coupling is as rigid as if the shafts were continuous. Its plan of construction is a system of drag links operating through a central floating plate, which is free to link itself to either shaft, and is also the medium for the transmission of 1000 horse-power to the 10,000-light alternating dynamo.

All of these engines were condensing, two of them being connected to Wainwright surface condensers, two to Worthington jet condensers, and two to Wheeler surface condensers. They were located in two groups, one of which, in Section 24, contained four side by side, with a connecting runway between the platforms, and with spiral stairways at each extremity of the space ascending to the common platform. The remaining two were isolated in Section 27, with independent platform and stairways.

But it was the engine itself that was the centre of interest, although there was plenty which merited attention in the rest of the exhibit. The following detailed description, together with sections through the cylinders and steam chests on the preceding page, will render it clear. It is a steeple compound, but although the arrangement of cylinders and connections to the crank is the same as any other engine of its type, the similarity ceases at this point. The working parts are all inclosed, and flooded with lubrication, following the practice of the makers with their other types of engines. All packing is metallic, so that the necessary attention is restricted to an occasional take-up of lost motion. The engine runs at a speed of 200 revolutions a minute, and its entire weight is 65 tons. Over all it measures but 17½ ft. high, and covers a floor space of but 11 ft. by 15 ft., while the whole combination of engine and dynamo covers but 12 ft. by 30 ft. The flywheel is 11 ft. in diameter and weighs 12 tons, and the governor, which is of the same general character as the makers use on their other compound engines, weighs (with its wheel) 7 tons. The shaft is 12 in. in diameter, the bearings are 13 in. by 30 in., and the crankpin dimensions are 11 in. by 11 in. The cylinders are 21½ in. and 37 in. in diameter respectively, by 22 in. stroke—the low-pressure being above the high-pressure, so that the pistons and rods may be completely disconnected without disturbing the cylinders. A fixed eccentric inside the crank case operates the low-pressure slide-valve, while only the high pressure piston valve is under the control of the governor. Upon a spindle carried at each end from the two rocker arms are supported all the reciprocating parts of the high-pressure valve gear, and part of this is a new form of inertia balance and steam starting gear. It may be remarked here that the real problem of high-speed steam engineering is a proper control of the pressures resulting from the inertia of the reciprocating parts. Of course the inertia pressures of the piston connections may be resisted by the crankpin or cushioned by compression, but in high speed and large powers, it is essential that the heavy valve gear carried by a free eccentric and flying weights should be provided with some appliance to absorb the inertia strains. In these engines the valve gear weighs nearly half a ton, while the inertia strain amounts to over two tons at each extremity of the stroke, and, to resist this, an inertia balance is provided in the form of a compression chamber, in which a trunk piston alternately compresses and releases the inclosed air. In this manner a varying resistance is obtained, which may be exactly suited to the inertia strains at all points of the valve stroke, and, automatically varying in degree as the stroke itself, varies to suit the different cut-offs. Furthermore, by maintaining a difference in the degree of compression at either extremity of the stroke, the weight may also be balanced, so that the only office of the eccentric becomes a means of mere impulse to keep up a vibration between two elastic forces, and—to govern. This cushioning device also serves as a steam starting gear after disconnecting the eccentric connections with the valve, through a simple cam movement, by admitting steam into the air chambers; so that there are two distinct offices performed by the same mechanism, thus avoiding complication and consequent increased liability to derangement.

Although not even the drawings of these engines had been completed a year previously, yet the last one had been assembled, worked under load and steam pressure, and delivered in Chicago before the opening of the Fair. Since their first day of service they were in daily operation, and, with the exception of legitimate adjustment, not a single change of detail was found necessary. Considering the extent of the plant, the number of these new engines, and the radical departure from their established practice of single action, which the builders, the Westinghouse Machine Company, of Pittsburg, have made, these performances were admirable, and must certainly be very gratifying to the builders who have ventured so much.

CAR-WHEEL GRINDING MACHINE.

THE machine illustrated on page 66 is designed for grinding wheels cast in contracting chills, and does the work with great accuracy; one man can handle and grind 200 wheels per day on it. It is not stopped to change wheels, but the emery wheel runs continuously. The machine consists of a circular body casting, with a section removed so as to admit the wheels to be ground. Resting upon this, and bolted to it, is a spider with three arms, from the centre of which the wheel is suspended in position for being ground. Two of the spider arms are provided with centring rolls, capable of lateral adjustment to suit wheels of different diameters. The third arm of the spider is provided with a crosshead in which is journalled a vertical shaft, carrying at its lower end a friction clutch which bears upon the flange of the car wheel, communicating motion to it during the process of grinding. The vertical shaft is driven by power from a horizontal shaft overhead, with which it connects by bevel gearing. The emery wheel is encased in a cast-iron hood, in which is journalled the emery wheel shaft. The hood is also intended as a safeguard against accidents. It is provided with mechanism to give it vertical and lateral motion, enabling the operator to adapt the machine to wheels of different diameters and widths of tread. It is located on the body casting, at a point opposite one of the fixed centring rolls, and near the power roll and clutch. This clutch, besides revolving the car wheel, serves as an elastic point to allow irregularities to pass, and, in each revolution, to be acted upon by the emery wheel. The two centring rolls being rigidly adjusted (one directly opposite the emery wheel), they force all irregularities toward the emery wheel, and, until the wheel is reduced to an equal diameter at all points, and a truly cylindrical form, it will show on its tread the low places untouched. The machine, which was shown at the Columbian Exposition, and is the invention of Mr. J. R. Titus, is constructed by the Ensign Manufacturing Company, of Huntington, West Virginia.

THE BRITISH TORPEDO-BOAT DESTROYER "HAVOCK."

ON page 67 we gave an engraving of the new torpedo-boat destroyer Havock, the first completed of over thirty vessels of a similar type ordered from several shipbuilding firms throughout the country at a cost of from 33,500*l.* to 39,000*l.* each. These vessels have been previously described in ENGINEERING (see vol. lvi., pages 545, 612, and 674). The Havock is 180 ft. long by 18 ft. 6 in. beam; is a single-deck vessel, in form greatly resembling the first-class sea-going torpedo-boats built by Messrs. Yarrow and Co., the constructors of the craft we are describing. Forward there is a long turtle deck, well elevated above the waterline, which covers in a lofty forecastle, in which the larger number of the crew are berthed. At the after end of this turtle deck is the usual conning tower with steering wheel. The next compartment is filled up with berths, and abaft a separate compartment is devoted to the cook, and contains also fresh-water tanks and two more berths. From the galley to the engine-room are the two boiler compartments, containing each a locomotive boiler with copper firebox, working up to 180 lb. per square inch, and capable of generating steam sufficient for the development of 1800 horse-power. The engine-room contains two sets of inverted triple-expansion engines, capable of developing collectively, without undue forcing, 3500 horse-power, each set of engines driving a screw. In the same compartment are two surface condensers, two centrifugal pumps and engines for driving them, fan engines, steam bilge pump, evaporator and distiller, air-compressing engines, and engine dynamo for the search light; and lastly, the engine for actuating the rudder, which can be controlled from either the forward or after steering station. Abaft the engine-room are two cabins for the engine-room artificers, then comes the officers' mess-room with its pantry, and last of all, quite at the stern, a large store space. The armament consists of an 18-in. bow torpedo tube for firing direct ahead; also two 18-in. swivel torpedo tubes for side firing, which are placed on a turntable aft. On the forward conning-tower, well elevated above the water-line, is a 12-pounder quick-firing gun, which practically has an all-round range. There are also two 6-pounder quick-firing guns, one at each side, and finally a 6-pounder placed on a high stand near the stern, having a very extensive range of fire. The depth of the boat being so much greater than is necessary for head room, admits of a water-tight flat, or lower deck; this has been built in the boat just above the water-line, extending from the stem to the forward stokehold, adding greatly to the safety of the craft in case of collision, and below, under the floors of the cabins, are spaces for magazines and stores. The coal-carrying capacity of the Havock is 60 tons, and the supply is placed in bunkers along each side of the boiler compartments, and is estimated to be sufficient for a run of 4000 miles at a 10-knot speed. The complement of officers and men to man this vessel is forty-two, for whom there is sufficient accommodation, but they are rather closely packed. The mean speed of four runs on the measured mile was 26.783 knots; the details of the trials have previously been reported.

