the footpaths. But with panels 7.25 metres (23¾ ft.) in length, the verticals and rods do not noticeably obstruct the traffic. The blocks of the wooden pavement are arranged in cross rows with preliminary gaps of 0.3 in., which have been filled with wooden laths, asphalte, and cement mortar. The wood is pine from the Gironde, which has stood the test in the pavement of the Paris streets; the blocks have a height of almost 5 in. As the pavement forms belts of considerable width, expansion gaps of 1 in. have been left near the kerbstones. These are filled with clay and sand; but trouble from expansion is not expected, as the wood was well moistened before being laid. On the one side of the roadway stone pavement has been applied, the chief reason being apparently to ascertain whether the concussions of heavy carts on these stones would shake the superstructure to any undesirable degree; if that should result, the stones would have to give way to wood. The rails have been laid on asphalte felting, and vertical strips of such felting have been placed between the rails and the adjoining wood blocks, so as to make another expansion joint.

The subsoil consists of gravel and sand; at −18 D.P. (Düsseldorf-Pregel) a firm marl is met with; the soil offered no difficulties, therefore. This Düsseldorf datum corresponds to + 27 N.N., indicating the elevation in metres of the zero above sea level. Two of the piers, namely, the central river pier and the right shore pier, numbered V. and VI., were sunk with the aid of caissons. In the case of the other piers, cofferdams with wood and iron sheet piling were resorted to, as at Bonn. The two piers V. and VI. have their base at −10 metres D.P.; the left shore pier at −3.5; the others at ± 0 D.P. For the two first-mentioned piers, water depths of 6 metres and even 9 metres (30 ft. maximum) had to be provided. According to the scheme, the left main arch was first to be erected; the pier V. is not symmetrical with regard to its longitudinal axis in consequence, as Fig. 93, page 679, shows. The caisson is rectangular, 30 metres long, 14.5 metres wide, and 3.15 metres high internally (98 ft. by 48 ft. by 10 ft. 4 in.). The dimensions of the caisson of Pier VI., views of which we reproduce in Figs. 94 and 95, are 31 by 14 metres. Both were built up by Ph. Holzmann and Co., of Frankfort, of main transverse girders, longitudinal girders, and diagonals. They weighed about 400 kilogrammes per square metre (82 lb. per square foot). The caisson of Pier V. was constructed on boats, and was afterwards suspended by means of twenty bolts to the false work; it had three air-locks. Fig. 96, reproduced from a photograph, refers to Pier VI. on the Düsseldorf bank, which was flooded at that time, in August and September, 1897. The caisson could be constructed on the false work, and only two air-locks were required, which the illustration shows distinctly. The pneumatic machinery and beton-mixing plant were on shore; the electric motors which raised the spoil were placed on the air-locks, through each of which nearly 70 cubic yards of spoil passed in 24 hours. The concreting of Pier V. was accomplished in eight days; this was in December, 1897. The high water of that winter pressed so much on the suspended caisson, that the pier could not at once be built solid. Strong walls were raised, and the hollows were afterwards, when the caisson had reached its depth, filled with rammed-down beton. The left shore Pier IV. was concreted under water with the help of the funnels which we explained on page 348 *ante*. This concreting had been commenced in the same autumn, 1896, and finished in contract time, not without difficulties experienced chiefly in driving down the piles. The beton laid, the trench was pumped empty, and the pier raised in the dry. The piers consist essentially of gravel beton, 1 part of Portland cement, 3 parts of sand, and 6 of Rhine gravel. Trass was not employed, because the foundations were laid during the cold season, when trass does not set with sufficient rapidity. The walls are faced with column basalt in the lower parts; then follows basalt lava up to high-water level, and, finally, tuffa, all hewn.

(To be continued.)

Electric Lighting in Russia.—The revenue collected by the St. Petersburg Electric Lighting Company last year was 52,350*l*., as compared with 27,754*l*. in 1898, showing an increase of 24,596*l*. The working expenses last year amounted to 37,954*l*. It is proposed to increase the capital of the company from 240,000*l*. to 400,000*l*.

THE JAPANESE BATTLESHIP "ASAHI."

One of the most noticeable features of recent years in the affairs of the East has been the determined effort made by Japan to maintain her supremacy as the first naval Power of that quarter of the globe. In her location in Asia and in her territory, consisting as it does of islands, an analogy to Britain's position in Europe is found, and for reasons similar to those which actuate us, superiority over her enemies on the seas has become a first consideration of Japan's policy. Owing to the marvellous energy of the rulers and people, Japan has therefore placed herself well within the first rank of the great Powers of the civilised world; all of the ships which now constitute her admirably organised Navy have been constructed since 1880. The war with China enforced the wisdom of the policy we have indicated, and with the indemnities received from China, the Government has appropriately, and probably wisely, put forward every effort, and availed itself of every possible help, to consolidate Japan's position by creating a strong modern Navy, by building a magnificent fleet of all classes of fighting ships. At the same time, the aim towards material progress in the peaceful arts has not been forgotten, and the subsidising of various large Japanese shipping lines and other subventions granted by the Government have all been made with the object of furthering commercial interests abroad and opening up the ports to foreign trade. The large naval programme thus found additional justification in the growth of the mercantile marine, as well as in the practice which has lately grown of European Powers interesting themselves in the acquiring of seaports and territory in the East. That the Japanese have succeeded in demonstrating the fact that they are the first naval Power in the Pacific is without a doubt. In proof, it has only to be mentioned that the Navy consists of about 90 vessels of all classes, comprising 10 first-class battleships, 10 first-class armoured cruisers, 20 fast protected cruisers, and the remainder torpedo-boat destroyers and small gunboats, all of the latest design and build, and fitted with armament of the most modern character. The intention of the Japanese Government is to spread their naval programme over a period of 10 years, and when this is completed they will not only be the most powerful maritime nation in the East, but one of the most powerful in the world.

The Asahi, which constitutes one of the most important of the new battleships—a fact borne out by the drawings we have reproduced—has been designed and built by Messrs. John Brown and Co., Limited, Clydebank. She has a displacement of 15,200 tons, and may well be described as the largest battleship afloat. The first keelplate was laid in September, 1897, and, notwithstanding several drawbacks during her construction, she has been completed in the short time of 30 months. As a suggestion of the importance of the work of design of a modern first-class battleship in general, and of the Asahi in particular, it may be said that no fewer than 2500 drawings and tracings were required for the guidance of those in the yards during the process of construction. In general appearance, the Asahi is very much like the vessels of the British Formidable class, and her offensive and defensive qualities are unexcelled. The principal dimensions of this fine ship are as follow:

Length between perpendiculars ...	400 ft. 0 in.
,, over all	425 ,, 6 ,,
Breadth extreme	75 ,, 2½ ,,
Depth moulded	43 ,, 7½ ,,
Normal mean draught	27 ,, 3 ,,
Displacement	15,200 tons.

The Scantlings.

The Asahi is built of steel throughout; her framing is on the bracket system. She has a cellular double bottom, and wing compartments on either side, which latter can be utilised for coal storage. Her ram, stem, sternposts, and shaft brackets are malleable steel castings. There are four principal decks—lower, middle or protective, main, and upper; and plans of these, with the boat deck, &c., have been reproduced,* while a series of cross-sections are given on page 686 of our present issue. Below the protective deck the framing is very uniform, the spacing amidships in the way of the citadel being 48 in.; above the protective deck in the way of the citadel, however, the framing is spaced 24 in. apart; forward and aft of the citadel the spacing is 36 in. The frames within the limits of the double bottom are 5 in. by 3½ in. by 12 lb., and reverse frames with 15-lb. brackets, and there are a great number of solid watertight floors throughout the ship. Forward and aft of the double bottom the framing is of the ordinary type, consisting of 6 in. by 3½ in. by 3 in. by 15 lb. Z bars split at bottom, one half forming reverse bar, and the other the frame. In the way of the armour at the forward and after ends the framing is of Z bars 10 in. by 3½ in. by 3½ in. by ⅝ in., with a strong longitudinal girder midway between the decks. The longitudinal framing is very thorough, no fewer than five longitudinals being worked between the centre keel and the protective deck, and two are watertight (see Figs. 13 and 14). The depth between the outer and inner bottoms is 42 in., which gives sufficient room for easy access to all parts of the double bottom. The outer shell plating averages 25 lb. in thickness, and the inner bottom plating is of a weight of 15 lb. The centre girder and the middle strake of the inner bottom plating are made specially strong, so as to resist any undue strain when the vessel is docked. There are eleven main watertight transverse bulkheads, extending from the keel to the upper deck. The bulkhead plating is of a thickness of 15 lb. below water, and 12½ lb. above, well stiffened by vertical and horizontal angle and channel-bars. There are 261 watertight compartments, all of which have been thoroughly tested. Such complete division should prove of great value.

On either side of the ship under the protective deck there is arranged an ammunition passage for the length of the citadel. The passages are very roomy and have been designed with the object of having as straight a run through as possible and to have the fewest obstacles in the way of the service of ammunition to the various guns.

The coal bunkers are arranged both above and below the protective deck, having a capacity in all of about 2000 tons. They are strongly constructed and are fitted with all the modern conveniences for the easy transfer of coal from the bunkers to the stokeholds. As has already been mentioned, the wing compartments are also adapted for the stowage of coal.

One of the features of the vessel is the omission of wood, where it could at all possible be done without. Experiments have been carried out at Clydebank, and it has been found practicable to completely fit up a cabin without the use of any wood whatever. All fittings, such as the stand for wash-basin, drawers, berth, book racks, &c., are all made of sheet steel, and as far as appearance goes there is no difference from a similar cabin fitted in wood. Of course, it has been the practice for several years back now to fit all the cabin bulkheads of steel, and such is the case in this vessel. As regards the comparison in weight and price, there is not much to choose between wood or sheet steel. Then, again, in the matter of wood for decks the same principle has been adopted. All wood on decks that could be done without has been omitted, and corticene laid in its place.

The Armour.

