THE INSTITUTION OF NAVAL ARCHITECTS.

THE proceedings on Thursday, the 26th ult., commenced with the reading of the following paper by Mr. J. H. Heck,

ON A MECHANICAL METHOD OF MEASURING A VESSEL'S STABILITY.

The machine or balance employed—see Fig. 1—in the experiments consisted of a mahogany frame A A carrying a box for holding an internal sectional model of a ship to be calibrated, attached to a steel bar D having knife edges, and working upon two steel plates as a fulcrum. At one end are two scale-pans E E suspended from knife edges, at the other end of the mahogany frame is a table F fixed to a spindle G working in bearings H H, and which is capable of being turned through any angular interval of 15 deg. To the underside of the table a frame K is fixed, supporting some balance weights L which can be raised or lowered so as to bring the centre of gravity of the total weight of the model, the table and the balance weights in the axis of the spindle G, thus practically enabling a constant weight in one of the scale-pans to balance the model when empty of water at all angular positions. The model has to be fixed to the table and placed in the upright position, weights being put into No. 1 scale-pan until the machine is balanced. The model is then turned through 90 deg., and the balance weights under the table adjusted so that the machine is still balanced. After this the model

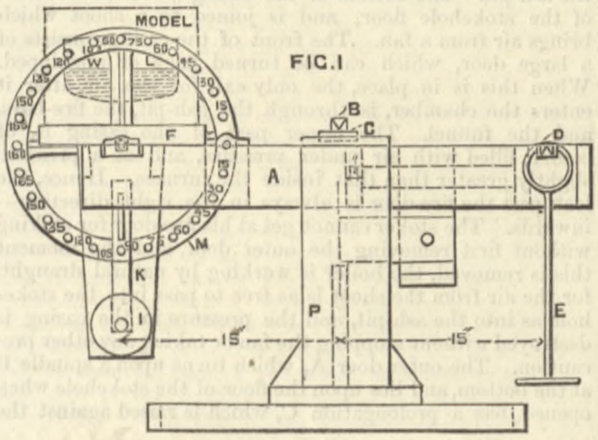
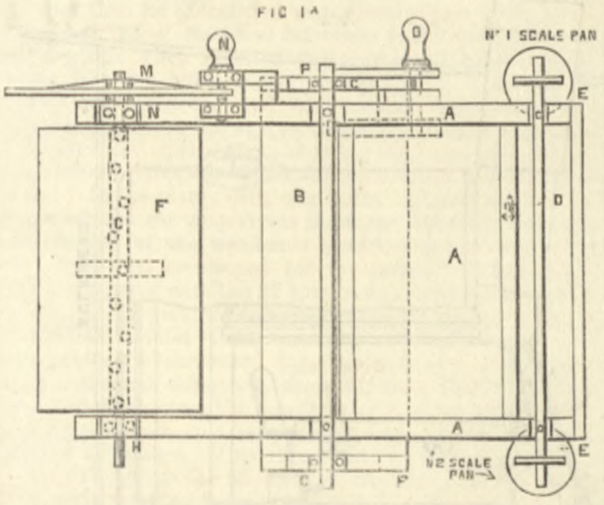


FIG 1ᴬ



HECK'S STABILITY BALANCE.