THE OIL-CARRYING STEAMERS "DELAWARE" AND "LACKAWANNA."

WE commence this week, on our two-page plate and also on pages 74 and 75, the publication of illustrations of two steamers recently built for carrying petroleum in bulk by Messrs. David J. Dunlop and Co., Port Glasgow. They were constructed to the order of the Anglo-American Oil Company, Limited, for their service between the United States and the United Kingdom. The steamers are on similar lines to, but larger than, the s.s. Manhattan, built by Messrs. Dunlop for the same owners about 3½ years ago, and which has since proved herself a very successful and economical steamer in the Atlantic petroleum trade. The two new steamers, named respectively Delaware and Lackawanna, are each 345 ft. long between perpendiculars, 44 ft. broad, and 31 ft. 6 in. in depth, moulded, with a total deadweight carrying capacity of 5200 tons, 600 tons being allotted for coals and 4600 tons for the cargo of petroleum. The subdivision of the vessel is very complete. There are in all ten thwartship water-tight, or oil-tight, compartments for the carriage of petroleum (Figs. 1 and 2). These again are divided by a longitudinal bulkhead running right fore and aft through all the tanks (Fig. 3). This fore-and-aft bulkhead is water-tight, although not constructed to stand the full test to which the cross bulkheads are subjected. In addition to the ten double tanks or compartments for oil, there is a large tank forward for carrying water ballast, while water may also be carried in the fore peak. The large tank is subdivided by the central bulkhead. Water ballast is also fitted aft under the engines, boilers, and in the peak. At both fore and aft ends of the series of oil tanks there is a cofferdam or well 4 ft. wide, entirely separating the oil from the rest of the ship (Figs. 2 and 3), these cofferdams extending right up to the spar deck.

The pumping power of this class of vessel being of the greatest importance, so as to give the quickest despatch at the loading and discharging ports, special care has been devoted to the designing of the pipe lines, and to the arrangement of all the pumps and valves, so that the cargo shall be worked in the most speedy and economical manner. The main pumps, of which there are two, were made by the Snow Steam Pumping Engine Company of New Jersey, and are of the usual duplex type, each having two steam and two water cylinders 14 in. in diameter, with a stroke of 12 in. and a maximum output of fully 500 tons per hour; but as we hope in a future issue to illustrate the pumping arrangement, as well as to give engravings of the engines and details of the boiler, we defer a detailed description.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, January 8, 1894.

MANUFACTURERS are beginning to feel more hopeful that the Wilson Tariff Bill will not get through, because of the increasing discontent among threatened industrial interests, and the rising opposition of constituencies, which members of Congress are obliged to respect. At the same time, the Administration Whips will not admit that there is the slightest possibility of a failure to pass the Bill. The iron trade is no better; mills are generally idle. The rail situation has not improved. The large orders expected in January are not likely to be placed. The vote on the tariff question in the House will not be reached before January 30, and brokers and railmakers say this has something to do with the holding back of orders. Steel billets are 16.50 dols. at Pittsburg, and steel rails will cost, perhaps, not over 17 dols. at most; which, with rails at 24 dols., leaves a margin wider and more satisfactory than can be had on any other product of steel mills. The outlook is not inviting, but the big and little consumers of iron will shortly be forced into the market. Forge iron has been liberally offered here at 12 dols.; best No. 1 foundry can be had at 14 dols. Quotations on structural material cannot be given, as all contracts placed are on terms known only to buyer and seller. The larger concerns outside of the Pittsburg district are not booking any orders just now. The merchant-iron mills are generally idle. Pig-iron production has reached 100,000 tons per week. Strong concerns have virtually withdrawn from the market, rather than meet the prices which have lately been mentioned by weaker concerns in need of money. Notwithstanding the depression and the general unrest, there are reasons for believing that a general expansion of demand, accompanied by a slight improvement in prices, is not as remote a contingency as has been supposed.

LAUNCHES AND TRIAL TRIPS.

THERE was launched at Dundee on Saturday, the 6th inst., a screw steamer named Glasgow, for Messrs. James Rankine and Son, Glasgow and Grangemouth. The vessel was constructed by Messrs. W. B. Thompson and Co., Limited, and is of the following dimensions: Length, 248 ft. 9 in.; breadth, 32 ft.; depth, 14 ft. 5 in. It is intended to employ her in the service between Grangemouth and Rotterdam, and for this purpose accommoda-

tion has been provided for forty-eight cabin passengers. The engines, made at Lilybank Works, Dundee, are of the triple-expansion type, and have cylinders 21½ in., 34 in., and 56 in. in diameter, with a piston stroke of 42 in. The boiler pressure is 170 lb., and the speed is expected to reach 13 knots. On deck there are three steam cranes and two steam winches. Steam steering gear has been introduced, and the vessel, whose tonnage is 1050, is fitted with water-ballast arrangements.

Messrs. Armstrong, Mitchell, and Co. launched on the 6th inst., at their Walker shipyard, on the Tyne, the Euplectela, for Messrs. M. Samuel and Co., of London. She is a spar-decked vessel of 340 ft. in length, 44 ft. beam, and has a moulded depth of 31 ft., and is being superintended by Messrs. Flannery, Baggallay, and Johnson, London, and Captain Coundon, marine superintendent. She is for the carriage of oil in bulk and general cargo, and is subdivided into numerous tanks, with a total capacity of 4860 tons of oil, and large bunkers. The engines and boilers will be capable of propelling the vessel at fully 10 knots at sea, and will be fitted by the Wallsend Slipway Company, of Wallsend.

Messrs. Earle's Shipbuilding Company, of Hull, launched on the 10th inst. a twin-screw steamer, built by them for the Great Eastern Railway Company's Continental service between Harwich and the Hook of Holland. This vessel, which was named the Berlin, is a steel twin-screw steamer 302 ft. in length by 36 ft. beam, and has two separate sets of triple-compound engines, expected to give a speed of about 18 knots. The cabin accommodation is similar to the Chelmsford (see ENGINEERING, vol. lv., page 779), which was built by the same firm for the Hook of Holland route last summer, the Berlin being a sister ship, with the exception that she has a little more length and beam. The Great Eastern Railway Company intend to have four boats of this type to perform the service.

In the early spring, or as soon as the state of the ice permits, the three Russian battleships, Sevastopol and Petropaulovsk, each of 10,960 tons displacement, 10,600 indicated horse-power, and 17 knots speed, and Sissoi Veliki, of 8880 tons displacement, 8500 horse-power, and 16 knots speed, will be launched at St. Petersburg. The two first-named ships will each mount four 12-in., eight 8-in., and twenty-four smaller guns; the third will carry four 12-in., six 6-in., and eighteen minor weapons. Each vessel has a complete water-line belt with a maximum thickness of 16 in.; and the two larger have 10 in., while the smaller has 14 in. armour on the turrets.

