighbourhood of the bridge in time to avoid the danger.

The law does not render it obligatory on the companies to use the air brake on all the cars of a freight train, but only on so many as will enable the driver to have sufficient brake power at his disposal for controlling the train down the inclines. This partial use of the air brake is a cause of accidents, for when the brake is brought into operation on some of the cars of a train, the cars not so braked are by their momentum forced against those that are, with such violence as to crush, and sometimes derail one or more cars. The law in this respect seems to require amendment. If the air brake is to be used at all on freight trains, it should be operative on every car.

From the above facts it will be seen that the problem of safely working heavy American freight trains down steep grades by means of the air brake has not yet been entirely solved. And when it is remembered that some of the large American engines require three men on the foot plate, viz., driver, fireman, and assistant fireman, and that the train crew consists of a conductor and two, three or four brakesmen, it may be questioned whether the economies claimed for the American methods are as great, as is sometimes hastily assumed.

GRADE CROSSINGS.

It is interesting to note that American railroads are imitating English practice in one respect, and that is in the abolition of level or grade crossings. Enormous sums of money are now being spent with this object. This is specially the case on the Pennsylvania Railroad, on which line some very large works, such as viaducts, bridges, and deviation lines, are in progress for the purpose of raising the tracks above streets and roads, and for improving grades and curves. These works are being paid for out of revenue and not charged to capital. The guiding principle followed in America on this much-debated question is, I was told, as follows: When a new work, however large, does not tap new sources of revenue, and does not serve a fresh area, but merely improves existing conditions and facilities, the cost is charged to income. When, on the other hand, new districts are reached, and fresh sources of traffic developed, the cost is charged to capital. To what extent the cost of works, such as those I saw in progress, amounting as they do in many places to a complete re-alignment and reconstruction of the railway, can be legitimately regarded as a charge against income, I cannot say, but it is not surprising that the shareholders should grumble at being called upon to make such sacrifices for the benefit of those who will succeed them. I heard one argument advanced, which, if not openly avowed, may have an occasional influence on American railway finance, viz., that as American railways were built almost entirely with money raised on bonds or debentures, and that as the ordinary stock, to a large extent, merely represents "paper," there is no obligation on those controlling the line to do more than pay the interest on the bonds and debentures, and that the ordinary stockholders have little or no moral claim to consideration.



MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

IN my last instalment of Naval Notes, written before the Navy Estimates had been announced, it was shown why I thought it would be good policy on the part of the Admiralty to include in the new shipbuilding programme more battleships and armoured cruisers. That the authorities are of the same opinion I am glad to see. In spite of prognostications to the contrary the vote for new construction has again been increased and the programme is even larger than it was in the previous year. We have already five battleships of the *King Edward VII.* class, which stand apart from all those built previously, in size and power, and to these three more are to be added. Last year the programme gave only two armoured cruisers, of the *Duke of Edinburgh* class, this year we are to have four more. As regards the smaller craft, perhaps, the most important announcement is that concerning the submarines, of which ten larger and better than their predecessors are to be laid down. Although there are no torpedo-boats in the programme there are fifteen destroyers, six more than in the previous year's programme, and there is another group of four scouts—the new type introduced in 1902. Without at the present time going into a criticism of the details of the above vessels, it may be pointed out that we have here indications of a settled and consistent policy. There is shown a determination to build in groups, and not to accumulate specimens. The principle of homogeneity in type is apparent throughout. There are naturally from year to year improvements and modifications in the ships of a group ordered later than their sisters, but to a great extent these are such that the older ships can, by additions, be brought up to date, and in this way the whole group is fitted for coherent work. Whatever part of the policy of the Admiralty be the subject of criticism I feel sure that in the matter I have referred to they will receive universal support.

In these notes, we are more concerned about matters of construction and armament and general administration than that of *personnel*, but it may at least be noticed that the present Board show a determination not to repeat the mistake made at the time of the passing of the Naval Defence Act. They are making provision for manning the new ships, at the same time as those ships are commenced themselves. Thus the expansion of the Navy proceeds on thoroughly sound and commonsense lines. The actual addition to the *personnel* is a little under 5,000, but in addition there is the special Act dealing with the manning of the fleet. By this, the system of short service which has already been working tentatively as regards the Coast-guard and the lately constituted Fleet Reserve, is now extended to the Naval Reserve, and men will be entered for a shorter term of service than the present one of twelve years on the understanding that they complete the term of twelve years in the Reserve.

In addition to this the limit placed upon the numbers of the Fleet Reserve has been removed, enrolment in this body having proceeded most satisfactorily. Thirdly, the Naval Volunteers have been re-established and extended to the Marine Corps, with this very important alteration that volunteers enrolled under this Act will be liable for service in time of war in any part of the world. It will be remembered that the old Corps of Naval Artillery Volunteers, which was abolished in 1891, numbered at that time 1,900 officers and men, but the scope of their duties was limited in such a way as to considerably diminish their value. As regards another matter connected with this subject it is noteworthy, as I predicted some time since, that the new Admiralty scheme of entry and training for officers is, in spite of all opposition, in process of being carried out. And the selection of the officers for the various appointments at Portsmouth, gives assurance that no obstacles will be allowed to prevent it being launched under favourable conditions.

Finally, we come to more contentious matter. The policy of the Admiralty in regard to reconstruction and repair of ships, and to their fitting out, has been the subject of much discussion; there has been no lack of self-constituted advisors and counsellors to urge the various assumed reforms in this direction. But the authorities are working on lines which, it is clear, have been recommended by Committees in which we have every reason to place our confidence. It is not to be disputed that modern vessels need repair much oftener and to a much larger extent than did their predecessors, whether of the old wooden types, or the ironclads which succeeded them. As a necessary consequence, our dockyards are much overburdened with work, and for this reason two steps have been taken to relieve the congestion which appeared imminent. Certain ships have been sent to the private yards for repair and reconstruction, while in addition it has been determined to fit out certain of the new vessels built by contract at the private establishments. These measures have been taken tentatively at present, and we have yet to see what the result will be. Anyone, however, who has given any study to naval matters must acknowledge that so far as previous experience can guide us there is no existing reason to suppose that the new arrangements will not prove satisfactory. Furthermore, some time since it was urged upon the Government that the time had arrived for establishing a new public yard somewhere on the East Coast. Those who took this line were apparently unaware that previously to their action this very matter had been under consideration by the Admiralty, and that a Committee, appointed by Lord Goschen to report on the subject had recommended early in 1902 favourably to the proposed undertaking. At the present time there are five yards in English ports—the three principal ones at Portsmouth, Devonport, and Chatham, with the two smaller yards of Sheerness and Pembroke. In Ireland, also, at Haulbowline, there is an establishment which has gradually been acquiring increased importance. But nothing has so far been done in this direction in North Britain. This circumstance, as well as the fact that there are several private yards quite competent to undertake Government work on the East Coast of England, pointed to Scotland as the locality for the establishment of an additional "Home port" if it be required. And the present Board has come to the conclusion that owing to the increase of the Fleet in commission and reserve in Home waters, and the consequent congestion of accommodation both for ships and men at the three Home ports of Portsmouth, Devonport, and Chatham, "the time has arrived for the creation of a fourth naval base and depot in the United Kingdom." This it is intended to establish in Scotland, and after an examination of all the available sites, and a thorough consideration of the question in its industrial and strategical aspects, the Board of Admiralty has selected the Firth of Forth as fulfilling all the necessary requirements. At the time of writing it is too early to discuss the questions that arise out of this proposed development. But it is in itself good evidence that the Admiralty are in every direction taking thought and action of the growing necessities of the Empire in its strategic and Naval aspects.

In the following notes the progress at home and abroad since our last issue will be found under the heading of the different countries.

GREAT BRITAIN.

The *Cornwallis*, battleship, which began her trials early last month, and then had to postpone them owing to the bad weather prevailing at the time, has now satisfactorily completed them. The speed attained was not quite so good as anticipated, owing, doubtless, to the heavy weather. The actual speed was 18·98 knots with 18,238 h.p. The coal consumption worked out at 1·89 lb. per unit of power per hour. It is anticipated that her sister ship, the *Albemarle*, will have completed her trials by the end of the financial year. The *Russell*, of the same class, was commissioned on February 18th at Chatham. It is reported that the *Cornwallis* will serve in the Channel Squadron, with possibly the *Duncan* as flagship; while the *Exmouth* will go to the China station to replace the *Goliath*. The *Commonwealth* is expected to take the water at the Fairfield Yard early in April. Of the armoured cruisers at the time of writing two are under trial, the *Kent* and the *Monmouth*. We have already referred to the trials of the first-named ship, in December last, and in February, after the pitch of her propellers had been altered, she realised only 21·7 knots as a mean speed when the contract called for 23. It was then decided to make the ship perfectly clean in the water, and under these conditions she improved her speed by three-quarters of a knot, being then still half a knot under her stipulated speed. Nevertheless, the Admiralty have accepted her, and her completion for commission is to be hurried on. The *Monmouth*, on her thirty hours' trial with 16,000 h.p., made a speed of 20·5 knots. The *Essex*, on her thirty hours' ⅕-power trial did 14 knots with 4,638 h.p., and at ¾-power did 19·6 knots with 16,132 h.p. Her full power trials were not completed at the time of writing.

Two of the new type of torpedo-boat destroyers, building by contract, have been put into the water, the *Erne* was launched at Palmer's Yard on January 14th, and the *Foyle* from the works of Messrs. Laird Brothers, Birkenhead, on February 25th.

The first-class torpedo-boat, No. 109, built by Messrs. Thornycroft, and launched in July of last year, has made her trials with satisfactory results. The results of her four hours' full power trial were as follows: Draught of water forward, 5 ft. 3¾ in., aft, 8 ft. 2½ in.; speed, 25·296 knots, steam pressure in boilers, 218 lb.; vacuum in condensers, 24·3 lb.; revolutions per minute, 392·8; mean i.h.p., 2,864. The details of a coal consumption trial previously run worked out at 2·68 lb. per i.h.p. per hour.

The first five submarine boats built at Barrow having been delivered at Portsmouth, went out for practice in charge of the *Hazard* on March 4th. After an experimental run they returned to their stations in Porchester Creek, the boat known as No. 1 being the last in the line. As she passed up the harbour an explosion occurred in the gasolene tank, owing, it is said, to water splashing into it. Four of her men were badly injured about the face, hands and arms, and were conveyed to Haslar Hospital. This is the second accident of this nature which has occurred recently.

Of the next group of submarines known as A1, A2, A3, A4, the first-named has been undergoing experiments at Barrow Dock, and it is expected that the others will be launched before the end of April.

FRANCE.

It will be remembered that during some manœuvres in the Mediterranean, two French battleships came into collision, and that, although the damage done was very trifling, an inquiry into the cause of the mishap naturally followed. As a result of this inquiry the officers in charge of the two ships were exonerated from blame, a decision which, it appears, did not satisfy the Minister of Marine. M. Pelletan overruled the naval authorities in the fleet, and removed both officers from their commands. Such a proceeding naturally gave rise to considerable discussion, some writers regarding this step as an unwarrantable interference with the disciplinary arrangements of the fleet, and others as likely to prove a hindrance to the initiative of officers. Some of the reasons given for the action of the Minister of Marine were that the captain of the *Bouvet* handled his ship clumsily, and was a generally unlucky commander, while it was alleged against the captain of the *Gaulois* that he had already been reprimanded by Admiral Potier for the manner in which he had moved his vessel in the exercises. While there can be no question that the Minister of Marine was quite within his rights in taking the action he did, it is held on this side of the water that in these matters it is at least expedient to allow the judgment of the technical advisers to prevail.

Although nothing further has transpired in connection with the progress of the French new constructions referred to in last month's notes, the report of M. Honore Leygue upon the French Naval Budget is still the text for discussion. M. Leygue commented upon some of the characteristics which it was proposed should be given to the new vessels, and pointed out that the homogeneity contemplated by the old programme was endangered. The modifications referred to were in the new battleships, the substitution of ten 7·6-in. guns for the original eighteen 6·4-in., and the addition of eight 3·9-in. guns in the cruisers; also the *Ernest Renan* was considerably altered, as explained last month, both in tonnage, speed, and armament. In the last-named respect two 9·4-in. guns take the place of four 7·6-in., and four of the 6·4-in. are to be omitted, the number being twelve instead of sixteen. Her plan as now arranged gives a length of 515 ft. 10 in., beam 70 ft. 6 in., and draught of water 26 ft. 10 in. The complement of the ship is to be 638 officers and men. Some changes are also to be made in the *Jules Michelet*, which will carry the same armament as the *Ernest Renan*. Although further trials were made in February-March with the armoured cruiser *Jeanne d'Arc*, they have not been attended with the desired results.

In the *Journal Officiel* of February 14th the Minister of Marine published a circular explaining his objections to the use of water-tube boilers with small tubes in large warships. He also gives his reasons for insisting on a ten hours' trial with full power, instead of a three hours' trial with fires alight under only three-quarters of the boilers. The amount of coal used per hour per square metre of grating area should be, in his opinion, increased from 110 to 150 kilos.

Although great efforts were made to raise the destroyer *Espingole*, which was sunk off Cape Lardier early in February, these have been unsuccessful. The new submarine boats X, Y, and Z, which have been designed by MM. Romazotti, Bertin, and Maugas, are to displace respectively 168 tons, 213 tons, and 202 tons. The largest (Y) will have a length of 142 ft. 8 in. and 9 ft. 9 in. beam. The diameter of X is greater, being 10 ft. 6 in.; the speed of these vessels will be from ten to eleven knots. The submarine *Lutin* has been launched at Rochefort. Two large submersible boats, designed by M. Laubeuf, and building at Toulon, have received the names of *Aigrette* and *Cigogne*. Their displacement is 172 tons, length 117 ft. 6 in., beam 12 ft. 6 in., and draught 8 ft. 6 in.

As mentioned in last month's notes, nineteen submersibles, or submarines, are to be put in hand during this year. One of them will have a displacement of 301 tons. She will be 160 ft. 6 in. long, 13 ft. 9 in. beam, 9 ft. draught of water, and the anticipated speed is 11 knots.

GERMANY.

The two German battleships of the *Wittelsbach* type, the *Braunschweig*, whose launch has been already mentioned, and J, now nearly ready to take the water, have some notable differences from the prototype of the class. In the first place there is an addition of 1,000 tons in displacement, which has been used for the substitution of 11-in. for 9·4-in. guns, and fourteen 6·7-in. for eighteen 6-in. The gain is a slight increase in power of penetration. In regard to the armament, also there is a re-arrangement of the 20-pounder guns, these being now more widely distributed than they were in the *Wittelsbach*. A certain amount of end on fire has been dispensed with, the *Braunschweig* being able to bring but four of her 6·7-in. guns to bear ahead, whereas the *Wittelsbach* could bring into action at the same point eight 6-in. In both the last-named features the Germans appear to be following the arrangement already in vogue in this country, and in the United States. In regard to armour also the protection of the main deck battery has been extended, until it now forms a complete citadel from one barbette to the other. The height of the fore barbette also has been reduced. It will be noted that these modifications in the type are not sufficient to interfere with the homogeneity of the class. They are, in fact, in the nature of the changes that will probably be found to characterise the difference between the *King Edward VII.* class in our own Navy, and the battleships of this year's programme.

The new torpedo boats of 350 tons, built at the Germania Yard have undergone their trials. Nos. 108 and 111 made 29·2 knots, and Nos. 113, 109, and 112 made, respectively, 28, 27·8, and 27·7 knots.

RUSSIA

The new Russian programme is announced, and is reported to have received the sanction of the Tsar. It is reported to include six first-class battleships of 16,000 tons displacement each, although another report places the number at five, but agrees in the displacement. These battleships, we are told, will be armed with four 12 in. and twelve 8-in. guns, as well as a large number of lighter pieces. There are also three first-class cruisers of heavy displacement, and smaller cruisers, destroyers and submarines in the programme. These Russian ships, it is said, are to be built within the next three to five years.

UNITED STATES.

The Appropriation for the Navy, as finally passed by the Conference Committee of the two Houses of Congress, amounts to a sum of over sixteen millions sterling, and includes a grant for the building of three battleships of 16,000 tons displacement, of the type of the *Connecticut* and *Louisiana*, and two battleships of 13,000 tons displacement, of the type of the *Ohio* and *Missouri*, vessels which are shortly to be placed in commission. The measure, as finally passed, was somewhat of a surprise, for while the House of Representatives, as reported in last month's notes, had provided for three 16,000-ton battleships and one 14,500-ton armoured cruiser, the Senate amended this Bill so as to provide for four 12,000-ton battleships, and two 9,500-ton armoured cruisers. It has been decided that the three new 16,000-ton battleships shall be named the *Vermont*, the *Kansas*, and the *Minnesota*, and the two 13,000-ton battleships will be named the *Mississippi* and the *Idaho*. Other features of the Appropriation Bill provide for doubling the number of midshipmen until 1913, and largely adding to the seamen class. Funds are also provided for ammunition for target practice, and prizes for marksmanship.

MINOR NAVIES.

The Argentine cruiser *Moreno* was launched from the Ansaldo Yard at Sestri Ponente on February 9th. This vessel is a sister to the Rivadavia, of which a description was given in the notes for December last. It is probable that both Chili and the Argentine will sell the greater number of the later vessels they have had constructed, these two countries having decided by treaty to reduce their naval strength

LOCOMOTIVE ENGINEERING NOTES.

Ten-Wheeled Express Locomotives.

It will probably be safe to predict that a date not far distant will see all locomotives that are intended for fast passenger service built with ten wheels. The tendency in that direction on the European and American continents, as well as in Britain, is so marked as to be quite unmistakable. It is not meant that the express engine of the future will necessarily be of the type which some American writers and their British imitators term, with regrettable ambiguity, "the ten-wheeler"; but simply that it will be a ten-wheeled engine. It is a little unfortunate that a term so vague as "ten-wheeler" should have been adopted by American writers, and perhaps still more unfortunate that those writers should have been servilely followed by English copyists, because a "ten-wheeler," like the famous Bristol and Exeter type of yore, may have a single pair of driving wheels with four-wheeled bogies in front and behind; or it may be of what America has taught us to understand as the "Atlantic type"—sometimes, by-the-bye, varied into the "Atlantic City" class. Again, it may have a four-wheeled leading bogie, the six other wheels being coupled, this constituting what the American writers prefer to term the "ten-wheeler" proper; or it may have eight wheels coupled with a two-wheeled bogie or pony-truck in front. That also is a type which originated in America and which is classified there as of the "Consolidation" order. Lastly, it may have all its ten wheels coupled, like Mr. Holden's new No. 20, on the Great Eastern, in which case it is known in Britain as a "decapod," that term, however, being only used in the United States, oddly enough, when the locomotive has a pony-truck in front, and therefore becomes twelve-wheeled. Yet another variation of ten-wheeledness is largely used in the British colony of New Zealand, being in fact for a long time the standard passenger express type in use there. In this case the three middle pairs of wheels are coupled, and there are leading and trailing two-wheeled pony-trucks. With such a variety of interpretations to choose from, it will at once be seen how unsatisfactorily misleading or ambiguous as a class-designation the term a "ten-wheeler" necessarily is.

The Two Principal Types.

For practical consideration, however, the types likely to come chiefly into British use may be deemed to be limited to two: (1) that having four wheels coupled with a leading four-wheeled bogie and a trailing pair of carrying wheels; (2) that having six wheels coupled with a four-wheeled bogie in front. But from these two bases or roots are springing, and will spring, a number of varieties in respect of details. In order to avoid any confusion of thought by importing American nicknames, it will thus be more convenient to classify those two main types by the names borne by two of the most prominent specimens of each order now at work in Britain. As it happens, those designations belong to the earliest British representative of the one class, and the latest yet brought out, of the other. Of the four-wheel coupled type, with leading four-wheeled bogie and single pair of trailing wheels, the earliest British exponent was the engine No. 990, designed and built by Mr. H. A. Ivatt, for the Great Northern Railway recently named "Henry Oakley," after a former respected general manager. It was followed very shortly afterward by Mr. J. A. F. Aspinall's No. 1400, on the Lancashire and Yorkshire, which differed from "Henry Oakley" in having inside cylinders 19 in. by 26 in. instead of outside cylinders 18¾ in. by 24 in.; 7 ft. 3 in. coupled wheels instead of 6 ft. 7 in.; and a far larger boiler with 2,052 square feet of heating surface instead of 1,444 square feet. Still, the types were identical so far as concerned their title to bear the American class-designation "Atlantic." There appears no reason to doubt that both of these engine-types have proved *pro tanto* successful; both, at any rate, have done excellent work under the writer's observation, and in view of the manifest advantages offered by this mode of construction, it is a little surprising that so far these two should be the only British instances of a type which in many other parts of the world has incontestably proved its solid value. Such, however, is the case. As yet Britain affords no other instances of the "Henry Oakley" or "Atlantic" mode of arrangement than those of the Great Northern and Lancashire and Yorkshire.

As yet the Lancashire and Yorkshire appears resolutely constant to its "1400" type, which now has some fifty or sixty representatives on that railway. Nor is this surprising, for the pioneer of the order virtually went as far dimensionally as loading-gauge limits permitted, assuming it to be found desirable to maintain the exceptionally large diameter of 7 ft. 3 in. for the coupled-wheels. No. 1400 and her sister engines have done, and are doing, admirable service, and the type has this notable advantage: that, should increased power be needed, it can promptly be obtained virtually on the same lines either (*a*) by reducing the driving-wheel diameter to 6 ft. 6 in. or 6 ft.; (*b*) by enlarging the cylinders, which even then the present vast boiler ought to be able to keep well supplied with "live" steam; or (*c*) by combining the two foregoing changes; or (*d*) by compounding the engine, which would enable more power to be utilised from a given volume of steam; or (*e*) by increasing the size of the boiler as well as of the cylinders while reducing the size of the driving-wheels. As yet, however, the necessity does not seem to have arisen.

Great Northern Variations.

On the Great Northern, however, as I mentioned last month, Mr. Ivatt has recently brought out two variations of his "Henry Oakley" or "990" class. As regards one of these no possible doubt can exist that it goes in the right direction. The variation consists simply in providing a vast increment of boiler-power. After the results given by "990" and her ten sisters, there does not seem room for the slightest doubt that Nos. 251–260, which are reproductions of that type, with a boiler 5 ft. 6 in. in diameter, affording 2,500 square feet of heating surface, will prove themselves capable of finer work than has hitherto been seen even on the Great Northern Railway. Doubts were justly entertained whether the boiler of "990" was large enough to afford full scope to the 18¾-in. cylinders. That doubt has now been resolved into a certainty by Mr. Ivatt's decision to enlarge the boiler dimensions. The addition of more than 1,000 square feet to the heating-surface ought to do wonders in the way of improved efficiency.

