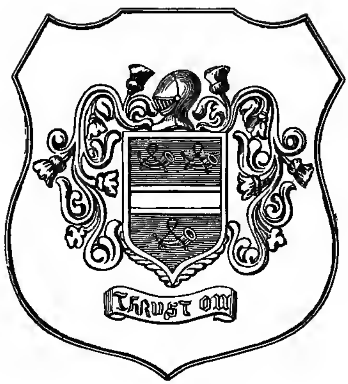
PALMERS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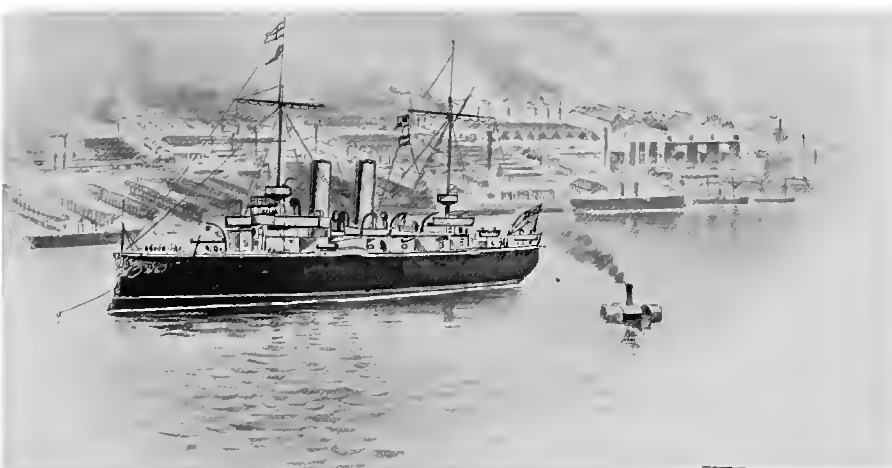
Palmers
Shipbuilding and
Iron Company
Limited.

Yours Sincerely
Charles McLaren

CHARLES B. B. McLAREN, Esq., M.P., Chairman of the Company.

SOME ACCOUNT OF THE WORKS OF PALMERS SHIPBUILDING & IRON COMPANY LIMD

Compiled by
MALCOLM DILLON
Secretary of Palmers Company.



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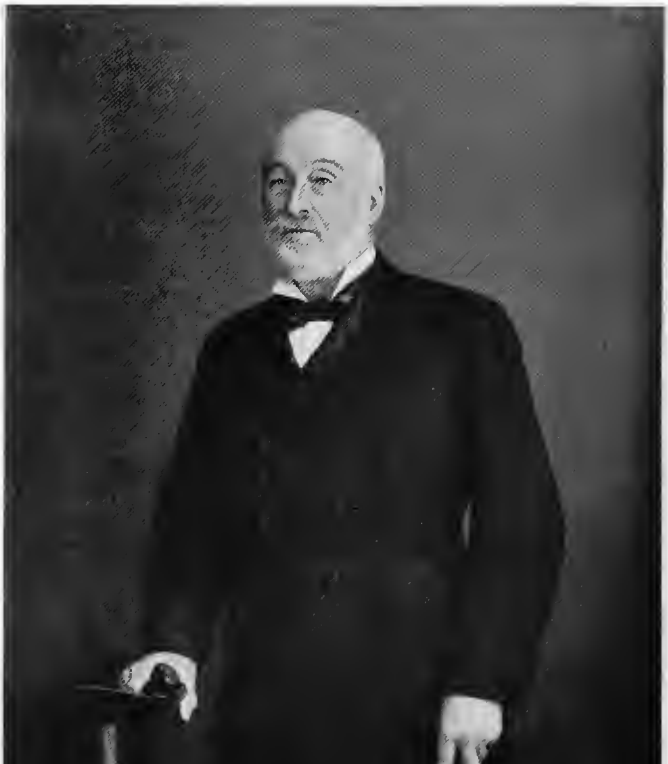
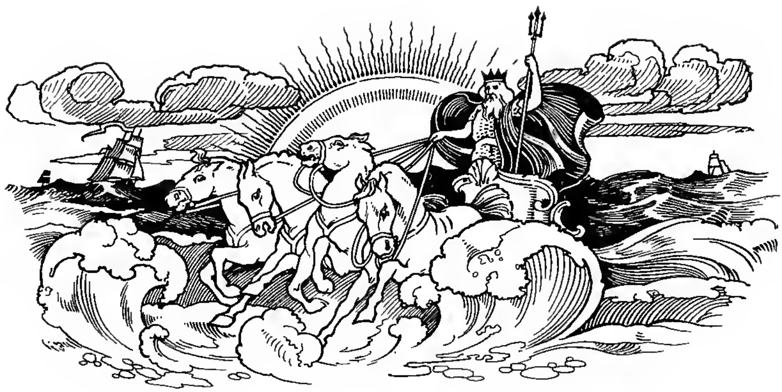


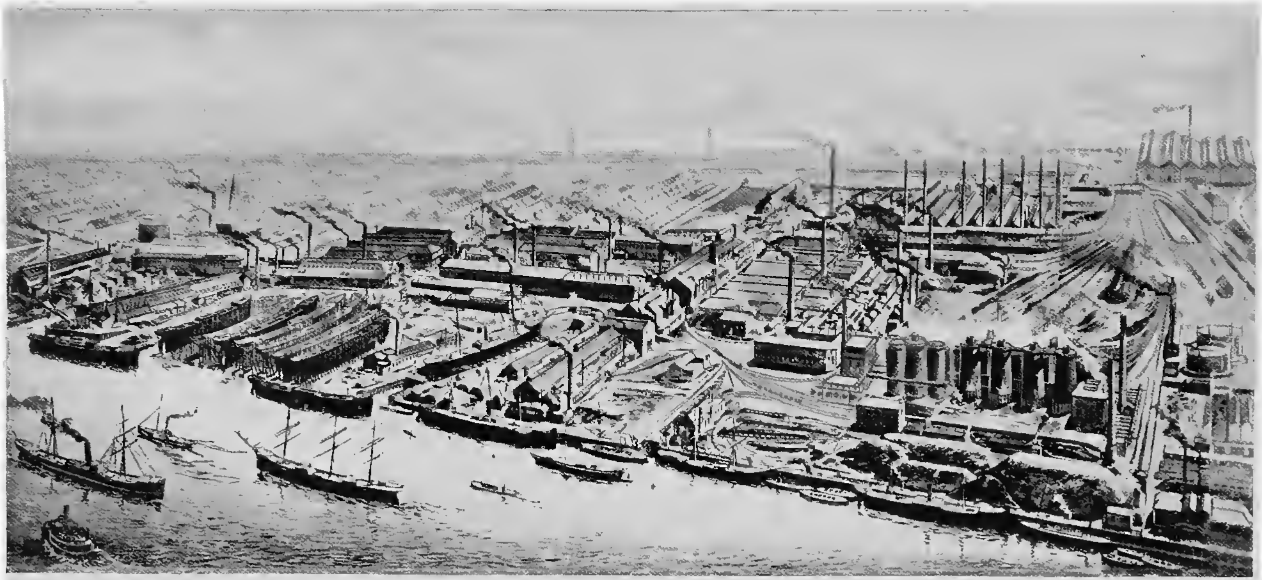
Yours faithfully
Chas. M. Palmer.



PALMERS SHIPBUILDING & IRON COMPANY LTD.