The screw steamer Ardanrose proceeded down Belfast Lough on her trial trip on the 15th inst. The vessel has been built to the order of Messrs. Clark and Service, of Glasgow, for the Ardan Steamship Company, Limited, and is a sister ship to the Ardandhu, lately completed by the same builders. The principal dimensions are: Length, 281 ft.; breadth, 39 ft. 6 in.; depth moulded, 25 ft. 4 in.; gross tonnage, 2130. The machinery has been constructed at Messrs. Workman, Clark, and Co.'s engine works, Queen's-road, and consists of triple-expansion engines and two steel boilers working at a pressure of 180 lb. These boilers are fitted with Howden's system of forced draught. On the measured mile an average speed of 13½ knots was attained.

The Burmeister and Wain shipyard in Copenhagen has just completed an ice-breaking steamer for the town of Odense. The dimensions are: Length, 70 ft.; breadth, 19 ft.; depth in water, without water ballast, 9 ft. aft and 6½ ft. forward. The engine indicates 220 horse-power, but can be forced up to 275 horse-power. There are two water-tanks aft, from which the water can be led to a water-tank forward, when the steamer is required to break the ice by its weight. The steamer is very heavily built to highest class Bureau Veritas. The cost is 3750*l*. It is fitted with a powerful electric projector. At a trial trip the steamer easily broke 5-in. ice at half-speed.

MISCELLANEA.

THE Birmingham Association of Mechanical Engineers paid a visit on Saturday, January 13, to the Corporation Water Works, Aston, Birmingham.

At a meeting of the Newcastle-on-Tyne Association of Students of the Institution of Civil Engineers, held in the Durham College of Science, on the 10th inst., a paper on "Piles and Pile-Driving" was read by Mr. J. R. Buterden, A.M. Inst. C.E.

The Congo Company contemplates the building of a telegraph line from Boma, over Matadi, Leopoldville, and Stanley Falls to the Tanganyika Lake. The total distance is about 4800 miles, and the completion of the whole line will occupy several years. The section Boma-Kenge is expected to be finished during 1894-95.

The Swedish Naval Department is recommending the building, during the next few years, of two additional ironclads—besides the completion of the one of the Svea type now in course of construction—two despatch vessels, six mine boats, and an extension of the stationary mine defence.

The traffic receipts for the week ending January 7 on thirty-three of the principal lines of the United Kingdom amounted to 1,226,134*l*., which was earned on 18,522¾ miles. For the corresponding week in 1893 the receipts on the same lines amounted to 1,192,919*l*., with 18,300¼ miles open. There was thus an increase of 33,215*l*. in the receipts, and an increase of 222½ in the mileage.

The Lords Commissioners of the Admiralty have decided to adopt the designs of, and have placed the order with, Messrs. Baxters, Limited, of Sandiacre, Nottingham, for the steam cable gear required for the new cruisers H.M.SS. Talbot, Minerva, and Eclipse, recently laid down at Devonport, Chatham, and Portsmouth Dockyards respectively.

A new system of ship ventilation has recently been fitted on several steamers by Messrs. Baird, Thompson, and Co., ventilating engineers, of Glasgow and London. Downcast and upcast shafts are fitted at either end of the holds to be ventilated, and ejectors, worked by compressed air, are fitted at the bottom of the upcast shafts. A constant circulation of air through the holds is thus secured.

Steamers are used on a continuously increasing scale in the German sea-fishing industry. The first fishing steamer was used in 1884, in 1888 there were twelve, in 1890 twenty-four, in 1891 forty-six, and in 1892 sixty-one steamers. Each of these steamers costs on an average 6000*l*., so the whole fleet represents about 370,000*l*. They all use German coal, and the requisite ice is also collected close to their respective ports.

The Department of Science and Art has received through the Foreign Office a despatch from Her Majesty's Minister in Chile, in which it is announced that the opening of the Santiago (Chile) Mining and Metallurgical Exhibition, 1894, has been postponed from April until September of this year; but, that, notwithstanding this deferred date of opening, all proposed exhibits can at once be forwarded to Santiago.

In a discussion on electric blasting, by the American Society of Civil Engineers, several speakers stated that there was but little need for insulating the leading in wires. Even in salt water, naked wires worked perfectly, from six to seven charges being exploded without any trouble from misfires. In fact, up to a length of 100 ft. these wires require no insulation when laid in water. On land insulation is of even less importance.

In a paper on "Furnace *v.* Foundry Practice," recently read before the Western Foundrymen's Association, Mr. E. A. Wheeler, of Sharon, Pa., advocates the common use of analysis of foundry irons. He remarks that two casts from a furnace are seldom alike in composition, and that this is the cause of frequent complaints, whereas, if the foundryman stated what analysis he wished his pig to have, there would be no difficulty in fulfilling his requirements.

The Glasgow University Engineering Society held its fifth ordinary meeting on Tuesday, the 16th inst., Professor Biles, M.C.I.N.A., presiding. The chairman opened an interesting discussion on "The Relative Merits of Keel and Centre-Board Yachts." At the close of the meeting a number of slides, illustrative of every class of yachts, were, through the kindness of Messrs. Adamson, photographers, Rothesay, and Mr. Wilfred Hunt, shown on the screen.

It is interesting to note that high-speed engines are now being experimented with for driving mill shafting. Thus Messrs. Willans and Robinson, amongst their orders for the Willans central engine last year, amounting to 18,950 indicated horse-power in all, had several for mill driving; one of these was for a 570 horse-power engine for a flax mill in Belfast, and another for a 540 horse-power engine for a flour mill in Germany. Of course the great bulk of the work done was for central station electric lighting, much of the output being repeat orders.

The Railroad Commission of Ohio have recently made a somewhat curious pronouncement upon the subject of country roads. They estimate that some 400,000,000 dols. would be required to improve the existing highways in the State, and that even then the cost of transport by road would be 25 cents per ton-mile, which seems rather an extravagant sum. On the railways of the State the cost of transport is said to be ½d. per ton-mile. Comparing these figures, the Commission suggest that instead of spending money on improving the highways, steel rails should be laid along them, and electric traction adopted.

The Archduke Carl Salvator of Austria has invented an automatic mitrailleuse, which has been most satisfactorily tested, and which is the outcome of exhaustive experiments. It is capable of firing some 450 to 480 shots per minute, and smokeless powder can be used; 40,000 shots are understood to have been fired through one barrel without any drawback. The cost for one mitrailleuse is about 100*l*. The Archduke Carl Salvator has previously made several inventions connected with firearms; in the present case he has been assisted by several Austrian officers.

Colonel W. M. Ducat, R.E., recently held a Local Government Board inquiry into the application of the Horfield Local Board and Barton Regis Sanitary Authority for sanction to borrow the sum of 11,948*l*. for works of sewerage and sewage disposal. The Bristol Sanitary Authority decline to allow the Horfield Board to convey their sewage into the Bristol system, and therefore it is necessary to construct the works for which the loan is now required. Mr. Cotterell, C.E., the engineer for the scheme, stated that the works had been designed for the International process. The inspector said he felt the scheme was a good one, and the inquiry terminated in the usual manner.