should be turned through all the angles required, care being taken to note down on a tabular form the weights respectively necessary to keep the machine balanced when the model is upright, and also when inclined on both sides of the vertical at the angles 15 deg., 30 deg., 45 deg., 60 deg., 75 deg., and 90 deg. In order to determine the righting levers for any draught, the model must be placed in the upright position, and the weights proper for that position should be put into No. 1 scale-pan. If water is now poured into the model to the height corresponding to any required draught, it will be necessary to put weights into No. 2 scale-pan to keep the machine balanced, such weight being evidently equal to the weight of the water in the model. The weight of the water in the model will then be determined and the water itself will have a similar form to that displaced by the vessel at the corresponding draught. The following operations will now give the righting lever for any inclination:—(1) Turn the model to the desired angle; (2) put the weight previously found necessary to balance the model at that particular angle into the No. 1 scale-pan; (3) add or subtract weights from the No. 2 scale-pan so as to balance the machine. The actual weight then in the No. 2 scale-pan is that necessary to balance the water in the model when inclined at that particular angle, and from the principle of the lever. Weight in scale-pan to balance water in model multiplied by its distance from fulcrum equals weight of water in model multiplied by the distance that the centre of gravity of the water is from fulcrum. The foregoing equality determines the horizontal distance between the centre of buoyancy of the water and the axis of the spindle, consequently if the distance between the centre of the spindle and the centre of gravity of the vessel as marked on the model is known, the righting lever is at once obtained. A check test can also be quickly obtained by inclining the model to an equal angle on the opposite side of the vertical. The values obtained should practically agree with that previously determined. Again it will be seen that if the model is inclined at an angle to the left of the vertical, the centre of gravity of the water travels further away from the fulcrum, consequently weight must be added to keep the machine balanced, while if the model is inclined at an equal angle to the right of the vertical, weight must be taken out, as the centre of gravity of the water is then nearer to the fulcrum, and as the weight to be added in the one case is practically equal to that taken out in the other, any important error can be detected at a glance. For deeper or lesser draughts it is only necessary to increase or diminish the water in the model. Generally the two fundamental operations to be done to determine the righting levers are as follows:—(1) Find the weight necessary to balance the model when empty of water at all the required inclinations. (2) Find the weights necessary to balance the model at the same inclinations when filled with water to the height corresponding to the desired draught. The difference between the two weights multiplied by their distance from the fulcrum and divided by the weight of water in the model gives the distance that the centre of buoyancy is from the fulcrum. The following is from the directions for making inside sectional models:—Fig. 2 is an illustration of such a model. As an example, suppose a model is required of the vessel whose longitudinal plan is shown by Fig. 3. (1) First divide the longitudinal plan, Fig. 3, into sections at intervals of 16ft., as 1, 2, 3, — — — —, &c., taking a half interval at each end as 1½ and 10½, and from the body plan make a tracing of the lines of the vessel at those sections. (2) Procure some planks of yellow pine which have been passed through the planing machine, having the thickness marked against the sections in Fig. 2 and Fig. 3. Any uniform thickness would do; ¾in. in

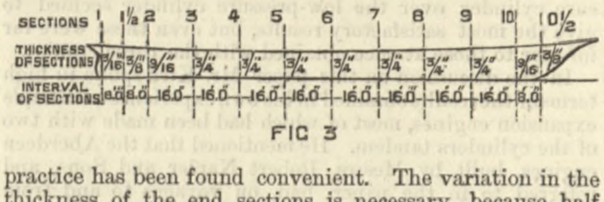
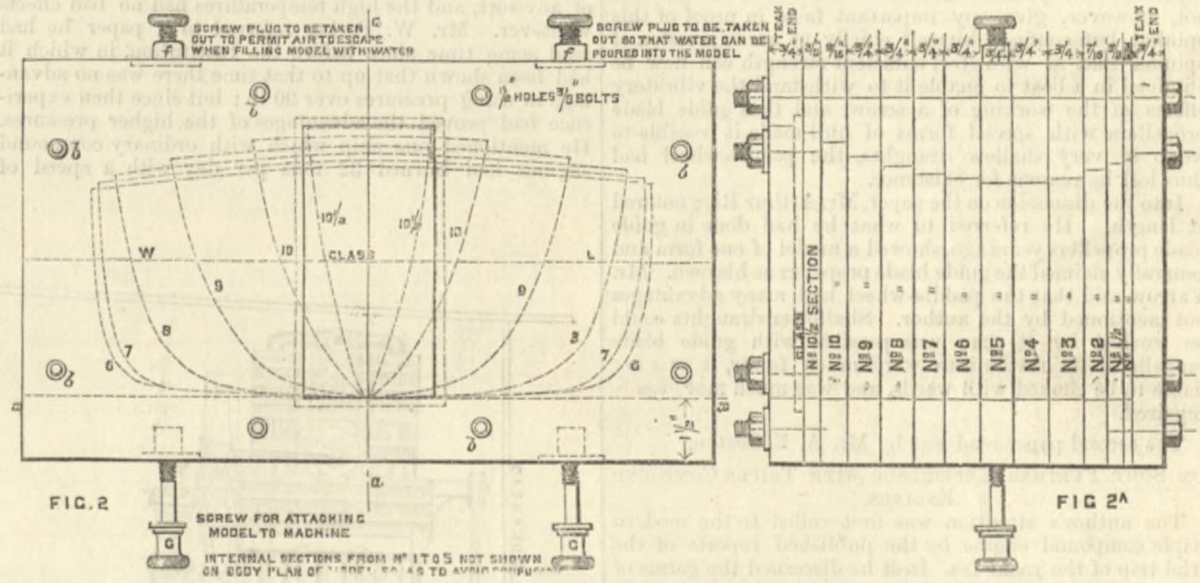