EVIDENCE that the district of the Tyne was from an early period an important shipbuilding centre is afforded by the fact that, writing more than a century and a half ago, Defoe, in speaking of this river, says: "They build ships here to perfection—I mean as to strength and firmness, and to bear the sea." Since this was written the world has moved at a marvellous pace, and remarkable progress has been made in the construction of ships, but the Tyne has well maintained the reputation she possessed in the days of Defoe. The annual aggregate of vessels launched from her banks now exceeds 300,000 tons, which is equal to about one-fifth of the whole shipbuilding output of the United Kingdom. The Tyne has been the birthplace of many great ideas. At Palmers the first screw collier was built from which grew our great steamship carrying trade. At Palmers, again, the superiority of rolled armour plates for vessels of war was first demonstrated, and the double bottom for water-ballast was originated. At Elswick, the genius of Lord Armstrong revolutionised modern ordnance, and on Tyneside Stephenson built and perfected the first locomotive which was destined to become so enormous a factor in human activity.

The Works of Palmers Shipbuilding and Iron Company are situated on the south bank of the river at Jarrow, in the county of Durham. Jarrow is about seven miles from Newcastle, and three miles from South Shields, and is approached by the North-Eastern Railway Company's branch line from Newcastle to South Shields. The town derives its name from the Saxon word Gyrwy or Gyrvy, meaning a marsh or fen, and referring to an extensive pool on the east side called Jarrow Slake. The Slake is an estuary of the Tyne, now largely reclaimed; but at one time it covered nearly 500 acres, and was sufficiently expansive to accommodate the whole Royal Navy of Egfrid, King of Northumbria. Jarrow is, however, best known to antiquaries as the home of the Venerable Bede, who, according to the historian Green, was "first among English scholars, first among English theologians, first among English historians," and who is styled by Burke, "the father of English learning." Bede was born in one of the adjoining villages in the year 673, and on the consecration of the Abbey at Jarrow in 684 was removed to that house from the Monastery at Monkwearmouth. He remained at Jarrow continuously until his death in 735, devoting his whole attention, as he himself tells us, to the study of the Scriptures, the observance of monastic discipline, the daily occupation of chanting



WORKS OF PALMERS SHIPBUILDING AND IRON CO. LD.

in the church, and to learning, teaching and writing. His remains were first interred in the church at Jarrow, but were subsequently stolen by a monk of Durham, and removed to the cathedral in that city. In the church, which includes a portion of the original abbey, is a rudely cut oak chair, said to have been used by Bede, the dilapidation of which is due to the passion for relics exhibited by pilgrims in past ages. Bede was the author of a large number of ecclesiastical works. "The lamp of learning," writes Surtees, "trimmed by the hand of a single monastic, who never passed the limits of his Northumbrian province, irradiated, from the cell of Jarrow, the Saxon realm of England with a clear and steady light, and when Bede died, history reversed her torch and quenched it in deep night." On the extreme west side of the Palmer Works is Bede's Well, which as late as the middle of the eighteenth century "was in repute as a bath for the recovery of infirm or diseased children," and in its neighbourhood were celebrated the usual sports of Midsummer Eve. It is supposed that the monk made the Well the object of his walks from Jarrow. The sylvan beauty of the spot has been

BEDE'S CHAIR, JARROW

marred by the presence of gigantic slag heaps, but every precaution is being taken to prevent the obliteration of this historic landmark.

The borough of Jarrow now contains upwards of 40,000 inhabitants, who are mainly employed in, or dependent upon, the Palmer Works. So completely, in fact, is the town identified with the works that it might more appropriately be called "Palmer's Town." It is governed by a mayor and corporation, the first mayor having been Sir Charles Mark Palmer, Bart., M.P.,

THE "REVENGE" LEAVING JARROW.
From the Original Picture by N. M. LUND, exhibited in the Royal Academy, 1898; now in the possession of J. D. MILBURN, Esq.

who represents the Jarrow division of the county of Durham in the House of Commons, and who was the founder of the Company, and its Chairman until he retired in 1893. Sir Charles was born at South Shields in 1822, and in conjunction with his brother George, commenced the shipbuilding business in 1851 under the style of Palmer Brothers & Company. Mr George Palmer subsequently retired from the firm, and the business was afterwards carried on by Sir Charles, who greatly enlarged the establishment by the addition of engine works, iron rolling mills and blast furnaces. It was converted into a limited liability company on its present basis in 1865.

The site of the shipyard was originally leased to the Palmer Brothers in 1851 by Mr Carr-Ellison, of Hebburn Hall, the father of the first Lady Northbourne, to whose family the property has since passed. At that time the only house standing between Hebburn Hall and Bede's Church—an area now covered with the dwellings of some 60,000 to 70,000 persons—was the Grange Farm, which dates from 1666, and is still occupied. The development of the neighbourhood since the establishment of the shipyard has been enormous. Johnson in his work on "The Making of the Tyne," describes the growth of the town of Jarrow as a nineteenth century romance. In less than half a century a small colliery village has expanded into an important industrial town, with a busy and thriving population, which, in spite of occasional periods of depression, nevertheless shows abundant signs of accumulated wealth and prosperity. In some respects Jarrow is a unique town. Its outward appearance is unattractive; that is inevitable in a working-class town amid the smoke-laden atmosphere of Tyneside; but it is the home of a vigorous community with a healthy public life. Nearly half of the town belongs to the workmen themselves. Early in the sixties, a building society was started at the works in which the men were prompted to take up shares in order that they might become the possessors of their own houses. They responded freely, and, in due course, acquired houses of their own, then others adjoining; and, fired with the spirit of speculation, whole streets were built by the more thrifty and enterprising of the men, many of whom at this day are very considerable property owners. In the seventies and eighties it was the boast of Jarrow that it had more working men property owners than any other town of its size in the United Kingdom.

Civic progress went hand in hand with individual prosperity, and education, religion, the arts and sciences, recreation and amusement, received their share of public attention as the village grew into the town. Jarrow now possesses commodious Board Schools, managed by a representative School Board, a Mechanics' Institute, a Hospital, a Theatre and Concert Halls, a public park, and numerous churches and chapels. The Mechanics' Institute was built in 1864. It has a library of 5000 volumes, and Science and Art classes are held there, the curriculum including naval architecture, machine construction, applied mechanics and kindred subjects. The Hospital was built in 1870 by Sir Charles Palmer, as a memorial of his first wife, and

ENTRANCE TO MECHANICS' INSTITUTE.

is maintained by the contributions of the workmen, for whose exclusive use it was designed, supplemented by an annual subscription from the Company. The hospital is managed by a committee consisting of the principal officials of the works, and representatives of the workmen, and has a resident Doctor and Matron, and a staff of Nurses. The head-quarters and drill ground of the

THE MEMORIAL HOSPITAL, JARROW.

1st Durham Royal Engineer Volunteers, a regiment, 700 strong, which is to a large extent recruited from the works, are also a feature of the town.

The Company's works cover an area of about 100 acres, and have a river frontage of nearly three quarters of a mile. They consist of a shipbuilding yard, graving dock

SHIPBUILDING YARD.

and slipway, engine and boiler works, steel works and blast furnaces, and include within themselves the entire range of operations from the smelting of the ore to the complete equipment of the vessel. The ore is received from mines controlled by the Company in Spain, and from other sources, at the blast furnace wharf, and is converted into pig-iron in the furnaces. The pig-iron is sent to the steel works, converted into steel, and rolled into plates and bars, and these in their turn pass to the shipyard where the vessel is completed and engined. There are about eight miles of railway within the works, and twelve locomotives are employed in conveying material between the various departments. The works are also connected by private lines with the North-Eastern Railway, and with the various collieries from which supplies of coal and coke are derived.