The Egyptian State Railways have just bought a mixed line of steel from various manufacturers, and the following particulars may be of interest: From Fried. Krupp, Essen, 2400 kilogrammes mild plate steel at 8*l*. 10*s*. per 1000 kilogrammes, 4000 kilogrammes round tool steel at 8*l*. 15*s*. From Ibbotson Brothers and Co., Globe Works, Sheffield, 170 kilogrammes round spring steel at 30*l*. per 1000 kilogrammes. From the Cockerill Company, Belgium, 20,750 kilogrammes flat spring steel. From the Solinger Gusstahl Actienverein, Solingen, 4300 kilogrammes round tool steel at 500 francs per 1000 kilogrammes (about 20*l*. per ton), and 5600 kilogrammes square tool steel at the same price.

The Dockyard authorities at Portsmouth do not expect that they will be able to lay down the keel-plate of the new first-class battleship Majestic upon the blocks until the beginning of February. The ship will be the largest ever built in the yard. It has been decided to lay her down in No. 13 dock, where the Royal Sovereign was floated out by the Queen. The head of the dock will have to be lengthened to accommodate the battleship. The greatest length of the dock is 416 ft., and its width at the entrance is 82 ft., while the Majestic will measure 390 ft. by 75 ft. beam. The dock is at present occupied by the Repulse, and until the work upon her is completed the preparation of the blocks cannot be proceeded with.

A new steam fire engine of 260 gallons capacity has just been constructed by Messrs. Shand, Mason, and Co., of London, to the order of Mr. J. C. Wills, a well-known resident of East Stonehouse, for presentation to the town. The ceremony of handing over the new engine to the Local Board took place on Tuesday, January 9, in conjunction with the opening of the Town Hall by the Earl of Mount Edgcumbe. The engine is similar in design to the powerful 450-gallon double-cylinder engine recently supplied to the London County Council by the same firm. At the trial steam of 100 lb. pressure was raised from cold water in 6 minutes 40 seconds, and a ⅛-in. jet projected to a height of 160 ft.

It appears that the legal right of workmen to combine is still doubtful in the United States. The receivers of the Northern Pacific Railroad have obtained injunctions against the leaders of the various labour organisations, enjoining them not to hinder the working of the railway, or to interfere "in any manner" with free men taking the place of strikers. One of the injunctions obtained also restrains the employés and unions from "combining and conspiring to quit, with or without notice, the service of the road, with the object of embarrassing or crippling its operation, and generally from interfering with the officers or agents of the receivers." As regards this particular provision, there appears to be doubt as to its legality, and the matter can only be settled by the Supreme Court.

Some rather curious results were exhibited in some transverse tests of old rails recently made at the Watertown Arsenal. When tested with the head in tension and the flange in compression, the rails broke off short without bending, but when tested the other way up they bent without breaking. On planing about $\frac{1}{16}$ in. of the metal off the head, the rail bent without breaking, in whatever direction it was tested, provided that the $\frac{1}{16}$ in. was taken off both top and corners. The explanation given is that the metal on the top and corners had been rendered hard and brittle by the action of wheels running over it when in place on the line. This broke easily in tension, and the fracture, once started, went across the whole section. When, however, this brittle layer was removed, the tendency to crack no longer existed, and the rail bent instead of breaking.

The Board of Trade returns for the past year show a serious falling off in imports and exports connected with the metal industries, the items of machinery and millwork alone showing any improvement. The imports of metals were valued at 20,629,317*l*., a decrease of 470,367*l*. on the returns for 1892. The exports of the same, including hardware, with the exception of machinery and millwork, were valued at 30,866,267*l*., a decrease of 2,177,649*l*. The exports of machinery and millwork were, however, as already stated, more favourable, being valued at 13,970,285*l*., an increase of 82,928*l*. The imports of chemicals diminished from 6,680,539*l*. to 6,353,643*l*., but the exports showed a flattering increase, viz., from 8,548,893*l*. to 8,695,234*l*. It is to be hoped that this is a first step towards our regaining our lost supremacy in the chemical industries.

Some very interesting experiments on the counterbalancing of locomotives were recently made with the experimental engine erected at the Purdue University. The engine in question is an ordinary locomotive, so mounted that its wheels run on rollers, the requisite resistance being obtained by braking these. A wire of soft annealed iron was introduced between the wheels and the rollers on which they ran. As the wheels revolved the wire was drawn through between the wheel and roller and flattened in the process. As the speed rose, however, a point was reached where the wire was not flattened uniformly, due to the variation in the pressure between the wheel and the roller, caused by the centrifugal force of the counterweights, which, at a certain part of the revolution, tend to raise a locomotive wheel from the rail. With the Purdue locomotive the wire showed that at 40 miles an hour this effect of the counterweights was sufficient to raise the wheel from the rail. At higher speeds the wheel would, of course, be raised still higher, thus subjecting the rail to a severe hammering action. As the centrifugal force varies as the square of the number of revolutions, and only as the first power of the radius, it would seem that locomotives with large wheels should punish the track less at high speeds than those with small wheels. Certainly, broken rails seem commoner in the States than here, though it must also be borne in mind that, on the average, heavier rails are used here, which would also tend to diminish the breakages.

THE OIL-CARRYING STEAMERS "DELAWARE" AND "LACKAWANNA."

CONSTRUCTED AND ENGINED BY MESSRS. DAVID J. DUNLOP AND CO., PORT GLASGOW

(For Notice, see Page 72.)

Fig.1

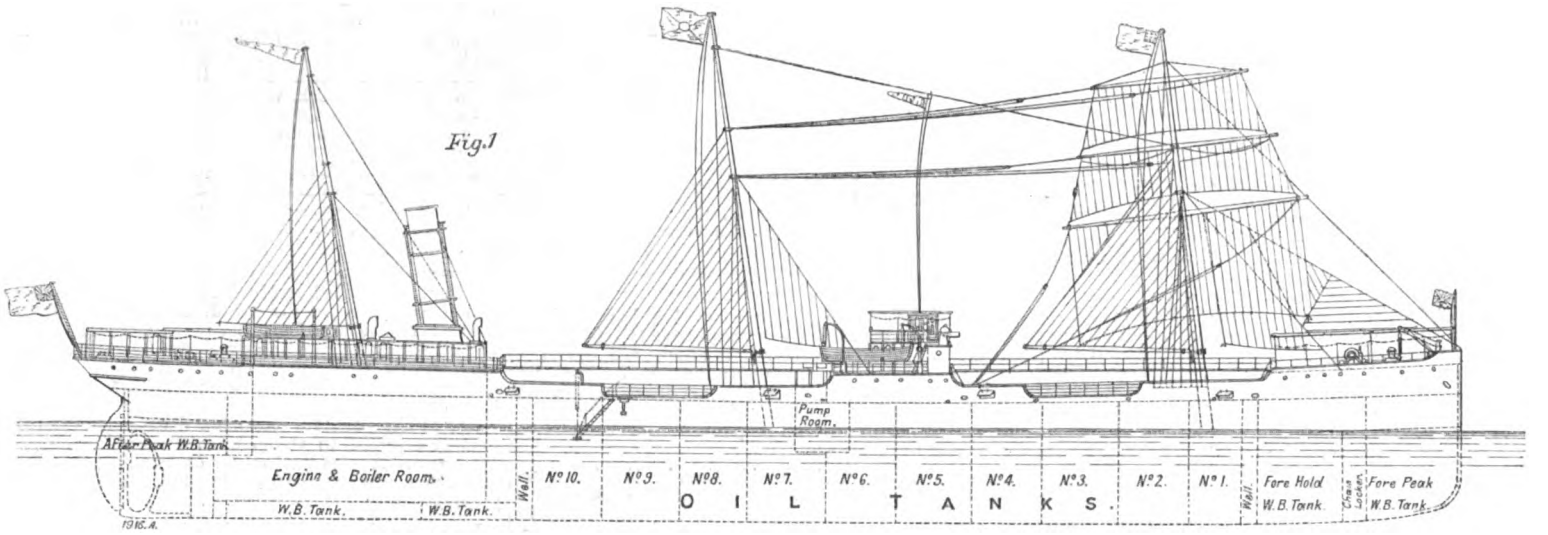


Fig.6.