The principle of the other variation of the "Atlantic," or "Henry Oakley," type on the Great Northern, is a good deal more open to exception, while at the same time its potentialities are so valuable as to entitle it to thorough trial. Whether the four 15 in. cylinders given to No. 271 with their short piston-stroke of 20 in. will really prove superior in practice to the ordinary two cylinder arrangement, can only be determined by practical experience. Mere theorising on such points has been proved over and over again to be utterly valueless, because it is virtually impossible to be certain that every influential factor has been taken into account or received due allowance as to its effect upon results. That the four cylinder arrangement does give a better balancing of working parts may be unhesitatingly admitted, and Mr. Ivatt has undoubtedly improved the prospects of his new engine's success by coupling the four driving wheels. The experiment is full of interest and importance, but its really relevant results will not be easily arrived at. No rational doubt can be entertained that No. 271 will perform good locomotive work. There is reason to believe that this has already been demonstrated, although here the writer is unable, as yet, to speak from personal experience. But the question which necessarily suggests itself is, not whether an engine of that type and those dimensions, will perform good service—which goes without saying—but whether it will do good enough service, and service sufficiently superior, to compensate for the self-evident drawbacks which attend that mode of construction. The question appears to be purely one of economy. Two pairs of cylinders with all their concomitant working parts must of necessity cost considerably more than a single pair, even allowing for their smaller size. Similarly, the upkeep and repairs of four cylinders and four sets of working parts must assuredly be more costly than those of two sets. It is not suggested or imagined that the cost will be double, but there can be no conceivable doubt that it must be materially increased. It may be urged that this would be in some degree compensated by the diminished wear and tear due to the superiority of balancing. That may be so, but scarcely to the full extent of the difference. Thus the point which has to be determined is whether the performance of the four-cylinder engine will prove so substantially better than that which would be obtained from a locomotive having only two cylinders of equivalent aggregate dimensions, as to provide an adequate *quid pro quo* when set against augmented expense of materials, construction, and repairs. And that is the true point at issue.

A Combination of Methods.

It may be worth while to point out here that the new locomotive engine in course of construction for the Great Western Railway at the works of the Société Alsacienne de Constructions Mécaniques, does certainly appear to combine all the points of merit indicated in the "Atlantic" or "Henry Oakley" classes just reviewed, the Great Northern and the Lancashire and Yorkshire. For the du-Bousquet-de Glehn engine, which is to be delivered to the Great Western in September or October next, has the reduced diameter of driving wheels above suggested for the Lancashire and Yorkshire engines, namely, 6 ft. 8 in. instead of 7 ft. 3 in.; also the enlarged cylinder capacity similarly suggested; the increased boiler capacity—2,300 square feet of heating surface, instead of 2,052 square feet; and of our cylinders, as in the case of the Great Northern

No. 271; also coupled driving-wheels, as in that case; while it further possesses the advantage of being able to use its vast steam supply more economically than either of the British engines, being founded on a system which in many years' experience has been tried and proved to give excellent results. Moreover, the practical trials of engines of this type have produced results equal in all respects to what might have been predicted on the basis of pure theory. Thus the Great Western, while making the third among the British railways to try the locomotive arrangement which might reasonably be known as the "Henry Oakley" type—"Atlantic" type in America—will do so under the specially advantageous conditions of apparently combining into one aggregate all the points of merit, possessed or potential, in the cases of the other locomotives above referred to.

The Other Ten-Wheeled Type.

While the Great Western is the latest, as the North-Eastern was the earliest, among British railways to try the other ten-wheeled type of express engine, there are not wanting indications that other British railways are about to fall into the same line. At present the Great Western has only one of these engines, namely, the type with six-coupled driving wheels and a four-wheeled leading bogie. The North-Eastern has fifteen, subdivided into two classes, which differ only in the respective diameters of the driving-wheels, those of the earliest ten being 6 ft.; and of the last five 6 ft. 8 in. But the Great Central Railway has already followed the trail with such vigour that, if it does not possess more engines of that type than the other two combined, it very soon will do so. Professedly the Great Central six-coupled passenger bogie engines are not designed for what is, strictly speaking, "express" duty any more than were the similar engines of the 3·121 class on the Northern Railway of France. But, just as the French ten-wheelers, while not originally intended for express service, gradually fell into that class of work through their proved suitableness to its requirements, so already, the Great Central ten-wheelers appear to be taking a share of fast passenger work on that line. It is rumoured also that, as in the case of the North Eastern, a variation of the class, having somewhat larger wheels, is about to be introduced. The type is manifestly suited in a special degree to the circumstances of heavy traffic on such a line as the Great Central, with its many miles of severe gradients, and its liability to slipperiness of rails on account of mountain mists. Another rumour at present current, but as yet unconfirmed officially, is that an express engine of the same order, only compounded on Mr. Webb's four-cylinder principle, has been put in hand at Crewe with the view of dispensing (even over such a severe length as the Preston-Carlisle stage, which includes the Shap bank of 1 in 75 for $4\frac{1}{2}$ miles), with the pilot assistance hitherto employed.

More Ten-Wheeler Varieties.

Reference has previously been made in these columns to the new departure taken by Mr. J. F. M'Intosh in respect of ten-wheeled express engines on the Caledonian Railway, namely in respect of the engines with six-coupled 5-ft. wheels (the leading pair being the drivers), inside cylinders, very large boiler, and leading bogie, which were built specially for work on the extreme grades of the Oban branch, and which have, so far, done their work admirably. An enlarged variation of this class, which Mr. M'Intosh has designed for the heaviest and fastest express services on the Caledonian Main Line, has been for some time under construction at St. Rollox, and it is understood that two, at any rate, will be ready to assist in the express services of the coming summer. So far as is at present known, they will have 6ft. 6in. driving-wheels six coupled, the front pair being driven by two inside cylinders, 21 in. by 26 in., while the leading end of the engine will be carried on a four-wheeled bogie; and the same enormous boiler with 2,500 square feet of heating surface that is employed on the huge No. 600 class of eight-coupled mineral engines, will be given to the new express locomotives, which should inaugurate a fresh phase in locomotive practice and experience. Thus, to sum up, it may fairly be said that when we find such engineers as Mr. Churchward, Mr. Ivatt, Mr. Worsdell, Mr. Aspinall, Mr. Robinson, and Mr. M'Intosh all making practical trial of one or other of the two main types of ten-wheeled engines for express duty, it may fairly be concluded that these have not only come to stay, but also are practically certain to hold an exceedingly prominent place among the express locomotives of the future.

C. R.-M.

AMERICAN RÉSUMÉ.

NEW YORK, 10th March, 1903.

Iron and Steel.

There have been no remarkable developments in the iron and steel industry of the United States during the past month, unless the expected advance in the prices of the ores of the Lake Superior region may be so classed. This increase will, of course, mean higher cost of production for finished iron and steel manufacturers who have to purchase their raw materials, and it comes at a time when coal and coke are still high, and but shortly after the recent rise in freight rates. The congestion of the railroads is still unrelieved, and it is surprising, all conditions considered, that consumption of pig-iron is still fairly brisk. In structural material the market has also picked up, builders apparently having decided that an early fall in prices is not promising. During the last week in January the constituent companies of the United States Steel Corporation reported orders aggregating £5,509,000, the largest sales in the history of the organization. Early in March the demand for steel gave indications of being pretty strong for some time, and foreign business in steel billets will probably show a good increase. In foreign pig-iron, however, comparatively little buying has been reported, prices having gone up 1 dol. to 1.50 dols. per ton, owing to better conditions in the home trade. The electric railway developments are causing large purchases in rails, and the outlook in wire and skelp has led to an advance in quotations. The Lake ore prices referred to are for the Mesaba ores: 4 dols. per ton for Bessemer furnace, at lake ports, and 3.20 dols. for the non-Bessemer ore; for the Old Range ores: 4.50 dols. per ton for the Bessemer, and 3.60 dols. for the non-Bessemer.

The United States 16-in. Gun.

On January 17th, at the Sandy Hook (N.J.) proving ground, occurred the test of the new United States Army 16-in. gun; the results of which were given out too late to be included amongst last month's notes, but as the gun is a much more powerful one than the Armstrong 16·25 in. gun of the British Navy, the figures will still bear interest. The total length of the gun is 49·7 ft.; its weight is 130 tons; and the weight of its projectile, 2,400 lb. With a charge of 640 lb. of nitro-cellulose smokeless powder, the gun developed a muzzle velocity of 2,306 ft. per sec., a muzzle energy of 88,000 ft.-tons, or 677 ft.-tons per ton of the weight of the gun. In loading, the projectile had to be rammed by some twenty men; and the powder was placed in the breech in six canvas bags, one bag having several pounds of the fine grain quick igniting powder to insure ignition.

Gun Development in the Navy.

An example of the recent development that has been made in the power of the guns of the United States Navy is afforded by the comparison of the energy of a 6-in. gun of a few years ago with that of a 6-in. gun of to-day. Then the gun was 30 calibres in length, and weighed 4·8 tons. Its muzzle velocity was 2,000 ft. per second, using brown powder and a 100-lb. projectile. Its muzzle energy was 2,773 ft.-tons, and its practicable rate of fire $2\frac{1}{3}$ aimed shots per minute. The latest type has a length of 50 calibres, a weight of 8·2 tons, a muzzle velocity, with smokeless powder and a 100-lb. projectile, of 2,900 ft. per second, and a muzzle energy of 5,836 ft.-tons. Its practicable rate of fire is 8 aimed shots per minute. The energy developed per minute per ton weight of the gun has thus been increased from $2{,}733 \times 2\frac{1}{3} \div 4{\cdot}8 =$ 1,444 ft.-tons to $5{,}836 \times 8 \div 8{\cdot}2 = 5{,}693$ ft.-tons, or nearly four times.

A New Ship Log.

A ship log comprising two tubes which project through the bottom of the vessel, two floats which rest in the water in the tubes, and a registering mechanism operated by the floats has been introduced by the Nicholson Log Company of Cleveland. The bottom of one of the tubes has an orifice normal to the direction of motion, so that the water in the tube stands at the same level as that outside the ship, and thus varies with a change of load. The other tube points in the direction of the ship's travel, and the water in the tube is maintained at a level depending on the speed. The tube, say of 1 in. diameter, is carried sufficiently below the ship's bottom to be beyond the influence of eddies set up by the skin friction. The positions of the floats are calibrated, so that the mechanism, which includes both an indicating gauge and a recording drum, will give direct readings of the speed in knots per hour.

New York's Bridges.

New York is fast becoming the city of bridges. There are now a dozen or more bridges spanning the Harlem

River, all of them so large that in most places they would command profound respect, and in a few years there will be five monumental structures joining the Long Island boroughs of the city with Manhattan Island. The second of these East River bridges has reached the stage of construction where all the floor beams are in place; and the third and fourth have finally been awarded approved designs. Equally with the present famous Brooklyn Bridge and the new East River Bridge, as the bridge just referred to is called, the third and fourth bridges will also bear some merited distinction. The third, or Manhattan Bridge, will not only be the longest city bridge in the world, having with its approaches a total length of 9,900 ft., but it will stand as one of the stiffest suspension bridges in existence, its supporting members to comprise, instead of cables, chains made up of eye-bars. These chains will form the tip chords of stiffening trusses, and will be attached rigidly to the steel supporting towers. The main span will be 1,470 ft., 135 ft. above high tide, and the towers will be 400 ft. high. There will be four of the eye-bar chains from which will be suspended the roadway, 122 ft. wide. This will have a carriage-way in the centre, with a capacity of four three-horse teams abreast; on each side of this there will be two street-car tracks, and over them two elevated railroad tracks, making eight railway tracks all told, and in the outermost position on each side will be a promenade nearly 12 ft. wide. It was first intended to provide huge hinge joints near the bottom of the steel towers, to allow for contraction and expansion of the eye-bar chains with changes of temperature and load, but it is now stated that as the amount of turning about the hinge would be so small relative to the height of the tower, that this longitudinal movement will be allowed for by flexure of the structure within the elastic limit. Four passenger elevators are to be provided in each of the anchorage piers, and the whole structure will be fireproof, and will cost about 13,000,000 dols. The fourth, or Blackwell's Island Bridge, will be much the heaviest and most capacious long span bridge ever constructed. Both the Forth and the proposed Quebec bridges have longer spans, but they are single deck structures, while the Blackwell's Island Bridge will have two decks, designed for heavy waggon traffic, six railroad tracks, and two promenades. It will have five spans, the longest of 1,182 ft., and aggregating 3,714½ ft., besides viaduct approaches, which bring up the total length to 7,349 ft. The trusses will all be of the cantilever design. The estimated total cost is 12,500,000 dols. The new bridges have been designed by Mr. Gustav Lindenthal and Mr. H. A. La Chicotte, engineer in charge, but work on the Blackwell's Island Bridge was commenced by Mr. S. R. Probasco, and continued by Mr. R. S. Buck. It should be added that the designs are all made with the approval of a consulting architect, so that something more than utilitarian giants are to be expected.

Canadian Niagara Hydraulic Plants.

During the past month a franchise was granted to the Toronto and Niagara Power Company to develop 125,000 horse-power from the Niagara River on the Canadian side. This now makes three companies having water-power rights on that side of the river, aggregating 375,000 h.p. The writer has estimated that these three plants in full operation will require about 30,000 cubic feet of water per second, and when it is remembered that the mean flow of the river is about 225,000 cubic feet per second, and that it drops at low water periods to 160,000 cubic feet, the magnitude of the diversion on the Canadian side alone can be apprehended. There are two large consumers of water on the American side—one, the Niagara Falls Power Company, soon to have a capacity of 110,000 h.p. The Toronto Company and the Canadian Niagara Power Company will develop on lines similar to the Niagara Falls Power Company; but the third, the Ontario Power Company, will probably divert 12,000 cubic feet per second from the river at a point about one mile above the Horseshoe Falls, and conduct it through three pipe lines 6,000 ft. long to penstocks which will drop down the river bank to the power-house a short distance below the Falls. The power-house will be located near the water's edge and will house direct-connected turbo-generators. The development of this company is likely to be particularly interesting, as the original or preliminary designs contemplated employing three wood-stave pipes, each 18 ft. in diameter. There is, of course, a scarcity of hydraulic data regarding the flow of water under such conditions, but it has been estimated that with a flow of 3,000 cubic feet per second in each pipe, which would mean a velocity of 12 ft. per second, there would be a loss of head in the pipe of 34 ft., and a net useful head of 175 ft. It is held that 50,000 h.p. can undoubtedly be obtained, and possibly 60,000 h.p., so that if seven penstocks, each of which have been chosen at 9 ft. in diameter, are provided, one will be in reserve. It is intended to supply three-phase 25-cycle alternating current at 6,000 to 6,600 volts at the generators.

Data on Arc Lighting.

According to Mr. W. D. Ryan, of the Lynn, Mass. Works of the General Electric Company, the following figures represent good practice in arc lighting, being based on data he has compiled: For machine shops, with high roofs, electrically driven machinery and no belts, 0·75 watt per square foot, the energy being based on the watts at the lamp terminals; machine shops, with low roofs, belts, and other obstructions, 1 watt per square foot; hardware and other stores, 0·75 watts; departmental stores, with light material and bric-a-brac, 1 watt; departmental stores, with coloured material, 1·25 watts; mill lighting, with plain light goods, 1·1 watts; mill lighting, with coloured goods, high looms, 1·3 watts; general office, with no incandescent lamps, 1·5 watts; drafting rooms, 1·75 watts.

A Hot-Water Hydraulic Plant.

A small electric plant operated by hot water exists at Thermopolis, Wyo. The turbine takes water from a hot spring, and the volume is 750 cubic feet per minute, and the available head 48 feet. The temperature of the water is 138 degrees Fahr., and the turbine had to be placed near tail water to utilize the head as fully as possible and to avoid creating a partial vacuum, which would cause the formation of steam and gas in the draft tube.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

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OUR MONTHLY RÉSUMÉ.

LONDON, 20th March, 1903.

Canadian Developments.

It is announced that about the middle of April a new fortnightly service of steamers will be inaugurated between Rotterdam and Montreal, which will be fed by Lake steamers running from the Canadian interior with grain and produce. The new service will be employed under the auspices of the Canadian Ocean and Inland Line (Limited), in connection with three specially designed Lake steamers now being built in this country—two on the Tyne and one on the Clyde. These vessels were ordered some time ago, and should be nearly ready to take their part in the new service. The ocean steamers for this service have also been acquired. The necessary link between the North-West and the port of shipment, Montreal, is provided by three Lake steamers, of a size to navigate the various canals *en route*. This and the acquisition of the Beaver Line of steamers by the Canadian Pacific Railway Company, point to the large development of the oversea trade of Canada. The Beaver Line was originally a Canadian concern until it was purchased by Messrs. Elder, Dempster and Co., Liverpool. It is now to be greatly enlarged by the Canadian Pacific Railway Company.

The British Merchant Fleet.

Some statistics issued by Lloyd's Register enable one now to measure the exact strength of the British Mercantile Marine, by taking on the one hand, the additions made during the twelve months to our tonnage, and, on the other, the deductions made from the Register by losses and sales to foreigners. The total additions amounted to 1,249,509 tons, nearly the whole being of new vessels built in the United Kingdom. The transfers from the Colonies and foreign sources were little more than 85,000 tons. The gross deductions from the Register were 506,155 tons, due to wrecks, breaking up, and dismantling, while a small percentage is due to sales abroad. Germany bought from us 36,584 tons of shipping; Italy 33,594; Sweden 29,109; Greece 28,568 tons, and so on, but very few of the vessels thus disposed of were of recent construction. Most of them, indeed, were old boats. After these adjustments the vessels on the Register of the United Kingdom stand thus, as at 31st December, 1902:—

	Vessels	Tons gross.
Steam ..	9,808	13,260,332
Sailing ..	10,449	2,090,871
Total ..	20,257	15,351,203

Our total tonnage has been growing from year to year, and last year the additions were greater than ever.

While the averages from 1893 to 1901 were three or four hundred thousand tons, the net increase during 1902 was upwards of seven hundred thousand tons. Another feature of the statistics is the immense preponderance of steam over sailing tonnage. Our steamers, moreover, are increasing in size, as well as in numbers. More than forty of them, last year classed by Lloyd's, had a tonnage exceeding five thousand. Two came to 12,700 each, while four more were above 11,000 tons each. The present year's figures in this respect promise to beat previous records, but the two new Cunarders about to be built, with a tonnage of close on 30,000 tons each, will not be ready before next year.

The following is a list of Atlantic "record" passages during the last fifteen years :—

Year.	Name of Vessel.	Line	From.	To.	Average Speed.	Time from Port to Port
1885	Etruria	Cunard	Liverpool	New York	19	6 days 17 hours 34 minutes
1887	Umbria	Cunard	Liverpool	New York	19¼	6 days 15 hours 28 minutes
1887	Etruria	Cunard	New York	Liverpool	19½	6 days 13 hours 26 minutes
1888	Etruria	Cunard	Liverpool	New York	19½	6 days 13 hours 26 minutes
1889	City of Paris	American	Liverpool	New York	20	6 days 9 hours 30 minutes
1891	Teutonic	White Star	Liverpool	New York	20^{1}	6 days 5 hours 45 minutes
1892	City of Paris	American	Liverpool	New York	20.7	6 days 4 hours 18 minutes
1893	Lucania	Cunard	Liverpool	New York	21	6 days 2 hours 11 minutes
1894	Lucania	Cunard	Liverpool	New York	21·81	5 days 20 hours 45 minutes
1898	Kaiser Wilhelm der Grosse	North German Lloyd	Southampton	New York	22·29	5 days 17 hours 43 minutes
1899	Kaiser Wilhelm der Grosse	North German Lloyd	Southampton	New York	22·86	5 days 14 hours 17 minutes
1900	Oceanic	White Star	Liverpool	New York	20·72	6 days 4 hours 9 minutes
1900	Deutschland	Hamburg American	Southampton	New York	23·32	5 day 11 hours 38 minutes
1902	Kronprinz Wilhelm	North German Lloyd	Cherbourg	New York	23·09	5 days 11 hours 57 minutes
1902	Deutschland	Hamburg American	New York	Cherbourg	23·51	5 days 11 hours 5 minutes

Shipping Conferences.

There has been a good deal of discussion lately about shipping conferences or rings, and Lord Onslow has even threatened Government opposition to the South African ring. But there are two sides to every question. Take, for instance, the New Zealand story. During the examination of witnesses by the Subsidies Committee, evidence was given about rates of freight between American and British ports and New Zealand intended to show that the freights from American ports to the Colony were much lower than the freights from British ports. The explanation was that the figures were taken out when American firms were having a war of rates of their own, and American rates were much below the normal terms for which goods could be carried as a matter of business. Sir Charles Cayser, however, handed in a letter from Mr. Edward Lloyd, dealing with the unfairness of the way in which the figures were taken for the purpose of comparison. The following paragraph from this letter is interesting. Mr. Lloyd says: "As a matter of fact, the rates of freight from New York to Australia and New Zealand had been raised some months before the date on which Sir Alfred Hickman gave his evidence before the Committee, and it is surprising, to say the least, that in coming forward to give evidence before the Committee, he did not make inquiries, when it was so easy to do so, and obtain reliable information, instead of trying to show the Committee that British shipowners were intent upon assisting foreign shippers and manufacturers as against British shippers and manufacturers."

Oversea Trade.