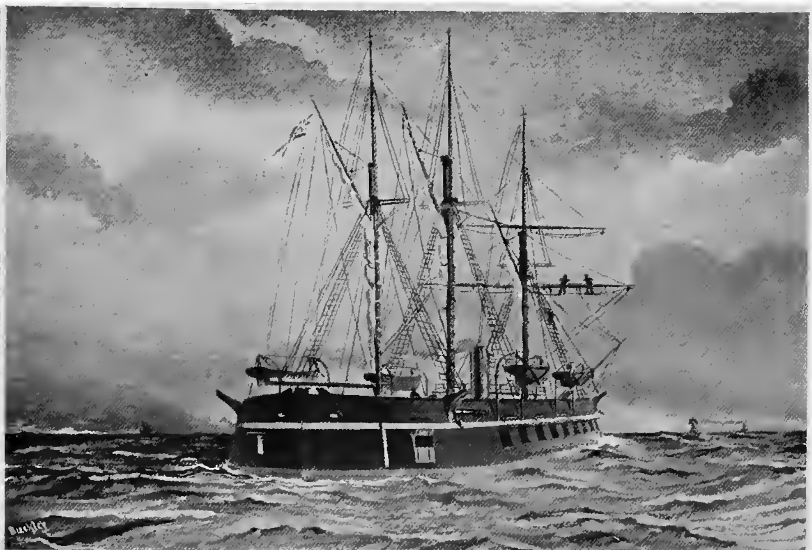
The Shipbuilding Yard was established, as has been stated, in 1851, on the site of an old yard where wooden frigates had, early in the century, been built for the British Government, and it is interesting to note that the first iron vessel delivered was a paddle tug named the *Northumberland*. About this period the competition of the new Midland coal fields began to seriously affect the sale of north country coal, which had hitherto been conveyed to the London market in small collier brigs, and it became essential in the interests of colliery owners to devise some means by which the staple produce of the district could be conveyed to the Metropolis in an expeditious, regular and economical manner. In order to accomplish this object, Sir Charles Palmer, who was connected with several large collieries in Northumberland and Durham, designed an iron screw steamer, the *John Bowes*, having a carrying capacity of 650 tons, which was capable of steaming nine miles per hour, and she was launched on 30th June 1852. The experiment proved a complete success, and to it may, in a great measure, be attributed the important development of iron shipbuilding on the north-east coast which afterwards took place. The *John Bowes*, which is still afloat although nearly half-a-century has elapsed since she was built, was the fore-

S.S. "JOHN BOWES," THE FIRST IRON SCREW COLLIER.

runner of a long list of screw colliers, and was speedily succeeded by the *William Hutt*, the *Countess of Strathmore*, and numerous similar vessels.

As the works expanded, vessels of more pretentious dimensions were taken in hand, the first being the large paddle mail steamers *Connaught* and *Leinster*, which were launched with their engines and boilers on board, and they were followed by the screw passenger steamers *Hudson* and *Weser*. The outbreak of the Crimean War in 1854 created the first demand for armour-plated vessels; the Jarrow company receiving an order for one ship of this class. She was a floating battery, intended for the destruction of the forts at Cronstadt, and designated the *Terror*, a name applicable alike to her character and proportions, her excessively sloping sides and bluff ends forming a remarkable contrast to the graceful lines of the modern battleship. It was at this juncture that the fame of the Jarrow yard established itself, for the *Terror* was built, armour-plated and launched in about three months, a performance which, considering the limited appliances then available, compares favourably with any subsequent records at Palmers' or elsewhere. This result was largely due to the inventive genius of Sir Charles Palmer, who conceived the idea of rolling instead of forging the armour plates. They were originally known as "Palmer's Rolled Plates." The utility and importance of this invention has since been fully demonstrated. The next contribution to the Navy was in 1862, when the ironclad frigate, *Defence*, was completed, the armour-plating of this vessel being 4½ inches thick, and tongued and grooved at the joints. The Indian troopship, *Jumna*, the largest vessel hitherto built by the Company, and one of the most successful, followed in 1866. She was one of a series of vessels designed, some for the Indian side, and others for the European side, of the Isthmus of Suez, prior to the opening of De Lesseps' famous canal. In the sixties, the company commenced the building of Atlantic Liners. They were from 300 feet to 340 feet long, with a gross tonnage of 3,300 tons, and were then considered to be very large vessels. Among them may be mentioned the *Montana* and *Dacota* for the

H.M.S. "TERROR"—THE FIRST WAR VESSEL BUILT AT PALMERS, 1854.



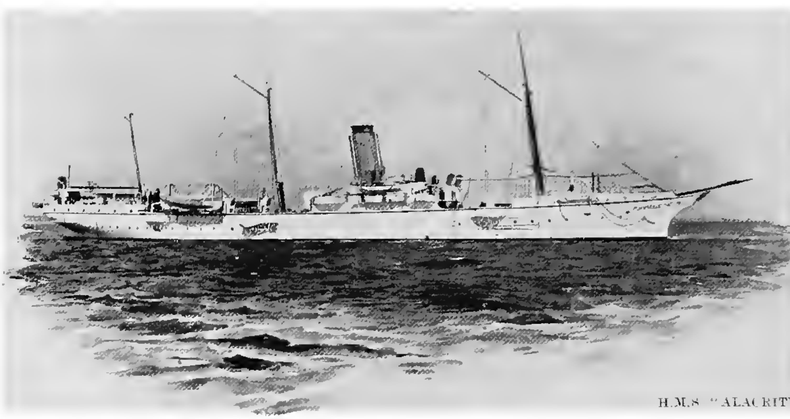
H.M.S. "RUSSELL"—FIRST-CLASS BATTLESHIP,
COMMENCED 1899.

old Guion Line, vessels of 400 feet in length, with an abnormal slope of side, flush shell plating, and water-tube boilers. The latter were subsequently changed for boilers of the ordinary type, but it is interesting to note that at this early date the adoption of the now well-known Belleville boiler had been, to some extent, anticipated. The American Civil War did not close before a demand had been made upon the resources of the Jarrow yard, for during that conflict two blockade runners were turned out. These were long, narrow paddle boats of light draft and high speed, and bore the not inappropriate names of *Ranger* and *Grapeshot*. The next noteworthy vessels were the *Cerberus* and *Gorgon*, names suggestive of their character and purpose, they being heavily armour-plated turret vessels of comparatively light draft and low free-board, intended for harbour and coast defence, and these were immediately followed by the armour-plated wood-sheathed frigates *Swiftsure* and *Triumph*, for oversea and foreign service. About this time the construction was commenced of three large vessels of special type for carrying petroleum in bulk, which vessels, like the *John Bowes*, proved to be prototypes of a similar class of steamer, for the building of which the Tyne is still a prominent centre.