FIG 3

practice has been found convenient. The variation in the thickness of the end sections is necessary, because half intervals have been taken at those places. (3) Cut the planks into the required lengths, drill eight holes in each piece as shown in Fig. 2, and bolt together the sections with two end pieces of teak by 5/8 bolts, plane the top and bottom up, mark a longitudinal centre line, take the sections apart, and with a square draw a centre line *a a* on each. (4) Mark with a gauge on each section a base line *x x*, say 1½in. from the bottom edge, lay the tracing of the body plan upon each section in turn, and with a pencil mark off the respective form of the vessel at that section. (5) Take the wood sections to the jigger or fret-saw machine, and saw out the portions within the pencil marks. It will be seen that the portion sawn out of the respective sections corresponds with the form of the vessel at those sections. (6) Varnish the wood sections, put them together, place the two teak pieces at the ends and bolt the whole together, taking care that the longitudinal centre lines are in the same straight line. The end next the bow section has a piece of ordinary window glass recessed into it; this permits the height of the water in the model to be readily ascertained. Several modifications of the machine were described.



SECTIONAL MODEL FOR HECK'S STABILITY BALANCE.

In the discussion upon this paper it transpired that the simple varnishing of the sectional models was insufficient to prevent error by absorption of water, and either boiling in paraffin or coating with white lead was necessary. The value of the machine was admitted by all the speakers, one of whom contrasted the elaborate and valuable, but still impracticable research work of French naval architects and mathematicians on the subject, with the results of the practical turn of mind that always shows itself in the work of English people. Mr. Hecks' machine was an example. It was suggested that when worked down to its most convenient form, every ship should be provided with one of these stability measuring machines, so that captains might find the stability conditions for themselves for the different cargoes they have to carry.

The next paper read was by Mr. F. P. Purvis,

ON THE STOWAGE OF STEAMSHIPS.

One of the foremost matters in the question of stowage is the complete knowledge of how many cubic feet of space are available for cargo in any given steamer. Information about this is always procurable from the builders, and should always be obtained by the owner; but care should be taken by the one to state, and by the other to inquire, what portions are included and what excluded. Six firms out of the twenty of whom the author received information include the beam spaces in their measurements, taking ordinates for measurement of holds ranging between the top of the ceiling and a height one-third the round of beam down from the top of the beam. One of the six uses the planimeter, and traces the pointer round the inside of ceiling and lining and the top of the beam. Ten others exclude the beam spaces, taking ordinates ranging between the top of the ceiling and a height one-third of round of beam down from the underside of beam at centre line of ship; or, in the case of two out of the eight firms, planimeter areas of the sections, by tracing the pointer round the inside of ceiling and lining and underside of beam. Two of the ten firms do not set off the one-third round of beam down from underside, in fixing the highest ordinate for area, but work simply to the underside of beam at centre line of ship; while one takes the highest ordinate at the underside of beam half-way between centre and side, which is equivalent to taking it at one-fourth the round of beam from underside of beam at centre line of ship. One firm includes about half the beam space by taking the highest ordinate at half the depth of the beam. Another firm includes the spaces between the beams, but makes a deduction for the space occupied by each beam of a quantity measured by the depth of the beam, and a fore-and-aft measurement equal to the depth of the beam. Three firms measure both inclusively and exclusively, according as grain, tea, &c., are carried, on the one hand, or cargoes that will not be stowed between the beams on the other. The foregoing analysis applies to the case of beams placed on every frame, or beams placed on alternate frames. When the hold beams are widely apart, space is invariably taken to top of beam, a deduction for actual space occupied by each beam being made by some firms. Besides differing in the inclusion or exclusion of the beam spaces, the twenty firms differ also in the value of deductions they allow for keelsons, deep plate frames, stringers, masts, pillars and ventilators. These variations in practice the author dealt with at length, and gave diagrams illustrating the sections of parts referred to, and the amount of space they in effect occupied. In appendices he gave statistical information on the rates of stowage, and giving information of importance to the subject. He also gave diagrams showing the variation of the metacentre height and length of the righting couple arm with different cargoes in the same ship.