The armoured protection is very complete; all the armour-plates have been supplied from the Sheffield works of the builders, Messrs. John Brown and Co., Limited. The plates are of steel treated by the improved Harvey nickel-steel process. The arrangement consists of the now usual forward and after barbettes placed at the ends of the central citadel. The main belt is 250 ft. long amidships; the total depth of this belt is 8 ft. 2 in., and the lower edge of the belt is 5 ft. 6 in. below the normal water line, and the upper edge 2 ft. 8 in. above it (Fig. 18). The maximum thickness of this belt is 9 in. The trial plates were subjected to three blows of an energy of 7208 foot-tons, and stood the test admirably, as will be seen from the photographs of one of the plates after attack, reproduced in Engineering, vol. lxvii., page 47. The central citadel of armour in the Asahi is completed by traverses or bulkheads extending obliquely across the ship and enclosing the bases of the barbettes which protect the positions of the heavy guns. Forward and aft of this main belt the protection of the water-line region of the ship is completed by armour carried to the bow and stern. This armour varies in thickness from 5 in. to 7 in. Above the main belt the sides from the top of the main belt to the main deck in the way of the citadel are covered with armour of a thickness of 6 in. (Fig. 17). The traverses or bulkheads are fitted with armoured doors for affording convenient means of communication along the deck when in port. The protective or middle deck amidships is angled so that the edge comes to the bottom of the main belt. Forward and aft of the citadel the protective or lower deck is at a lower level. It will thus be seen that the protection of the vitals of the ship is almost perfect. The protection of the armament is arranged in a very thorough manner. For the 12-in. guns at the extremities circular barbettes rise from the protective deck to a height of 22 ft. 4 in. above the normal water-line. The maximum thickness of the barbette armour is 14 in. (Fig. 18). The guns of the main armament are protected by 6-in. shields, which, of course, revolve with the guns. Each 6-in. gun is enclosed in a casemate with an armoured front 6 in. thick and rear plating 2 in. thick (Fig. 14). The armour on the main conning-

* The profile (Fig. 1), and the plan of boat deck (Fig. 2), were published as a two-page plate in our issue of April 6; the longitudinal section (Fig. 3) and the plans of the upper and main deck (Figs. 4 and 5 respectively), were published as a two-page plate in our issue of May 4; but these two plates will be bound with the two-page engraving accompanying this issue to adjoin this complete article of the ship, and are thus described and referred to in detail here.

THE TWIN-SCREW BATTLESHIP "ASAH

CONSTRUCTED BY MESSRS. JOHN BROWN AND

(*For Descr*

Fig. 6 MIDDLE DECK.

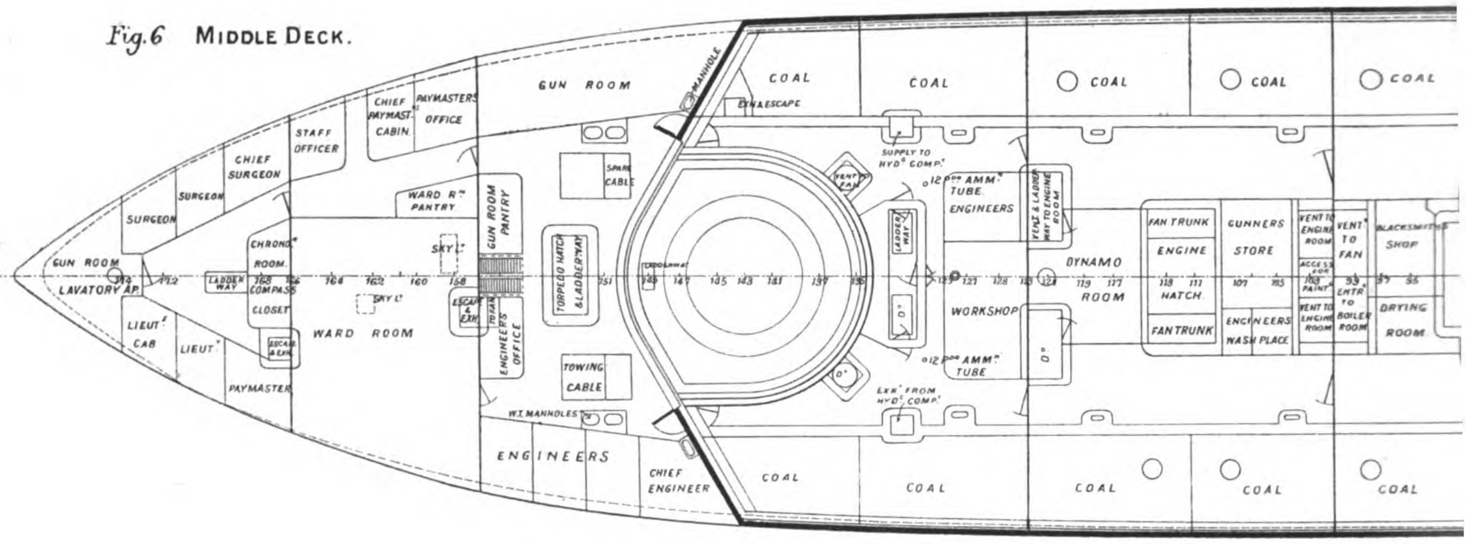


Fig. 7. LOWER DECK.

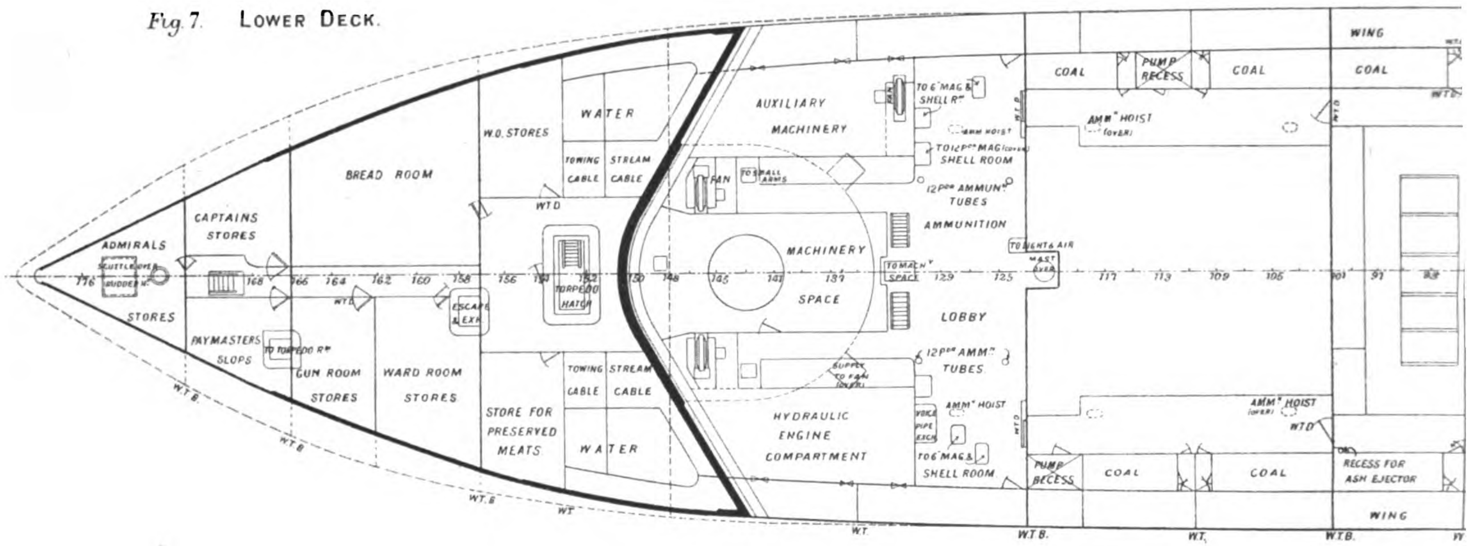


Fig. 8. PLATFORM DECK.

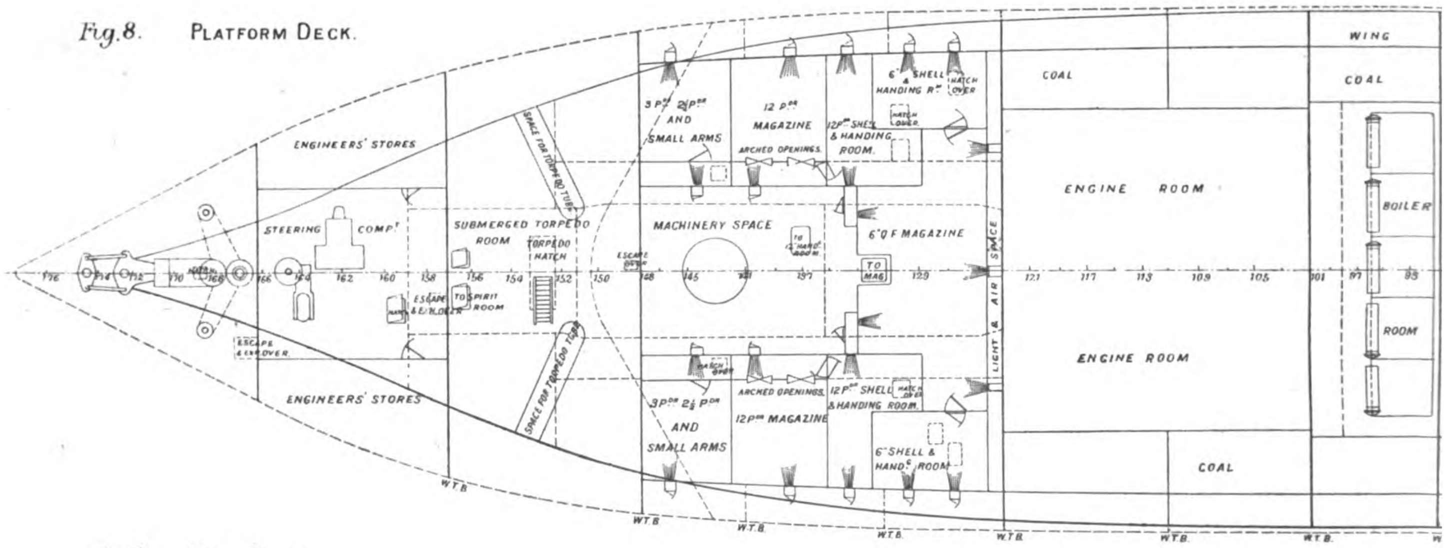
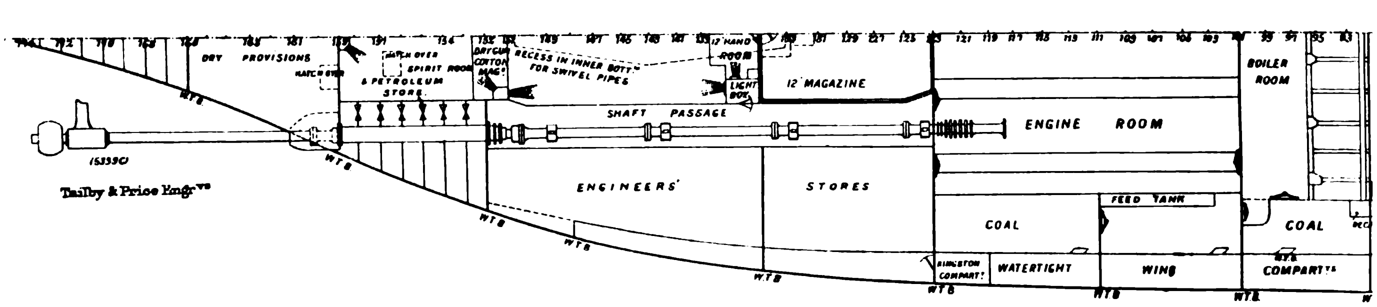