The next order given by Her Majesty's Government was in 1876 for the construction of a series of flat-bottomed gunboats for river service. They were of a peculiar form, being very broad for their length, which was only about three and a half times their beam. The desired and estimated speed was realised, and thus the then existing theory that narrowness in proportion to length was essential to obtain speed was very largely discounted. In order to show the diversity of the work

H.M.S. "ORLANDO."

entrusted to Palmers Company by the Government, it may be here stated that an order was received in 1881 for six torpedo-mining-boats of 65 feet length and 15 feet beam, and about 104 tons displacement, which, small and comparatively unimportant as they were, received the same careful attention in their construction as previous and subsequent larger contracts commanded. About four years after, in 1885, the swift despatch

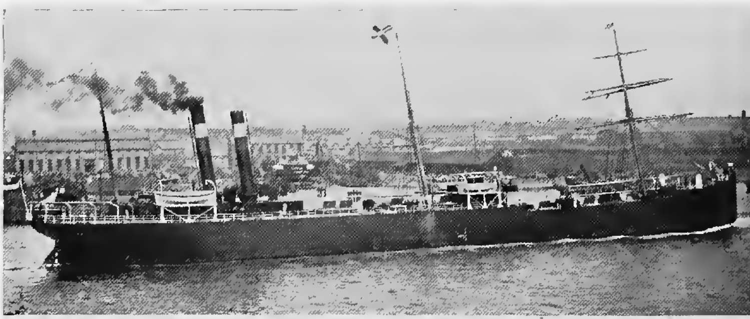


H.M.S. "ALACRITY."

vessels, *Surprise* and *Alacrity*, were added to the Company's long list of successes, and not only maintained its reputation for excellence of work in the hulls, but established an added renown for successful high-speed machinery. In 1888, the belted cruisers, *Orlando* and *Undaunted*, were produced, these vessels proving the forerunners of the modern armoured cruiser, although the original design has been considerably modified by

H.M.S. "RESOLUTION."

the introduction of Harveyised armour. Closely following the belted cruisers were the wood-sheathed cruisers, *Pique*, *Rainbow*, and *Retribution*, and the first-class battleships, *Resolution* and *Revenge*, which latter are among the largest fighting ships afloat. The last named vessel was completed within a year of her launch—a record which has not yet been surpassed. At the same period the Company supplied the designs and specifications for three armoured cruisers, which were built for the Spanish Government at Bilbao. The three vessels were



THE AMERICAN PETROLEUM COY. TANK STEAMER "ROTTERDAM."

named the *Maria Theresa*, *Viscaya*, and *Almirante Oquendo*, and took part in the recent Spanish-American war.

The Company has constructed one of the largest vessels afloat for carrying oil in bulk—the steamship *Rotterdam*, and has also built and engined for the Peninsular & Oriental Steam Navigation Company their passenger steamer *Borneo*, and their large twin-screw cargo steamer *Socotra*, both of which vessels have proved eminently successful.

In 1893 a new departure in shipbuilding and engineering

1. 

2. 

3. 

1. Peninsular & Oriental Steam Navigation Co.'s Steamer "SOCOTRA."
2. Hamburg-American Co.'s Steamer "ASTURIA."
3. Messrs Elder, Dempster & Co.'s Steamer "MONTCALM."

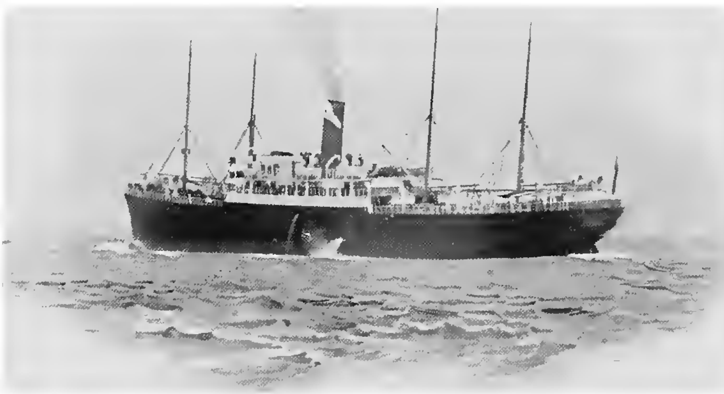
was made, when the Company accepted from the Admiralty a contract to build three torpedo-boat destroyers of 27 knots speed. As the building of this class of vessel had hitherto been almost wholly in the hands of specialists, the production of the boats by warship builders throughout the country was watched with very great interest. The success of the Jarrow boats was, however, complete; the speed trials of the

WESTERN AUSTRALIAN GOVERNMENT'S TUG "PENGUIN."

Janus, *Lightning*, and *Porcupine* exceeding the most sanguine expectations. A further order for six other vessels of 30 knots speed almost immediately followed, the results being equally satisfactory, some of them on their trial trips attaining a speed of over 32 knots per hour. Altogether, with the new orders now in hand, the Company will have built no less than 15 of these vessels, or a larger number than has been turned out by any other individual firm for the British Government. The

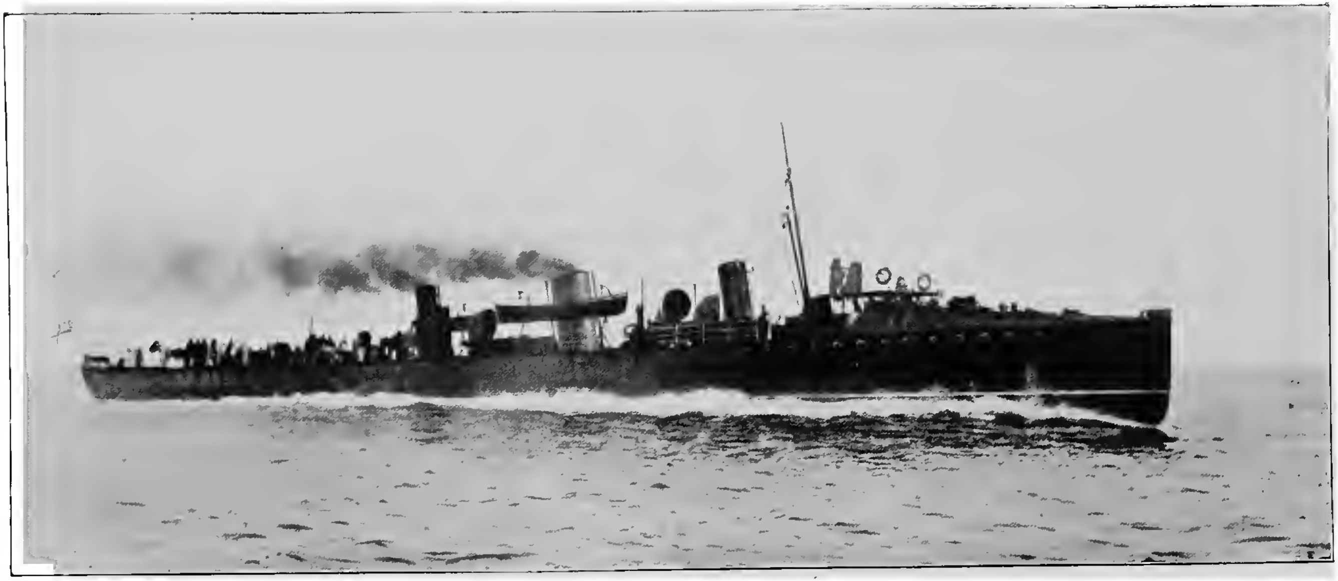
H.M.S. "STAR"
STEAMING 31·9 KNOTS PER HOUR.

most recent Government order is the first-class battleship *Russell*, a vessel of the latest and most formidable type, with which good progress has already been made, and sanguine hopes are entertained that as regards celerity of completion, the record in the case of the *Revenge* will be exceeded. Several steamers of over 8000 tons and some of 10,500 tons deadweight for the Atlantic cattle trade have been recently delivered, and others of similar capacity are now in hand. In addition to numerous



S.S. "MANCHESTER PORT."

electrically-driven modern machines and tools, hydraulic presses, pneumatic riveters and caulkers, electric drills, &c., the shipyard possesses its own forge, where forgings of the largest class are manufactured for the ships in hand, and also rivet works capable of supplying the shipyard and boiler shops. There are, in addition, large fitters', plumbers', joiners', and cabinetmakers' shops, where the manifold internal fittings required in ship construction, including steering gears, &c., are manufactured. From



H.M.S. "BAT"
STEAMING $32\frac{1}{4}$ KNOTS PER HOUR.

this it will be seen that the shipyard is capable of turning out vessels of the largest and highest class in a practically completed state. The berths have been recently re-arranged to admit of the building of ships up to 600 feet in length.