On returns obtained from all owners of steamers of 20,000 tons and upwards engaged in oversea trade, the operations of about one-third of the world's foreign-going tonnage are tabulated as under, the figures in parentheses referring to the number of companies. The money is in dollars, because taken from the records of the United States Bureau of Navigation :—

Flag.	No. of Vessels.	Gross Tons.	Book Value.	Capital Stock.	Dividends.	Bonds and Debentures.	Interest.
			$	$	$	$	$
British (40) ..	970	3,211,024	158,110,756	107,718,529	6,840,067	31,3[illegible]	1,226,143
German (11) .	497	1,858,139	95,613,745	56,810,500	3,483,920	25,036,077	803,895
French (6)	206	649,519	51,538,338	25,765,500	1,107,550	31,0[illegible]	1,026,418
Japanese (3) .	156	315,663	16,608,906	16,989,000	1,983,900	1,895,000	32,500
Austrian (3) ..	110	283,990	12,164,818	7,754,600	429,954	9,108,639	334,093
Netherlands (6) ..	107	285,448	16,204,009	14,793,600	953,870	4,078,940	94,087
Spanish (6) .. .	99	266,944	21,091,265	10,804,333	796,570	5,076,330	99,898
Italian (3)	130	254,490	10,278,337	10,229,000	212,080	–	—
Danish (4)	157	211,883	10,788,691	8,192,224	526,104	2,288,452	84,892
Russian (2) ..	30	39,073	2,806,413	1,866,250	195,637	—	—
Norwegian (3) ..	48	37,169	2,219,268	1,822,936	113,900	—	—
Greek (1)	9	11,270	597,347	965,000	57,900	–	–
Swede (1)	11	11,054	544,040	487,760	22,512	—	—
Total (for 89 companies) ..	2,530	7,436,575	398,565,933	264,205,232	10,736,407	110,851,732	3,701,926

According to these returns the British vessels stood at a book value of $49.22, or about £10, a ton, and dividends averaged 6·35 per cent. The German vessels were valued at $51.45 per ton, and the dividends averaged 6·13 per cent. The French vessels work out at $79.34 per ton, and the dividends at 4·30 per cent. The Japanese vessels are valued at $52.61 per ton, and the dividends average 11·67 per cent. The vessels belonging to the three Austrian companies were valued at $42.83 per ton, and the dividend averaged 5·44 per cent. The Netherlands ships were valued at $56.76 per ton, and paid 6·44 per cent. The Spanish boats were valued at $79.01 per ton, and the companies paid 7·37 per cent. The Italian vessels were valued at $40.38 per ton, and the dividends 2·07 per cent. The Danish vessels were valued at $50.91 per ton, and the companies paid 6·42 per cent. The Russian steamers stand at $71.82 per ton, and pay 10·48 per cent. The Norwegian vessels stand in the books at $59.70 per ton.

The Outlook in South Africa.

Matters of technical interest are still very much overshadowed by political considerations in all parts of South Africa—more especially in Cape Colony. In view of the vital interest attaching to the question of railway construction, it is gratifying to note that the conference on the matter opened in Johannesburg, under the presidency of Lord Milner, has concluded its deliberations, and that no fewer than seven new lines have been approved, with a total length of 668 miles, at an estimated cost of £5,161,000. These lines all touch various centres of production, whether of coal, grain, or metals, and connect with important places, such as Pretoria, Johannesburg, Bloemfontein, and Krugersdorp. The question of native labour crops up again with all its old persistency, and as it is estimated that thirty thousand natives will be required for the next two years, it has been suggested that this advanced railway policy will be accompanied by an increasing scarcity of labour in the mines. Experts, however, have been able to show that the natives who will take up railway work are those who, under no circumstances, would work in the mines. Much skilled white labour will also be required, and we may confidently anticipate that the opening up of these new lines will mark the beginning of a renewed era of prosperity for South Africa.

At the Mines.

The output in the Transvaal is slowly but steadily increasing, but it will be some months yet before all the available engineers, metallurgists, and artizans accustomed to mining work who are already in the town and district, can be absorbed by the mines. Until the men with years of local experience have found suitable employment there is small chance for new men, unless they secure work before starting, or have influence with directors or managers. In spite of this fact, and of the high cost of living, especially as regards rent, there is a steady stream of new arrivals. A single unfurnished room costs, with electric light, from £3 to £6 per month, while small houses of about four rooms are eagerly taken up at £15 per month. The cost of building brick houses in a substantial manner at the present time may be estimated at elevenpence per cubic foot, or say £200 per room for medium sized houses, while stands 15 ft. by 100 ft. range from £75 each in the less favoured suburbs, say two miles south of the town, to £600 and more in the nearer and more fashionable districts in the north. It is evident, therefore, that married men, who have to maintain their families in Johannesburg on salaries of £25 or £30 per month are having anything but rosy times.

Native Wages.

The following is the schedule of native wages now resumed, which was referred to last month. It shows vividly the economic difficulty involved in any attempt to substitute unskilled white labour at a living wage for native labour :—

Mine.	*Per day.*
Tram boys (10 ft. trucks), timber boys and helpers at stations	1 2
Shovellers	1 3
Hammer boys, trammers (16 ft. trucks), boys cutting hitches for timber, assistants for platelayers and pipemen ..	1 6
Machine helpers, dry shaft and winze boys, pumpman's labourers	1 8
Wet shaft boys, stope gauger's helpers, air hoist drivers	2 0
Station and headgear boys (when no white man is employed), and wet shaft boys in development work	2 6
Mill.	
Crusher boys	1 4
Ore trammers	1 9
Attendants on stamps, elevators, vanners, blankets, etc.	2 0
Cyanide.	
Indoor boys and residue truckers ..	1 4
Zinc cutters..	1 6
Filling and discharging vats	1 9
Other surface labour.	
Drill packers	1 0
Surface labourers and carpenters' boys ..	1 2
Blacksmiths' and masons' labourers ..	1 4
Fitters' boys, drill sorters, coal boys, and engine cleaners	1 6
Cooks and sorting boys	2 0
Blacksmiths' strikers, office, store and assay boys, mule drivers, stokers, and police	2 6

In addition to the above actual payments to the natives, sixpence per day must be added for the cost of food and shelter. Each mine is allowed, under the existing agreement, to pay special rates to 7½ per cent. of the total number employed.

Mechanical Progress.

At the Elandslaagte Coal Mine the whole of the coal is now mined by means of electrical coal cutters which are managed by native labourers, of course under the supervision of white men. And in this connection it may be pointed out that at the present time there is a good opportunity for the introduction of labour-saving appliances of a simple and effective character, for even if nothing is gained in cost, the labour saved would be available for other purposes.

A new wet sampler for battery pulp, which seems to meet all requirements, has been introduced by Mr. Higham, the cyanide manager at the City and Suburban Mine. We hope to be able to give a full description and illustration of this apparatus very soon, but in the meantime the principle of its action will be understood from the following outline. A slotted pipe is moved slowly across the stream of pulp by means of a screw, and when it emerges on either side of the stream it operates a reversing apparatus, which causes the screw to rotate in the opposite direction. The portion of the pulp which enters the extremely narrow slot constitutes the sample, and is delivered by the pipe into any suitable receptacle.

Mr. Harland, the battery manager at the Robinson Mine, has invented an automatic mercury feeder for mortar boxes, which will soon be on the market. A device of this kind is desirable to avoid irregular feeding, due to carelessness or to the fact that amalgamators have many other duties to perform.

Uniform Time.

Several Governments have agreed to establish a uniform official time, based on the meridian of 30° east of Greenwich, so that the time in the colonies included will be two hours ahead of English time. This agreement embraces Cape Colony, Natal, Transvaal, Orange River Colony, Southern Rhodesia, and Portuguese East Africa.

"Wireless" Telegraphy and Lighthouses.

Our readers are not likely to have forgotten the striking review of "wireless" telegraphy, contributed to PAGE'S MAGAZINE a few months ago by Sir William Preece, K.C.B., F.R.S. "It is not wanted across great oceans," said Sir William, emphatically; "it is wanted across narrow, rocky channels, and between tide-swept island homes." Apparently the value of aetheric telegraphy for the latter purpose has impressed itself upon Mr. Marconi also for we find him expatiating on the subject in no uncertain manner at the annual meeting of the Association of Chambers of Commerce of the United Kingdom. A resolution was brought forward in favour of steps being at once taken to connect all lightships and lighthouses with the shore by means of telegraphy, telephones, or wireless telegraphs. Mr. Marconi said that those who had been identified with, or had worked at, the problem before them knew that the great difficulty which beset them, in addition to that of expense, was the fact that the cables laid for the purposes of communication between lighthouses and lightships and the shore did not last any length of time, owing to their chafing against rocks and lighthouses. "Wireless" telegraphy had now reached a stage in which it could be satisfactorily employed for those communications.

New Safeguard for Shipping.

In England at the present time there was no lighthouse connected with the shore by that system, but it was in use in several places outside England. In the United States it had been in use for two years between the Nantucket lightship and the shore—a distance of 55 miles—and had worked very satisfactorily. In Germany the system was established between the Borcum Riff lightship and the shore, and had worked with equally satisfactory results for nearly three years. It was also in use in Newfoundland. In England an experiment had been tried for the satisfaction of the Trinity House authorities between the East Goodwins lightship, and the shore, and he believed it was on record that the system worked satisfactorily on that occasion. Therefore, he did not think there was any technical difficulty in establishing the service. To make a connection of between twenty and thirty miles, or even a greater distance, would not cost more than from £300 to £400, which compared with at least £200 per mile by the cable method. Besides adding to the defence of lighthouse-keepers, such communication would very much increase the safety of shipping. In addition to certain warships, there were now twenty-eight passenger liners plying in British waters which carried "wireless" telegraphy apparatus. The disadvantage of there being no lighthouses in England so fitted was demonstrated the other day, when one of the French passenger cross-Channel packets got in distress off the Goodwin Sands. Fortunately, the Belgian steamer which saw her was fitted with the "wireless" telegraphy apparatus, and was able to report the distress to Dover, where the message was received by another vessel similarly equipped. But for the fact, however, that there was a boat at Dover fitted with the apparatus, the message could not have been transmitted, and tugs would not have been sent out to render assistance.

The New Naval Base.

The announcement that the Government intend to establish a new naval port at St. Margaret's Hope, on the north side of the Firth of Forth, is the outward token of careful deliberations in official quarters extending over several years. Following the new scheme of naval training which Lord Selborne presented to the nation on Christmas morning, it should do much to dispel the fears of panic-mongers and to prove that the Admiralty is fully alive to the necessities of the times. We shall await with interest further details of the scheme. Mr. Balfour explained in the House of Commons that Lord Goschen and the late Lord of the Admiralty in March, 1900, appointed a committee, which fully examined the whole question of present and prospective accommodation for ships in his Majesty's dockyards, and as to how the harbours and anchorage waters at our disposal can be utilised for ships both completed and under construction. This committee reported in January, 1902, that the growth of the Navy would shortly make it impossible for the existing ports to accommodate all the ships on the establishment. The committee further stated that the most advantageous position for this naval base was in the estuary of the Forth. The Board of Admiralty, after full and careful consideration, approved this recommendation, and the Government therefore decided to establish a naval port and base on the north side of the Firth of Forth at St. Margaret's Hope. They have for some months been engaged in negotiations for the necessary lands, and the fact that these negotiations were going on made it impossible for the Government to take the House and the country into its confidence earlier in regard to this important matter. The new naval arsenal has been selected for its strategical qualities, which include proximity to the coal and iron industries of Glasgow, and a fine natural harbour, with deep water. It will tend to relieve the growing congestion of our existing home ports, and should prove itself an enterprise of the utmost value to the nation. Further reference to the new establishment will be found in our "Naval Notes."

American Railways.

Lieut.-Colonel H. A. Yorke's report on the working of American railways covers an astonishing amount of ground, and in addition to the question of steam railroads, deals with surface lines or tramways, subways and elevated railways, and high speed electric inter-urban railways. Of the elevated railways of New York, Brooklyn, Boston, and Chicago, he deems it unnecessary to say much, as "they are not likely to be initiated in any English town. They are noisy and unsightly, and the columns supporting them occupy a great deal of street space, and constitute a hindrance to street traffic." In view of the efforts that are being made to solve the problem of urban locomotion in London, his remarks on the railways of New York and Boston have a peculiar and timely interest :—

"The three cities, Paris, New York, and Boston, afford an object lesson to London. They have faced the problem of urban communication in a business-like fashion, have decided what they want, have arranged for the financing of the work, and have settled the routes along which transportation is to be provided, before allowing the ground to be broken, instead of proceeding in a haphazard fashion, and leaving the most valuable concessions to be scrambled for by private companies. It is much to be hoped, if I may be permitted to say so, that a tribunal will be appointed, before it is too late, to consider the congestion of the London streets, and to propose a remedy.

"The subway in New York is still incomplete, and will not be opened for traffic before the year 1904, but that in Boston has been in use since 1898. In both cases the subways are as near the surface of the streets as possible, and have, as in Paris, convenient stairways to afford access to the stations, no elevators being therefore needed. Such subways are in many ways preferable to deep level 'tubes.' They are safer, more easy of access, possess a purer atmosphere, and afford conveniences to the public which are worth considerable sacrifices to attain. What New York has cheerfully suffered, and is still suffering, to obtain its subway, has to be seen to be believed."

A very interesting account of the electric (high speed) inter-urban railways is included, and it is remarked that experience gained in America should be of great value in this direction to those engaged in the construction of similar lines under the name of "light railways" in this country. The report is the outcome of much careful and unbiassed observation. It affords valuable insight into the whole question of American railway organisation, and should be of much assistance to English railway experts.

NOTABLE BRITISH PAPERS OF THE MONTH.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

IMPERIAL TELEGRAPHIC COMMUNICATION.

WE append some interesting excerpts from a paper on "Imperial Telegraphic Communication and the 'All-British' Pacific Cable," read by Mr. Charles Bright, F.R.S.E., before a special meeting of the London Chamber of Commerce. The Right Hon. Lord Brassey, K.C.B., in opening the proceedings, referred to Mr. Bright as a high authority on all matters connected with ocean telegraphy, and remarked that his father, the late Sir Charles Tilston Bright, the eminent engineer, was knighted when but twenty-six years old, for the laying of the first Atlantic cable.

The share which telegraphy performs in uniting the British Empire was, on October 31st, 1902, advanced a very important stage with the actual completion of the All-British Pacific Cable and telegraphic girdle. This will ever be a memorable period in the history of the Empire.

THE STRATEGIC IMPORTANCE OF BRITISH CABLE ROUTES.

The importance of the Pacific Cable from a sentimental point of view is by no means to be despised; and there can be no question that direct and unbroken Imperial telegraphy can do more than anything to foster trade between the mother country and her Colonies, and to bring about something in the nature of Imperial Federation or a Pan-Britannic Customs Union, tending to render us independent of the good offices of the rest of the world. It has been estimated that our expenditure in "cabling" to Australia previously stood at over £1,000 per day; and one of the immediate effects of the Pacific Cable in the matter of future inter-Colonial trade is that a message will now take inside an hour instead of upwards of a day to reach the hands of the person to whom it is addressed. Another effect of the Pacific Cable—which indeed took place immediately the scheme became "dangerous"—is that the rates from this country to Australasia now stand at 3s. instead of 4s. 9d. and formerly 9s. 4d. on the average. The new telegraph will also serve to attract further attention to the "Canadian-Pacific" route as an alternative to Globe-trotters. But any scheme for further, and independently, reducing the chances of a total breakdown of telegraphic communication with, and amongst, our Colonies could scarcely fail, in the end, to commend itself to British subjects in their present frame of mind; and it is even quite conceivable, in the event of a European war, that the Pacific Cable and the Atlantic lines might some day be the only means of communication with Europe. If Britannia is to continue to rule the waves she will require to keep a sharp look-out in the Pacific, as the probable scene of any future naval battle; and it will be conceded, presumably, that naval supremacy must necessarily be accompanied by direct communication with the nearest coaling stations as well as with head-quarters.

THE WEAK POINT IN THE PACIFIC CABLE.

The weak point in the Pacific Cable is, of course, the long section on the route eventually decided upon between Vancouver and Fanning Island—running into 3,458 nautical miles. The result is a slow working system, and this in competition with a complete system of high-speed cables. Thus, if the traffic is to be remunerative, it is bound to become congested at certain hours of the day, in view also of the difference of time. Thus, if only on this account, and to meet interruptions and possible lengthy repairs, the line must be duplicated sooner or later. This duplication might, however, well take the form of a link with the American Pacific Cable, as, indeed, I pointed out some years ago in the course of a report, as well as in the *Times*, the *Fortnightly Review* and elsewhere. This would have the advantage of increasing its scope for traffic; and in view of the immense commercial field of China and our relations with Japan, this idea should appeal to most of us—for strategic as well as commercial reasons—if the American Pacific line be furnished with a branch to Japan. On the other hand—by way of avoiding a duplication of the All-British Pacific Cable—there has been some talk already of an arrangement with the company controlling the rival lines to Australia; and I note that a prominent shareholder of the Eastern Extension Telegraph Company thinks that "if the Pacific Cable breaks down, those controlling it would be disposed to enter into an arrangement with the rival line, and that in that case they—the 'Extension' Company—would be able to get back to higher rates." The experience of joint purses, however, in the case of the Indian traffic is not very happy from the public standpoint. Anything like a partnership between a Government and a company is objectionable in principle, seeing that the Government should be concerned with looking after the interests of the public. We cannot have any more taking of oysters and leaving shells. Though the duplicating system of the "All-British" Pacific Cable may well be Anglo-American in character, the original system itself should be strictly "All-British" to and from headquarters. At present this is not the case between England and the nearest end of the cable at Vancouver. In other words, the new Pacific line constitutes a private wire between Canada and Australasia, but not so between the Admiralty here and the admiral in command of the Australasian station. The situation is somewhat peculiar. On the one hand our cablegrams can pass through any of the "Anglo-American" or "Direct United States" Company's Atlantic cables which are British with All-British landings on the eastern seaboard of Canada. The telegraphic connection of these systems with Vancouver is, however, as far as Montreal, by means of the American-owned wires of the Inter-Colonial Railway. On the other hand, if we entrust our messages to the Commercial Cable Company to go by any of their cables, it must be remembered that, though this system lands on Canadian territory, it is an American company; moreover, these cables pass in shoal water somewhat closely to St. Pierre de Miquelon—a French Colony south of Newfoundland, where two of the French Atlantic cables land. Again, its immediate connection with the Canadian Pacific land lines involves a journey of 270 miles through the State of Maine; and beyond this the "Canadian Pacific" Telegraph could, in the event of our being at war with the United States (as also in the case of the Inter-Colonial line) be interrupted at many points with comparative ease. The "Commercial" Company has exclusive working agreements with the Canadian Pacific Company to the effect that all messages from the Pacific Cable to this country must be handed over to the latter (Commercial Company) cable system.

A NEW LINK WANTED.

Surely all this points to the necessity of an independent (All-British) telegraphic link between the mother country and the Pacific Cable at Vancouver, at a low tariff. A general statement from the Colonial Office in 1899 required that this should be furnished, but nothing further has been published on the subject since then; and I would ask what is the use of going in for an expensive "All-British" cable, if the land line connection is open to easy attack? In the case of a possible war with the United States, the Pacific Cable would be of no use whatever, owing to the position of the existing Canadian land line connection, if for no other reason. As regards the rest of the route, any new "All-British" Atlantic cable might suitably be taken at a respectful distance from St. Pierre, and avoiding shoal water off Newfoundland as much as possible. The objection to the Northern Gulf of St. Lawrence route on the score of ice is probably not insurmountable, and it would, of course, be the best route strategically. Short of this, St. John's, Newfoundland, should at any rate, be again fortified and provided with a cruiser, cable depot, and repairing ship, to meet the present condition of the undefended Atlantic cables along the route that connects up with our new Pacific line through Canada. A new Atlantic cable should at this end be landed much nearer headquarters than any of the existing lines and an underground connection provided with a view to avoiding the delays and interruptions to which our Atlantic and Eastern systems are prone on the overhead wires. Sir Charles Dilke has made this one of his special subjects of attention; and, from a strategic standpoint he considers the cables approaching Cornwall seriously open to attack. I venture to think that this objection would less apply in the narrower and fortified part of the English Channel, and for service reasons would be better suited than other suggested changes. When it is remembered that an Atlantic cable costs about half what a first-class battle ship costs and that the latter is often of little use out of touch with headquarters, it will be seen that the sum involved for carrying out the "All-British" connection with the Pacific Cable is not altogether out of proportion with the degree of necessity. In view of the fact that 10,000 messages cross the Atlantic per day, surely it cannot be said that there is no room commercially for another Atlantic Cable. Let us hope that the Pacific Cable has broken the spell, and that it will be realised that a number of other lines of communication on a variety of routes are also desirable in the interests of the Empire, for strategic and commercial reasons. The bridging of the Pacific should be regarded as a first step only, though certainly very materially meeting the requirements of the case.

THE STRATEGIC ASPECT OF ALTERNATIVE LINES ON DIFFERENT ROUTES.