Fig. 9. HOLD PLAN.



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' FOR THE IMPERIAL JAPANESE NAVY.

LIMITED, AT THEIR WORKS AT CLYDEBANK, N.B.

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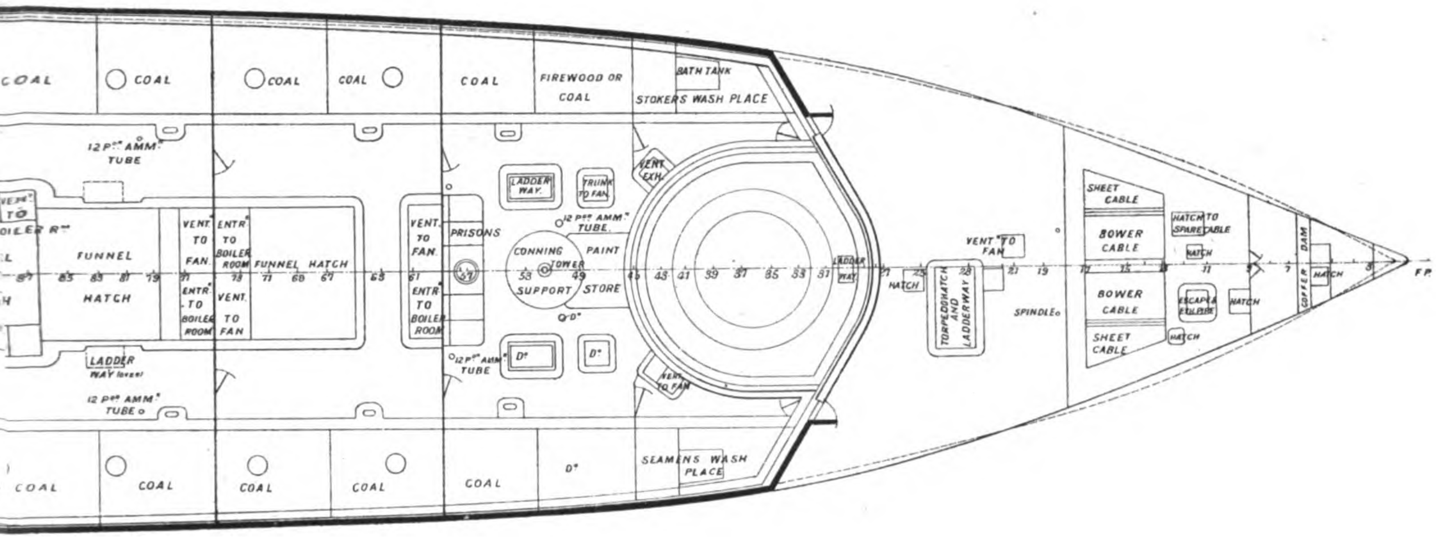
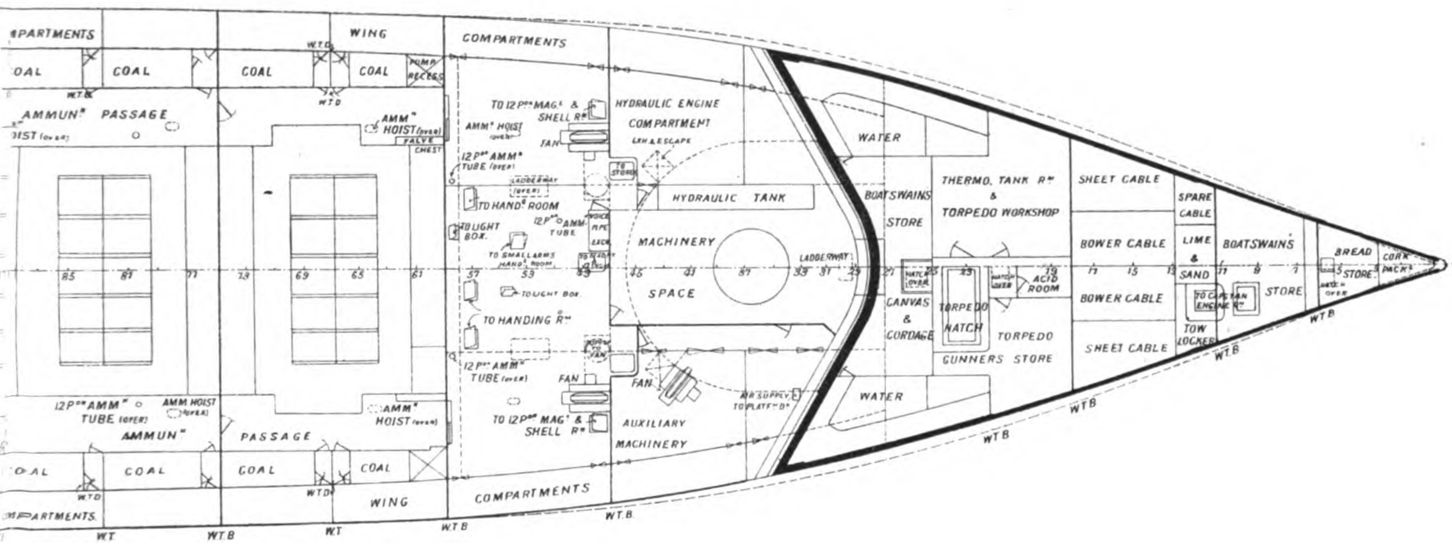
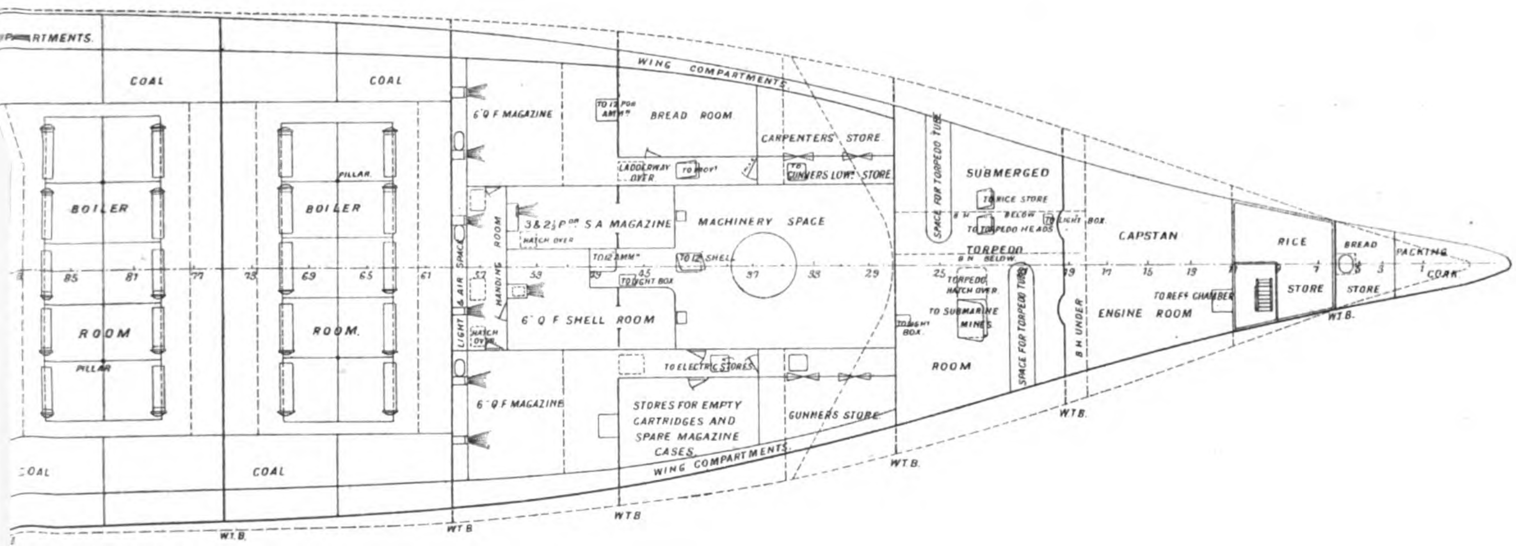
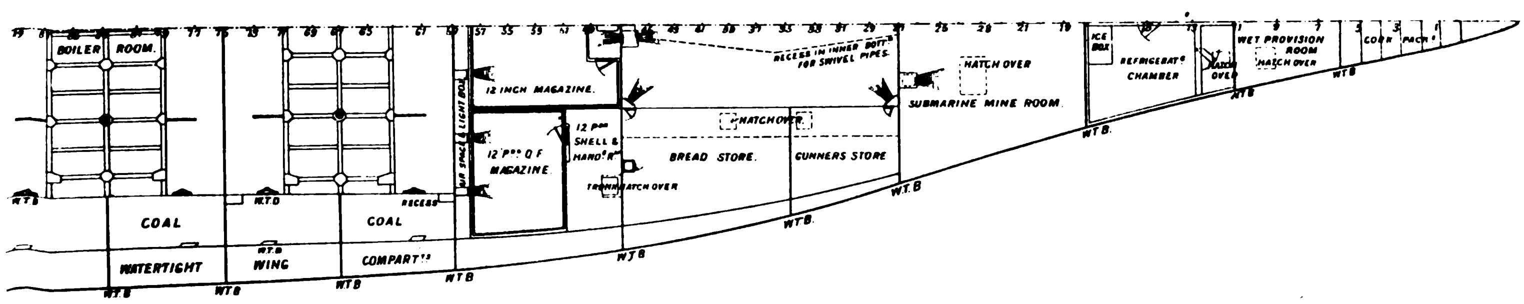