The graving dock is 440 feet long by 70 feet wide and some notable repairs to vessels have been executed in it. The repairs to the oil steamer *Rotterdam*, which occupied the dock for 137 working days after grounding

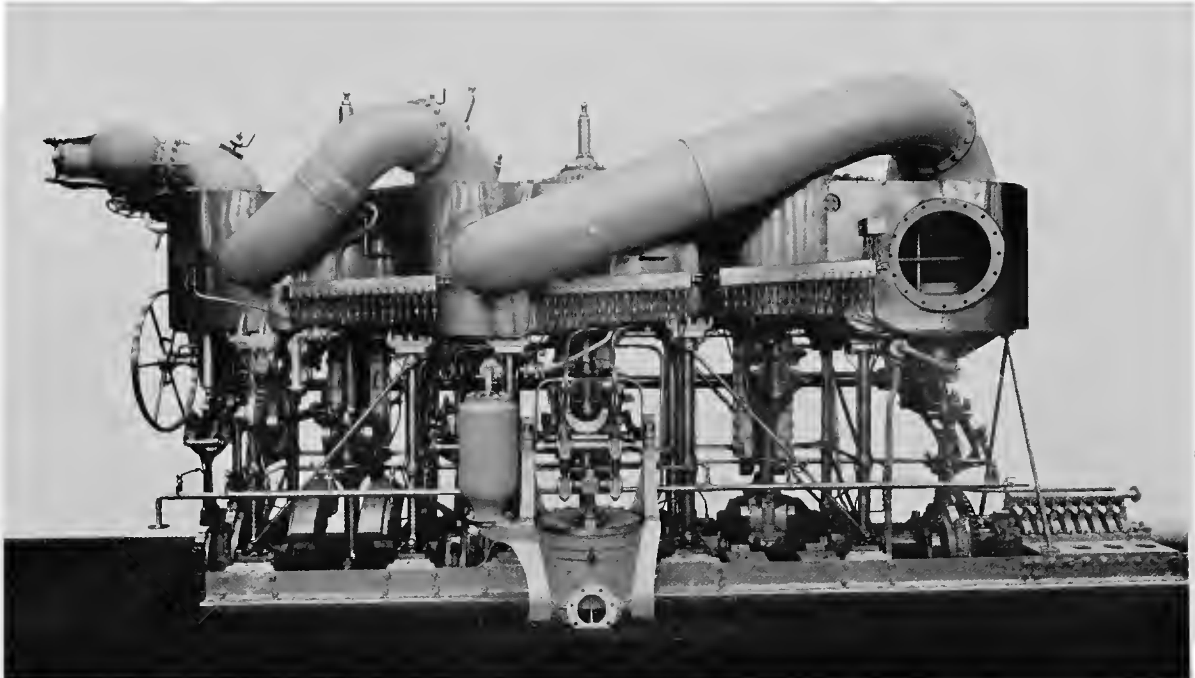
Trinity Yacht "IRENE."

recently on the coast of Newfoundland, and to the steamers *Brinkburn* and *Strathcarron*, are cases in point. The slipway, worked by hydraulic power, is 600 feet long.

In the preceding description of the shipyard, reference has been made to the very satisfactory results attained by machinery constructed in the engine works, but it will be interesting to note a few further particulars of this department, the productive capacity of which may be

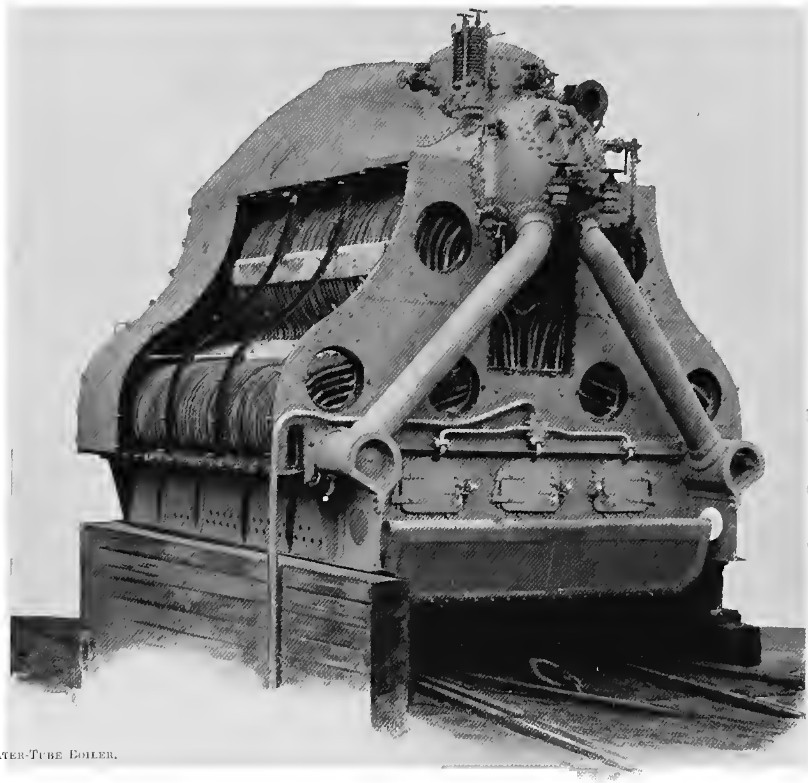
GRAVING DOCK, &c.

gauged by the fact that 34 sets of engines and boilers have been turned out in one year. The work produced is of great variety, ranging from the engines of a steam launch to those for large cargo and passenger steamers, and from the light high-speed machinery for a torpedo-boat destroyer to the ponderous engines for a first-class battleship. The department is self-contained, having its own forge and also foundries for the production of iron, brass and steel castings; and the boiler shops were recently re-erected and equipped with plant of the most modern type, capable of dealing with boilers of the largest and heaviest description. Among the various machines in these shops are a plate edge-planing machine, capable of taking a plate 35 feet long by 12 feet wide and planing two edges simultaneously; a set of vertical rolls, capable of bending cold a shell-plate 12 feet wide and 1⅝ inches thick; a 200-ton hydraulic flanger; a hydraulic riveting machine with 12 feet gap, and capable of exerting a pressure of 150 tons; also a special boiler-shell drilling machine with four drilling heads; a two-headed machine for drilling and tapping holes for stays and stay tubes, and screwing the stays of tubes into position without the use of hand labour, and a large number of other special tools. It may be here mentioned that vertical rolls for boiler shell-plates were first used in these works, and the original rolls were in operation until the heavy rolls above mentioned were erected. The shops are also equipped for dealing with the "Express" type of water-tube boiler, and more recently a plant for the manufacture of Belleville boilers has been added. A speciality of the department is the manufacture of the "Reed" water-tube boiler, the invention of Mr J. W. Reed, manager of the engine works department, which has been



ENGINES OF TORPEDO-BOAT DESTROYER.

adopted with well-known results in the high-speed boats already referred to, and also in vessels constructed for the Admiralty on the Clyde. It may be observed that nearly 25 miles of tubes are used in the manufacture of the



Water-Tube Boiler.

boilers and machinery of each 30-knot destroyer. Heavy marine boilers can be turned out at the rate of one per week, and, in addition, a large number of water-tube boilers are produced, of pressures ranging up to 300 lbs. per square inch.

H.M.S. "PYRAMUS."