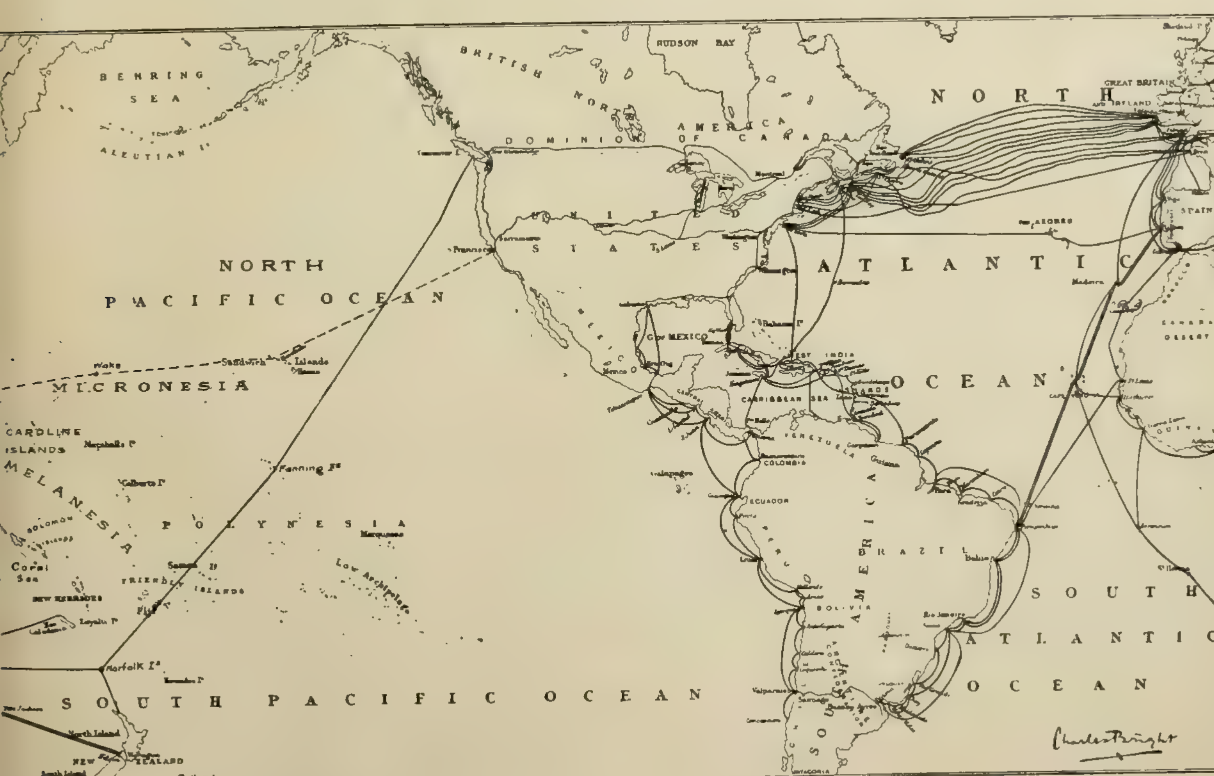
Let us now turn to the strategic aspect of alternative lines on different routes. This has often been misrepresented. For instance, those who have advocated the ordinary trade routes as the best strategically for cables, have by way of backing up their contention, laid stress on the fact of our men-of-war being on the spot. But it should be remembered that in the event of a "surprise war" our communications with the rest of the Empire *viâ* the Mediterranean would probably be cut off before war was actually declared. This would not be an easy matter for the enemy to accomplish, but it would be a sufficiently valuable achievement to be worth a good deal of trouble on their part. For that very reason, it should be similarly worth our while to render such an achievement out of the question beforehand ; and that is best accomplished by increasing the number of our telegraph *routes*, and making future cables further out of the reach of naval powers. As things stand at present, in practically every case, the enemy could only effect interruption to our traffic by more than one line being disturbed at the same time. This would probably always involve more than one European Power being against us, but it would be a possibility to be reckoned with in the event of a "surprise war." As a matter of fact, it could always be effected in the absence of one of our battleships being on the right spot at the right moment in both cases. Rapid communication with her fleets at foreign stations is an absolute essential, indeed, for a power in command of the sea at, and previous to, the outbreak of war. If it happened that France and Russia were combined against us, the latter would at present be in a position to cut off our communications with India and Australia in the Mediterranean, besides interrupting the system of the Great Northern Telegraph Company on the one hand and the Indo-European Telegraph Company on the other, whilst France paid her attention to the system *viâ* the African East and West Coasts respectively, as well as the European land lines and the cables in the English Channel. The mere fact that the Associated Companies are in the habit of setting aside a part of their reserve fund for war risks clearly indicates that they do not really consider their cables safe in time of war. The companies, however, contend that strategic cables could be laid "to order" as required. This undoubtedly might be practicable, though often difficult to accomplish ; but if we recognise the likelihood of our communications being interrupted before war has been declared, we are here again presented with the spectacle of "locking the stable door after the horse has been stolen." As a matter of fact, in many instances it would be several weeks, if not months, before the missing link could be restored, during which time the effect might be disastrous. In this argument, too, the companies appear to forget for the moment the scarcity of gutta-percha, so often referred to by them. Some students of the subiects have suggested that the cutting of neutral cables is contrary to International Law ; but Article XV. of the Convention on the freedom of

THE WORLD'S TELEGRAPHIC SYSTEM.

belligerents, arrived at during the International Telegraph Conference held in Paris in 1884, seems to pretty well dispose of that argument. In any case we know from experience that cables undoubtedly would be cut in time of war, in spite of all Conventions or International Laws, which would, indeed, be a broken reed for a great commercial nation like Great Britain to lean upon in the event of war with other naval Powers.

Then there are those who consider that a line which touches on foreign soil can readily be converted at short notice, into an "All-British" line by a change of route in the event of war. Of course, such a thing might be done with a successful issue; but the risk is great, and the result is liable to be less satisfactory in any case than an "All-British" line "ready made," which is a matter of paramount importance irrespective of any commercial view. The suggestion that such "All-British" lines should be made "to order" as required seems to indicate an admission as to the utility of this class of line, though the suggestion has been made by those who argue that cables are least liable to disturbance in time of war if landed on foreign territory of various nationalities. Certainly a shallow water "All-British" line would be more prone to cutting if we were at war ourselves; but on the other hand any strategic cable should be laid in *deep* water if possible. Moreover, the secrecy secured for the "All-British" line—an advantage applying in times of peace as well as during war—is an advantage which exists in no other class of cable. This advantage is sufficiently great even to counterbalance any greater chance that may exist, under given (common) circumstances, of its being cut, if this country were engaged in war. Though it is quite true it is impossible to foresee the precise seat of any future war this country may be engaged in, surely it is well worth being prepared for an emergency beforehand, in at least any likely quarter. That is evidently the conclusion that our Continental neighbours and the United States have arrived at already as regards cable communication. Lines laid for strategic reasons meet their requirements best, if laid in deep water, *with few landing places* on out of the way (non-trade) routes, their exact course, except at the ends, being kept secret in the open, broad ocean, where they are admittedly difficult even for a cable ship to find, and even when the route is actually known. Moreover, a knowledge by the enemy of the position of a cable in deep water is a far less serious matter than when laid in shallow water. A man-of-war can pick up and cut a cable in shallow water just as it is equally true she can probably more easily repair a cable here; but without long lengths of actual cable, grappling rope, and the necessary picking up machinery, she cannot do much with a deep-water cable.

It is scarcely necessary to call attention to the importance of telegraphic communication with all our



N.B.—Only the principal land lines which connect up the submarine cables of the world are shown.

naval fortified and garrisoned coal stations, besides all "Defended Ports." To effect this alone, the ordinary trade routes must be departed from. One of the few reasonable points against "All-British" cables is that of setting the backs of Europe as well as the United States against us. But this has been practically discounted by the fact that France and Germany, in addition to our American cousins, are now going in for similar precautions themselves—initially on account of the cables of the world being British-*owned*. A stock argument sometimes brought up to show that "All-British" cables are not necessary from the point of view of secrecy of messages, is based on the value of the cipher code in this connection. Surely, however, it is a mistake to rely on the security of the cipher, or any code, when we know by experience that the most difficult cipher can be translated if a sufficient number of messages are available to work on, together with a knowledge of the correspondent's identity, and the probable nature of his communications. Probably the ciphers of most of the European Foreign Offices have been translated by other interested Powers many a time; and if once a system of half-code, half plain language is indulged in, the decipherment becomes a comparatively simple matter. Apart from this, the mere fact that messages passing through foreign territory are subject to serious and often intentional inaccuracies and delays is a sufficient argument in favour of "All-British" lines. Cables landing on foreign shores are, it should be remembered, largely worked by clerks of the country even in times of peace; and if trouble was in the wind the confiscation of the telegraph office would probably be effected previous to the declaration of war. That would not be likely to occur in the case of a cable landed on British territory, and certainly not if in any sense guarded.

The Telegraph Companies have very naturally paid their first attention to the trade routes, as giving the best prospects of revenue; but these are not good routes strategically, wherever the cable passes through shallow water in the vicinity of foreign territory. The class of cables, whose object is mainly strategic, have seldom been laid for the reason that they are liable to be non-paying. But we should recognise them as a necessary policy of the age at almost all hazards; and it is just these lines that the State should first consider the advisability of itself laying, if necessary. What is the use of an idea such as Imperial Unity—or how can it be relied upon in practice—without Imperial mobility in a strategic sense? This latter can only be effected by "All-British" cable communication under definite Government surveillance, either direct or through a subsidised company acting as their agent. Considering what we pay for our postal sea service, this view should be readily accepted; for, obviously no country requires strategic cables so much as the British Empire with its far-reaching possessions. If certain strategic cables were laid, the traffic on the ordinary trade routes would be less liable to become disorganised in war time, by the suppression of code messages. The typical strategic line, avoiding foreign soil, has been materially assisted by a recent invention. By its means long sections of *expensive typed* cable can be avoided whenever an island, however small, can be found on the route, for the apparatus to be inserted between the ends of the incoming and outgoing cable. This forms a system of re-transmission which dispenses with the necessity of a large staff of operators for effecting the same manually. But the reason for which we require "All-British" cables in addition to international lines does not rest merely on strategic grounds. We need them for consolidating the Empire—politically and socially—as well as for the assistance of Imperial trade. The Companies have already provided a fair network of cables on trade routes; but direct "All-British" lines are now required, if only to ensure speedy and united "cabling" facilities with the whole of the Empire in times of peace and war. If we could render the entire British Empire practically as one country, by means of telegraphy, a great result would be achieved. For commercial, and trade reasons, the more links on various routes the better to ensure communication in all directions at all times; and at least one of these routes should, for the various reasons enumerated, be "All-British." At the present moment the "All-British" element in the now existing girdle is broken at two spots only, Madeira and St. Vincent, both Portuguese territory; and though Portugal may be regarded more as an ally than as a possible enemy, it is also true that no belligerent would hesitate to consider so feeble a neutral power, the fact being that the value of a cable landing on neutral territory all depends upon circumstances—that is to say, what the neutral power is and the condition of politics at the time. The complete "All-British" chain might be completed by a cable from Ascension (or Sierra Leone) to Barbados or Jamaica, where it would meet the cable coming from Canada. Such a scheme would constitute the first truly "All-British" line from this country to the Cape. Time does not permit me to go into the various useful cable routes that should be taken in hand; but I will only mention that—partly in view of future trade between Canada and the Cape—a useful "All-British" line might be established between these countries either *viâ* the West Indies or by a more direct route, connecting up with the "All-British" Atlantic Cable that I have already spoken of as a link with the Imperial Pacific line. The accompanying map, besides bringing into prominence the Pacific line, is specially designed to show the telegraphic girdle in a complete, unbroken form; that is to say, going by the Western (Pacific) route to Australasia and returning by either of the Eastern routes, or *vice versâ*. There are other lines more urgent for strategic reasons which the Cable Communications Committee have taken note of. A difficulty in getting funds voted for purely strategic cables exists owing to the Treasury having so many calls for immediate indispensable and indeed vital needs; and purely strategic cables never appear under this head until too late! Experience is certainly a sure means of learning our needs; but in things national it would be better to do so by forethought.

THE MECHANICAL ENGINEERING OF MODERN COLLIERIES.

At a well-attended meeting of the Birmingham Association of Mechanical Engineers an interesting paper on "The Mechanical Engineering of Modern Collieries" was read by Mr. Bardill, of Aston. The speaker traced the development of various appliances found necessary by the mining engineer to cope with the ever-increasing demand for fuel, and paid a tribute to their efficiency :—

Taking a look back for even a comparatively short period, say forty years, the total coal raised in the United Kingdom in the year 1860 was 80,042,698 tons ; in 1870, 110,431,192 tons ; in 1880, 146,969,409 tons ; in 1890, 181,614,288 tons ; in 1900, 225,170,163 tons. This wonderfully increasing demand and supply has not been due so much to the increase of the number of collieries, as to the increase in the number of tons of coal won per day, rendered possible by the introduction of better mechanical appliances for the mining, handling, and transportation of coal. Thus, whilst even only twenty or thirty years ago a daily output of coal from one shaft of 300 tons to 500 tons would have been considered almost unattainable, yet, in the present day, we have collieries raising from two to three thousand tons per day without fuss and commotion, the coal being mined, conveyed underground —in many cases a distance of some miles—wound, screened, sorted into many sizes, and, often the same day, a good deal of it is in the hands of the consumer.

Thus, at the Bolsover Colliery a record has been reached of 3,217 tons 5 cwts. maximum output, lifted from a depth of 365 yards in 9 hours, of which 2,221 tons 3 cwts. were drawn at the downcast shaft and 996 tons 2 cwts. at the upcast. At Cresswell Colliery, in a nine hours shift, a maximum output of 3,053 tons 4 cwts. has been raised from a depth of 450 yards, 2,200 tons of which were drawn from the downcast shaft and 852 tons from the upcast shaft. On May 1st of last year, a record quantity was drawn from the No. 2 pit of the Cambrian Collieries, Clydach Vale, of 2,729 tons from a depth of 450 yards. The week's record at the same pit for an ordinary week's work was 13,019 tons. Large as these amounts appear, they have probably been excelled.

In the older days the mining engineer and manager was a child in mechanical matters, and he used to provide endless amusement to the mechanic by his coining of many patent phrases when describing the technical details of some of his possessions : but that type has now passed away, and to-day, by force of circumstances as well as by education and experience, the mining engineer is also a mechanical engineer of a very high and varied order, and not only does he know his geology and the Mines Regulation Act better than his Bible, but he can converse with the most accurate and most minute detail any question you like in connection with engines, boilers, pumps, electric light and power, telephones, cables, locomotives, rolling stock, horse-flesh, explosives, carpentry, brickwork, concrete, brickyards, coke ovens, miners' unions, rural district councils, employers' liability, or the best means of lubrication. He is, moreover, a grand type of man, saddled with heavy responsibilities, which, yet, sit lightly upon his shoulders, because he is full of confidence in his own powers.

WINDING ENGINES.

Proceeding to pass a running comment on the leading items which are contributed by the mechanical engineer for the development of a modern colliery, the author first dealt with the subject of winding engines.

It is a long story that is covered from the hand "Waller" or direct acting hand winch or the horse capstan to the modern colliery winding engine, with its massive proportions, its Corliss valves, steam brake, steam reverser and automatic cut-off gear. Yet there are some aspects of colliery winding engines which have remained permanent. For instance, the direct acting steam engine is practically universal for this purpose, and it is only in sinking or in a very small colliery that a geared engine is ever seen. Some very large engines have been built in this country for winding, but generally the cylinders are from 30 in. to 42 in., and heavier engines than these are not proved to be more efficient.

Winding engines are also nearly always non-condensing, and as such are fearful steam eaters and their thermal efficiency must be low. A few attempts have been made at compounding, but the success attained has not led others to follow their example. A few of the more modern collieries have gone in for steam economy by the introduction of automatic cut-off and expansion gear, but I have seen a number of these discarded or out of action at various collieries I have visited. Generally the mining manager looks at the matter as of little moment, as he has always at his command a lot of fuel he cannot sell or hardly give away, and he uses his boilers much as a borough engineer uses his refuse destructors, *i.e.*, not so much for its calorific value as its convenience for destroying a nuisance. No doubt, however, as modern appliances are improved so as to utilise cheap small fuel more generally, the value of the small coal will improve and the colliery manager will accordingly pay more attention to his own fuel bill. At present the difficulty of finding a market for small coal is acute, and I saw at a colliery only the other day twenty 10-ton waggons of small which had passed through a ½-in. mesh, which the manager told me he could not sell at 9d. per ton, and it was not worth the carriage.

With regard to valves the D slide valve, fitted with Stephenson's link motion, was originally used, and even now is popular with many engineers, especially if balanced, but the Cornish drop valves have enjoyed, perhaps, the greatest favour by reason of their comparative ease in handling. Piston valves have also been used occasionally, but later practice is a departure in favour of Corliss valves.

With regard to boilers, the Lancashire types are most generally employed at about 80 lb. to 100 lb., and many collieries still use the old egg end boiler with pressures from 45 lb. to 60 lb. A number of collieries, especially in

South Wales, have adopted water-tube boilers and high pressures, some even fired by gas from coke ovens.

HEADSTOCKS.

Proceeding to discuss the subject of headstocks, he remarked :—

There is no specific rule or experience which decides whether steel, iron or timber are the best material for headstocks, or yet whether the lattice or girder type are most suitable, it being argued that with timber there is liability of fire or rotting, whilst in the case of steel a good deal of paint is required for prevention of corrosion. Either type, however, if made of good material and workmanship will last as long as the seam will last, or at least as long as it is desirable it should last in the interests of the contracting engineer.

WINDING ROPES.

The winding ropes are, of course, a very important institution. Happily accidents from the breaking of these are very rare, but they do occur, and there is yet room for the engineer inventor to prevent the possibility of such an accident as that which occurred a short time ago at the Tirpentwye Colliery, when fourteen men lost their lives by the breaking of a winding rope. But even if the winding rope be safe, we are still, be it remembered, in the hands of the engineman, and if he suddenly lose his head, we are dashed into the pit bottom or carried aloft into the headgear. In this awful position, years ago, we were as safe in one cage as in the other, but modern invention has prevented the possibility of our being dragged over the winding pulley by the adoption of detaching hooks which are now in compulsory use. There are now a number of these hooks, and these coming into play at an over-wind would detach the rope, and the catch arrangement coming also into play would leave us suspended in the air until relief came to hand, which, however uncomfortable, is much to be preferred to being dropped down to the pit bottom, a distance of 500 yards, where the sudden stop would be fatal. Cases have, however, occurred where, although the winding rope has been properly detached, the chains supporting the cage have been severed and the cage has been dropped down the pit, rendering the detaching arrangement only partially effective. Supplementary devices have been, therefore, invented to catch the cage itself. A very useful device is that invented by Mr. Sebastian Smith.

There is still the possibility of danger by the descending cage, and many accidents have happened where men have been killed and maimed by being dashed into the pit bottom by the over-wind of the ascending cage, and here is yet another chance for the inventor.

On reaching the bottom of a modern and well-managed pit, one is struck by the wonderful order and method by which everything is conducted, and the celerity with which, say, 1,000 to 2,000 tons are hauled and lifted to the surface in one day, and all done without the least confusion or fuss. We realise this amount better if we think of 2,000 separate tons tipped up at the doors of 2,000 houses in one day, or see it carried by 250 railway waggons, making up seven or eight railway mineral trains.

SYSTEMS OF HAULAGE.

Discussing the various systems of haulage below-ground, the writer referred to the fine examples of mechanical engineering skill that may be seen in Midland counties :—

There are various systems of haulage in vogue, and for some reason each type seems to confine itself to certain districts. Thus, in the Midlands, we have the endless rope system, worked principally by powerful steam engines on the surface. A splendid example of this system is shown by the Ansley Hall Colliery, near Nuneaton, where it may be said, much to the credit of the management, not a single horse or pony is below ground, and, although a difficult mine to work, with a heavy gradient of 1 in 2, yet everything is systematically carried out. On arriving at the pit bottom the empty tubs are pushed off the cage by the full tubs, and are taken round a sharp curve. They are immediately seized by an electric-driven creeper or machine elevator, which is a flat chain, with fingers or catches at intervals, which engage the axles of the tubs. The empty tubs are then carried to a height which gives them a gradient of 1 in 80, down which they run by gravitation to the boy who attaches them to the endless rope, which conveys them to the coal face, a distance of nearly a mile. The speed of the rope is 2½ miles per hour, and the tubs are attached to the rope by a "Smallman" patent clip at equal distances of 20 yards. The seam is developed by a main haulage road which is practically level, but anything but straight, owing to the undulation of the seam. This road is worked by an electric haulage plant which is a feeder for the main haulage, which latter is worked by a steam engine from above.

There is a peculiarity in this colliery by the reason that the coal is being worked at a much greater depth than the level of the bottom of the pit shaft, this being reached by an incline in the pit, which is 880 yards long. About 350 yards, commencing from the bottom, the incline is 1 in 7, after that it varies from 1 in 2 to 1 in 1½. After reaching over the top of this incline the tubs are detached from the rope at some distance from the pit bottom, and run with an easy gradient to the pit shaft without undue velocity. The capacity of this plant is 110 tons per hour, which involves the attachment of 240 full tubs per hour, and the same amount of empty tubs, this duty being performed by one man at each end of the rope. The engines driving this haulage are a pair of horizontal high pressure engines—girder type—by Messrs. Robey & Co., Ltd., having cylinders 20 in. diameter by 40 in. stroke. They are fitted with Corliss valves and link reversing gear, and are geared down to 1 in 9 by massive spur wheels. The main rope wheel is 10 ft. diameter, and is fitted with removable steel segments. The rope is 1¼ in. diameter and weighs 15 lb. per fathom, and is passed three complete wraps round the rope wheel.

In the South Wales district, mechanical haulage is confined almost entirely to the tail rope system, and is accomplished mainly by a host of small hauling engines of about 6-in. and 8-in. cylinders, worked by compressed air. In fact, compressed air, both for pumping and hauling, is very popular in this district, and some of the collieries are possessed of very fine compressed air plants. Indeed, I have seen collieries where it would be suggested to the casual observer that the plant consisted of a large air compressor with a colliery attached to it. Naturally, compressed air is looked upon with great favour for underground power by reason of the ventilation given off by the exhaust, although the freshness of the air thus given, after being compressed and carried perhaps through two miles of pipes, does seem open to question.

Lancashire, Yorkshire and the North have a combination of endless and tail rope haulage, and there is also variation as to power used. Steam, compressed air, and even oil engines are used. But, no doubt, before long electricity will be used almost exclusively for this purpose, and during the last few years it has made very rapid strides. As long as its safety can be guaranteed, it is the ideal power for underground work, especially for mines, where the workings are far out from the shaft. Its adoption is, however, by no means general yet. Some approach the question nervously, and others go, perhaps, too far, and are using electric power for their main haulage; and we know of main haulage installations now being put in to 500 h.p. Whether these large installations for this purpose are as efficient and as economical as the surface steam haulage engine and strap rope remains to be seen, but there is no question as to the use of electricity for the subsidiary haulage for bringing the coal from the stalls to the main haulage road, a duty done in most cases at the present day by ponies. There is no doubt that before long, independent of any humanitarian sentiment, mine managers will find, in the interests of economy alone, that it is much better to introduce electric haulage, instead of horse-flesh, as not only is the up-keep less, but the first cost is less also.

PUMPING, etc.

Thus it will be seen that in the question of underground transport alone, there has been—and still is—a very large field for the mechanical engineer, and with the development of deeper seams and extended areas, this question alone will open up a tremendous field for the introduction of mechanical appliances. Already, electric locomotives have been introduced into many American collieries, and once a useful standard has been adopted in this country, there is a probability of a great demand, especially for mines with fairly level workings. Whilst on the question of transport, it must not be forgotten that many modern collieries also have a good deal of surface transport to deal with, and I know of several collieries where they keep six to eight locomotives in work, and from fifteen to twenty miles of permanent way, all properly equipped, besides keeping up a large quantity of rolling stock.

Now, as we can very easily imagine, one of the most difficult questions in connection with mining is, keeping the mines free from accumulations of water, and, especially in some districts, this is perhaps the heaviest duty to undertake—especially in sinking—until the artificial barriers, whether in the form of C.I. tubbing, or in heavy and close brickwork, have stemmed out the tide from the water bearing strata. In many cases this is sufficient, as deeper down the strata is so dry that the absence of water becomes a danger, and now in many mines the water-cart has become an institution, and makes one or more visits daily to damp the dust which, in its dry state, has been known and proved to be the cause of dreadful explosions and the loss of many dear and precious lives. In other cases water is present to such a large degree outside the walled barrier of the shaft as would form a constant source of danger by its sheer weight outside the shaft walls, and frequently it has burst its barriers and flooded a shaft. To obviate this danger a separate shaft is sunk to the water-bearing measures, and pumps are erected to drain away the water and thus relieve the pressure. It is of great historic interest to note here that this was the first use that steam engines were ever put to, for it is on record that, in the year 1712, Thomas Newcomen erected his first pumping engine near to Wolverhampton. A number of these early engines are still to be seen, and some of them in an improved stage are still at work and are doing very useful service.

VENTILATION.