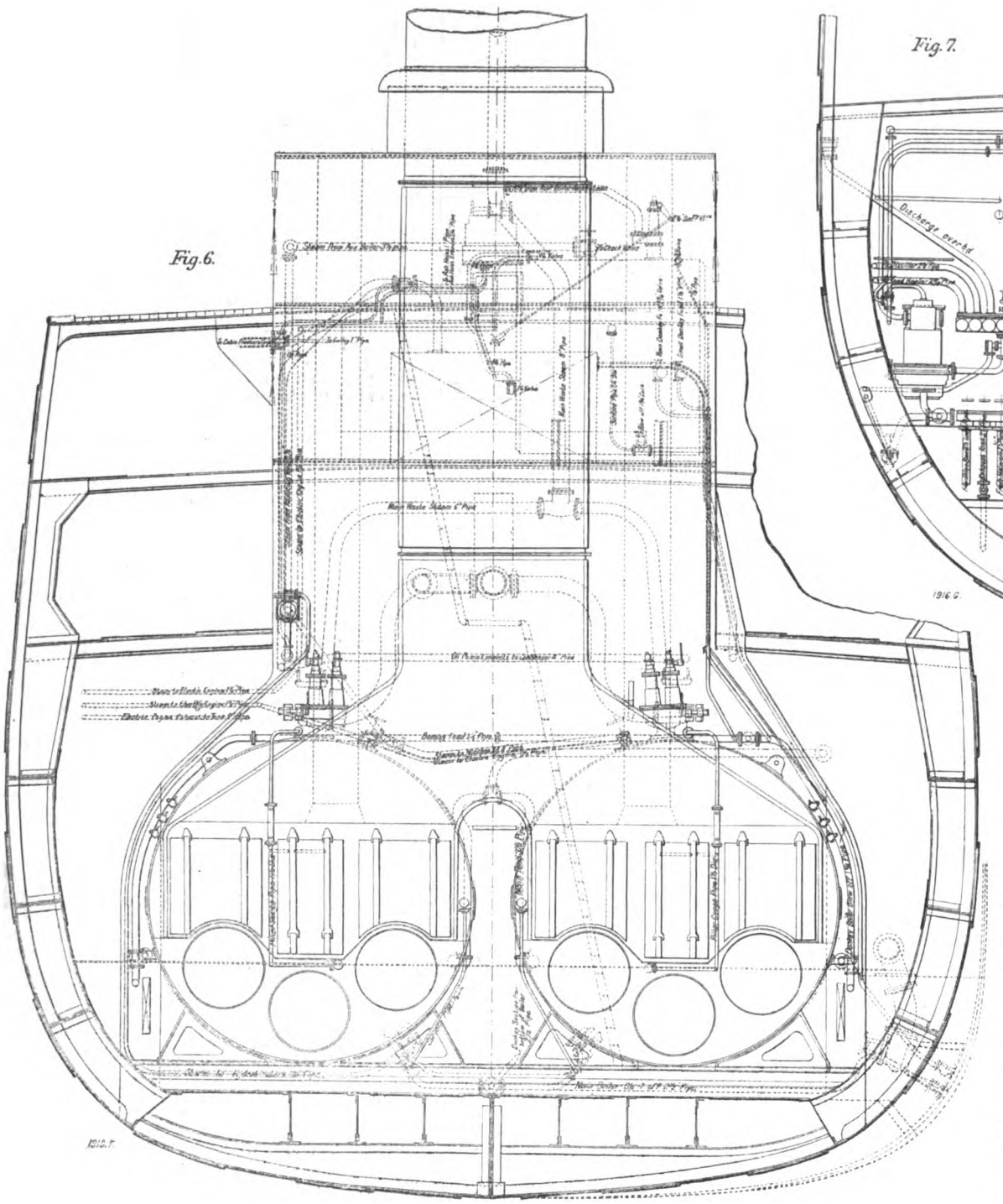
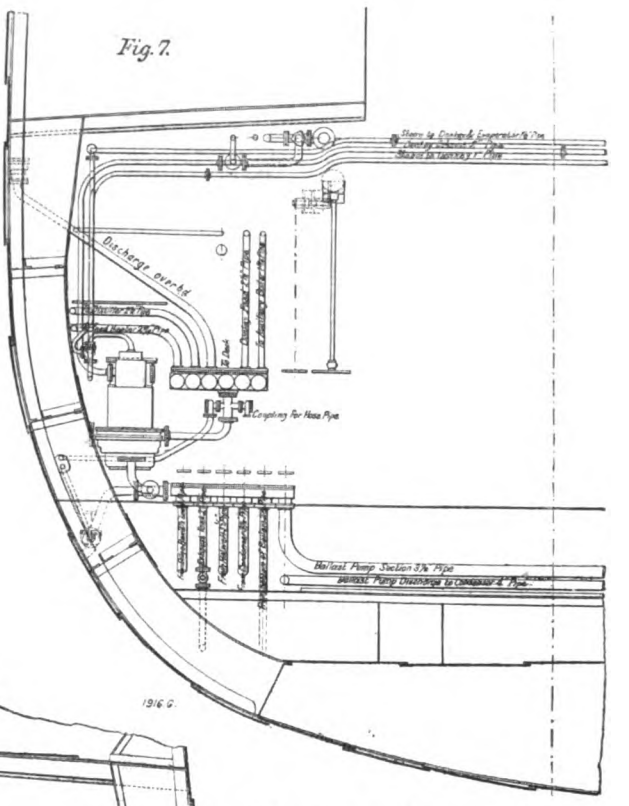


Fig.7.



THE COPENHAGEN FREE HARBOUR.—The water in the basin of the free harbour having reached the same level as in the Sound outside, several sluice dams are now being removed by various means. In the southern reservoir a large dredger is removing the bottom down to 30 ft. below ordinary water level.