In the iron foundry, in addition to all the castings required for the engines, a feature is the manufacture of ingot moulds and slag tubs, for which there is a considerable demand, thousands of tons being turned out during the year. In the machine and erecting shops there are machine tools of the most modern type, for turning out the various classes of work in the most perfect manner, and with a minimum of labour. In the lower erecting shops, engines of various sizes for single and twin screw merchant vessels are built, while in the upper shop torpedo-destroyer engines to run about 400 revolutions per minute, and representing the finest class of work, are erected side by side with engines of 18,000 horse-power, for one of our largest battleships. Vertical and horizontal engines, simple, compound, triple and quadruple and paddle engines have been built here, and it is worth noting that the first set of triple-expansion engines used in the British Navy were made in these works. For lifting machinery

West Jetty and Sheerlegs.

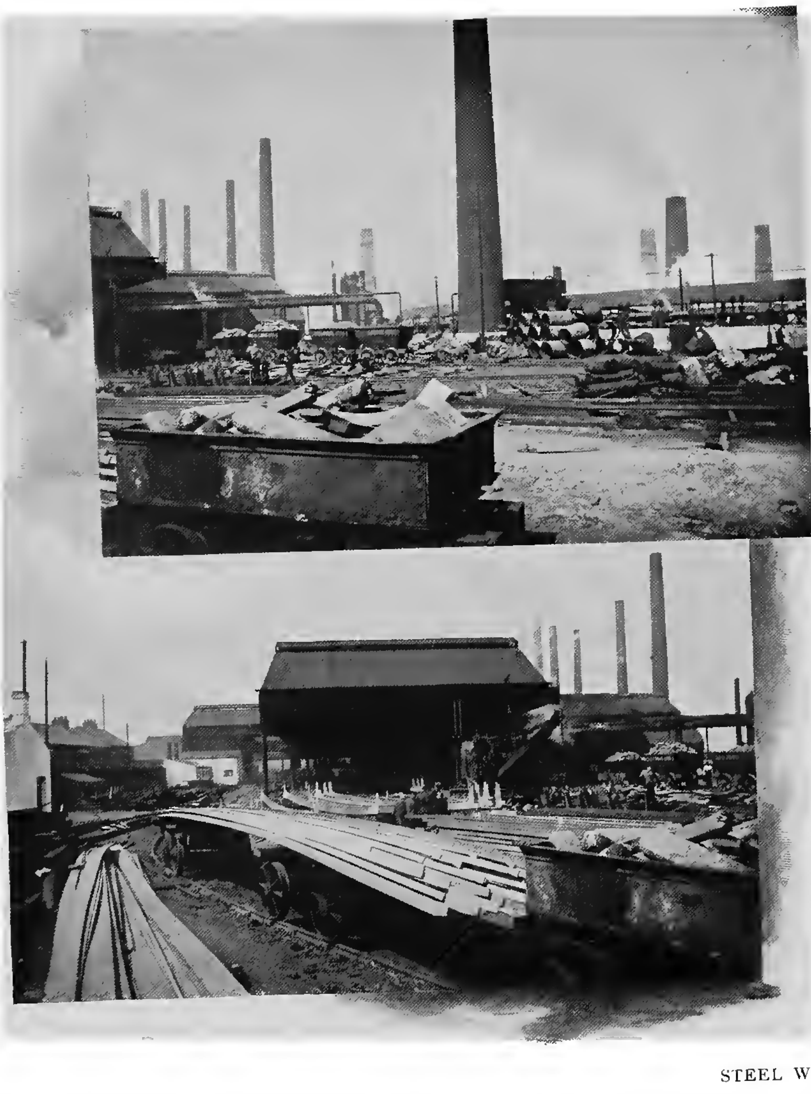
ENGINE WORKS—FITTING SHOP.

and boilers on board, a new set of sheerlegs has recently been erected, capable of lifting regularly 120 tons. They are 135 feet high, with an overhang of 60 feet, are capable of lifting the largest boilers on board at any state of the tide, and are the largest and most powerful sheerlegs in this country.

In the pig-iron making department there are five blast furnaces of the most modern description, with the usual equipment of hot-blast stoves. One of these furnaces is set apart for the manufacture of Cleveland iron, principally for foundry purposes. In the other furnaces high-class hematite pig is produced for the manufacture of the mild steel now so largely used in shipbuilding. The Cleveland furnace produces on an average 650 tons of pig-iron per week, while the hematite furnaces produce about 1000 tons per week per furnace, a total production of nearly 250,000 tons per annum. Each of the five blast furnaces in operation is about 80 feet high, of 24 feet diameter at the boshes, and 11 feet in the hearth. The bulk of the hematite produced is transferred to the Company's own steel works, where it is converted into Siemens-Martin mild steel by the acid process, the surplus iron being sold to neighbouring steel makers. In the steel works there are eight melting furnaces of modern construction, each of 40 tons capacity per charge; and the steel produced by them is cast into ingots suitable for plates and sectional material. In the rolling department there are two 38-inch cogging mills, one of which cogs for plates and the other for sectional material. There is a 36-inch sectional mill, driven by a pair of 50-inch reversing engines, in which all kinds of sections used in ship and bridge-building are rolled. There are two smaller bar mills, viz.,—a 20-inch and a

BLAST FURNACES.

12-inch, in which smaller sections, and rounds and squares are rolled. The plate-mill has rolls 30 inches in diameter by 8 feet long, and produces on an average 1000 tons per week. The sheet mill has rolls 22 inches in diameter by 5 feet long, and is chiefly used for the rolling of material employed in the construction of torpedo-boat destroyers. The mills are fully equipped with the usual guillotine shears, hot and cold saws, and punching and straightening presses, besides some noteworthy contrivances for saving heat and labour. There is a complete installation of electrical power for driving all the outlying machinery, and there is also an extensive plant for electro-galvanizing. The lighting is effected by electricity. With this plant the steel works are capable of supplying the whole of the plates, sheets, angle-bars, channels and beams required for the construction of vessels in the shipyard, and in addition, a considerable quantity of steel is sold to outside shipbuilders, both in this country and abroad. For the most part, material is sent to the shipyards in the condition in which it is rolled, but the rolling-mills are equipped to enable that department to undertake portions of the finishing work which shipbuilders occasionally find inconvenient. For instance, there is a powerful plate-ripping and edge-planing machine which enables this department to undertake the trimming and shaping of plates up to six inches thick. There is also a complete plant for cambering and welding the knees on ships' deck beams. The success of this plant will be understood when it is mentioned that these finished deck beams find their way into every shipbuilding port in the country, as well as to many of the shipbuilding centres on the Continent.