The discussion on this paper was taken with that on a paper by Mr. John Nicholson,

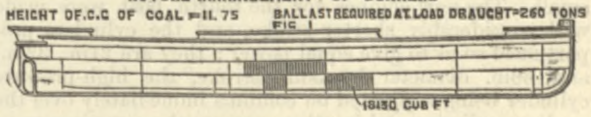
ON A METHOD OF ARRANGING THE COAL BUNKERS OF A STEAMER SO AS TO REDUCE THE BALLAST TO A MINIMUM.

The object of this paper was to prove that the position of coal bunkers in steamers should not be arbitrary, and that by judicious arrangement much ballast may be saved, especially in steamers consuming large quantities of coal. For example, the steamer to which Fig. 1 refers requires actually at the load draught 260 tons ballast. If the centre of gravity of coal were 16·33ft. above keel, 30 tons ballast would be sufficient, and the steamer could carry 230 tons more cargo without increase of draught. In steamers having their coal low, the centre of gravity is raised when the coal is consumed. In case of a single

ACTUAL ARRANGEMENT OF BUNKERS

HEIGHT OF C.G. OF COAL = 11.75 BALLAST REQUIRED AT LOAD DRAUGHT = 260 TONS

FIG 1

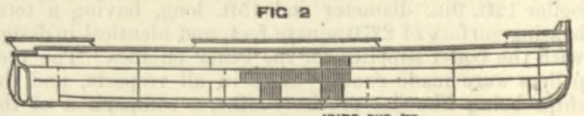


BUNKERS ALTERED

HEIGHT C G OF COAL 16.33

BALLAST REQUIRED AT LOAD DRAUGHT = 30 TONS

FIG 2



POSITIONS OF COAL BUNKERS.

bottom ship, as much ballast must be taken at starting as is required to give sufficient stability with coal consumed. An excess of ballast is, therefore, carried at starting. If the coal is stowed high, the ballast is in excess when the coal is out. There is a height of centre of gravity of coal between these two extreme limits which requires a minimum ballast. For the calculation of this height the author gave formulæ. He also gave diagrams showing the ballast required at various draughts for different arrangements of bunkers, and for an arrangement of coal bunkers complying with the formulæ. Another diagram referring to a double-bottom ship showed how the possibility of taking in ballast during the voyage may be taken advantage of for further increasing the cargo-carrying capacity. He also gave specimen calculations, showing how the results he proposed could be obtained.

The discussion on these papers was very much of the complimentary kind which follows the reading of papers that need time for perusal, but for which no time is allowed, before useful discussion can be entered upon. The great importance of reducing as much as possible the variation in the stability curve of a vessel with different cargoes lent much importance to Mr. Nicholson's paper. It was strongly insisted that many ships, stable enough with most homogeneous cargoes, often returned with cargoes, with which they sailed with a margin of safety not calculated to comfort either owners or passengers if they knew it.