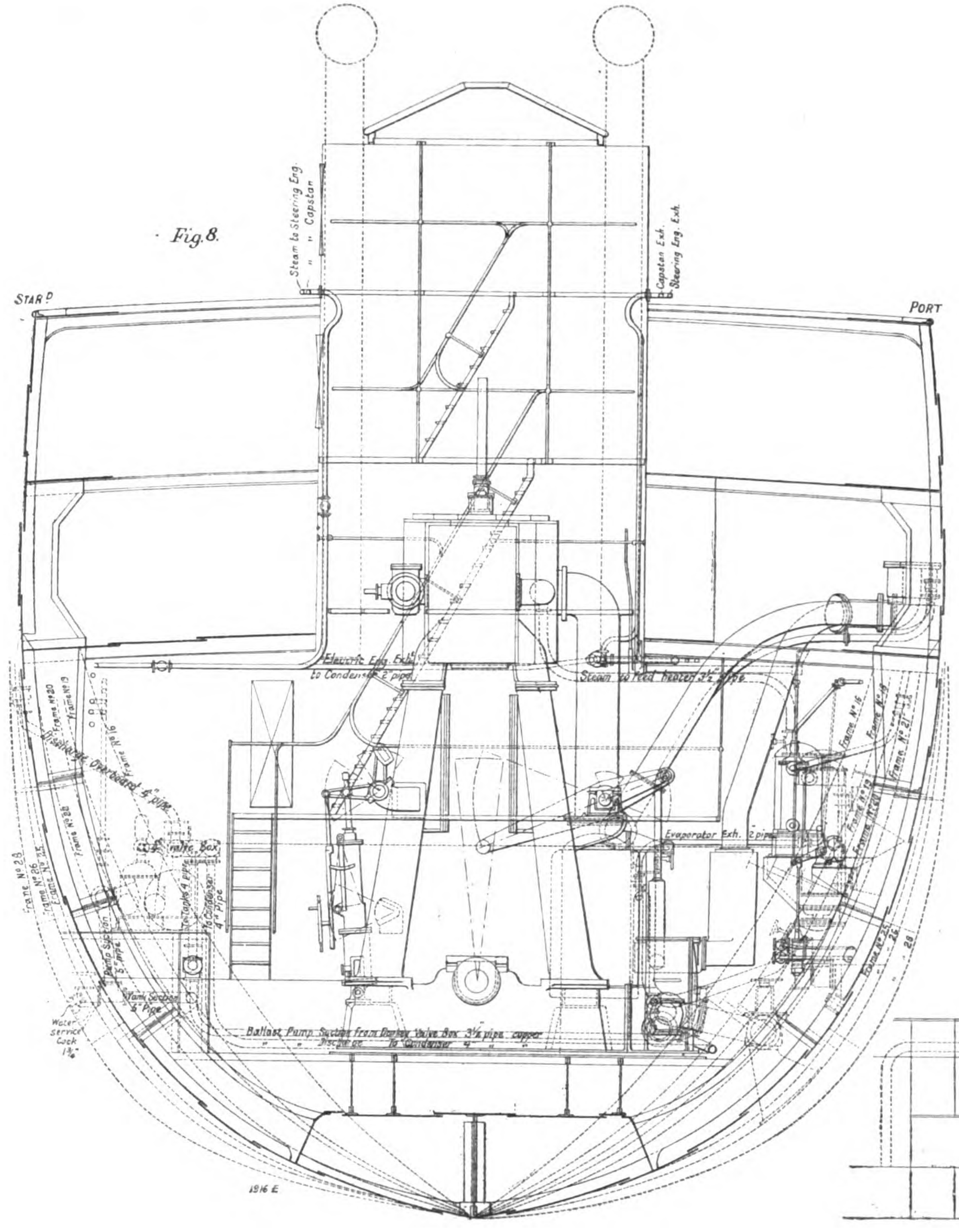
STATE INSURANCE IN GERMANY.—There are at present some 7½ millions of persons compulsorily insured against sickness, 11 millions against incapacitation, and 18 millions against accidents. As all independent artisans also will have to be insured shortly against accidents, the number is likely to reach 20 millions.

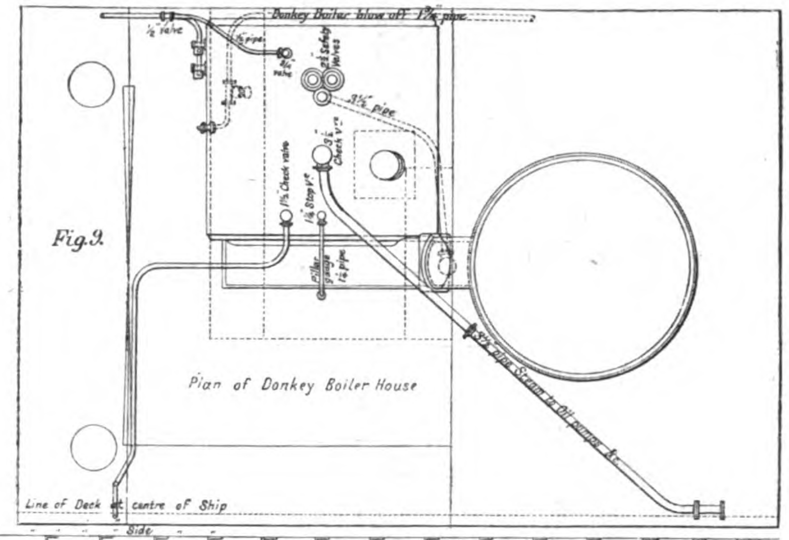
BELGIAN BRIQUETTES.—The exports of briquettes from Belgium in the first eleven months of last year amounted to 437,231 tons, as compared with 313,833 tons in the corresponding period of 1892, and 328,566 tons in the corresponding period of 1891. France was the largest foreign consumer of Belgian briquettes, having imported 207,837 tons in the first eleven months of last year, as compared with 161,006 tons in the corresponding period of 1892, and 173,268 tons in the corresponding period of 1891.

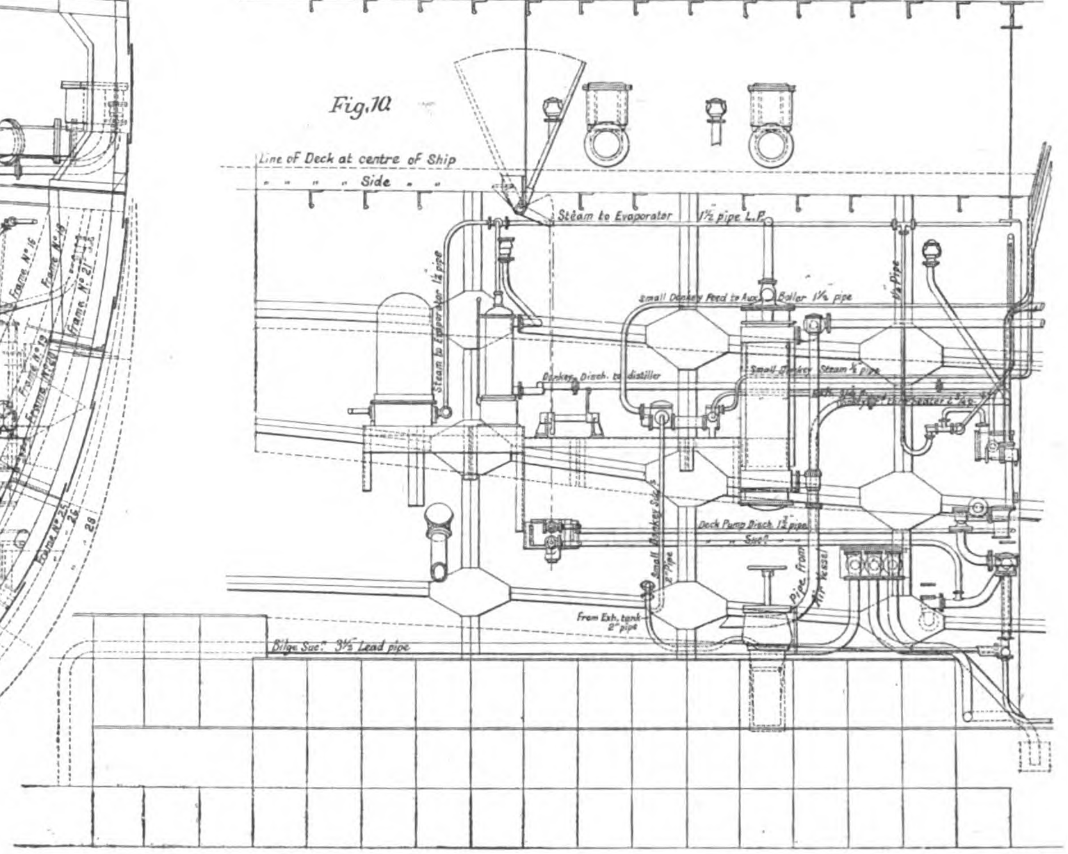
MACHINERY OF THE OIL-CARRYING STEAMERS "DELAWARE" AND "LACKAWANNA."