Another colliery institution of equal importance to that of pumping is the question of ventilation, and, here, again, the mechanical engineer has given much valuable time to the study of the question of the mechanical propulsion of air. Perhaps, in no other department of mechanical science is so little known of a definite nature as in the question of fans, and none to which more attention has been given with so poor a margin of success. The ideal fan is a sort of philosopher's stone, and the fortunate individual who dreams he has found it, is often subject to a rude awakening. For instance, we may have heard that some particular fan will deal with about three times the cubical contents of air in a given time than any other fan will. This may be true, but we venture to predict that if that fan were called upon to deliver air at 10 in. to 16 in. water gauge, there would, after a very few minutes, be an addition to the scrap heap. Nevertheless, a number of good fans have been produced, and the names of Waddel, Guibal, Rateau, Capell, Heenan, and Schiele have given reliable instances of good work in this direction. Fans for mine ventilation are mostly direct driven. But, again, many are rope driven, which is the next best thing, as the fan is like the sanctuary lamp—it must never go out. Thus, fan engines are generally duplicated; at least, if they are not, they ought to be.

CAGES.

Having now had a good look round below, let us follow the next load of coal taken up the shaft and see what is taking place above ground. In these days of quick winding and large outputs, single deck cages are not sufficient, so two, three and even four decks are introduced. This, of course, introduces complication above as well as below, because, if time is to be saved and real efficiency gained, there must be as many landings as there are decks, and as all coal tubs must be brought to one uniform level when they reach the screens, it is necessary to make arrangements to deal with this problem. Mechanical genius has again come to the rescue. This difficulty is got over in several ways. First, a separate stop is made by the cage at each floor, necessitating very nice and careful handling on the part of the engine-man, which is cleverly done, but also at the cost of wasting the time for actual winding.

Secondly, where two or more landings are provided, the tubs are lowered by supplementary cages, the loaded tubs providing power for lifting up the empties.

Thirdly, a better system, where the banking room allows of it, is by a system of gravitation roads and haulage creepers, as is well illustrated by Bolsover, where only four men are employed in banking 2,500 tons per day.

Fourthly, a new system was introduced some twenty-five years ago by Mr. G. Fowler, of Babbington Collieries, which employs hydraulic power, not only for lowering the tubs from the high level to ground, but also for ejecting the tubs from the cage itself.

The apparatus consists of two vertical and two horizontal rams; by the side of the winding cages there are duplicate cages, one side of which holds three empty tubs, whilst the other side is empty. When the loaded cage is drawn out of the pit, and is brought to rest on the props, the horizontal rams are set into motion behind the empty tubs, which are pushed forward into the winding cage, pushing out the loaded tubs into the empty duplicate cage. The winding cage then descends on another journey. Then, whilst the winding is going on, the duplicate cage is lowered to ground level and the loaded tubs are taken off and empty tubs are loaded on the opposite side and raised ready for a repetition. Ninety draws per hour are made in this manner from a shaft 220 yards. All the hydraulic levers are under the control of one man, who occupies a sort of signal box close by the pit. A similar arrangement is in use at the pit bottom, with this exception, that whilst at the pit top the pressure is obtained by means of a hydraulic pump and accumulator, the pressure at the pit bottom is obtained by tapping the tubbing in the pit shaft at the water-bearing strata and conveying this down the shaft in a pipe when a pressure of 280 lb. per square inch is easily obtained.

SCREENING.

Passing on now to follow the coal. It is taken by gravitation roads, self-acting inclines, or endless wire ropes, to the screens, which are now one of the most important features of a modern colliery. There it has to be sorted, sized, and cleaned ready for the market, and during the past twenty-five years or so, when the mechanical banking of coal was first introduced, it has developed into a fine art. The old system, which most will have seen in operation at small local collieries, was to have a platform fixed about 5 ft. high above the rail level and along the side of the railway waggons, and the coal tubs were brought alongside and their contents capsized on to the platform, where the large pieces were picked out and stowed into the waggon as large coal. Next, the cobbles were separated by a six-pronged fork, and the small remaining was shovelled into the waggon direct. This system is, of course, entirely out of the question for large outputs, besides which modern markets require a more minute classification of sizes, and it is no uncommon thing for as many as twelve to fourteen different classes of coal to be made at one colliery, all differing in size and quality.

A modern screening plant generally consists of one or more tipplers for emptying the tubs of their contents, a screen or riddle for separating the different sizes, and a number of picking and conveying belts or travelling tables for picking out the stone, bind and pyrites, and delivering the coal into the waggons. In typical coal screening plant, the coal is brought from the pit by a creeper or self-acting incline, and delivered on to the tippler platform, where it is tipped, and the empty tub returned by gravity to the pit. The coal is then passed from the tippler down a fixed bar screen, where a good deal of the small coal is taken out and conveyed by a travelling belt to the slack waggon load. The large coal then passes along the cleaning belt, where stone and other impurities are dressed off, and where it is also separated, should the seam contain two or more qualities. The coal remaining then passes on to the shaking screen, where it is divided into nuts, beans, peas, and duff, or as many sorts and sizes as the market demands.

Different localities have different fashions in coal screening plant, due, partly, to the local demands, to the quality of the coal and the usage of the particular neighbourhood. Thus, South Wales scarcely ever makes more than two sizes. Yorkshire, Lancashire, Durham, and the North more generally follow the same plan of first screening and then cleaning the coal; but Nottinghamshire, Derbyshire, Leicestershire, Warwickshire and Staffordshire go in largely for re-screening, that is, before and after picking, and the hand loading system is largely in vogue, which consists in fixing a long travelling belt between two lines of waggons, and the men select the coal as it comes along and hand-stow it in the creeper.

The value of the paper was enhanced by illustrations of typical plant.

THE SPEED REGULATION OF STEAM ENGINES, STATIONARY AND MARINE.

IN the course of a paper on the above subject read before the Institute of Marine Engineers, Mr. W. Welbury, of Leeds, explained that his object was to point out the condition of efficiency attained in the speed regulation of the stationary engine, to give some examples of this, and to ask why, if it had been possible for the stationary engine-builder to reach such a state of excellence with his regulation, the marine engineer had made no serious attempt to deal with this matter? He contended that, so far from being a hopeless matter, the speed regulation of marine engines was quite within their reach, if they would only investigate.

STATIONARY ENGINES

The two different methods of governing stationary engines, by throttling and through variable expansion gear, with the variations of these methods usually employed, were explained and contrasted, it being claimed that the latter was not only the better method for close control, bnt that an economy of over twelve per cent. in steam consumption resulted from its use. The valves generally used in connection with governors were also described; the author considered that the best and simplest form of variable expansion gear consisted of a shaft governor coupled direct to the distributing valve, which should be a balanced slide valve. This form of gear being suitable for all speeds, engines up to 3,000 i.h.p., fitted with it were working with results that could not be excelled, either for economy, or speed regulation. The piston valve was not suitable for use with variable expansion gear, as it could not be kept steam-tight for any length of time. The circumstances connected with the invention of the shaft governor by Mr. Wilson Hartnell were related in detail. It was also shown why it is impossible to keep the speed exactly constant under varying conditions of load, as the speed must change before the governor could act and thus regulate the steam supply to the engine. It was possible to make a governor so fine as to keep the variation of speed within one per cent. of normal, but this was not advisable where sudden and extreme changes of load had to be dealt with, as under these conditions there was a liability to set up governor hunting.

In engines used for the generation of electricity, it was now realised that too fine regulation was a mistake, more particularly where alternating current was used and generators had to run parallel in this case; especially, the governor must not be too susceptible to slight changes in load, or a condition of surging was set up, caused by a periodic transfer of part of the load of one generator to another and back again. This might occur to such an extent as to throw the generators out of step, with serious results. To make clear what was meant by alternators running in parallel, it might be as well to give a simple illustration. The alternators might be supposed to be spur or cog wheels with a certain amount of slackness between the teeth, to agree with what is termed the "Permissible Allowable Variation on either side of Rotation," this variation, ranging from ·83 per cent. of the circumference on the rotating part with a two-pole machine, to ·028 with a 60-pole machine. The wheels were free to be moved in and out of gear. One being in motion at the desired speed, to get another one in gear with it without the teeth coming in contact with each other, to run and to come out of gear again, under the same conditions, was what was required to be done; it would be conceded that to accomplish this object the speed regulation must be under close control. The present excellence had not been attained without considerable research and experiment; the stationary engine builder, by perseverance, had overcome what at one time seemed insurmountable difficulties and now regulated his engine speed to suit any requirements.

MARINE ENGINES.

The marine engine certainly required a governor; the changes of load it was subject to were so great and so frequent, that it seemed strange to put it to its work without. All engineers with sea experience understood "racing," what an uncomfortable time it was, and how heavy repair bills were after a continuance of it, if nothing worse happened. The worst moments of a race were those when the propeller rose out of the water and again, when descending, its blades struck the surface. The marine engineer had never inquired thoroughly into this question, or made a special study of it, such as it deserved and would repay, for a great amount of damage to the machinery of steamers was caused by the want of effective speed regulation. Attempts had been made to check this wastage by strengthening certain parts, but with only partial success; to eradicate a disease it was first necessary to remove the cause.

The reasons given by the marine engineer to account for his neglect of this important matter did not appear to be justified by facts, and might be summed up as follows:—That the marine engine working mostly at full load, did not require regulating. That the tri-compound engine was so well balanced, it did not race, or raced very little, that he had tried many governors and none had been successful. The actual facts were that breakdowns were on the increase, many of which could be directly traced to racing. The tri-compound engine raced more than the engines of the past, for it had a larger volume of steam not under control of the throttle valve, in the numerous cylinders, steam chests and passages between it and the condenser. Thus hand throttling, which was so effective with the simple engine, fairly so with the compound, was now rarely resorted to. That he had tried many governors was no doubt correct; but were measures taken to prove that the principles on which the design and action of these governors were based were such as to promise success? As the speed of the stationary engine had been under control for a long time, it gave sufficient grounds on which to base inquiry. The absurd claims made for some of these governors should excite suspicion, for they claimed a finer regulation than could be obtained in many stationary engines with good flywheel allowance. In their design the principles of speed regulation were not considered; they were simply made to imitate hand-throttling. The throttle-valve had only two positions, viz., full open or dead shut; therefore their action was much like that of a hunting governor.

After some further description of marine engine governors in use during his sea-going days, the author said he considered that a trial of these governors on a stationary engine would be interesting; for, as the most potent factor in speed regulation was the flywheel, and as this could not be used to assist in controlling the marine engine, it was more difficult to control, so that a governor to regulate the latter, must first be able to regulate the former, as it was a simpler task.

That it was possible to control the marine engine within such fine limits as the stationary engine did not seem feasible, neither did it seem necessary. What was required was such control as would eliminate all heavy shocks. To do this it would be necessary to find some means which would replace or reproduce on the marine engine the effect of the flywheel on the stationary engine; to attempt to control the speed of any multiple-expansion machine not subject to this influence, by simply throttling the steam, was useless.

But there were methods of replacing this influence which promised success. First, a governor might be arranged to act on the reversing gear, reduce the stroke of the valves and so limit the admission of steam to the cylinders. Secondly, the governor to close the throttle valve, after which the steam in one or more steam-chests could be allowed to flow into condenser; thus the power developed by the engine, after steam was shut off, was under control. Any attempts at speed control could only be successful if carried out on the principles of speed regulation. The author also gave some practical hints on designing governors, and the features which he considered should be embodied in a marine engine governor. The paper was illustrated by means of lantern slides, the illustrations shown and explained being the McLaren shaft governor; McLaren electric lighting and power engines, both open and enclosed types; Moscrop slips showing how the engine can be varied while running; the effect of light and heavy flywheels, both with and without governor connected; indicator diagrams, showing how a variable-expansion governor acts as a throttling governor, etc.

THE CONVEYANCE OF MATERIAL.

MR. G. F. ZIMMER, Assoc., M.Inst.C.E., recently contributed a paper on the mechanical handling of material to the Institution of Civil Engineers. The appliances were described under three heads, viz.:—

(*a*) Appliances for lifting in a vertical direction, or from one level to another, called elevators;

(*b*) Appliances for moving material in a horizontal direction, called conveyors;

(*c*) Appliances which combined the two former operations.

ELEVATORS.

Elevators in a primitive form had been known and used for a considerable time, and since their introduction had undergone little alteration except in details. They consisted of endless belts or chains to which suitably shaped buckets were attached, and which ran over two terminal pulleys fixed at different levels. Grain-elevators were usually vertical, and were encased in wooden and iron trunks; while mineral elevators were generally in a slanting position at an angle of 45° to 60°. Grain-elevators were fitted with leather or textile bands, while mineral elevators had malleable or wrought-iron chains as support for the buckets. Grain-elevators, travelling at a speed of 250 ft. to 350 ft. per minute, according to the size of their terminal pulleys, could deliver satisfactorily if in a vertical position, while mineral elevators, which travelled at the rate of only 50 ft. to 160 ft. per minute, required the inclined position, so as to discharge their load clear of their own buckets. Inclined elevators were more easily driven than vertical elevators, on the principle of the inclined plane. In vertical elevators, in order to effect perfect discharge, the centrifugal force must be sufficient to overcome the gravity of the material; so for a specifically heavy material it was necessary to have a higher centrifugal force, that was greater speed of elevator, than for a specifically lighter material. While it was usual to run coal-elevators at 90 ft. to 120 ft. per minute, according to the friability of the coal, coke-elevators ran at only 50 ft. to 90 ft. per minute. On the other hand, minerals which did not deteriorate through breakage could be elevated at the rate of 120 ft. to 160 ft. per minute. A very rational form of elevator was that fitted with a continuous chain of buckets. It was of much larger capacity than an ordinary elevator of the same dimensions. It received and delivered the feed more uniformly, and, as the buckets need not plough intermittently through the contents of the elevator well, slightly less driving power was required.

CONVEYORS.

The types of conveyor were numerous, and some of them were of great antiquity. The oldest type was undoubtedly the Archimedean screw, worm, or spiral conveyor. It consisted of a continuous or broken blade screw described round a spindle, revolving in a suitable trough, and thus propelling the material slowly from one end of the trough to the other. The ratio of the diameter to the pitch of all worms depended upon the kind of material to be conveyed. It ranged from a pitch of one-third of the diameter to a pitch equal to the whole diameter of the worm, and even more. The greater the pitch, the greater the driving power required. A detail of great importance in all worm conveyors was the intermediate bearing. This, if cumbersome, obstructed the passage of the material, a result which was to be carefully avoided. Delivery of the material from a worm conveyor could be effected at a number of points: it was only necessary to provide a suitable outlet. The principal advantages of the worm conveyor were its simplicity and small first cost; it was, moreover, of great service where a mixing of the material to be conveyed was desired. The chief disadvantage was the large amount of driving power required, and the breakage of the material conveyed.

Conveyors of the drag or push-plate type consisted of a fixed open trough. The material to be conveyed was deposited in this trough, and was pushed or dragged along by a series of plates attached to an endless chain. The speed of travel ranged from 60 ft. to 180 ft. per minute. The cable conveyor consisted of a V or U-shaped trough through which was dragged a wire rope with dish-like attachments. The speed of travel was 100 ft. to 120 ft. per minute.

Band conveyors had been introduced a little more than twenty years ago, and were now one of the best means of conveying large quantities of almost all kinds of material, especially for long distances. They consisted of a band which ran over two terminal pulleys. Early band conveyors had been almost entirely used for conveying grain. The tightening of a band conveyor was done in a similar manner to the tightening of elevators. In long conveyors the tightening-gear consisted of a pulley held in tension by weights over which the belt passed. The tight side of the band was the one which should preferably be used for conveying the material. To withdraw the feed of a band conveyor at an intermediate point, a throw-off carriage was employed. The speed at which band conveyors for grain were run, varied from 450 ft. to 600 ft. per minute. The lower speed was for oats or other grain which contained a quantity of chaff that would be blown off the band at a speed exceeding 500 ft. Maize, beans, and heavier seeds were conveyed at the highest speed of 600 ft. per minute. Band conveyors for heavy materials, such as coal, coke, minerals, etc., were very similar to those previously described, with the exception that all the fittings were much more substantial. The principal advantages of band conveyors were the small amount of power required to drive them, and the fact that they did not injure the material conveyed. The disadvantages were that a great many small bearings had to be oiled and kept in repair.

The continuous-trough or travelling-trough conveyor consisted of an endless trough, the sections of which were riveted to the links of suitable chains. The endless trough travelled over two terminal pulleys. These conveyors travelled at 75 ft. to 100 ft. per minute. They were in their construction very similar to the push-plate conveyor, but each section of trough took the place of a push-plate on the endless chain.

The vibrating-trough conveyor was the latest type, and consisted of troughs which received the material at one end and delivered it to the other by means of a succession of suitable backward and forward movements of the troughs. These might, therefore, be classed together with the two previous types, the band and the travelling-trough conveyors, as in all three the material was, so to speak, conveyed in a trough without the action of a stirring or pushing element, as was the case with worms, push-plates, and cable conveyors. It was obvious that all kinds of materials which deteriorated through rough treatment should be conveyed on appliances of the last three types. The support of the trough in its reciprocating motion had been effected by flexible legs in an oblique position. For considerable lengths and capacities the conveyors were balanced. The load could be fed into or withdrawn from any of these conveyors at any number of points, without cessation of work. The material travelled at the rate of 40 ft. to 70 ft. per minute.

COMBINED APPLIANCES.

Under the heading (*c*) there were only two types to be mentioned—the travelling, or tilting-bucket conveyor and the pneumatic conveyor. The former consisted of two endless chains or ropes held at certain distances apart by suitable bars which were fitted with small rollers at each end. Every link, and sometimes every second link, carried a bucket, so that the whole was an endless chain of buckets, which were not, however, fixed like an elevator bucket, but were movable, and suspended above their centre of gravity, so that they were always in an upright position, whether they were moving horizontally or vertically. Each bucket carried its load to the point at which delivery was required, and here it was met by an adjustable device which tilted each bucket in its turn and thus emptied the contents. The material to be conveyed was not injured in the least. Such conveyors required little driving power, and one main drive was sufficient for a whole installation. The second and last appliance under this head was the pneumatic elevator. Mr. F. E. Duckham, M.Inst.C.E., had designed the apparatus which had been in use at the Millwall Docks and in docks of other ports since 1895. The plant consisted of an air-tight tank from which a pipe was connected to the bulk of material to be conveyed. The air was withdrawn from this tank by means of a second pipe connected to an exhauster, and as the air passed through the first-named pipe it drew the grain with it into the tank. The arrangement for removing the grain from the tank without destroying the vacuum was described and illustrated. The Bolinder timber conveyor was also described.

Provision was made in many modern power stations, gasworks, and mines for automatic handling of the materials; and there was no reason why labour-saving appliances should not be employed in dock works, etc., for the handling of the excavated material.

MINING IN KOREA.

A PAPER on this subject was recently given by Mr. L. J. Speak at a meeting of the Institution of Mining and Metallurgy.

NOT OPEN TO FOREIGNERS.

Korea, he said, is not open to foreigners for mining, with the exception that one subject of each of the great Powers may secure one concession. Until recently, only the Americans, British, Germans, and Japanese had located their concessions. The principal terms on which these concessions are granted are that mining supplies may be imported duty free, and that the king shall receive 25 per cent. of the profits. The American concessionaires compounded for this tax on profits by a fixed payment of about £2,500 per annum. Other concessionaires will on this precedent be able to claim the same terms. As yet the American concession, which is situated in the north-west of Korea, near the Manchurian frontier, and has an area of 400 to 500 square miles, is the only one which has arrived at the producing stage.

Considering the situation and the size of the concession, its financial history is probably unique. Starting about five years ago with ten light stamps, it has without further capital developed and equipped itself with

200 stamps. At first the only practicable route to the mine was *viâ* Séoul, a distance of about 250 miles. Later a route was opened by water transport to Ping Yeng, and from thence about 120 miles by land. Now, by a well-organised service of schooners and flat-bottomed boats, the company is able to land most of its goods during the period of summer rains direct on to the concession within thirty miles of all its mines.

The principal mines now being worked are :—

Group A. .	Chittabalbie . .	20	stamps
	Maibong . .	40	,,
Group B. .	Kuk San Dong	20	,,
Group C. .	Tabowie . .	40	,,
	Taracol . .	80	,, (in course of erection).

In addition there are several mines where prospecting or development is going on, and there are also several mines let on tribute to natives.

The three groups mentioned above are about twenty-two miles apart, and consequently each has its own superintendent. All the mines are quartz ledges in granite. The mills are provided with vanners, but have no cyanide plant for the tailings. In the case of one mine, the concentrates, which are very rich, are shipped to America, but as a rule they are cyanided on the spot.

GENERAL CONDITIONS.

Water is plentiful, except for a short period during the height of the winter. Lumber, mining timbers, and cordwood, though not too plentiful, are cheap owing to the cheap labour, but steps are now being taken to develop a water-power scheme in order to preserve the timber. Labour is generally plentiful, but considerable difficulty is met with in obtaining suitable white foremen and overseers, who are mostly obtained from the Western States under contract, and, as in similar cases all the world over where personal selection is not possible, are not always satisfactory. Japanese are largely employed as carpenters, blacksmiths, and engineers, and many of them are excellent workmen ; their wages are mostly three shillings per day, but a few get more. Chinese are largely employed as surface coolies in the mills and cyanide works, and to a limited extent underground. They are preferable to Koreans for such employment, as they work more regularly and require less supervision. They are also indirectly useful in preventing labour troubles and checking thieving, as they do not mix with the Koreans. The ordinary wages of a Chinaman is 10½d. per day. Koreans are employed for the rest of the work ; their carpenters are expert adze-men, and as miners and tool-sharpeners become very efficient. At a recent drilling contest, the winning double-handed team, using ⅞-in. steel drills, sharpened in the ordinary way, finished 22 in. in a granite boulder in ten minutes.

KOREAN COOLIE LABOUR.

The pay of an ordinary Korean coolie is 7½d. per day, and of a miner or carpenter, 1s. 3d. per day. No food or lodging is provided for any of the Oriental workmen. Koreans run most of the hoisting engines and no serious accidents have occurred. After allowance is made for the difficulties of language, it must be said that these Japanese, Manchurians, and Koreans are as intelligent and as capable of receiving instruction as a European would be who had been brought up without knowledge of our methods. Their religious and moral ideas are somewhat crooked, but they are amenable to common-sense. A Korean is not so conservative as a Chinese.