tower forward is 14 in. thick and on the after one 3 in. The main deck in the way of the citadel has a thickness of 1 in., and thus affords additional protection from any shells which find their way in above the main deck.

The main armour and barbettes have been strongly framed and fastened. The belt armour backing is of teak and has a thickness amidships of 4 in., varying towards the ends of the ship. The backing behind the barbette armour is also 4 in. thick. The armour bolts range from 4½ in. to 2 in. in diameter and are tapped into the plates from 5 in. to 2½ in. The bolts are fitted with white hempen grummets saturated in white lead and have well-fitting teak plugs driven over the heads. The armour of the conning tower forward is the only exception to the use of Harveyed nickel-steel; the curvature of the plates, it was found, was too great to enable this class of steel to be successfully employed. The plates in this case are consequently made of ordinary Harveyed steel. The tower armour is 14 in. thick and the screen plate 12 in. thick. The crown plate is 3 in. of nickel steel. The tube housing the voice pipes, &c., is of forged steel, and has a diameter of 2¾ ft. outside and is 8 in. thick (Fig. 3.) The ammunition trunks for the 6-in. guns are 2 in. thick and have cofferdams fitted round them at the protective deck. By the foregoing brief description of the protection, we think that the Japanese Navy can pride themselves in the knowledge of possessing the most powerfully armoured vessel afloat.

The Armament.

The Asahi's armament, which is of Elswick design and manufacture, consists of four 12-in. guns mounted in pairs forward and aft. The axes are at a commanding height above the water; and each pair of guns command an arc of training of 240 deg., viz, 120 deg. on each side of the fore-and-aft line of the ship (Fig. 4). All the loading and sighting operations are carried out under cover of the thick armoured barbettes already described (Fig. 3). There are fourteen 6-in. quick-firing guns installed on board, eight on the main and six on the upper deck. Four guns can be trained directly ahead and four others directly astern, and the total arc of training of each of the 6 in. guns is 120 deg. Each is enclosed in an armoured casemate before mentioned, so designed as to give effective protection to the gun's crew, either from the direct fire of the enemy or from the secondary effects of the explosion of shell in the 'tween decks (Figs. 4 and 5). There is quite a host of smaller guns, and they are all placed in what has been considered the most effective positions for them, as shown on the plans (Figs. 4 and 5). There are twenty 12-pounders, eight 3-pounders, four 2½-pounders, and several Maxim rifles. Four submerged tubes are carried in two rooms, one at each end of the vessel. The tubes are suited for discharging 18-in. torpedoes, of which 16 are supplied. The vedette boats are fitted with tubes for discharging 14-in. torpedoes (Fig. 2).

The stowage of ammunition has been so devised as to lead to the minimum of transport and to the entire avoidance of the crossing of the lines of supply to guns of different calibres. This is rightly considered a matter of great importance, and will tend to simplicity and certainty in time of action. The magazines and shell-rooms for the 12-in. guns are in the hold, and the shell and ammunition can be transferred from them by means of hydraulic hoists, and the gun can be loaded at any position of training (Fig. 3). The magazines and shell-rooms for the 6-in. guns are arranged on the platform deck (Fig. 8), and the ammunition is transferred to the various positions along the ammunition passage (Figs. 15 and 16). Spacious ammunition lobbies have been arranged for the easy working of the ammunition, and when the ship is in action there is little chance of congestion during the service of ammunition. Winches are placed in the ammunition passage immediately underneath the 6-in. hoist, and by means of an endless chain system the ammunition is delivered to the various casemates. The magazines for the smaller guns are in the hold and on the platform decks, from whence the ammunition is conveyed by hand to the respective guns. The numerous voice pipes which are fitted form a most important feature in this vessel. By means of these the ship can be directed from a very large number of different positions, and in action this will prove invaluable as a means for fighting the ship. The two masts have military tops, on which are mounted several of the smaller guns (Fig. 1). Above the military tops are platforms on which are placed searchlights. The after masts are mounted with a large derrick for boat hoisting purposes. There are also two yards on each mast for signalling purposes (Fig. 1).

Officers' and Men's Accommodation.

And now to consider the ship from the habitable point of view. The accommodation is of the latest and most approved design, and the size of the various cabins is greater than in other nations' ships of a similar type. Commencing with the main deck aft (Fig. 5) there are arranged there the suite of rooms specially designed for the use of the admiral. Here we find, a day saloon, dining saloon, bedroom, lobby, and pantry, with bath-room and lavatory, all arranged conveniently to one another. These apartments are all fitted appropriately for their respective uses, and all in first-class style. The panelling of the day and dining saloons is of a light nature, and the furniture is in keeping with it. The bedroom, which is fitted with a brass bedstead, is done up in enamel white and is a large, airy apartment. The admiral has also a day cabin arranged on the upper deck in the aft deck shelter (Fig. 4). This cabin is similar in design to those already described. Adjacent to the admiral's quarters on the main decks, room are arranged for the captain, commander, chief staff officer and six other rooms for officers of the staff. These rooms are fitted with all the latest improvements, and are tastefully upholstered. There are day cabins arranged for captain and chief staff officer, and rooms are set apart as offices for the various secretaries and clerks required. Forward of those cabins, and also on middle deck (Fig. 6), are arranged the cabins for lieutenants, engineers, and officers of lower grades. The ward-room is a very large apartment, situated on the middle deck, and is handsomely finished. It is arranged to seat 40 persons, and is fitted up with all necessary furniture—such as bookcases, settees, tables, &c. The pantry is adjacent to the ward-room, with a door for direct communication. The gun-room is also situated on this deck, and is a large apartment, fitted in a neat and substantial manner. Rooms are also arranged on the middle deck aft for charts, chronometers and compasses, and are fitted up in a manner suitable for their respective uses. Numerous baths for officers and crew, are arranged in various parts of the vessel. Ample space has been allotted for the crew, and everything has been provided of the latest pattern, such as bag racks, ditty boxes, hat racks, mess racks, &c. The messing accommodation is sufficient for 760 men, exclusive of the petty and warrant officers, and, of course, the tables and seats can be raised when not in use, so as to give good deck clearance. The sleeping accommodation for the crew is for about the same number, all to be accommodated in hammocks. The ship's complement, it may be added, consists of: Admiral, captain, commander, eight staff officers, five lieutenants, three surgeons, three paymasters, five engineers, five expert officers, 11 warrant officers, and 730 of a crew, making a grand total of 773 all told.

There are three galleys, admiral's, officers', and crew's, all grouped together on the main deck (Fig. 5). The galleys are supplied with the latest type of cooking ranges, boilers, hot plates, and all other items necessary to make a complete galley outfit. The store-rooms have been arranged in a very thoughtful manner. The lower deck (Fig. 7), forward and aft of armoured bulkheads, has been entirely utilised for this purpose, the object in view being to keep the stores in such a position that they may be easily got at. All the admiral's, captain's, ward-room, gun-room, and officers' stores are arranged aft, and the boatswain, warrant officer, and carpenter's stores forward. The bread-rooms and provision-rooms are large and have ample capacity for long voyages. The fresh-water tanks are built into the ship forward and aft of the citadel and have a capacity of 17,000 gallons. The wet and dry provision-rooms and spirit-room are below the protective deck, at the forward and after ends. A refrigerating installation has been fitted. It is on the cold-air principle, and has been supplied by the firm of Messrs. J. and E. Hall, Limited, Dartford, Kent. The refrigerating chambers are arranged below the protective deck forward and are of a very complete nature.

On the upper deck (Fig. 4) there are deck shelters forward and aft, in which are arranged for the convenience of the officers and crew, the water-closets and seamen's head. In the after shelter, rooms are arranged for the use of admiral and captain as day cabins, as already mentioned. In the forward shelter there are ready-use store for gunner and carpenter, also lamp-room and rooms for other deck stores. Above the upper deck is the boat deck (Fig. 2), on which the boats are stowed, and from which the work of manipulating them is performed. There are also several of the smaller guns mounted on this deck.

Navigating bridges are arranged both forward and aft (Fig. 1), and they are so arranged that the navigation of the vessel can be carried out with ease. On the forward bridge is the pilot house, immediately above the main conning tower, and on the after bridge is placed the chart-room. There is a flying bridge immediately over the pilot house forward, from which a clear view can be got of the whole length of the vessel.

(To be continued.)

Rolling Stock for Russia.—The Russian Government is about to let contracts for 200 locomotives and several thousand goods trucks. The locomotives are to be of a very powerful type, being intended to draw trains half as heavy again as those which are now running upon the completed portion of the Trans Siberian system.