CONSTRUCTED BY MESSRS. DAVID J. DUNLOP AND CO., PORT GLASGOW.

(For Notice, see Page 72.)







ROYAL METEOROLOGICAL SOCIETY.

THE annual meeting of this Society was held on Wednesday evening, the 17th instant, at the Institution of Civil Engineers, Westminster, Dr. C. Theodore Williams, President, in the chair.

The Council, in their report, stated that the Society had made steady and uninterrupted progress during the year, there being an increase in the number of fellows, and the balance of income over expenditure being greater than in 1892. They also reported that Dr. C. Theodore Williams, previous to vacating the office of President, had expressed a desire for the formation of a fund for carrying out experiments and observations in meteorology, and that he had generously presented to the Society the sum of 100*l.* to form the nucleus of a research fund.

The President, Dr. C. Theodore Williams, in his valedictory address, gave an account of the climate of Southern California, which he made most interesting by exhibiting a number of lantern slides. In the autumn of 1892 Dr. Williams visited this favoured region, chiefly with a view of investigating its present and future resources, and its suitability for invalids. After describing the entrance into California from Utah and Nevada, the general geography, and the mountain ranges, he pointed out that the mountain shelter is tolerably complete, and that the protected area consists of (1) valleys, chiefly running into the coast range from the sea and rising to various elevations, such as the fertile San Fernando and San Gabriel valleys, or else (2) more or less extensive plains, as those of Santa Aña and San Jacinto. Southern California is subdivided into two portions, eastern and western, by the Sierra Nevada, and its spurs, the San Gabriel and San Bernadino mountains. The climate of the eastern portion, which is an arid region, is very dry, very hot in summer, and moderate in winter. The climate of the western portion has three important factors, viz., (1) its southern latitude; (2) the influence of the Pacific Ocean, and especially of the Kuro Siwo current, which exercises a similar warming and equalising influence on the Pacific coast of North America as the Gulf Stream does on the western coasts of the British Isles and Norway; and (3) the influence of mountain ranges, these affording protection from northerly and easterly blasts, and also condensing the moisture from the vapour-laden winds blowing from the Pacific. Dr. Williams then gave particulars as to the temperature and rainfall at Los Angeles, San Diego, Santa Barbara, and Riverside. From these it appears that the climate of Southern California is warm and temperate, and, on the whole, equable, with more moisture than that of Colorado, and that it is a climate which would allow of much outdoor life all the year round. The President next described the effect of the climate on vegetation, and showed what results had been obtained by diligent watering and gardening in this beautiful region. Wine and brandy are made in South California, but oranges and lemons are the leading crops, varied with guavas, pineapples, dates, almonds, figs, olives, apricots, plums, and vegetables. On higher land apples, pears, and cherries bear well, and our English summer small fruit is also grown, while strawberries ripen all the year round, and are plentiful except in July and August. Dr. Williams concluded by saying that many an invalid has regained vigour and health, as well as secured a competence, in the sunny atmosphere of Southern California.

Mr. R. Inwards, F.R.A.S., was elected President for the ensuing year.

H.M.S. "RESOLUTION."

TO THE EDITOR OF ENGINEERING.

SIR,—The admirable leading article in ENGINEERING of the 5th inst. on the subject of the Resolution and Sir E. Reed's letter in the *Times* will, it may be hoped, have greatly tended to allay the not unnatural anxiety which has been created by exaggerated newspaper accounts of that ship's behaviour on her first voyage from England. I may at once say that, in the light of such information as has now been allowed to transpire, there may have been some (perhaps pardonable) exaggeration in the officer's letter which the *Times* published at my suggestion. If my covering letter gave some colour to any undue disparagement of an undoubtedly fine battleship, I am sorry. Anyhow, it is a matter for congratulation that the publicity given in the press and in Parliament has elicited a partial statement of facts, which, I submit, tends far more to restore confidence than undue reticence.

Scientific men, as well as practical seamen, will generally agree in the very clear exposition which ENGINEERING has given on the points bearing on the seaworthiness of the Resolution. There are, however, a few considerations to which it is, I think, important to draw attention. Firstly, the theory that ships of great stability are the greatest rollers requires qualification. It is quite true that broad ships (the Resolution class are nearly three times as broad as deep in the water), having much initial or statical stability, are great rollers. Like a piece of flat board 1 ft. wide by 4 in. thick, they try to conform their inclination to the slope of each wave. Add to this cause the momentum of side armour, swinging on a radius of about 38 ft. from the centre, and tending to carry the ship beyond the inclination of the wave surface; and again, add the absence of bilge keels and practical absence of main keel (as in the Royal Sovereign class), and you have a great roller, possibly a dangerous roller, as the statical stability rapidly diminishes at excessive angles, and the centre of gravity is comparatively high. The case of vessels having great stability owing to the low position of the centre of gravity is totally distinct. These may roll deeply, but they never can roll dangerously. As a matter of fact, racing yachts (quoted in ENGINEERING), which have more righting power than any known vessel, are, unless very broad, not great rollers, and, of course, rolling over would be a physical impossibility. Take, again, the old "lead mines" instanced in ENGINEERING, *i.e.*, vessels with a heavy cargo low down. It was not excessive rolling which was their fault, but, on the contrary, their excessive righting power to check rolling, which, after the impulse of a wave, caused them to jerk back to the vertical with such suddenness as to endanger their masts and to strain their hulls, so that many foundered, but *never by capsizing*. The great roller, on the contrary—a marked peculiarity—is the ship which pauses at the end of the roll, so as to give an unpleasant momentary impression of doubt whether the ship would right herself. So, again, the statement that stability is deliberately sacrificed to obtain steadiness of platform must not be accepted without great qualification. In the first place, the desired result has not been attained, as evidenced in the Royal Sovereign class, which rolls much, notwithstanding the centre of gravity being high, if not unduly so. In the second place, I would ask, What designer would not gladly (if he could with due regard to other requirements) increase the angle of vanishing stability? the angle at which the centre of gravity—owing to its relative height—instead of rising with increased inclination, begins to fall.

Secondly, your remarks about the period of the ship synchronising with the period of recurring waves are most apposite, and not sufficiently attended to. In heavy seas, a scientific seaman will time the recurrence of waves, and never allow it to synchronise with his ship's known period. An alteration of course of a couple of points, or an alteration of speed, will always destroy the synchronism, and thus obviate what might become a source of danger.