The main principle on which this labour is managed is to have all natives work under the direct supervision of white men without any intermediate native foremen. With proper organisation the number of labourers a white man can look after is mainly determined by the extent of ground they are spread over. At the Tabowie mine, for example, eight levels are open, and one white overseer is required to look after four levels. The overseer examines every hole drilled to see if it is of proper depth and correctly placed, and that it is a suitable hole for a charge of one-fifth of a pound of dynamite ; the overseer also must be wide awake to the possibilities of miners omitting to blast their holes and stealing the dynamite. He also keeps a careful tally of steel and tools in use, and of candles. After a short experience the overseer finds he can do this without much trouble, and can very quickly detect delinquents. Most of the overseer's time is occupied in superintending the timbering, and the tramming of the ore.

THE TABOWIE MINE.

The following is the actual crew employed in the Tabowie mine during May, 1902 :—

Europeans . .	1	foreman
	4	overseers
Asiatics . .	2	timekeepers, one Korean, and one Japanese
	3	Korean engineers (hoist)
	2	,, ,, (pumps)
	2	,, firemen
	12	,, carpenters and timbermen
	100	,, miners
	10	,, tool-sharpeners and helpers
	48	,, shovellers, carmen, station-men, etc.
	13	,, toolboys, etc.

altogether five Europeans and 192 natives ; in addition there is the frequent help of a gang of eight surface coolies and some work done in the general workshops. During the month the above crew extracted 2,904 tons of ore and put in 366 ft. of drifts, cross-cuts and raises. The ground is not hard, but it all requires dynamite, and also requires timbering throughout. The stopes vary from 4 to 15 ft., averaging perhaps, during May, about 8 ft. ; all stopes are timbered, square setts being used in the large stopes.

The occurrence of the ore-chutes is somewhat complicated and not conducive to cheap systematic stoping throughout. The bulk of the ore during this month was hoisted from the shaft.

The principal stores consumed were :—

1,100 lb. dynamite
5,500 detonators
12,000 ft. of fuse
50 boxes of candles
400 lb. drill steel
590 mine timbers
8,000 ft. of planks and lagging
48 cords of wood

EXPENDITURE.

The total expenses were as follows :—

Europeans	£130
Native wages	270
Stores ; shops ; coolie gang, etc. ..	240
	£640

equal to 4s. 5d. per ton mined on 2,904 tons.

Similarly in June, with 3,220 tons of ore mined, the total costs equalled 3s. 8d. per ton, and in July, with 3,350 tons, 3s. 5d. per ton.

These costs include all maintenance and construction expenses during the period, and also an amount of development work exceeding the stoping requirements. They include assaying costs, but not surveying nor expenses of general management. The stores are, however, charged to the mine at a slight profit, and the actual native wages paid was about £30 per month less than stated above owing to the present low price of silver. The discount on silver is credited to general expenses.

It will be noticed how rapidly the costs diminish with increased tonnage ; it is largely on this account that during the period under review the cost of mining in other places on the concession averaged 5s. to 6s. per ton. The different mines also vary much in working facilities and in hardness of the rock ; where the rock is hard less timber is required, which nearly compensates matters.

On the whole, mining costs in Korea may be roughly estimated thus : With a stoping width not less than 4 ft., and where there is not an excessive amount of dead-work, the total cost of mining will be from 4s. to 5s. per ton. This would cover all ordinary costs, but would be exclusive of new hoisting engines and boilers or shafts.

In milling and concentrating recent costs have been as follows :—

Tabowie Mill—Forty stamps with vanners and canvas plant—

		Tons milled.	Cost per ton.
May, 1902	..	4,008	1s. 8·8d.
June, ,,	..	4,130	1s. 7·5d.
July, ,,	..	4,589	1s. 7·1d.

This mill is run by steam power, wood being used as fuel ; the screen used during May and June was equal to 35 mesh, and during July, 30 mesh. The mill is not new, and the costs include all maintenance and repairs of both mill and vanners, as well as assaying and bullion smelting costs. There are other mills on the concession working at approximately the same costs. For a mill and plant of forty stamps a fair average cost of working would be 1s. 9d. to 2s. per ton, according to price of fuel and situation. In the mills Chinese become very efficient, as they are usually experts at sign language ; white men must, however, invariably be present.

The work accomplished with this class of labour in Korea shows what may be hoped for with regard to future mining in the temperate zones of the Far East.

HYDRAULIC MACHINERY AND THE DISTRIBUTION OF HYDRAULIC POWER.

In the course of a paper on the above subject, contributed by Mr. F. J. Haswell, M.I.Mech.E., at a meeting of the Liverpool Engineering Society, the author dealt at some length with the mechanically produced high-pressure hydraulic powers supply, with special reference to the more recent developments.

THE HYDRAULIC DIRECT ACTING LIFT.

The hydraulic direct-acting lift is the only one in which it is possible to apply the power from below, without the intervention of any ropes or gearing, and to be quite independent of all overhead sheaves, girders, etc. ; it is also, perhaps, the nearest approach to absolute safety possible, as the cage is supported by a steel column in direct contact with the water, the cylinder, ram and cage being carried by solid foundations. A long lift of this type, without any means of balancing the weight of the cage and ram, is not a very economical means of using power, and to get over this difficulty, and to dispense with the old chain and balance weight, Mr. Ellington, in 1880, brought out his hydraulic balance.

As the cage ram has to be considered as a column supporting its load at the top extremity of its stroke, it is generally of a larger area than would be required if it was worked direct from the main ; the accumulator pressure must therefore be reduced to suit the larger area.

SUSPENDED LIFTS.

Several excellent types of hydraulic suspended lifts are made, and where circumstances make it undesirable to use a direct-acting lift, one of this type makes a very efficient substitute. The hydraulic apparatus usually consists of a refinement of Armstrong's jigger of long stroke, with quadruple wire ropes, each one being capable of supporting the load. The cage is balanced by inverting the cylinder so that the ram moves downwards; the weight of the ram, ram-head, sheaves, etc., thus acts as a counterweight ; any additional weight required can be slung from the ram head, or an additional overhead sheave and independent balance weight provided. This arrangement does away with the danger of the ram descending by gravity without the cage if the latter should stick and the water leak or syphon out of the cylinder. In the differential lift the ram runs right through the cylinder, but is reduced in diameter for half its length, the pressure acting on the annular area or difference between the two diameters.

The multiplying sheaves are generally attached to the small end or tension rod. The safety gear should be attached to the underside of the cage and not the top, as is sometimes done; in the latter case it is necessary to make the sides and bottom of the cage stronger than would otherwise be required, in order to resist any strain caused by the safety gear coming suddenly into action.

An intensifier is practically an inverted balance minus the weights. Pressure is admitted to the large ram and work taken off the small one, the pressure being increased in the ratios of their areas. By a proper proportioning of these, any desired pressure can be obtained; they are used for increasing the pressure in cylinders for packing, pipe drawing, metal squeezing and testing, and many other purposes where a very high pressure is required. When a continuous flow of intensified water is demanded, the machines can be used in pairs or groups placed side by side, each automatically working the valve of its neighbour.

MINE PUMPS.

As collieries increase in depth, the drainage problem increases proportionately. It will therefore be interesting to consider what advantages hydraulic transmission of power for pumping enjoys over other means for this purpose.

For lifting water from great depths—700 to 900 yards—the old fashioned bucket pumps driven by gearing are not satisfactory; they are expensive to maintain, have a low efficiency, and take up valuable space both inside the shaft and above the ground. Steam pumps are objectionable on account of the loss due to condensation in the long line of pipe; the heat lost by radiation raises the temperature in the pit and necessitates expensive ventilating plant. Electric transmission would appear to possess advantages not offered by other means, but on examination these apparent advantages are considerably discounted. Electric machinery is perhaps the most delicate of all, and requires constant care and more attention than it would get at the lowest depth of a mine; its enemy, water and damp, is there in abundance, and a cable and motor charged with a high tension current are not the safest of neighbours in the already dangerous atmosphere. But perhaps the electric motor would show its weakest point in the event of the mine becoming flooded in part or wholly; the motor would be "drowned" and the pumps useless at the time when most urgently needed. This emergency would affect the efficiency of the hydraulic pump favourably, as there would be greater head on the suction and a less unbalanced head in the delivery pipe; it would work for a considerable length of time under water, as lubrication would be applied to the pressure water in the suction tank or through an automatic lubricator fixed in the pressure main at any point.

The pump itself could be started and stopped from the surface, frequent visits to it being unnecessary. The pressure pump on the surface could be driven by electric, gas, oil, steam, hydraulic or any other motor. These facts taken in conjunction with the simplicity and reliability of hydraulic machinery would lead one to take a sanguine view of the future of hydraulic mine pumps, and I would venture to prophesy that they will be as much used in this country as they are on the Continent and in the United States.

SEWAGE PUMPS.

In low-lying districts subject to flooding, or where the flow in the sewers is impeded by tidal action, hydraulic pumps are used with considerable success.

A complete installation, consisting of a central pumping station, accumulator, etc., and over eight miles of 5-in. main working thirty-four Ellington's patent automatic pumps in seventeen sumps, connected to the sewers, have been at work in Buenos Ayres since 1893.

They are all single acting; the pressure water is admitted by a common slide valve through the ram to the cylinder, which, it will be seen, is placed inside the large displacement plunger; this is driven down by the pressure and lifts the sewage into the rising sewer. The return stroke is made by the small push back rams, which are constantly under pressure and take the place of balance weights and chains.

The diameter of the plungers is 30 in., and the stroke varies with the work required, the head and friction on the delivery sewers being different at different sumps. The maximum speed of working is ten double strokes per minute; they are started and stopped automatically by a float actuated by the rise and fall of the sewage in the sump, one pump being placed lower than its fellow, in order that it may do its full work before the second starts. The work was carried out by the Hydraulic Engineering Company, of Chester, to the order of Messrs. Bateman, Parsons, and Bateman, the engineers to the Argentine Government. The efficiency, including all losses in the valves, mains, etc., at full speed, averages about 41 per cent. This compares favourably with the compressed air system, which has an efficiency of about 20 per cent. (Proc. I.M.E., July, 1895, p. 378). The same system has been adopted for the drainage of Woking and district, and a somewhat similar installation is in use at Margate (Ency. Britt., Edition 10, Vol. XXXI., p. 895).

EJECTORS.

Where only small amounts of water or sewage have to be dealt with, an almost ideal apparatus is provided by the automatic ejector. It is used extensively in buildings whose basements or cellars are below sewer or tide level, and consists of a small hydraulic ejector with a nozzle about $\frac{3}{32}$-in. bore, pressure to which is controlled by a side valve in conjunction with a hydraulically-operated stop valve. It is stopped and started by an adjustable float, which slides on a tappet rod connected to the slide valve lever; the travel of the float and range of rise of the water can be adjusted as required. The water in rising carries the float up until it engages with the top tappet on the rod and sets the apparatus in action, which does not cease until the water falls to its lowest level, when the weight of the float, resting on the bottom tappet, carries down the lever, shuts off the pressure and stops the apparatus. It is compact and usually placed in a sump below the floor level. Many of them are working in Liverpool. The first one, which was fixed over two years ago, was in operation for eighteen months, working for three periods of five minutes each every twenty-four hours, without any adjustment or repairs whatever, and was then examined as a matter of precaution. The maximum height to which water has been lifted is about 35 ft., and the consumption of power water about 4½ gallons per minute.

Power being left on the pipes day and night, they are always ready to cope with any sudden emergency, such as an exceptionally high tide and heavy downpour of rain combined.

ROCK DRILLS.

Actuated by hydraulic power, rock drills have many advantages. At the work in connection with the boring of the Simplon Tunnel, after many experiments and trials, the "Brandt" hydraulic drill was adopted as most suitable; it consists of a direct-acting hydraulic cylinder with a piston of about 29 square inches effective area, the piston rod having a mandrel at its forward end to which the hollow bit is secured. This bit has three fangs or cutting edges and is held up to its work by the pressure on D.A. piston and revolved by two small cylinders, each one 1⅞ in. diameter by 2⅜ in. stroke, bolted to the feed cylinder. The exhaust water can be discharged direct inside or outside the hollow cutter, thus cooling it, and at the same time washing the debris out of the hole and keeping the atmosphere clear of dust.

The maximum revolutions of the drills, which are 3 in. diameter, three being mounted on one carriage, are ten per minute, but these and the pressure vary with the character of the work. With the lower pressure of 680 pounds square inch and the drill working in friable limestone, the total pressure on each cutter is 9,000 kilos (about 20,000 pounds), the average advance is 8 metres (26¼ ft.) per day of twenty-four hours; number of blasts six to eight, and quantity of material removed each time is about 4 ft. of the heading, or 260 cubic feet. In harder rock, quartz, spar and mica, a higher pressure is used (1,175 pounds square inch), and the amount removed about 160 cubic feet per blast.

PELTON MOTOR.

The special form of impulse turbine, known as the Pelton Wheel, has been in general use for many years in the United States, where its simplicity of design and small cost of maintenance and repairs has been fully appreciated, but it is in comparatively recent years that it has been introduced into this country and adapted to high velocity jets. It consists of a wheel with buckets or cups generally shaped in the form of two U's joined thus, ω, which are mounted on the periphery, and one or more nozzles. The jet strikes the centre web of the buckets and re-acts on the "wings" before falling into the exhaust tank. It is well to bear in mind that at a given working pressure the speed of the periphery is the same for all powers; the power of a given diameter of wheel can be varied only by adjusting the diameter of the nozzle or altering the number of jets, and so making the consumption of water correspond with the work given out. When the power required is constant, such as for hair brushing, tea mixing, circular saws, ventilating fans, etc., the simple motor described is suitable. It practically requires no attention beyond oiling the bearings, and where these run in an oil bath it will run for a month or more literally unnoticed, and is therefore particularly suitable for situations where no skilled attention is available. One of these motors has been under the author's personal observation for the past seven years, and has not had repairs of any description. When the power required varies and the variations are known, two or more nozzles of different diameters can be fitted, one by itself giving (say) 1 h.p., the other 2 h.p., and both together 3 h.p.; or two or more motors can be mounted on the same shaft with similar results. When very steady running is required, as in driving a dynamo for electric light or power work, and the pressure and load are subject to slight variations, a governor is required. A simple but uneconomical form is used in the United States, where water power is cheap and natural heads abound; the nozzle is pivoted and its position controlled by the governor, which, as the speed rises, lowers it, so that the jet clears the buckets of the wheel; but where the water passes through a meter and is sold by the unit some more economical method must be used. As the speed of the water at a pressure of 750 pounds square inch is 320 ft. per second, revolutions of motor from 1,500 to 2,000 per minute and area of nozzle only ·072 in. to give 1 h.p., the problem is by no means a simple one. but it has been very fairly met by the Hydraulic Engineering Company, of Chester, who have adopted an arrangement consisting of a solid cone which fits inside the jet cone. As the work fluctuates the solid cone is withdrawn or advanced by the governor, liberating or throttling the water as required. A hand-regulating device on the same principle is used where a governor is not necessary.

BELL RINGING APPARATUS.

Among the many minor applications of hydraulic power may be mentioned an ingenious arrangement for ringing fog bells at the N.E.R. Co.'s docks at Hull. It consists of a small hydraulic cylinder fitted with a piston and rod, which latter extends up to and beyond the bell. At its top end there is a tappet, which in rising lifts a small trigger at the end of a bell crank lever, on the other arm of which is attached the hammer for striking the bell. After the tappet has reached the top end of its stroke the trigger falls, and upon the return stroke the tappet engages the top side of the lever, raising the hammer. When the tappet slips past the end of the lever the hammer falls and strikes the bell. The valve which operates the mechanism is a circular balanced D valve, rotated by a three-arm tumbler arrangement actuated by a tappet worked from the lower end of the piston rod. The gong is timed to sound once every twenty seconds, the timing arrangement being a simple gun-metal diaphragm, the correct diameter of the hole in the middle being arrived at by experiment. Mr. George Shaw, the assistant dock engineer, who designed the apparatus, says, "In seeking for a means of tolling the bell, hydraulic power was at once decided upon. The mechanism for utilising h.p. is at once simple, and the first cost and subsequent upkeep is small. The bell has been in operation for seven years and has given every satisfaction. The pressure of the water in the main is a maximum of 800 pounds per square inch."

ARTIFICIAL FLAGSTONE PRESS.

The Liverpool Corporation have for some time used hydraulic presses for making concrete paving slabs, made from a mixture of Portland cement and clinker from a refuse destructor. A cast iron mould is filled with the proper mixture of concrete, which has above and below it a porous cloth. The mould is pushed into the press by a small hydraulic cylinder and piston. The pressure from the hydraulic main is admitted to two cylinders whose rams hold the die in position against the cross-heads of the press, and also to a larger central ram which forces up the loose diaphragm compressing the concrete and driving out a large proportion of the water contained in it. By another movement of the same lever the pressure water is diverted from the press cylinder into that of an intensifier, and communication is opened between the intensifier and the press, raising the pressure in it to 2½ tons per square inch, and driving still more water out of the mould. The diaphragm is clamped to prevent the slab falling out, drawn out of the press by the piston and turned upside down. A small hydraulic lift carrying a trolley is run up beneath it, the clamp released, and the finished slab removed and stacked for drying, leaving the reverse side of the die ready to be filled with concrete for another slab. A second die with traversing gear and lift has been fitted at the opposite side of the press, so that one mould can be prepared while the first is under pressure. This press, and many more similar, was designed and constructed by Messrs. C. and A. Musker, of Liverpool.

FIRE EXTINGUISHING APPLIANCES.

The velocity of a high pressure jet of water can be usefully employed in reinforcing or intensifying the pressure delivered from the ordinary town main. The late Mr. Greathead made use of the injector or jet pump principle in his combination hydrant, which is an ordinary hydrant with the addition of a nozzle of small bore in its centre, connected to the high pressure main. The large body of water is supplied from the low pressure main tank or dock, and the lifting power from the high pressure main. With a low pressure supply of (say) thirty pounds per square inch, a jet of 150 gallons per minute through 200 ft. of 2½-in. hose, with a 1-in. nozzle, can be thrown to a height of from 70 to 90 ft., the proportion of power water to that lifted being about 25 to 100. At Melbourne, where the town's pressure is low, an injector hydrant is connected to a system of small sprinkler pipes spread over the roof and windows of a large building, so that when the pressure is turned on, a protecting sheet of water is spread over the building.

An arrangement by which the injector hydrant can be worked automatically has been designed and patented by Mr. Ellington. The hydrants are connected to the high and low pressure mains or suction tank in the usual way, and the valve controlling the admission of the high pressure water is operated by a small accumulator. A slight leak is allowed through this valve sufficient to cause the accumulator to fall slowly; when it gets near the bottom of its stroke it further opens the valve, rises again and shuts the valve and thus continues until a demand is made on the hydrants, when the reduction of pressure, due to the increased velocity of the water, causes the accumulator ram to fall sharply and fully open the valve, admitting the high pressure water to the nozzle, and injects the combined jets into the sprinkler pipes or fire hose.

Pressure is constantly on the pipes, the apparatus thus being ready for action at any moment. Several are at work in London, Manchester, etc., but the excellent fire service provided by the Liverpool Corporation rather militates against their extensive adoption in this city. The use of the apparatus in connection with automatic sprinklers, etc., has been accepted by the Fire Insurance Committee as entitling users to a special discount from insurance rates.

LUBRICATING.

To secure easy and satisfactory working of any machine, it is essential that the working parts be kept properly lubricated; the working faces of slide valves are no exception to this rule. In installations where return mains are provided, and the same water is used over again, it is usual to mix with it soft soap or other lubricant. In most public hydraulic power supplies this is impracticable, and provision has to be made for introducing from time to time small quantities of lubricant as near as possible to the point where needed. A number of devices for this purpose have been designed, and among the best in use at present is that known as Thornton's lubricator. Another useful lubricator is known as Waygood's. It consists of a cylinder with tight-fitting piston, with piston-rod of rather large area. The lubricant is placed in the annular space surrounding the rod, and pressure admitted to both sides of the piston, the difference of area causing it to ascend and force the oil into the pressure pipe. The rate of movement is controlled by a screw-down cock as in a sight-feed lubricator. Many more applications of hydraulic power might be mentioned if time permitted, such as shearing and punching machines, riveters, manhole cutting machines, portable drilling and tapping machines, waggon traversers, coal hoists, capstans, dock gate sluice and bridge gear, etc.; but at the same time it is not asserted that hydraulic transmission of power is the only system suitable in all cases and on all occasions. It, like other means of distribution, has its field, and hydraulic power seems to be marked out by natural selection as the most suitable means for actuating machinery where power has to be employed in producing rectilinear motion intermittently through comparatively short distances. In most power transmission plants, other than for tramway or railway work, the demand is of a very intermittent character, and the system of small generating units adopted in hydraulic stations is one which lends itself to the most economical production of power. The engines are automatically controlled by the accumulator, and regulate their speed to suit the output, thus avoiding unnecessary wear and tear, and the reduction of mechanical efficiency, which takes place when engines, though not fully loaded, have to be run at a constant speed.

COST OF HYDRAULIC POWER.

As to the cost of producing hydraulic power. The most authoritative and detailed statement on the subject is contained in a paper read before the Institution of Mechanical Engineers by Mr. E. B. Ellington (Glasgow Meeting, 1895) and supplemented in the *Encyclopædia Britannica*, edition 10, volume 31.

In the former a comparison is made between the cost of a public supply of hydraulic power and that of electricity obtained from a central station on almost exactly the same scale. The particulars were taken from the records of the London Hydraulic Power Company and of the Westminster Electric Supply Corporation for the year 1894. It is shown that, reducing both to a common basis, the station cost of hydraulic power is 5·172d. per 1,000 gallons, and the corresponding cost of an equal amount of electric energy, 9·014d., or, reduced to Board of Trade units. 0·793d. and 1.383d. respectively. At the Wapping Pumping Station of the London Hydraulic Power Company, taking rough small coal at 10s. a ton, the station cost for the year 1900 came out at less than ½d. (·465d.) per electric unit, or a little more than 3d. per 1,000 gallons.

COMING EVENTS: APRIL—MAY, 1903.

April.

1st.—Society of Arts: Ordinary Meeting.

2nd.—Civil and Mechanical Engineers' Society: Paper—"Recent Experiments with Centrifugal Fans," by Mr. W. Gilbert, Wh.Sc., A.M.Inst.C.E., at 8 p.m.

3rd.—Institution of Junior Engineers: Paper—"Greasy Condensation Water as Boiler Feed," by Mr. William Paterson, at 8 p.m.

4th.—Manchester Association of Engineers; Afternoon: Inspection of Municipal School of Technology; Evening: Tea at Grand Hotel. Paper—"The Practical Training of Engineering Employers," by Mr. M. Ingram, at 7 p.m.—Birmingham Association of Mechanical Engineers: Paper—"Steam and Steam Engine; Has the Last Word been Said?" by Mr. J. Batey, at 7 p.m.