WORKMEN'S COMPENSATION CASES.

Johnson v. *Adshead*.—This case was heard in the Rochdale County Court on Wednesday, May 2. The question was whether a workman could enforce an order made under the Workmen's Compensation Act by means of a judgment summons and an order to commit the employer to prison for non-payment of the amount due on the award.

A judgment summons was applied for on behalf of the applicant, who had suffered injuries while working at the respondent's sawmills at Stoneyfield in March. Immediately after the order awarding 8s. per week was made, the respondent had sold up his stock, and since then he had made a composition with his creditors. He had made no payments to Johnson. It is provided by Clause 8 of the second schedule to the Workmen's Compensation Act that an award registered in the Court, or a memorandum amounting to an award, "shall for all purposes be enforceable as a County Court judgment." In the course of his judgment, His Honour, Judge Bradbury, said that there were many ways of enforcing such judgments, among them being undoubtedly the power of proceeding under an order of the Court by way of committal on the non-payment of the debt. Section 5 of the Debtors Act pointed out the procedure in regard to committal—that if a judgment was obtained in any Court, including, of course, the County Court, a person who did not comply with the judgment could be committed to prison for a period not exceeding six weeks, or until he paid. This was one mode of enforcing judgment. Nineteen out of twenty judgments obtained in the County Court were enforced by judgment summons. Under the two sections named it seemed to him that the matter was decided; it was to be enforced as a County Court judgment, and a County Court judgment could be, and was, enforced by committal to prison. He had, therefore, come to the conclusion that the judgment summons applied for could issue. He thought the difficulty in the matter had arisen owing to the fact that under the rules and forms provided in the Workmen's Compensation Act there was no form, and there was no rule which dealt with procedure by judgment summons. Rule 49 dealt with execution as a mode of enforcing an award under the Compensation Act, and there was a form given for execution; but there was nothing said in the rules or forms about enforcing an award by means of a judgment summons. That, however, could not, in his opinion, cut down the absolute provision of the Act, which said it could be enforced as a County Court judgment. He thought it was clear that a judgment summons could issue, and he directed that it should be issued.

Percival v. *Garner*.—This was an appeal from an award of the Liverpool County Court Judge, in favour of the applicant. It came on for hearing in the Court of Appeal on May 19. It appeared that a building was being erected on certain chemical works belonging to Messrs. Bowman and Co.; the work was carried out under the supervision of Messrs. Bowman, who supplied the architect and the materials. Garner, the present appellant, supplied and paid the labourers for the brickwork; who were, nevertheless, under the orders and control of Messrs. Bowman. Garner was remunerated at the rate of ½d. per hour on the time of the men engaged by him.

One of the labourers, the husband of the present applicant, was killed while so employed as a labourer, and the question was whether Garner was an "undertaker" within the meaning of the Act, and as such liable to pay compensation. The County Court Judge held that he was "the person undertaking the construction of the building in question," and awarded compensation.

By Section 7 sub-section 2 of the Act, "undertakers" in the case of a building mean the persons undertaking the construction, repair, or demolition.

Mr. A. P. Thomas appeared for the appellant, Mr. M. A. D'Arcy for the respondent.

The Court allowed the appeal.

In the course of his judgment, Lord Justice A. L. Smith said that the person against whom proceedings must be taken to recover compensation was the person undertaking the construction of the building. It was clear that in the present case Messrs. Bowman and Co. were the persons undertaking the construction of the building. They were erecting the building on their own land, they employed their own architect, the building was being erected under their supervision, and the men were, while at work, under the control of their foreman. The appellant merely undertook to supply the labour. That did not make the appellant an "undertaker" within the meaning of the Act. The proceedings were taken against the wrong person. The decision of the County Court Judge must therefore be reversed.

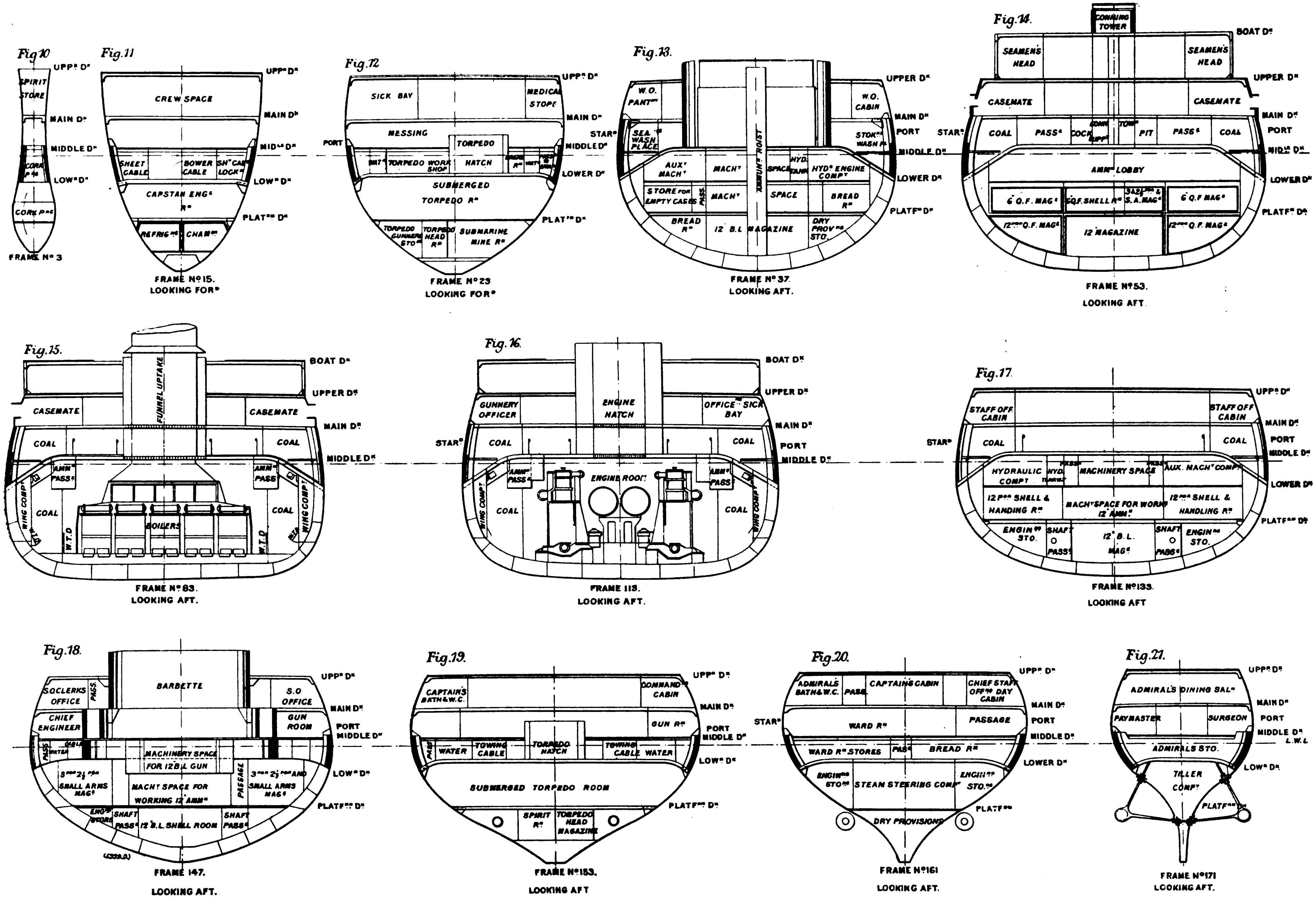
Lord Justice Vaughan Williams and Lord Justice Romer agreed.

Messrs. Ruston, Proctor, and Co, Limited.—The report of the directors, which is brought down to March 31, 1900, states that the balance of profit for the year is 48,159*l*., which, after deducting 21,023*l*. for depreciation of buildings, &c., directors' remuneration, and interest on debentures, leaves a net balance of 27,135*l*. This, with the balance brought forward from last year, gives an available total of 28,615*l*. The directors propose a dividend of 14s. per share, being 7 per cent. for the year (free of income-tax), carrying forward 1115*l*. The directors consider it desirable that the capital of the company should be increased; and at the forthcoming annual meeting it will be proposed that this should be done by the creation of 10,000 additional shares of 10*l*. each, to by issued at such prices and on such terms and conditions a shall be determined.

THE TWIN-SCREW BATTLESHIP "ASAHI," FOR THE IMPERIAL JAPANESE NAVY.

CONSTRUCTED BY MESSRS. JOHN BROWN AND CO., LIMITED, AT THEIR WORKS AT CLYDEBANK, N.B.

(*For Description, see Page 680.*)



Length of engine ...	...11.000 m. (36 ft. 1 in.)
Width ,, ...	... 6.000 ,, (19 ,, 8 ,,)
Weight of flywheel	33 tons
Total weight of engine ...	127 ,,
Double-Acting Blowing Engine:	
Diameter of cylinder ...	1.700 m. (66.93 in.)
Length of stroke	1.400 ,, (55.15 ,,)
Diameter of piston-rod ...	.244 ,, (9.6 ,,)
Height...	4.000 m. (13 ft. 1.5 in.)
Length	5.500 m. (18 ft.)
Width...	3 500 m. (11 ft. 6 in.)
Weight	31 tons

The gas used was delivered from five blast-furnaces, making Bessemer pig chiefly, into a chamber, where it was cooled and thoroughly washed with water jets; but by another arrangement the gas could be admitted direct to the engine after passing through a meter, careful observations being, of course, made during the trial of the amount of gas consumed. The apparatus used for this purpose was the same that had been devised in 1898 for testing the first large engine of the kind built by Messrs. Cockerill. This earlier engine, which was of 180 horse-power, gave very satisfactory results; the consumption of waste gas per horse-power per hour was 3.329 cubic metres (117.600 cubic feet). The engine recently tested showed a saving of about 7 per cent. over the earlier efficiency. The best result that was recorded during the trial was the development of 900 indicated horse-power, giving effective work of 725 horse-power in compressed air, with a consumption of 2.853 cubic metres (100.800 cubic feet) per hour. This Delamere-Deboutteville and Cockerill engine is certainly one of the important novelties of the Exhibition, and suggests a considerable economy in blast-furnaces for the early future. The concluding words of the report we have referred to, which was prepared by M. H. Hubert, Director of Mines in Belgium, may be quoted as a just summary of this interesting work. "If we remember that the first and very elementary trials in the direction of using blast-furnace gases direct only date back for about five years, since the first experimental eight-horse motor was completed at Seraing in 1895, when it was considered necessary to furnish it with extensive appliances for cleansing and scrubbing the gas, we cannot fail greatly to admire, and thoroughly to appreciate, the ability and perseverance with which M. Delamare-Deboutteville and the engineers of the the Cockerill Company have met and overcome all the difficulties that attended a complete solution of the problem."