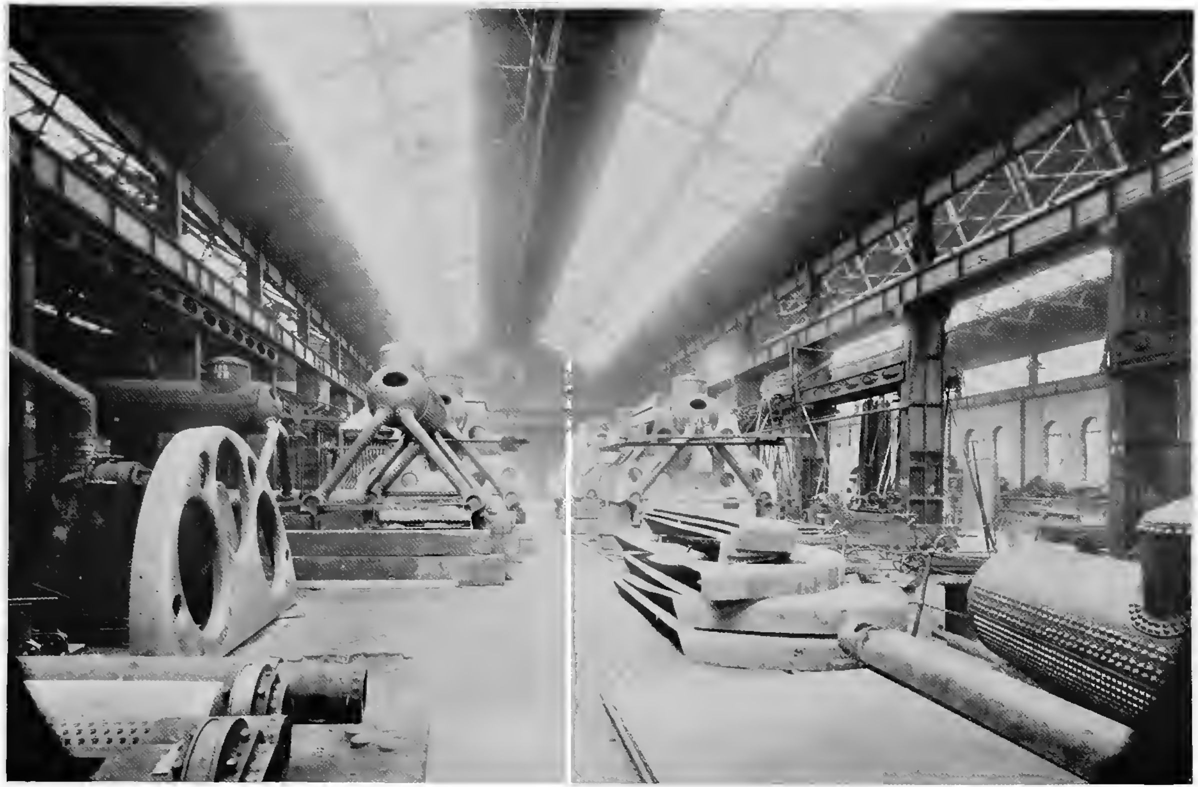
STEEL WORKS.

The method of manufacture of pig-iron and steel may be here described. As regards Cleveland iron, the stone is conveyed to Jarrow from the Yorkshire mines in the Company's fleet of steamers. It is first placed in open-topped cylindrical kilns, together with coke breeze and coal smudge, and roasted, the roasting driving off the moisture and part of the impurities, leaving the iron in the state of peroxide, and in an easily smeltable condition. This roasted ironstone is charged into the top of the blast furnace, together with coke and limestone, the coke being obtained from the collieries of the district, and the limestone from quarries which are close at hand. The limestone is used as a flux for the earthy impurities of the ore, with which it combines and forms an easily fusible slag. Hot air at a pressure of 5 lbs. per square inch, and at a temperature of between 1500° and 1600° Fahrenheit, is blown into the furnace through tuyeres, and coming into contact with the coke, the ensuing combustion gives off an intense heat. Part of the carbon of the coke is consumed in producing this heat, and part combines with the oxygen in the oxide of iron, leaving the metallic iron free. The fluid iron, in virtue of its superior weight, sinks to the bottom of the crucible, while the fluid slag, being lighter, floats on the top. The furnace is tapped every six hours, the bulk of the slag being first drawn off through a slag-hole above the level of the melted iron, and the iron is afterwards tapped off at a lower level, and cast on beds of sand into "pigs." The product is known as Cleveland iron. The higher qualities of Cleveland iron, that is, Nos. 1, 2, 3 and 4 foundry, are used for foundry purposes. The closer grained quality, known as No. 4 forge, is puddled and converted into wrought iron.

NEW BOILER SHOP
(South-End).

In these works, however, the bulk of pig-iron manufactured is that known as hematite, and is used in the manufacture of Siemens-Martin steel. For this purpose it is necessary that the pig-iron should be exceedingly pure, and especially free from sulphur and phosphorus; hence the necessity of using hematite ores. These ores are obtained from the north and south of Spain, and from the north coast of Africa, and are brought direct to the Company's wharf by steamers carrying about 3000 tons each. As these ores are natural peroxides of iron, no preliminary roasting is necessary, and they are at once charged into the furnace, together with limestone and coke as before, and cast into "pigs" as in the case of Cleveland iron. It should be mentioned that each pig bears a distinguishing brand; Cleveland pigs being branded "Jarrow," and hematite pigs "Tyneside." On account of the superior richness of iron in hematite ores as compared with Cleveland ironstone, less time is necessary to smelt them in the furnace, less slag is produced and more iron obtained in a given time as compared with the manufacture of Cleveland iron.

The conversion of Cleveland iron into wrought iron is thus effected. About 5 cwts. of Cleveland iron are charged into a small rectangular furnace, known as a puddling furnace, the bottom of which is lined with oxidising materials. The pig-iron, which is combined with over 3 per cent. of carbon, and may contain over 1 per cent. of silicon and 1½ per cent. of phosphorus, is melted on this bottom, and is partly oxidised during melting. Shortly after melting, active oxidation takes place, which causes the material to rise in the furnace and "boil," slag freely forming on the top and carrying with it the bulk of the impurities of the iron. This slag is tapped off, leaving the



NEW BOILER SHOP
(North-End).

iron clean. As soon as the "boil" finishes and the iron subsides in the furnace it is stirred or puddled by means of an iron rabble, and assumes a granular or pasty condition. By means of the rabble it is divided into several pieces and patted into balls, which are placed under a steam hammer, known as a shingling hammer, where it is further worked into shape and the last traces of slag expelled. It is then passed through a rolling mill and made into flat bars which are known as puddled bars. The pig-iron has now been converted into wrought iron comparatively free from carbon, silicon, and phosphorus. These puddled bars are cut into lengths and formed into "piles" with scrap wrought iron. The "piles" are brought to a welding heat and rolled into plates or bars as may be required.

Passing on to the conversion of hematite pig-iron into steel in the Siemens' furnaces, it may be stated that the Siemens' furnaces at these works consist of rectangular chambers about 24 feet by 11 feet inside. They are heated by gas made from coal on the premises, and are regenerative: that is to say, the waste heat leaving the furnace, and which would otherwise escape by the chimney, is caught in large chambers in which are loosely-piled fire-bricks. These bricks become highly heated by the escaping gases, and when the furnace is "reversed" the heat so caught is given up to the gas and air which are entering the furnace. In the puddling process for the manufacture of wrought iron it was stated that 5 cwts. of pig-iron were dealt with at a time. In steel making, however, quantities of 40 tons are dealt with in each charge. Pig-iron is charged on the bottom of the furnace, together with scrap steel to the extent of about 20 per cent. of the total weight of the charge, and after the

SHIPYARD FITTING SHOP,

charge is thoroughly melted, Campanil ore, which is very pure hematite ore, consisting chiefly of peroxide of iron, is thrown into the molten mass. The oxygen in the ore combines with the silicon and carbon in the pig-iron; large quantities of carbonic oxide gas are given off, which results in a violent "boil" in the molten mass, and this brings every part of the metal within the oxidising influence of the ore, with the result that the oxide of iron in the ore gives up its oxygen to the carbon and silicon in the pig-iron, leaving the iron in the ore free as metallic iron, and the iron in the pig-iron free from silicon and carbon. The ores usually contain sufficient lime to form a fusible slag; but if not, limestone in small quantities is added to combine with the earthy impurities of the ore. After all action ceases, the metal is tapped through a hole in the side of the furnace into a huge ladle holding 40 tons, and while it is running, ferro manganese in a finely-divided form is thrown into the ladle where it melts and combines with the purified iron, its function being to finally remove all oxides and leave the metal in a truly metallic state. From the ladle the metal is tapped into rectangular iron moulds known as ingot moulds, and cast into rectangular shapes known as ingots. These ingots are put into heating furnaces, and, if for the manufacture of bars, are rolled directly into finished shapes. For the manufacture of plates, however, they are first rolled into flat rectangular pieces known as "slabs," which are again re-heated and rolled into plates. The plates or bars are cut to required sizes for use in shipbuilding, bridge and roof building, boiler making, or other manufacturing purposes. Before leaving the works they are inspected and

SAILING-SHIP "LYDGATE" IN DOCK.

subjected to careful tests to prove their strength and ductility, and are usually further inspected and tested by surveyors attached to various inspecting bodies, such as the Admiralty, Lloyds, British Corporation, Bureau Veritas, and German Lloyds, besides the Inspectors of railway companies and engineers.