6th.—North-East Coast Institution of Engineers and Shipbuilders: Council Meeting at Newcastle.—Society of Engineers: Ordinary Meeting, at 7.30 p.m.

7th.—Institution of Civil Engineers": Paper, at 8 p.m.

8th.—Liverpool Engineering Society: Paper—"Description of the Kendall Waterworks," by Mr. J. H. Parkin

9th.—The Mining Institution of Scotland: Annual Meeting at Hamilton.

11th.—Birmingham Association of Mechanical Engineers: Visit to the Cable Tram Depôt, Hockley Brook.—North of England Institution of Mining and Mechanical Engineers: General Meeting.

13th.—Institution of Mechanical Engineers: Graduates' Meeting.—Institution of Marine Engineers: Annual Meeting.

21st.—Institution of Civil Engineers: Paper, at 8 p.m.—Society of Arts: Meeting, Applied Art Section.

23rd.—Institution of Mechanical Engineers: Anniversary Dinner.—Institution of Electrical Engineers: Meeting at 8 p.m.—North-East Coast Institution: General Meeting at Sunderland.—Society of Arts: Meeting of Indian Section.

24th.—Institution of Mechanical Engineers: Ordinary Meeting at 8 p.m.—Institution of Civil Engineers, Students Meeting: Paper, at 8 p.m.

25th.—North-East Coast Institution of Engineers and Shipbuilders: Graduates' Meeting at Newcastle.

27th.—Society of Arts: Paper—"Mechanical Road Carriages," by Mr. W. B. Beaumont, M.I.C.E.

28th.—Institution of Civil Engineers: Annual Meeting of Corporate Members, Election of Council and Auditors, etc., at 8 p.m.

29th.—Liverpool Engineering Society: Annual General Meeting.—Society of Arts: Ordinary Meeting.

May.

1st.—Institution of Junior Engineers: Paper—"The Effect of Design on Methods of Construction, from a a Contractor's Point of View," by Mr. R. W. Newman M.I.M.E., at 8 p.m.

2nd.—Birmingham Association of Mechanical Engineers: Paper.

4th.—Society of Arts: Paper No. 2, by Mr. W. B. Beaumont.—Society of Engineers: Ordinary Meeting at 7.30 p.m.

5th.—Society of Arts: Meeting of Colonial Section.

6th.—Society of Arts: Ordinary Meeting.

7th.—Civil and Mining Engineers' Society: Paper—"The choice of Steam Boilers," by C. E. Stromeyer, M.I.C.E., at 8 p.m.

SOME BOOKS OF THE MONTH.

"MANUAL OF ELECTRICAL UNDERTAKINGS AND DIRECTORY OF OFFICIALS, 1903."

Compiled under the direction of Emile Garcke, M.I.E.E., F.S.S. Publishing Offices, Mowbray House, Norfolk Street. Cloth. 15s. net.

THE seventh annual volume of this indispensable manual places at the disposal of electricians, corporation officials, investors and others, a wonderfully complete record of the current progress of electrical engineering. Its 1,500 pages are packed with data of the utmost value to every electrical engineer, the size of the work keeping pace with the steady growth of their electrical industry. The following figures show for each year the aggregate capital issues by companies in shares, debentures, and loans, and amounts borrowed by municipalities for electrical undertakings:—

	£
1896	61,109,525
1897	69,209,478
1898-1899	84,742,020
1899-1900	105,977 719
1900-1901	123,636,602
1901-1902	165,807,474
1903	186,158,964

The work affords a complete information regarding all electrical companies formed under the Joint Stock Acts, and electrical undertakings belonging to Local Authorities. It is classified under five sections, viz.: (1) Electric Lighting, Traction and Power; (2) Telegraph and Telephone; (3) Manufacturing and Miscellaneous; (4) Directory of Officials; (5) List of Electrical Companies registered since 1856.

Some special subjects dealt with in the section—"Progress of the Year"—are: London Underground Railways; The Light Railways Act; History of All-British Pacific Cable; Tunbridge Wells Telephones; Government Trunk Wire Service; Post Office and Municipal Telephones.

Excellent maps illustrate the various power schemes, and of special interest are those dealing with the London Tramways, one showing the existing and authorised tubes, the other dealing with the 1903 promotions. There are also maps dealing with fourteen county power schemes, and fifteen inter-urban electric tramway schemes.

Coloured diagrams show the comparative results of working of electricity supply and electric traction undertakings, with other particulars.

"THE CHEMISTRY OF INDIA-RUBBER":

Including the Outline of a Theory of Vulcanisation. By Carl Otto Weber, Ph.D. With four plates and several illustrations in the text. Charles Griffin and Co., Ltd. 314 pp. 16s. net.

THE publication of Mr. Weber's book fills a yawning gap in the scanty literature of india-rubber, and places much valuable information at the disposal of those whose business it is to deal with the remarkable group of colloids comprised under the name. A treatise concerned with the nature of india-rubber, its chemical and physical examination, and the determination and value of india-rubber substitutes should be very welcome to chemists and technologists at a time when this useful substance is finding fresh uses almost every day. As the author remarks, the cradle of the india-rubber industry, as of so many others, stands in this country, but it is still very largely developing on empirical lines.

In none of the industrial countries have any organised efforts been made to bring to bear upon the problems of this industry the full resources of modern chemical and physical research. This is, no doubt, also the reason why, notwithstanding the occasional claims of "trading puffs," the efficiency of the rubber trade in Great Britain is in no way inferior to that of the United States, Germany, or France. But it is of importance that manufacturers should clearly realise that india-rubber and the industry connected with it offer wide fields for scientific research, the exploration of which has already commenced; and the india-rubber industry of the future will belong to whatever country may take the lead in the scientific investigation and elaboration of its problems.

The author gives the outlines of a theory on vulcanisation, together with particulars of the discovery of this phenomenon, and devotes the concluding portion of the work to the question of sanitary conditions in india-rubber works.

"GERMANY AND ITS TRADE."

By G. Ambrose Pogson. London and New York: Harper and Brothers. 174 pp., 3s. 6d.

ANOTHER of Harper's excellent International Commerce Series. The volume is much on the lines of its predecessors and includes a vast amount of fact and figures, usefully tabulated, and of first-rate importance to the student and business man.

As the editor remarks in his introduction, "If a foolish panic about the 'German Bogie' was circulated by alarmist writers a few years ago, that is all the more reason why the minds of the new generation should be brought into contact with the facts. Mr. Pogson's skilful tables show very clearly and accurately the main lines of German progress. Ancient seats of art and industry, great coal and iron fields, splendid water-ways, the substitution of a large Free-Trade area for a network of petty and vexatious tariffs, and, above all, an industrious population, now gradually being raised by an efficient system of education to a general level of intelligence far higher than that which most of its commercial rivals have attained—these, it may be suggested to students of German economy and finance, will help us to understand why a country comparatively poor, and very heavily burdened by military expenditure, has grown in many respects so much more rapidly than other Continental Powers."

A specially interesting chapter is concerned with German commercial policy and the German tariff. The final section deals with commercial education. We note that as yet, even in Germany, this subject, in the strict sense, has not got beyond the experimental stage. Mr. Pogson's carefully studied pages afford ample food for reflection, and the volume is a notable addition to the reference library.

"VALVES AND VALVE-GEARING":

A Practical Text-book for the Use of Engineers, Draughtsmen, and Students. By Charles Hurst. Third edition, revised and enlarged, with frontispiece, numerous illustrations, and five folding plates. Charles Griffin and Co., Ltd. 154 pp., 8s. 6d.

MR. HURST'S well-known work now appears with an additional chapter on Drop Valve Gears, and the original portion has been carefully revised. Part I. deals with Slide Valves, Part II. with Corliss Valves, and Part III. with Double-Beat Valves and Miscellaneous Gears. The work includes a great number of diagrams illustrating the best modern gears, and is essentially practical throughout.

"THE ARITHMETIC OF COMMERCE AND TRADE."

For Use in Schools and Offices. By S. Jackson, M.A. (Oxon). Allman and Son, Ltd. 164 pp. 2s.

THIS work will be especially valuable to the student who wishes to acquire a practical knowledge of arithmetic, such as is required in every-day business life. Moreover, the examples are so clearly worked that he should be able to achieve this object without the assistance of any other teacher. The following sections are included: Ordinary Methods in Arithmetic; Short Methods in Arithmetical Operations; Prices; British and Metric Tables; Percentages and Profits; Interest and Inland Exchange; Interest Annuities and Insurance; Stocks and Shares; Invoices, Account Sales and Accounts Current; Foreign Exchanges.

"THE CARE AND MANAGEMENT OF STATIONARY STEAM ENGINES":

A Practical Handbook for Men in Charge. By Charles Hurst. With thirty-one illustrations. Crosby Lockwood and Son. 88 pp. 1s. net.

A LITTLE manual which deals in an essentially practical manner with such points as Water in Cylinders and Leakages, Taking Indicator Diagrams, Valve Setting, etc. The man who finds himself in charge of an engine without much previous experience will find these pages helpful and instructive.

"AN ELEMENTARY TREATISE ON THE MECHANICS OF MACHINERY":

With Special Reference to the Mechanics of the Steam-Engine. By Joseph N. Le Conte. Macmillan. 312 pp. 10s. 6d. net.

ILLUSTRATED by numerous plates and diagrams and furnished with an index, Mr. Le Conte's work should prove a valuable addition to the library of the student. It is the outline of a course of lectures on the kinematics and the mechanics of the steam-engine arranged for the benefit of students in the Department of Mechanical Engineering of the University of California. The eighteen pages comprising Part I. are devoted to introductory matter; Part II. deals with the machinery of transmission, and Part III. with the mechanics of the steam-engine.

CATALOGUES AND TRADE PUBLICATIONS.

The Harris Patent Feed-Water Filters, Ltd., 73, Queen Victoria Street, E.C.—An illustrated pamphlet of 32 pages, containing short descriptive articles on the "Harris-Anderson" Purifier, the "Harris-Anderson" Water Softener, and the "Harris" Feed-Water Filter. The first-named is "an apparatus for the absolute removal of oil, both free and emulsified, from the boiler-feed of condensing engines"; the second, an automatic apparatus for softening water for engineering and domestic purposes; and the third is the well-known "Harris" Feed-Water Filter for removing grease and other impurities from feed-water of land and marine boilers. Attention is called to the large number of men-o'-war and other vessels which have been fitted with this type of filter. Excellent illustrations of one or two of these vessels appear, including H.M.S. *Terrible*, H.M. turbine destroyer *Viper*, the *Campania* and *Lucania*, etc.

Dorman, Long and Co., Ltd., Middlesbrough.—We understand the Britannia Rolling Mills, which have been stopped since August last for enlargement and reconstruction, have now resumed operations. We have received from the above firm an interesting list of the sections of girders adopted by the Engineering Standards Committee, and the hope is expressed that customers will support the movement by specifying standard sizes, all of which will be kept in stock. They are still able to supply other sizes, however, should they be required for any special purpose, and, as a result of their recent alterations, they are now in a position to supply the large-sized girder 24 in. by 7½ in. by 100 lb. per foot.

The Ropeways Syndicate, Ltd., London.—A very interesting booklet of excellent design and first-class execution, a notable feature of which is the whole page half-tones, and extra large insets illustrating many of the aërial ropeway installations in all parts of the world which have been erected by this firm. One of the principal advantages claimed for this method of transportation is the enormous saving effected when conveying materials over rough and hilly ground—where, by ordinary methods, it would be necessary to take long and circuitous routes—and a profile is given of a light ropeway—to carry 50 tons per day—which covers "the most remarkable ground ever dealt with," being "precipitous and rugged in the extreme." Its length is 4,400 yards, and the number of trestles (which, we are informed, have been reduced in this instance to an extent hitherto unprecedented) is only seventeen. Prospective customers will do well to read the various hints regarding estimates which are contained in this booklet.

Fraser and Chalmers, Ltd., London.—A series of illustrated pamphlets descriptive of some of the improved mining machinery manufactured by the firm. The data is as follows: Description of a modern Corliss permanent winding engine used in sinking, with half-tone illustrations and sectional diagrams. Particulars of the Whitmore Governor, safety brake and over-winding gear with illustrations and diagrams. Illustrated description of a double King-Reidler Air Compressor built for a South Wales Steam Coal Company. List of Reidler Compressors ready for immediate delivery and under construction.

The Wilfley Ore Concentrator Syndicate, Ltd., Moorgate-street, London.—A pamphlet of 10 pages with sectional drawings describing the McDermott Sizer—of which this firm are the sole proprietors. It is the invention of Mr. Walter McDermott, and is designed for separating the different sizes of crushed ore before it is fed on to dressing machinery. It is claimed that by the use of this sizer the pulp can be prepared in a manner more suitable and in such a way as to materially increase the efficiency of the concentrating plant, and can be adapted to whatever type of dressing machine happens to be employed.

Royce, Ltd., Hulme, Manchester.—A neat little brochure of 28 pages printed in two colours on the best art paper with embossed cover, and containing some very fine half-tone illustrations of various kinds of dynamos and motors—which we are told are constructed throughout "with a view to obtaining the highest electrical efficiency and mechanical soundness." A price list of the different types is given, and the photos are interesting as including one of an open multi-polar electric generator, which can be adapted for belt or rope driving or direct coupling to engine or turbine. There is also an illustration of a 300 kilowatt direct-driven power-generator for traction service—and reproductions of semi and totally enclosed motors of various kinds adaptable to many uses. Included in this catalogue are some useful "Speed and output" tables for voltages from 100 to 500.

The Simplex Steel Conduit Company, Ltd., London and Birmingham.—The fifth annual catalogue of 200 pages, bound in leather, and of excellent design and shape, can be readily carried in the pocket for immediate reference. The list contains numerous woodcuts, with particulars of eight grades of conduit, and a large number of new fittings, enamelled and galvanised. Amongst other features may be mentioned: The screw socket system (patented), described as "a cheap metallically continuous system, giving absolute electrical continuity which can be readily earthed at any point in order to ensure a thoroughly watertight, efficient, and safe protection for circuits at an extremely low cost"; patent spring lids, for which special advantages are claimed; porcelain interiors, a large assortment of which have been designed for use with the Simplex Standard junction boxes, circular and rectangular; electroliers and brackets of artistic and ornamental design. Copious wiring notes and instructions appear at the end of the book.

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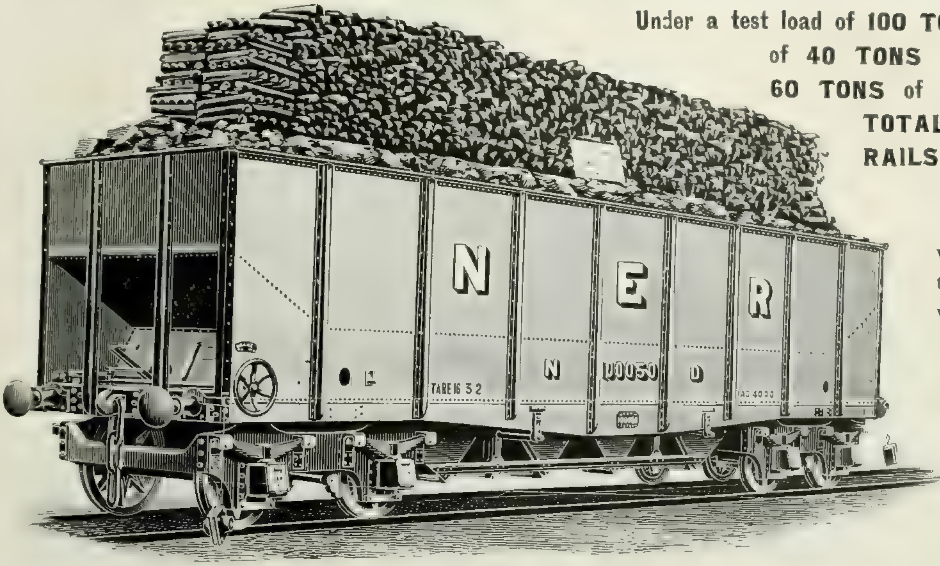

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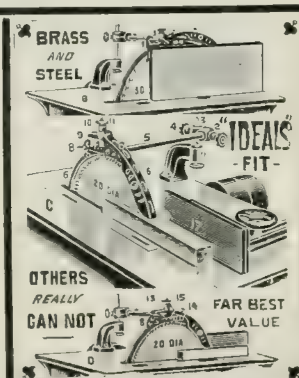

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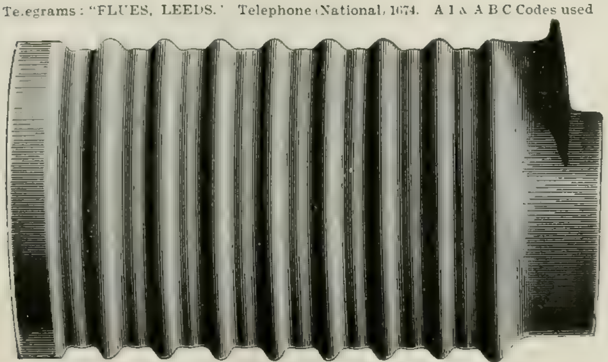

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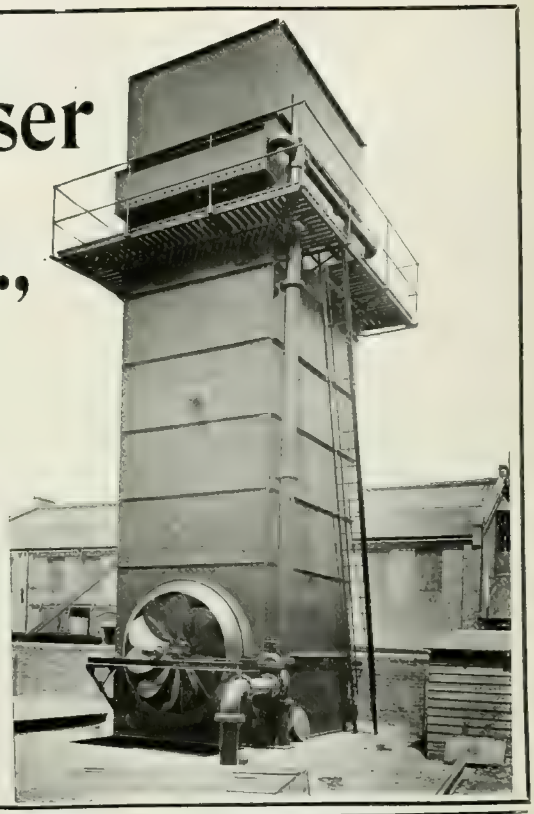

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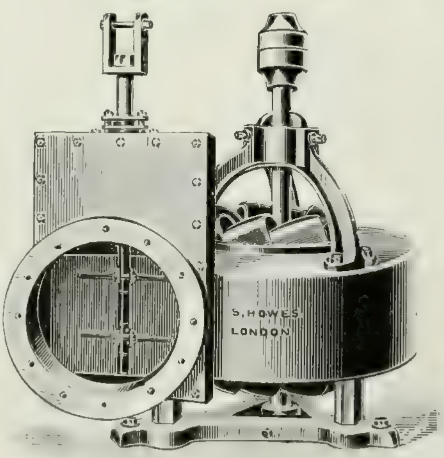

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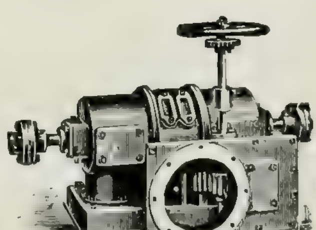

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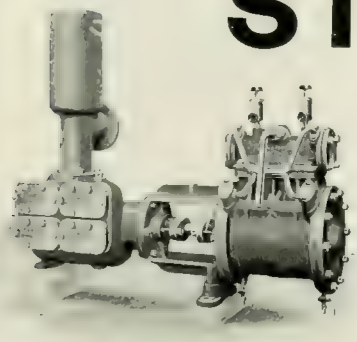

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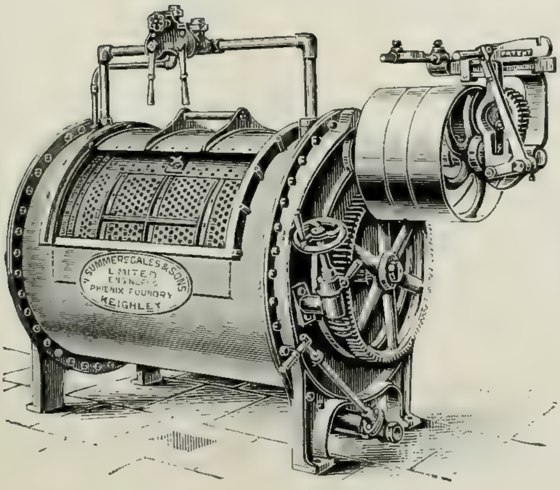

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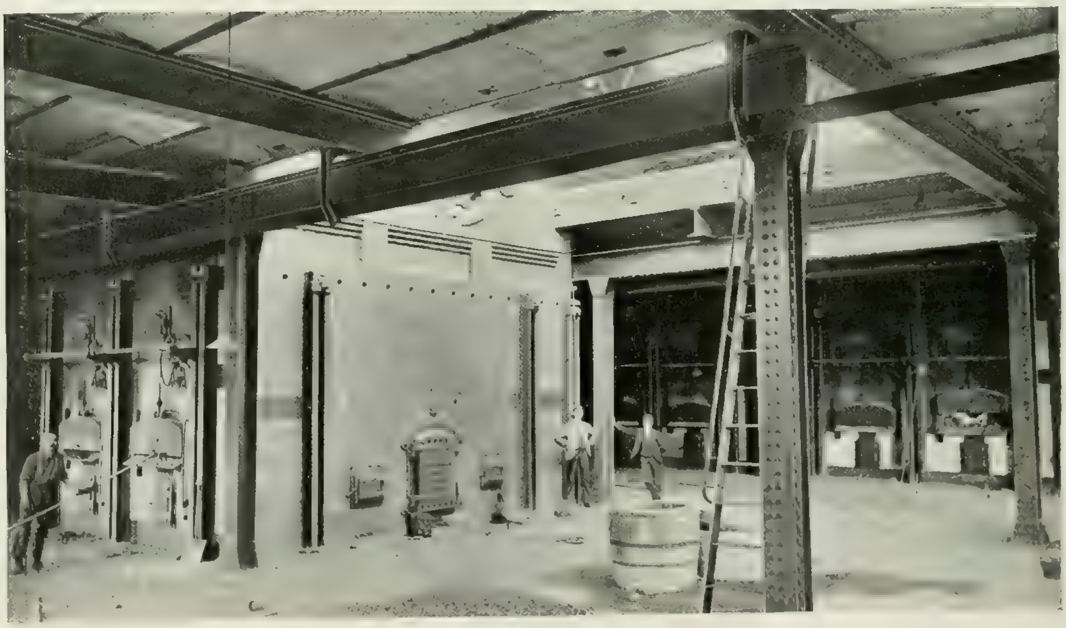