THE PARIS EXHIBITION ELECTRIC POWER STATION.*

THE TRIPHASE ALTERNATOR OF THE NANCY GENERAL ELECTRIC COMPANY.

CONTINUING our notices of the various installations that compose the great electric power station of the Paris Exhibition, we this week give illustrations (on page 845) of the triphase alternator exhibited by the Compagnie Générale Electrique de Nancy, which is direct coupled to one of the several engines supplied by Messrs. Weyher and Richemond, and which we shall describe on a future occasion. The generator belongs to the class of alternators with fixed armature and revolving inductor; it is designed for an output of 450 kilowatts at 50 periods and 93 5 revolutions per minute. According to whether the load is inductive or non-inductive, it absorbs from 530 to 660 effective horse-power. The armature is built up of very soft iron plates ½ millimetre thick, insulated with paper; it is held together by four rigid and well-ventilated cast-iron frames bolted together. For convenience of transport and erection, the armature has been made in halves, the lower part of the frame carrying the feet by which it is bolted to the bedplate, while four rings are attached to the upper half, as shown in the illustration, for convenience of erection. On each side of the circular frame of the armature are placed six radiating tie-rods secured to a central collar and the periphery, and provided with adjusting screws; by this arrangement the rigidity of the armature can be greatly increased, at the same time that the weight is diminished, and the proportions between the mass of the cast-iron frame, and the wrought-iron plates of the armature, reduced. The winding, which is of the ordinary triphase type, is so arranged as to avoid all crossing in the connections of the coils, as well as in the coils themselves; cable is used for the winding, instead of copper strip; the coils are insulated by tubes of micanite. The clear opening of the armature is 4.50 metres (14 ft. 9.17 in.) in diameter, and the outside diameter is 5.050 metres (16 ft. 6.82 in.); the width of the cast-iron body is 580 millimetres (22.84 in.); it carries 96 coils, of which 32, connected in series, constitute the winding for one phase; the total weight of this fixed part of the generator is 14 tons. The inductor revolving within the armature consists of a cast-steel ring with eight arms, and having 64 poles screwed into the periphery of the ring. Like the armature it is made in halves for convenience of transport and erection, and is mounted on the shaft by bolts and rings shrunk on hot. The coils are machine-wound on insulating shells, the section of wire being such as to insure a full margin of safety under all conditions; the cross-section of the coils is oval, which gives the best utilisation of space, special facility in manufacture, and a minimum length of wire. The poles are wound so as to avoid crossings and long connections, and the finish of the work is excellent. Two carefully insulated cables, passing down one of the arms, are in connection with two rings, whence is brought, by means of rubbing contacts, the continuous exciting current required. The weight of this part of the generator wound complete is 9.6 tons. On the overhanging end of the main shaft is mounted the armature of the six-pole exciter which gives a continuous current of 120 volts for exciting the alternator. This machine is wound in series, in order that only one rheostat may be required. The output of this dynamo, at 93.5 revolutions, is 120 volts and 75 amperes. It is almost unnecessary to say that the Compagnie Générale Electrique de Nancy, is one of the leading electrical companies in France.

* See pages 647, 712, 746, 775, and 815 *ante.*

THE JAPANESE BATTLESHIP "ASAHI."

(*Concluded from page* 681.)

THE AUXILIARY MACHINERY.

THE auxiliary machines are very numerous, and to give a complete description of each individual machine or system would suffice for an article in itself. They include Brown's steam tiller and telemotor gear, air compressors, engines and dynamos for electric power and lighting, searchlights, workshop engines and machines, ventilating fans, refrigerating machinery, capstan engines and cable gear, combined heating and ventilating apparatus for crews' quarters on the patent thermo-tank principle, coaling winches and Temperley's transporters, boat-hoisting winches.

Steering is effected in the Asahi from different positions of the ship, and by alternative methods. The chief and easiest method is by the hydraulic telemotor, which is used in conjunction with the steering engine in the steering compartment aft. The arrangement which is fairly well known, is the patent of Messrs. Brown, of Rosebank Works, Edinburgh.

The air-compressing machinery is contained in two rooms on the lower deck. The machinery is used for charging the air chambers in the locomotive torpedoes, the air, of course, actuating the propelling mechanism of the weapon. The sensible course has been adopted of keeping one end of the ship independent of the other, so that one could be fought after the other has been put out of action. This part of the equipment has been supplied by Messrs. Brotherhood and Co., London, who have fitted out many warships with machinery. The hydraulic machinery, to which reference should be made, is also in two engine rooms on the lower deck. The power is used for operating the barbette turntables, hoisting ammunition, elevating and loading guns. The rooms are all well ventilated, a point which is not always sufficiently attended to.

The ship is lighted throughout internally by electricity. The engines and dynamos for this purpose are of the most approved design, and the electric lighting arrangements are complete in every respect. The coal bunkers are, of course, supplied with the fixed lights, customary in the most modern of battleships. Two yard-arm reflectors, each with eight 50 candle-power 80-volt incandescent lamps, are also fitted. Six searchlight projectors are placed at different positions on the ship, one on each mast and one at each end of the forward and after bridges. These searchlight projectors are very powerful and are fitted with automatic carbon feed lamps, those in the tops being also supplied with distant controllers with watertight Bifranner switch. Electric lighting is arranged also for distant signalling purposes. All such items as compasses, telegraphs, and instruments on the upper deck and bridges, conning towers and torpedo direction towers, the bow and masthead, are all fitted with incandescent lights. The dynamos, which are placed in a room on the middle deck, are three in number of 600 amperes 80 volts, and are supplied by the well-known firm, Messrs. Siemens and Co., Limited; the engines are supplied by Messrs. Bellis and Co., Birmingham. All wire leads are of the best high conductivity copper and form a complete wire circuit, no earth being formed by the ship. There is also a complete system of electric bells throughout the ship with tell-tales fitted in the various important positions. All the work in connection with the fitting out of the ship with the electrical power has been carried out by the electrical department of the Clydebank works.

A workshop for the use of the engineers has been arranged on the middle deck amidships, and is fitted with all the most useful of machines; in fact, it is really a floating repair-shop. Nothing has been omitted which would prevent any repairs from being expeditiously carried out.

For ventilation there are six fans driven by steam, arranged three forward and three aft, below the protective deck and within the citadel. These supply fresh air to all the compartments beneath the water line and thus all hatches can be closed when in action. All the downcasts to these fans are fitted with armoured gratings where they pass through the armoured decks. The compartments above the water line are ventilated naturally through cowls. Special ventilation is provided for the coal bunkers, all of which exhaust into the main funnels. There has also been adopted in the crew's quarters of this vessel a patent known as "Stewart's patent ventilating thermo-tank," which combines heating with ventilation and can be regulated as required. The principle is intended to combine an efficient ventilating system with an improved arrangement of heating. An efficient form of heater is combined with a steam or electrically driven fan, and placed on deck or outside the compartment to be heated or ventilated. This heater is connected to the ventilating trunking through the compartments and rooms, and any required volume of air at any desired temperature can be delivered to the compartment. By a suitable arrangement of valves on the connection to and from thermo-tanks, air may be exhausted from the compartment to the atmosphere; or may be circulated in the compartments throughout the heater, and thereby raise the temperature. It may also be delivered direct into the ventilating trunks without passing through the heater. The temperature can also be reduced when the vessel is in hot climates by means of direct expanded gas from a refrigerating plant.

The capstan and cable holders are actuated by a vertical inverted engine, having two cylinders each 16 in. in diameter and 14 in. stroke. The whole of the capstan cable-holders are driven from the engine by means of mitre gearing. There are two cable-holders suitable for the size of the cable carried. They are of cast steel with solid stops. They are arranged to run loose on their shafts with gun-metal bushes. Each holder is provided with one wrought-steel reliever fitted into a cast-iron rubbing block. A cast-steel drumhead is fitted firmly to the centre cable holder spindle between the forecastle deck and the upper deck, to enable the capstan on the upper deck to be worked by hand. The vessel is fitted complete with all cable gear, and during the tests everything worked satisfactorily. There is also a vertical inverted capstan engine fitted aft, having two cylinders each 10 in. in diameter and 12 in. stroke, and is similar in construction to the forward one. A warping capstan is also fitted on the upper deck aft and is arranged to work by hand as well as steam. The lower portion is in the form of a cast-steel cable-holder suitable for 1⅞-in. cable. The body of the capstan is portable and the head is arranged to take full set of capstan bars.

The anchors and cables are of the best make, and were thoroughly tested before delivery. There are four bower anchors, each of 120 cwt., ex-stock; one stream anchor, of 40 cwt., ex-stock; three kedge anchors, each of 25 cwt., ex-stock. These anchors are all of the latest pattern. They are stowed on bill boards specially constructed and adapted for the speedy transit of the anchor overboard when they are released. There are four cables of $2\frac{7}{16}$-in. stud chain, and one cable of 1⅞-in. stream chain. These are stowed in lockers constructed forward on the lower deck, and are so placed that they are convenient for the cable being easily led to the holders.

The Asahi is amply supplied with boats, there being no fewer than 16 of all kinds. These boats are all stowed in such a manner so that they can be manipulated in the easiest fashion when required.