Mr. Purvis's paper was upon a subject for the first time brought before the Institution; and taken together the papers were considered to be of unusual importance to the shipowning community, as showing the necessity for concerted action, so as to procure uniformity of methods of measurement. It was mentioned that even for coals 40, 43, 46, and 48 cubic feet per ton were the common rates of stowage variation chiefly dependent upon the different methods of measuring space available for cargo, 48ft. being the most common, and 43ft. for Welsh coal. It was urged that the great variation in the specific gravity of cargoes carried made it imperative that some more enlightened method of dealing with the subject than hitherto should be adopted; and Mr. Purvis's paper seemed to point the way.

A paper by Captain J. C. Tuxen, "On Yacht Measurement and Time Allowance for Racing," concluded the afternoon business.

On Thursday evening proceedings commenced with a paper by Mr. J. I. Thorneycroft,

On the Most Suitable Propeller for Shallow Draught.

This was a very short paper, in which the author spoke of the results obtained by some boats fitted with guide-blade propellers and built by his firm, and compared the improved propeller with the paddle-wheel. He expressed his conviction that this modification of the screw will supersede the paddle-wheel in shallow water. He did not, however, give any important facts in proof of this opinion, but confined himself chiefly to an expression of opinion that as with steel sufficient strength can now be obtained in a boat to enable it to withstand the vibratory effects of the working of a screw, and that guide blade propellers with special forms of hull made it possible to work in very shallow draughts, the paddle-wheel had thus lost its reasons for existence.

Into the discussion on the paper, Mr. Arthur Rigg entered at length. He referred to what he had done in guide blade propellers years ago, showed a model of one form and generally claimed the guide blade propeller as his own. Mr. Yarrow said that the paddle-wheel had many advantages not mentioned by the author. Shallower draughts could be worked by it than was possible with guide blade propellers, its revolutions were much fewer, it was not liable to be choked with weeds, and was much more easily repaired.

The second paper read was by Mr. A. E. Seaton,

On Some Further Experience with Triple Compound Engines.

The author's attention was first called to the modern triple compound engine by the published reports of the trial trip of the yacht Isa. In it he discerned the germs of a successful new type of engine. At his instance a triple expansion engine was constructed in lieu of the ordinary compound for one of four sister ships which were then in hand for Messrs. Thomas Wilson, Sons, and Co., the latter only stipulating that it should be of the same power as the engine already contracted for. As Mr. Seaton was convinced that economy was due to the system rather than to the higher pressure, it was decided not to increase the boiler pressure more than was necessary to suit the triple system. The other three ships already alluded to were being fitted with engines having cylinders 25in. and 50in. diameter by 45in. stroke, and supplied with steam of 90 lb. pressure from a double-ended boiler 13ft. 9in. diameter by 15ft. long, having a total heating surface of 2310ft., so that these engines had every qualification for being economical so far as general proportions went, the stroke being an abnormally long one and the boiler of ample size. Experience has since shown that these engines are economical in coal and the wear and tear exceptionally small. The new engines for the fourth boat were made with considerably shorter stroke, and the cylinders proportioned so as to give equal power; they are 21in., 32in., and 56in. diameter by 36in. stroke, the high-pressure cylinder being supported on columns immediately over the medium cylinder, and in other respects these engines were made as near as possible like the others above-named. Steam at 110 lb. pressure is supplied from a double-ended boiler 12ft. 9in. diameter and 15ft. long, having a total heating surface of 2270 square feet, and identical in design with the boiler supplied for the other engines. The propellers were made exactly alike in all respects, and the ships being likewise precisely alike, a comparison of the performances of the one fitted with the triple engines could be made with as little grounds for differences of opinion as is possible. One of the ships fitted with the ordinary compound engines was named the Kovno; that with the triple compound engines the Draco. Their dimensions are as follows:—Length between perpendiculars, 270ft.; breadth, 34ft.; depth of hold, 18ft. 3in.; and of 1700 tons gross register. They are ordinary cargo boats built of steel, having a raised quarter-deck and long bridge amidships, but nothing about them otherwise requires comment. After making a voyage or two to the Baltic and finding that everything was working satisfactorily, the Kovno was loaded with 2400 tons dead weight, and sailed in January, 1883, for Buenos Ayres, the Draco was loaded with 2425 tons dead weight, and sailed March, 1883, for Bombay, the distance in both cases being about 6400 miles. It was thought advisable, for purposes of comparison, that the ships should steam at as near as possible the same speed, and to attain this object we considered the safest plan was to instruct the engineers as to the average amount of coal they were to burn per day, and experience with these ships on their Baltic voyages had fixed this at 12 tons in the case of the Kovno and 10 tons in the case of the Draco. During the voyage each ship seems to have had fair average weather, and equal care was taken in getting the best results possible. The average speed of the Draco was, however, 8·625 knots, or 207 miles per day, the engines making on the average 57·5 revolutions per minute, while the Kovno did only 8·1 knots, or 194 miles per day, the engines making 55·5 revolutions. The coal used was ordinary South Yorkshire, just as it comes from the pits for bunker purposes. The indicated horse-power in each case would average about 600. The total coal consumed was 326 tons in the Draco and 405 tons in the Kovno, or a saving of 19·5 per cent. over the ordinary compounds, with an increase of speed of 6·5 per cent. The author gave particulars of other vessels—the Grodno, the Yeddo, the Rosario, and the Finland, the results of working with which confirmed those obtained with the Draco. The author's firm have now entirely given up the construction of two-crank triple expansion engines, because of the impossibility of equally dividing the work between the cranks; for, although the engine when running appeared to be perfectly balanced, the wear of the brasses of the crank having the two cylinders was always considerably more than that of the other. Placing the high-pressure cylinder over the low-pressure cylinder seemed to give the most satisfactory results, but even these were far inferior to those at once obtained with the three cranks.