Thirdly, it used to be, and no doubt still is, compulsory on officers to measure extreme rolls. It was stated in Parliament that no reliable observations for roll were taken! Is it conceivable that so simple, interesting, and important an observation was omitted? I imagine the engineer on duty, if allowed, could have supplied the information, seeing that it was an essential point for the ship's safety. I may here observe that the amount of roll is not usually obtained by pendulums or by clinometers. Pendulums are of little value unless placed at the centre of gravity of the ship. If so placed (as is sometimes the engine-room one), they will give the roll with fair accuracy; but the common and most reliable method is the simple contrivance of "battens," a batten on a pivot being pointed by an officer on the bridge to the horizon at the extreme roll, and its angle from the ship's horizontal line of deck measured.

Fourthly, it is most satisfactory to learn that the accumulation of 4 ft. or 5 ft. of water in the engine-room was only due to omission of common precautions to close apertures, and not to any structural weakness in the hull proper. But this is not a matter to be lightly treated. Four feet or 5 ft. of water in a vessel of much rise of floor would be of little moment, but in a flat-floored ship (like our battleships) the amount is serious, and, if increased, might well have risked putting out the fires, or, at least, making it very difficult for the stokers to keep steam. A ship's preparation for heavy gales is hardly secondary in importance to her preparation for battle, and should form an important part of her inspection at the home port before leaving. And if it be in any degree true that, when prepared for bad weather, there was only one small hatchway for 700 men to pass up and down, and that the atmosphere below became poisonous, so great a defect might have been ascertained by keeping the ship "bottled up," as for a gale, for a day or two in port, and would certainly have been remedied.

Fifthly, granting that no risk of rolling over exists under any circumstances, there is still every reason to adopt such measures as will prevent excessive rolling. It is enough to mention the necessity of a steady gun platform, and also, a matter not always considered, the risk of injury to boilers owing to many of the tubes at every deep roll being above the water level, and thus becoming unduly heated. Nor should the great strain on the holding-down bolts of the boilers be forgotten. Ever so little play may cause the fracture of a steam pipe, and it is needless to dilate on what that means in a closed stokehold.

One word more. It must not be supposed that discussions on the seaworthiness of ships are calculated to discourage Her Majesty's naval forces. Seamen are used to carry their lives in their hands and to make the best of the ships they sail in, without question. All the more reason for anxious care on the part of those responsible for the ships, and that naval officers, qualified by a lifetime of experience and study of the principles of naval construction, should express their opinion.

I am, Sir, your obedient servant,

ALGERNON DE HORSEY, Admiral.

Cowes, January 15, 1894.

BALANCING OF ENGINES, AND BRIDGE FAILURES.

TO THE EDITOR OF ENGINEERING.

SIR,—The conclusions appended to the lengthy monologue appearing under the above heading in the correspondence columns of your last issue, being somewhat indefinite, I venture to suggest the necessity for greater elucidation, at the risk of wearying your readers.

As most engines are required to spend the major portion of their active existence with the working fluid in circulation, the desirability for setting aside the consideration of the same can scarcely be conceded; in fact, the greater portion of the essay in question seems to deal elementarily with the possibly conflicting requirements of *utilisation* of crank effort and balance of axial stresses; the mass of the revolving counterweight is absolutely inoperative in modifying the crank effort, which depends simply upon the instantaneous moment of the steam stress and inertia stresses of the piston and its connections to the crankpin.

A vertical engine may be supposed, without undue extension of imagery, to be precisely a horizontal motor set up on end, but as the axial disturbances due to the acceleration of the moving parts are greatly in excess of those in a normal direction, the net result in the former case is merely a tendency to alternately lift and depress the total mass, or at worst, if centre of gravity and centre line are not coincident, to rock the whole in a vertical longitudinal plane; in the latter case frictional resistance to vibrations of the whole body in a horizontal plane must be aided, and, if possible, entirely superseded, by the "pull" of efficient counterweights in order to attain high speeds with economy and safety.

As the disturbance of load on rail due to the radial pull of a counterweight equivalent to little more than half the mass of the moving parts, is considered quite as much as is desirable, the obvious suggestion to the seeker for high speeds is to couple a pair of axles and distribute fully equivalent counterweights equally between both—certainly a more satisfactory and less expensive arrangement than the counterweighted crank advocated by Mr. Rolfe, though it may impose a slight strain on the coupling-rods when running without steam; as the record is held by engines constructed on this principle, the suggestion has higher credentials than the mere recommendation of the writer.

Mr. Rolfe's statement as to the habitual disregard of inertia stresses by the engineers' department will be news to many. It may safely be said that no responsible firm of bridge-builders would countenance such a practice, and the sooner the company in question (for surely such neglect is not general) takes steps to secure an efficient staff the better for all concerned.

Broken springs are earning an unenviable notoriety in connection with railway accidents in this country, and such safeguards as elaborate hangers and rubber washers are far less efficient than the simple equalisers neglected by our fashionable builders, but which are possibly an item in reducing expenditure on the line that runs its locomotives to best advantage.

Yours, &c.,

J. D. T.

January 15, 1894.

THE PATENT OFFICE LIBRARY.

TO THE EDITOR OF ENGINEERING.

SIR,—I think your readers would be astonished if they knew what an enormous amount of money has been extracted from the pockets of inventors, over and above the expenses of pretending to grant "protection" to the individuals who have committed the crime of inventing something new and useful. The figures are really startling.

From 1617 to 1852 14,359 patents were applied for, and most of them completed, at an average cost to the applicants of 400*l.* each. The *surplus* on each would average 300*l.* This would produce a net surplus of 4,307,700*l.*

From 1852 the surplus steadily increased, and attained its highest point in 1883, when it reached 172,527*l.* 11s. 2d. The new law coming in force in 1884 must have upset the expectations of the authorities, as the surplus dropped to 39,704*l.* 4s. in 1884, 10,769*l.* 5s. in 1885, and in 1886 there was a deficit of 2813*l.* 5s. 11d.

From 1887, with a surplus of 42,702*l.* 2s. 5d., to 1890, the increase has been steadily rising, 1890 producing a surplus of 109,366*l.* 8s. 4½d.

The total "surplus" amounts to the enormous sum of 7,311,507*l.* to the end of 1892.

Now with such an amount as this to handle, one would think there would be no meanness displayed as to the supply of new books to the library. Yet it is the fact that from 1890 there has been nothing but stagnation in this respect. New books which ought to be on the shelves are not bought *for want of funds!* Old books remain unbound. Old specifications are getting ragged and out of print. And this is the recompense to inventors for their seven millions of surplus. Surely those who subscribe so heavily for "protection" ought, at least, to have access to the very latest productions relating to science and research.

The library is very useful, as far as it goes, and the officials freely afford every assistance to readers and searchers. *The fault is to be traced to those who hold the purse-strings*, and meanly refuse to dole out a few pounds from the enormous surplus continually flowing into their hands. These people appear to be entirely ignorant of the loss and disappointment endured by an inventor who applies for a foreign patent, and receives a refusal, accompanied by a reference to a recent work which *is* in the foreign library, but *is not* in the British library.

Yours truly,

THOMAS MOY.

8, Quality-court, W.C., January 15, 1894.

MACHINERY *v.* MANUAL LABOUR.

TO THE EDITOR OF ENGINEERING.

SIR,—It is a remarkable and gratifying sign of the times for an influential technical journal like yours to concern itself with ethical questions, though as engineering, like all other progress, is dependent upon social conditions, there is certainly nothing surprising in the innovation.

Your correspondent is quite on the wrong tack when he can see no remedy for the evils resulting from the displacement of labour by machinery but the curbing of inventive genius. The natural effect of labour-saving appliances would obviously be the lightening of toil,