It is of interest to add that many eminent shipbuilders and engineers have been trained at the works, or have passed some time in the Company's service, including Mr John M'Intyre, senr., the originator of the double bottom for water-ballast; Mr John Thornycroft, the well-known builder of high-speed vessels; Sir James Allport, subsequently General Manager of the Midland Railway Company; Mr Zimmerman, Chief Director of the Vulcan Yard at Stettin, and designer of the *Kaiser Wilhelm der Grosse;* Mr F. C. Marshall, of Messrs Hawthorn, Leslie & Coy., whose name is associated with the introduction of forced-draught; Mr John Price, now a director of Messrs C. S. Swan & Hunter, Ltd.; Mr J. P. Wilson, formerly General Manager of Messrs Thomson's Clydebank Shipbuilding Coy., who is still connected with the works; Mr F. W. Dick, the present manager of the iron and steel departments; and Mr A. Adamson, who became General Manager of the Naval Construction & Armaments Co., of Barrow, afterwards amalgamated with Messrs Vickers Sons & Maxim, Ltd.

The number of men and boys employed by the Company is not far short of 10,000, and the wage bill averages between £500,000 and £750,000 per annum. The wages are paid weekly, and notwithstanding the large number of recipients, the distribution is completed in about fifteen minutes without the least confusion or error.

The productive capacity of the works is shown in the following table, which gives the tonnage of ships built since 1852. The total number of vessels completed is 753, and their aggregate gross register is nearly one million and a quarter tons, a total which, it is believed, has never been exceeded by any shipbuilding establishment :—

YEAR.	TONNAGE.	YEAR.	TONNAGE.
1852	920	1876	8,635
1853	3,539	1877	16,235
1854	7,469	1878	23,470
1855	5,169	1879	36,080
1856	7,531	1880	38,117
1857	6,816	1881	50,192
1858	7,625	1882	60,379
1859	11,894	1883	61,113
1860	4,653	1884	28,911
1861	4,751	1885	25,057
1862	22,493	1886	20,725
1863	17,096	1887	19,324
1864	22,896	1888	47,076
1865	31,111	1889	64,669
1866	18,973	1890	42,312
1867	16,555	1891	30,279
1868	15,842	1892	33,170
1869	11,900	1893	19,543
1870	26,129	1894	35,141
1871	19,267	1895	27,440
1872	12,810	1896	36,185
1873	21,017	1897	40,319
1874	25,057	1898	41,824
1875	15,819	1899	42,683

The indicated horse-power of engines built since 1870 is as follows:—

YEAR.	H.-P.	YEAR.	H.-P.
1877	2,443	1889	45,910
1878	10,580	1890	37,500
1879	11,930	1891	22,350
1880	13,625	1892	37,400
1881	18,150	1893	31,757
1882	20,110	1894	15,900
1883	28,910	1895	15,350
1884	22,730	1896	23,850
1885	9,370	1897	13,570
1886	12,540	1898	26,830
1887	28,120	1899	13,300
1888	11,610		

A list of fifty-six vessels of war constructed for our own Government, at Jarrow, is appended, and it will be seen that these include every description of fighting ship, from the river gun-boat to the battleship. It is estimated that, placed in a line, these vessels would form a wall of defence extending over nearly three miles, thus constituting a noteworthy, if not an unsurpassed record of naval shipbuilding.

LIST OF WAR VESSELS

BUILT BY

PALMERS SHIPBUILDING AND IRON CO. LD.

BATTLESHIPS.

DATE.	NAME.	DISPLACEMENT.	I.H.P.
1854	*Terror*	— tons	—
1862	*Defence*	6,270 „	2,540
1872	*Cerberus*	3,480 „	1,670
1872	*Gorgon*	3,480 „	1,670
1872	*Swiftsure*	6,910 „	4,910
1872	*Triumph*	6,910 „	4,910
1893	*Resolution*	14,150 „	13,000
1893	*Revenge*	14,150 „	13,000
1899	*Russell*	14,100 „	18,000

CRUISERS.

DATE.	NAME.	DISPLACEMENT.	I.H.P.
1885	*Surprise*	1,650 tons	3,000
1885	*Alacrity*	1,650 „	3,000
1888	*Orlando*	5,000 „	8,500
1888	*Undaunted*	5,000 „	8,500
1891	*Rainbow*	3,600 „	9,680
1891	*Retribution*	3,600 „	9,680
1891	*Pique*	3,600 „	9,680
1898	*Pegasus*	2,135 „	7,000
1898	*Pyramus*	2,135 „	7,000

LIST OF WAR VESSELS—*Continued.*

RIVER GUNBOATS.

DATE.	NAME.	DISPLACEMENT.	I.H.P.
1875	*Medina*	363 tons	410
,,	*Medway*	,,	,,
,,	*Sabrina*	,,	,,
,,	*Spey*	,,	,,
,,	*Slaney*	,,	,,
1876	*Esk*	,,	,,
,,	*Tay*	,,	,,
,,	*Tees*	,,	,,
,,	*Don*	,,	,,
,,	*Dee*	,,	,,
,,	*Trent*	,,	,,
,,	*Tweed*	,,	,,
1889	*Planet* (Austrian)	500 tons	3,500

TORPEDO MINERS.

DATE.	NAME.	DISPLACEMENT.	I.H.P.
1879	*No. 1*	104 tons	130
,,	*No. 2*	,,	,,
,,	*No. 3*	,,	,,
1880	*No. 4*	,,	,,
1881	*No. 5*	,,	,,
,,	*No. 6*	,,	,,
,,	*No. 7*	,,	,,
,,	*No. 8*	,,	,,
,,	*No. 9*	,,	,,
,,	*No. 10*	,,	,,

LIST OF WAR VESSELS—*Continued.*

TORPEDO-BOAT DESTROYERS.

DATE.	NAME.	DISPLACEMENT.	I.H.P.
1895	*Janus*	252 tons	3790
,,	*Lightning*	,,	,,
,,	*Porcupine*	,,	,,
1897	*Star*	322 tons	6000
,,	*Whiting*	,,	,,
,,	*Crane*	,,	,,
,,	*Flying Fish*	,,	,,
,,	*Chamois*	,,	,,
,,	*Bat*	,,	,,
1898	*Fawn*	,,	,,
,,	*Flirt*	,,	,,
1899	*Spiteful*	,,	,,
,,	*Peterel*	,,	,,
,,	*Syren*	,,	,,
,,	*Myrmidon*	,,	,,

TROOPSHIP (Indian)

DATE.	NAME.	DISPLACEMENT.	I.H.P.
1866	*Jumna*	6,050 tons	700

BATTLESHIPS DESIGNED.

DATE.	NAME.	DISPLACEMENT.	I.H.P.
1893	*Infanta Maria Teresa*	6,980 tons	13,000
,,	*Almirante Oquendo*	,,	,,
,,	*Viscaya*	,,	,,