In the discussion on this paper Mr. Kirk spoke in high terms of the results obtained in his own experience with triple expansion engines, most of which had been made with two of the cylinders tandem. He mentioned that the Aberdeen engines, built by Messrs. Robert Napier and Sons, and referred to in the paper, had, on voyages to and from Australia, worked with 1·65 lb. per indicated horse-power, and had given no trouble. He spoke of the effects of the large use of cylinder oil and its effects in boilers, but remarked that, on the whole, he had found that the high economy of the triple engines was not attended by any greater wear of any sort, and the high temperatures had no bad effects whatever. Mr. W. Parker referred to a paper he had read some time since before the Institution, in which it had been shown that up to that time there was no advantage in using pressures over 90 lb.; but since then experience had proved the advantages of the higher pressures. He mentioned one ship which with ordinary compound engines had burned 32 tons per day with a speed of 8·5 knots, and with triple engines it had afterwards burned but 9·5 tons per day on a speed of 9 knots, the pressures being 80 lb. and 150 lb. respectively. He spoke of the bad effects of mineral oil in the boilers. This, he said, left a residue which was a most effective non-conductor. He had made an experiment which proved this. He had put a bucket of water on a fire, and when it boiled it was taken off and could be placed on the hand without injury. A solution of some of the residue of mineral oil found in a boiler was then painted over the inside bottom of the bucket, when it was found that when water was boiled in it the bottom of the bucket was red-hot. Mr. Denny spoke of the move now being made in quadruple expansion with engines having two pairs of cylinders tandem. He expected to get very high economy from these engines. Captain Thompson mentioned a ship fitted with triple expansion engines plying between England and Australia, which were "pounding" away from the day they left one port until the time they reached the other, or about forty days without stopping, and which gave one indicated horse-power throughout for 1·6 lb. of coal. Mr. Seaton, in referring to the oil question, said that the sight feed lubricators might be said to get over the difficulty, for they saved more than half the oil, while the lubrication was much more effectively performed.