THE PROPELLING MACHINERY.

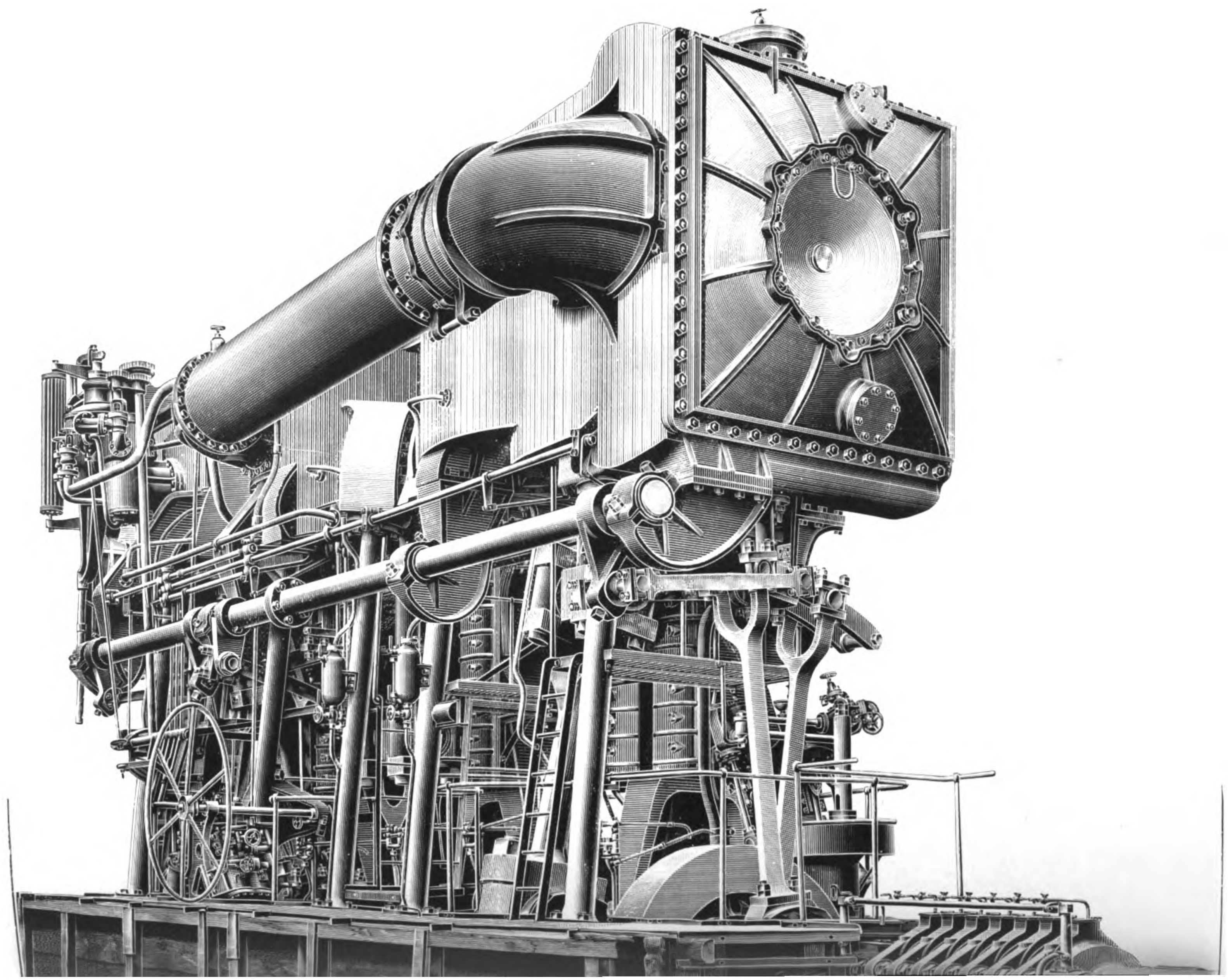
The Asahi is propelled by two sets of three-cylinder triple-expansion engines which are illustrated by engravings on our two-page plate. Each of the two sets is designed to develop 8000 indicated horse-power, giving a combined indicated power of 16,000. Steam is supplied by water-tube boilers of the latest Belleville economiser type, working at a pressure of 300 lb. per square inch which will be reduced at the engines to 250 lb. Each set of engines is placed in a separate engine-room, divided by longitudinal watertight bulkhead, which extends the whole length of the machinery space. Each engine-room is in all respects similar to but entirely independent of the other.

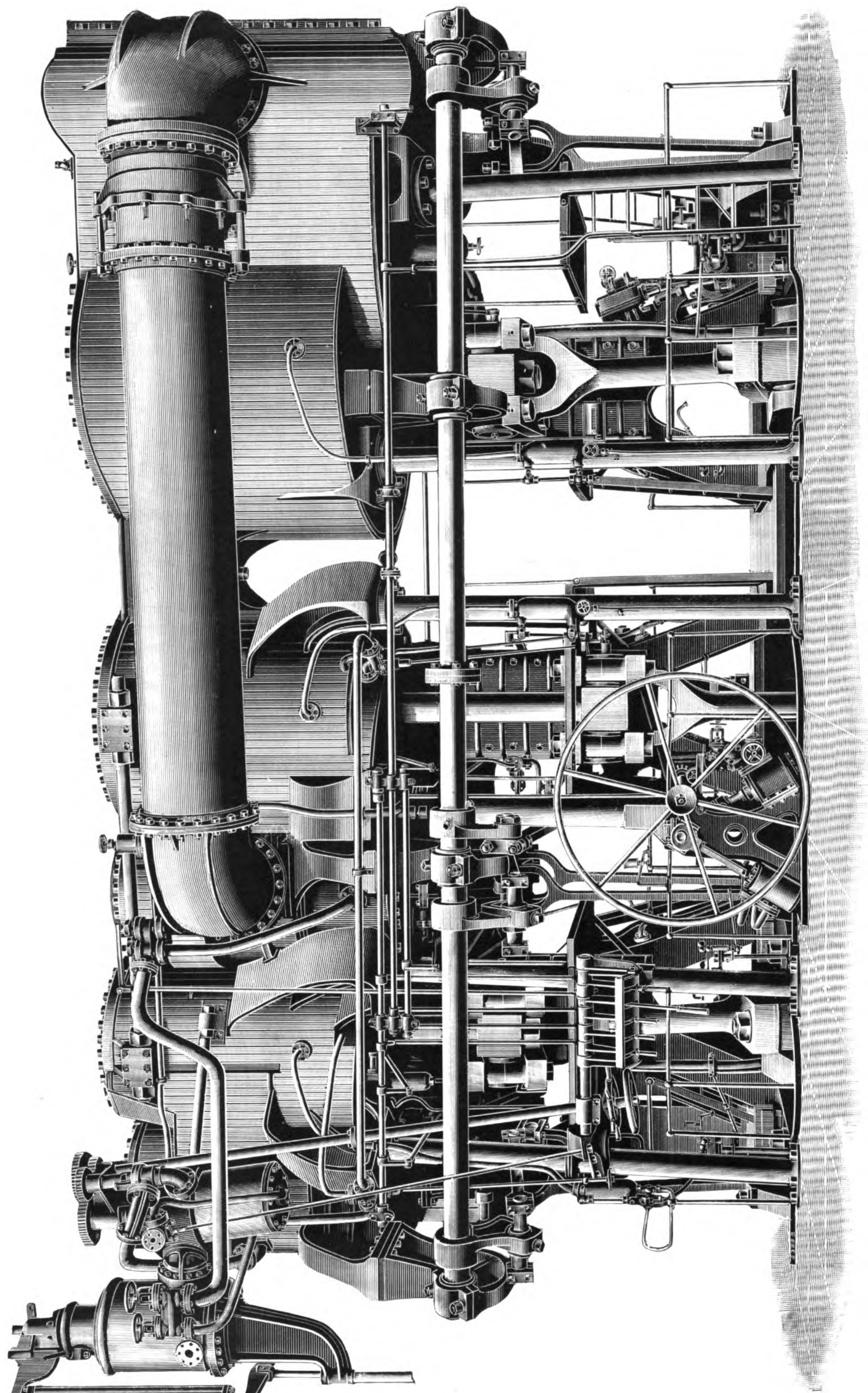
The main engines are of the vertical inverted type, supported on cast-iron columns at the back, and inclined wrought-steel columns at the front. The soleplates, or main bearing frames, which are made of the cast-steel skeleton type to insure lightness, are strongly bolted together so as to form one homogeneous stiff foundation for the engines. All the cylinders are fitted with separate liners, and are steam-jacketed. The diameter of the high-pressure cylinders is 32½ in.; that of the intermediate-pressure cylinders, 52 in.; and that of the low-pressure cylinders, 85 in.; all having a stroke of 4 ft. The high and intermediate pressure cylinders are fitted with piston valves of the inside type, having

TRIPLE-EXPANSION ENGINES OF THE IMPERIAL JAPANESE BATTLESHIP "ASAHI."

CONSTRUCTED BY MESSRS. JOHN BROWN AND CO., LIMITED, CLYDEBANK, N.B.

(*For Description, see Page* 846.)





approved adjustable packing rings; whilst the low-pressure cylinders are fitted with treble-ported flat slide valves, having a special type of relief frame fitted at the back to relieve them of steam pressure. The weight of all the valves is suitably balanced in order to reduce the strain on the valve gear as far as possible; the latter is of the double-eccentric link-motion type. The cylinders, which are entirely independent castings, are connected together by attachments which, while allowing for the expansion of the different parts, insure, at the same time, longitudinal stiffness; and to further increase their stability in the event of ramming, &c., strong struts are fitted between the high-pressure engine and the forward structure of the vessel, as well as transversely between the respective cylinders in each engine-room.