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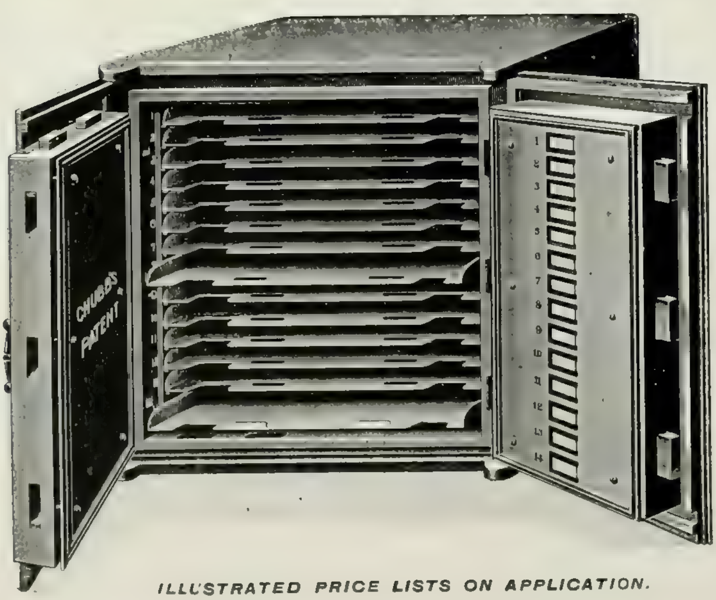
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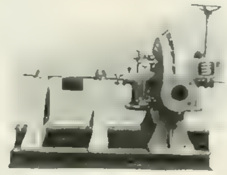

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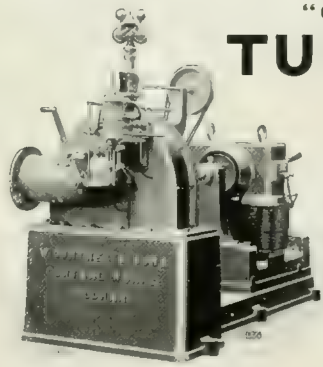

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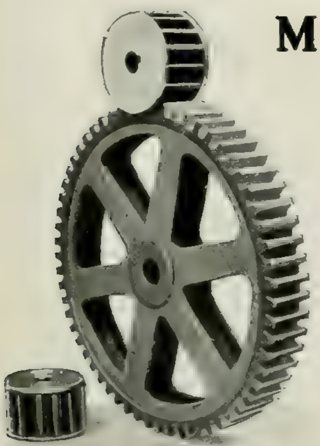

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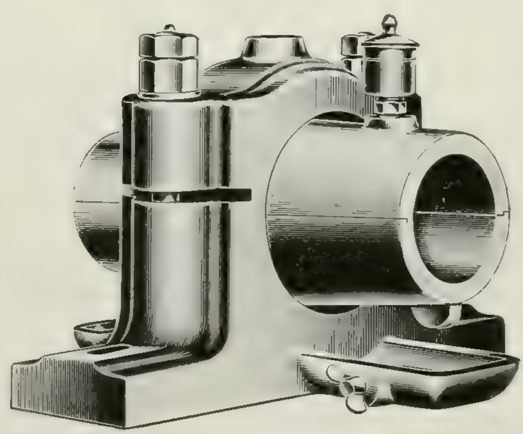

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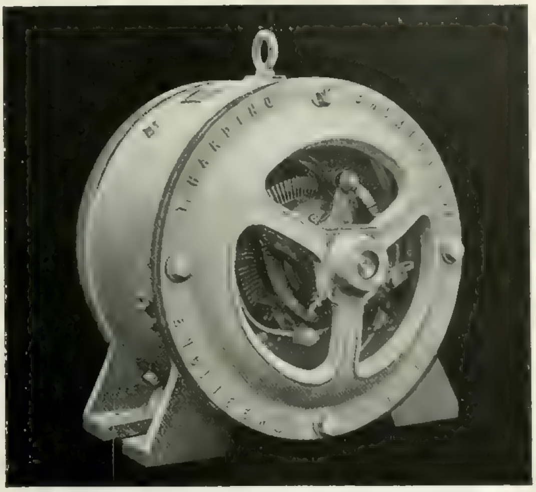

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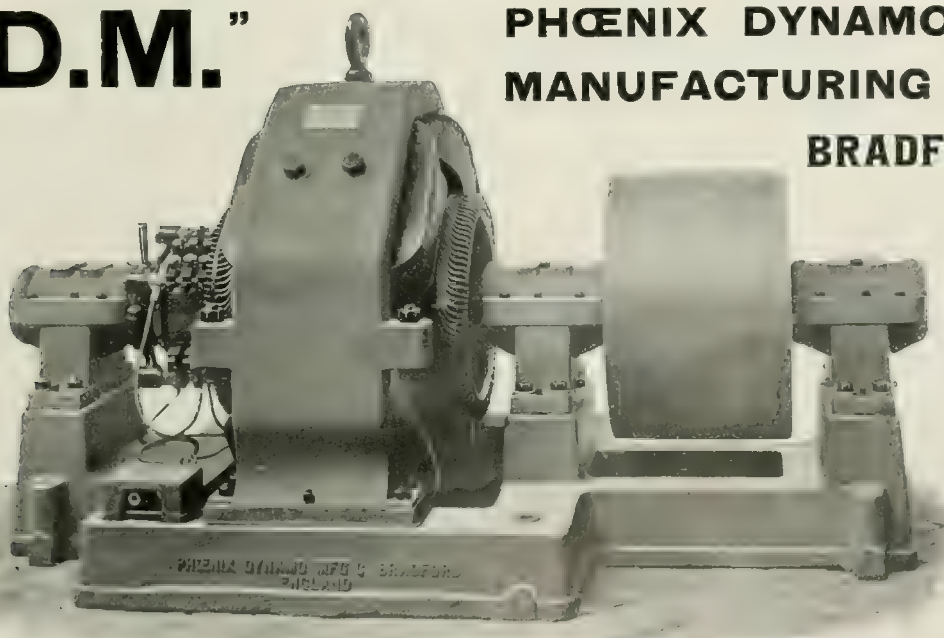

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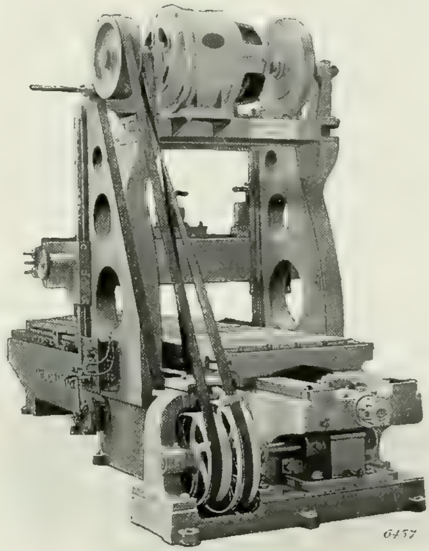

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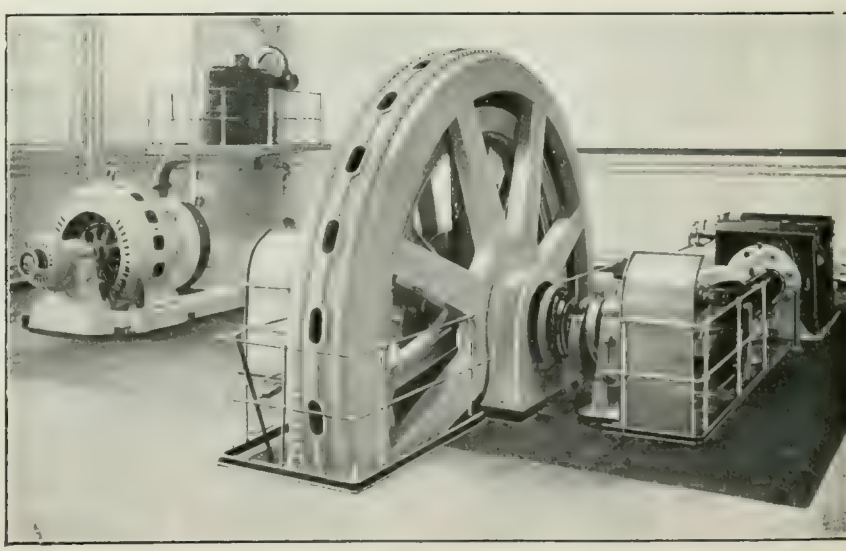

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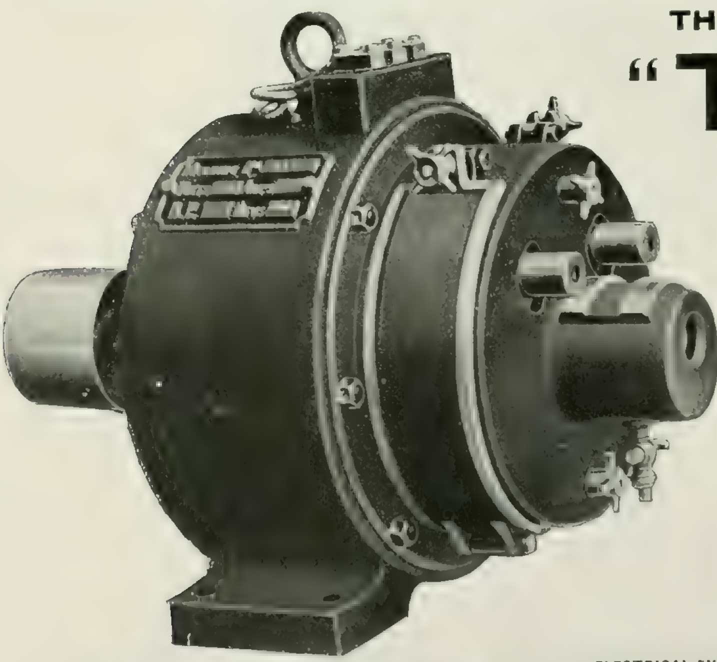

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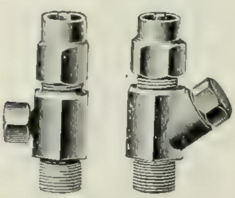

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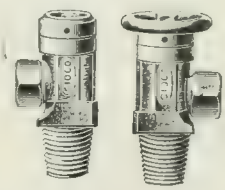

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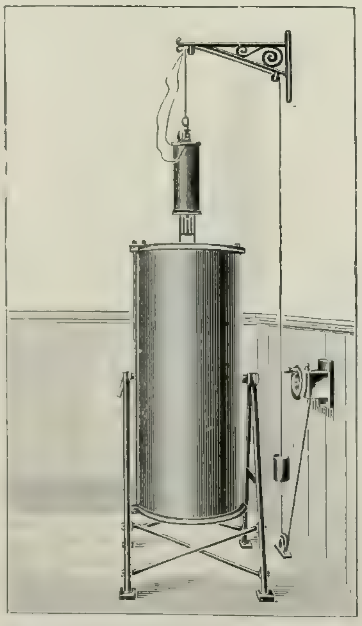

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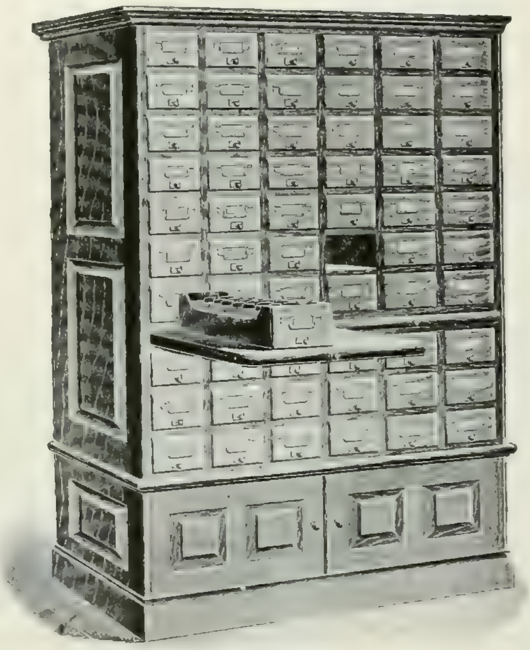

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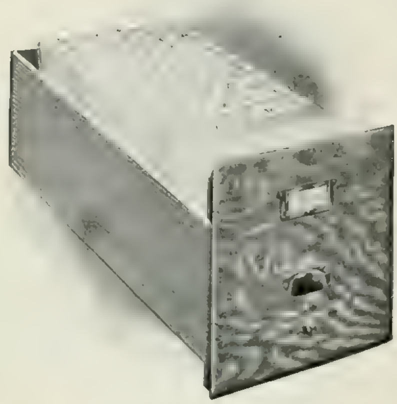

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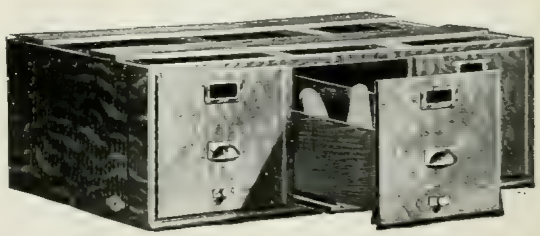

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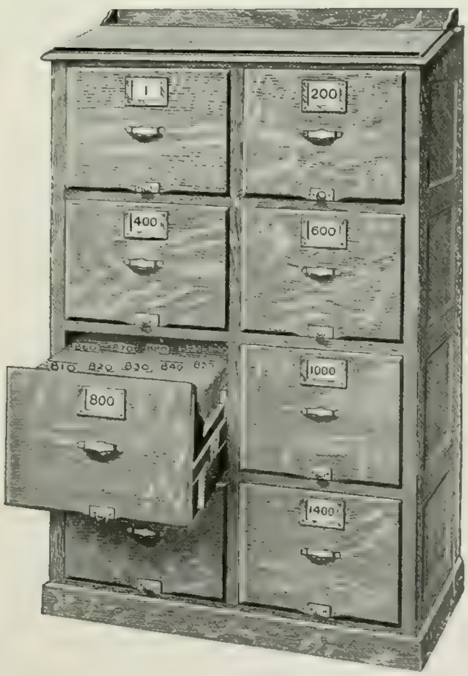

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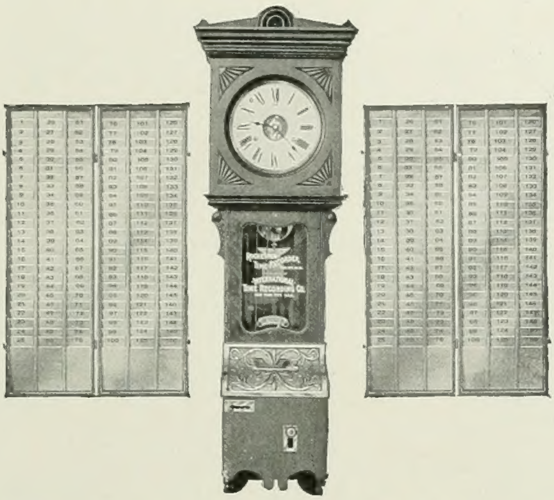

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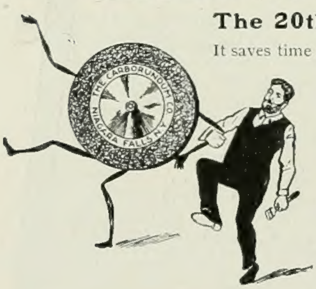

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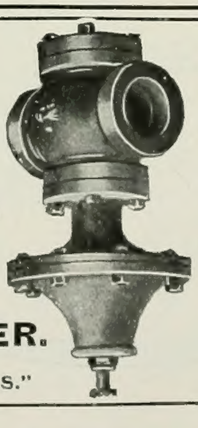

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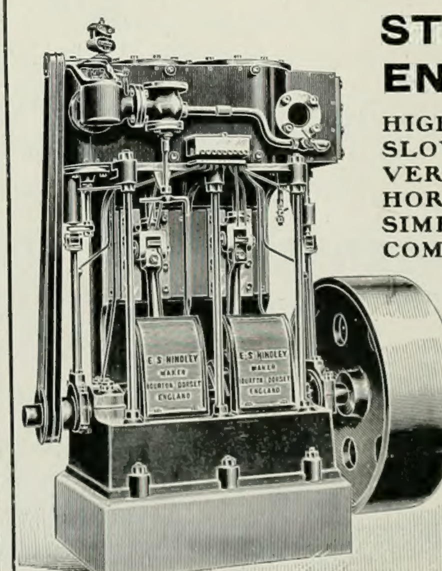

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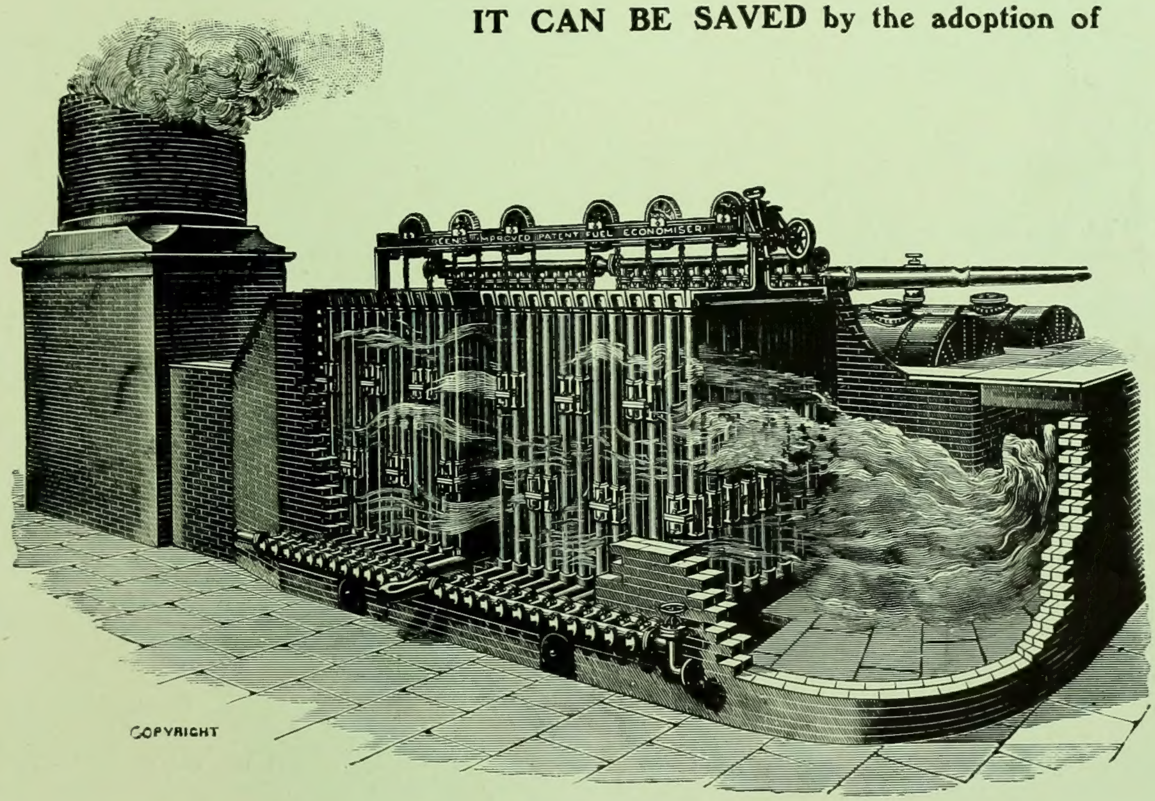

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HIGH-CLASS

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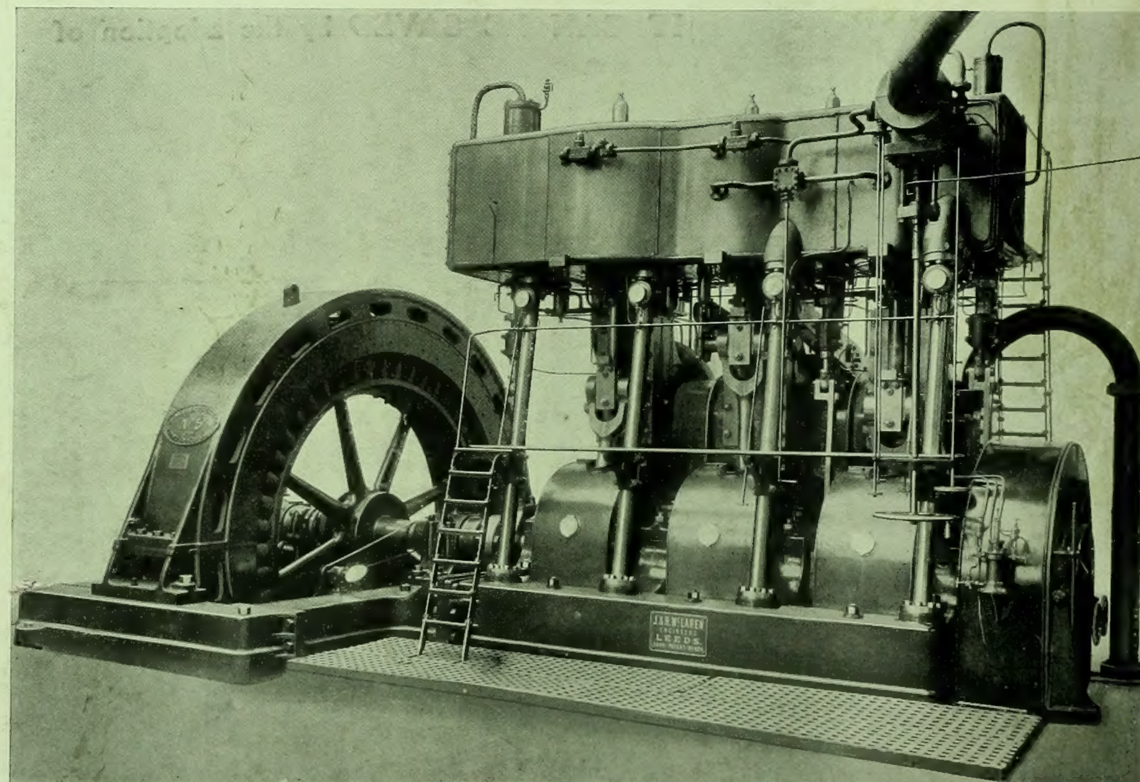

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ALL SIZES FROM 200 to 3,500 H.P.

Specifications and Quotations on application to—

J. & H. McLAREN,

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