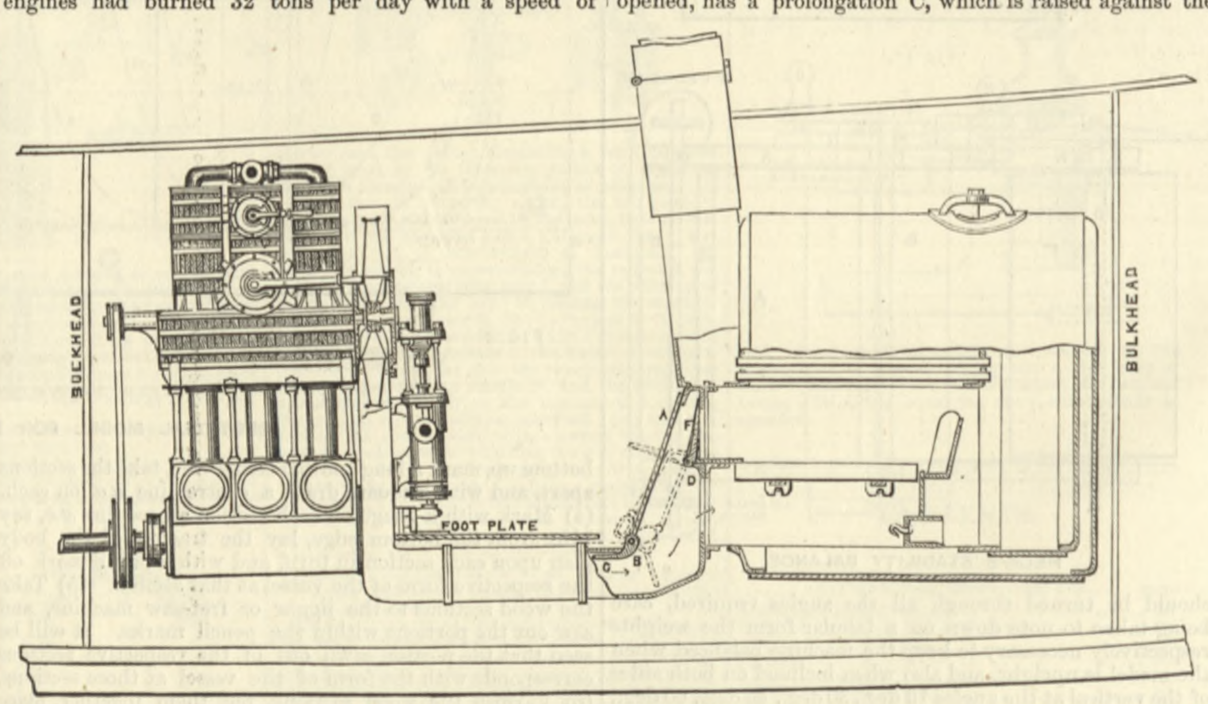
The next paper read was by Mr. J. MacFarlane Gray,

On the Theoretical Duty of Heat in the Steam Engine.

In this paper the author brings forward his views as to the inaccuracy of the second law of thermo-dynamics, and in dealing with the variation in the specific heat of water and the vapour of water at different temperatures, seeks to show that if these differences are rigorously dealt with and the errors of Regnault's formula eliminated, "the efficiency of the steam engine is, theoretically, nearly 6 per cent. greater at 212 deg. Fah. than the second law makes it, and at 428 deg. Fah. it is nearly 15 per cent. greater. This refers only to the reversible cycle change-of-state engine." Mr. MacFarlane Gray's paper and its subject are of great interest, but we cannot deal with it here, as it would have to be given at length or not at all. He intends to publish a book dealing completely with the subject, and we may then be able to give it the attention it deserves. The discussion upon it was confined to one speaker.

On the Application of Moderate Forced Draught to the Furnaces of Small Steam Vessels, upon Willans' System.