The air pumps are not worked by levers in the usual manner from the main engines, but are entirely separate. Close under the main condensers are placed a pair of direct-driving, single-acting air pumps, actuated by steam cylinders working on the compound principle, the pumps running at a speed of 30 strokes per minute. The suction pipes of these air pumps are cross-connected, so that at lower speeds the one set of pumps suffices for both engine-rooms, which may prove of great advantage in the event of accidents.

The main condensers, which are built of riveted brass plates, are placed in the wings of the ship and have a collective cooling surface of 16,000 square feet. Adjacent to them, at the aft engine-room bulkhead, are placed two auxiliary condensers, one in each engine-room, having a combined cooling surface of 2220 square feet. Water is circulated through the condenser by two 18-in. centrifugal circulating pumps each driven by independent engines, having, in addition to suctions from the sea, the usual bilge connections.

The boilers are placed in three separate compartments, there being in all five stokeholds running athwartships. The forward and middle groups consist of ten boilers, placed five in a row, back to back; and the aftermost group consists of a single row of five boilers. There are thus 25 boilers with economisers, viz., 15 boilers having eight elements and seven pairs of tubes; 10 boilers having seven elements and seven pairs of tubes; 15 economisers having eight elements and ten pairs of tubes; and ten economisers having seven elements and ten pairs of tubes.

The main feed system consists of three main and three auxiliary pumps of Messrs. G. and J. Weirs' well-known double-acting type.

The main steam supply is conveyed by two lines of steel steam pipes, one line being arranged on each side of the ship, and leading into a large steam separator on the aft boiler-room bulkhead. Each line of main steam piping is entirely independent of the other, as are also the connecting pipes from the boilers to each of these lines. Any boiler may, therefore, be cut off from the steam without interfering with the performance of the others in the compartment, as may also any compartment from which these main steam pipes lead, without affecting the working of the other compartment. Any group of boilers may supply steam to any of the engines; and the same remark applies to the feed system.

THE STEAM TRIALS.

The Asahi left her moorings in Portsmouth Harbour on Tuesday, March 20, and proceeded to Spithead, where, after adjusting compasses, she commenced her preliminary trials by running a series of progressive miles in Stokes Bay, with the following results:

Progressive Speed Runs.

Mile Runs.	Revolutions.	Indicated Horse-Power.	Speed in Knots.
First set of runs ..	36	613	6.69
Second set of runs ..	50	1610	9.28
Third " " ..	71.5	4855	13.06

These data having been obtained, the ship anchored at Spithead for the night, and on Wednesday morning left for the westward at 6.30 to carry out her high-speed coal-consumption trial, the results showing that at 12,947 indicated horse-power the consumption was only 1.6 lb. per horse-power per hour. The following Table gives the mean results:

High-Speed Coal-Consumption Trial.

		Starboard.	Port.
Steam in boilers		270 lb.	
Vacuum		25½ in.	25½ in.
Revolutions per minute ...		100.4	100.45
Mean pressures	High ...	110.2 lb.	107.6 lb.
	Intermediate	39.5 "	37.7 "
	Low... ...	17.0 "	16.1 "
Indicated horse-power	High ...	2223	2170
	Intermediate	2042	1944
	Low... ...	2340	2228
Indicated horse-power ...		6605	6342
Collective I.H.-P.		12,947	
Speed of vessel		17.5 knots	
Coal consumption per I.H.-P. per hour		1.6 lb.	

The high wind and heavy sea prevented the ship anchoring at Torbay, as had been previously arranged, instead of which she steamed on to Plymouth, and was safe at anchor in the Sound by 7 p.m. On Thursday she remained at anchor, adjusting the draught to meet the requirements of the specification, and on Friday she commenced her full-power trial between Start Point and Barry Head, a distance of 12.26 knots. Four runs were made between these points, the mean results obtained from the series being as follow:

Full-Power Trial.

		Starboard.	Port.
Steam in boilers		280 lb.	
Vacuum		25½ in.	25½ in.
Revolutions per minute ...		108.4	108.3
Mean pressures	High ...	115.21 lb.	115.32 lb.
	Intermediate	49.09 "	46.69 "
	Low... ...	20.93 "	19.34 "
Indicated horse-power	High ...	2508	2516
	Intermediate	2737	2608
	Low ...	3105	2886
Indicated horse-power ...		8350	8010
Collective I.H.-P.		16,360	
Speed of vessel		18.3 knots	

This is certainly most satisfactory, the ship having a mean draught of 27 ft. 3½ in., corresponding to 15,340 tons displacement.

After the full-speed trial circles were made to port and starboard with each steam-steering engine, and with the ship still at full speed. Then at a speed of 15 knots, the hand-steering gear was successfully tried, after which stopping, starting, and reversing trials were carried out. The ship then ran the remaining 90 knots to Spithead at a speed of 17 knots, anchoring there shortly before midnight.

RECENT LOCOMOTIVE PRACTICE IN FRANCE.*

By M. EDOUARD SAUVAGE, Member, Assistant Engineer-in-Chief, Rolling Stock and Running Department, Western Railway of France.

(*Translated from the French.*)

RECENT locomotives on the French railways are chiefly remarkable for their high power, rapid increase in the power of locomotives being not, however, peculiar to France.

Four-cylinder compound locomotives are frequently used: there are to-day in France more than 800 locomotives of this kind in service or under construction. The four cylinders drive either two, three, or four axles. With two driving axles the machines have large wheels, and are intended specially for working express trains, but they may also be employed advantageously for the heaviest passenger trains, and even in certain cases for goods trains. The locomotives with three axles have also large wheels. They draw easily long goods trains or heavy passenger trains; they have been employed to work express trains, but exceptionally rather than regularly. This type of engine renders very great service, since it is suitable for almost all trains; it allows considerable increase in speed for goods trains, which becomes more and more necessary on the network of the principal French lines.

For heavy and slow trains, principally on steep inclines, four driving axles are used; but this type of machine is generally less in favour than the preceding: almost all engines with four driving axles have already become a little antiquated.

It is important to observe that much importance is attached to the preservation of the coupling of these axles together, instead of driving separately one axle or a group of axles by each pair of cylinders.*

The advance in the power of engines has brought about an increased weight upon each pair of wheels. A load of about 17 tons per axle is generally allowed to-day in France although a few years since 15 tons were seldom exceeded.

Amongst the details of construction one should notice first of all the dimensions of the fire-grates and of boilers. To obtain a sufficiently large diameter, especially with large wheels, the axis of the boiler has been raised much more than was done formerly; generally a height of 2.50 metres (8 ft. 2$\frac{7}{16}$ in.) above the rail-level is to-day the normal height, although formerly this dimension was nearer 2.15 metres (7 ft. 0$\frac{11}{16}$ in.). This necessitates the short chimneys characteristic of modern locomotives. It is scarcely necessary to add that engineers have never regretted this increased elevation of boilers; if there still exists a divergence of opinion in this matter, it is between those who think that there is no disturbance in the stability and those who think that there is a distinct advantage in this respect.

The effective pressure of steam in boilers has been carried to 14, 15, and even 16 kilogrammes per square centimetre (199, 213, and even 228 lb. per square inch), the compound system making good use of these high pressures.

TABLE I.—FOUR-CYLINDER COMPOUND LOCOMOTIVES, IN USE OR ON ORDER ON JANUARY 1, 1900. (ORDINARY FRENCH GAUGE.)

See pages 849 & 851	Railway.	Numbers of the Series.	Number.	Total.	Year Ordered.	REMARKS.
	LOCOMOTIVES WITH TWO DRIVING AXLES.					
Fig. 1	Nord (Northern)	701	1		1885	Driving axles not coupled radial axle in front.
2		2121-2123, 2187	17		1890 and 1892	
3		2188-2157	20		1894	
11		2158-2160, 2161-2180	23		1895 and 1897	
		2611-2642	2	63	1898	Type "Atlantic."
4	Ouest (Western)	501-502	2		1893	
5, 6		503-542	40	42	1897 and 1899	
	Etat (State)	2701-2706	6		1895	
		2801-2804	4	10	1899	American locomotives, Vauclain system.
	Paris Orléans	1 20	20	20	1898	
	Midi (Southern)	1701-1714	14		1893	
7		1751-1774	24		1895 and 1896	
8		1775 1784	10	48	1897	
	P. L. M. (Paris, Lyons, and Mediterranean)	C 1-2	2		1887	Two driving axles between two carrying axles.
		C 3	1		1892	
		C 11-12	2		1891	
		C 21-60	40		1893	
9		C 61-150	90	135	1898	
10	Est (Eastern)	2401-2432	32	32	1898	
	Total number of locomotives with two driving axles .			350		
	LOCOMOTIVES WITH THREE DRIVING AXLES.					
12	Nord (Northern)	3121-3170	50	50	1897	
13, 14	Ouest (Western)	2501-2525	25	25	1898	
	Paris-Orléans	1701-1725	25	25	1899	
	Midi (Southern)	1301-1302	2		1895	
16		1303-1312	10		1897 and 1898	
		1401	1		1895	
15		1402-1415	14	27	1398	
	P. L. M. (Paris, Lyons, and Mediterranean)	3261-3300	40		1897	Locomotives with four driving axles converted.
17		3401-3550	50	90	1898	
18	Est (Eastern)	3401-3450	60	60	1893	
	Total number of locomotives with three driving axles ..			277		
	LOCOMOTIVES WITH FOUR DRIVING AXLES.					
	Nord (Northern)	4101-4120	20	..	1889	Woolf's system, tandem cylinders.
	P. L. M. (Paris, Lyons, and Mediterranean)	3201-3202	2	..	1887	
20		4301-4302	2	..	1887	
		3211-3260, 3301-3362	112	..	1892 and 1893	
19		4501-4540	40	176	1891 to 1895	Converted engines.
	Total number of four-cylinder locomotives .. .. .. (This does not include Mallet locomotives for the metre-gauge light railways.)			803		

Referring to the frames of locomotives, the leading

* Paper read before the Institution of Mechanical Engineers.

* This remark does not apply to M. Mallet's articulated locomotives employed in France on the light railways of one-metre gauge, with which the present paper does not deal.