Four years ago the desire to use condensing engines in very small boats running in salt water was less general than it is now, when even the smallest steam cutter carried at the davits of a yacht is, or admittedly ought to be, fitted with some simple form of condenser. Nevertheless, the owners of the smaller classes of coast-going steam yachts, with non-condensing machinery, were alive to the advantages of condensing, and the question often arose—How to get the same power as before from an existing boiler deprived of its accustomed exhaust draught in the funnel? The question how to increase the evaporative performance of these low-funnel return-tube boilers admitted, it must be owned, of an obvious answer—namely, that forced draught must be applied to the moderate extent necessary to make up for the loss of the exhaust steam in the funnel. Mr. P. W. Willans devised the plan shown in Fig. 1. A casing or chamber, a few inches deep, is fixed to the boiler front over both the usual fire-door and the opening into the ash-pit. The bottom of the casing is below the level of the stokehole floor, and is joined to a shoot which brings air from a fan. The front of the casing consists of a large door, which can be turned back or unshipped. When this is in place, the only exit for the air, after it enters the chamber, is through the ash-pit, the fire-bars, and the funnel. The upper part of the casing is, of course, filled with air under pressure, and at a pressure slightly greater than that inside the furnace. Hence, the leak past the fire-door is always in the right direction—inwards. The stoker cannot get at his fire-door for stoking without first removing the outer door, and the moment this is removed, the boiler is working by natural draught, for the air from the shoot is as free to pass into the stokehole as into the ash-pit, and the pressure in the casing is destroyed without stopping the fan or taking any other precaution. The outer door A, which turns upon a spindle B at the bottom, and lies upon the floor of the stokehole when opened, has a prolongation C, which is raised against the



WILLAN'S ARRANGEMENT FOR FORCED DRAUGHTS.

top of the air shoot while A is shut, but descends and closes the air shoot as A is opened. The spindle B carries a crank or lever, connected by a slotted link with another lever on the spindle D, which carries the fire-door F in such a manner that F does not commence to open until C has closed the air shoot—though with an easy fit—and has practically shut off the blast. This plan, which appears to work quite satisfactorily, has been applied in several cases, one being that of a steam fishing yacht of about 40 tons, the machinery of which, of 100 indicated horse-power, is shown in Fig. 1. The first application of Mr. Willans's plan was in a small wooden coast-going yacht, the Brenda, of about 61ft. on the water-line, built in 1882. Displacement and draught were required to be small for making trips to the Mediterranean through the French canals; and as high speed was also desired, it was necessary to restrict the size and weight of the boiler as much as possible. With this object Mr. Willans designed an oval return-tube boiler, 7ft. long by 5ft. wide by 6½ft. high, stayed across. It had one furnace tube of 2ft. 9in. diameter, the fire-bars being about 4ft. 3in. long, giving a fire-grate area of nearly 11 square feet. The total heating surface was 375 square feet, which was, of course, very large for the size of boiler, a fact accounted for by the large proportion of heating surface in the tubes—330 square feet—in comparison with the whole. This was obtained by using a great number of small tubes—148, of 1⅝in. diameter. The tubes were of brass, and about 5ft. long. The form of boiler was convenient, as giving good bunker room at the sides, and it saved weight, in comparison with a cylindrical boiler, by somewhat restricting the water space. At the same time, good provision was made for circulation. As might be expected, the large tube surface extracted the heat from the gases most effectually; and the temperature in the up-take, though never tested with care, was low in comparison with that usual in small marine boilers. The working pressure was 120 lb. The height of the funnel above the fire-bars was less than 11ft. The engine of the Brenda was an ordinary Willans's patent compound surface-condensing engine, with low-pressure cylinders of 12¾in. diameter and 10in. stroke, able to indicate 150 indicated horse-power at 360 revolutions, and 120 lb. steam pressure. As economy in this vessel was deemed less important than light weight, a low ratio of expansion was adopted—under five to one—and the coal consumption, as ascertained by numerous trials, all somewhat rough, but reliable in the aggregate, lay between 2½ lb. and 2¾ lb. per indicated horse-power per hour. This was, when working at moderate powers, up to about 120-horse power.

As the reading of this paper did not commence until 9.35 p.m., few were in the mind to discuss it when it was read; in fact, the paper, as far as discussion is concerned, was, like many others read in a heap before the Institution, lost. Mr. Quelch mentioned, with reference to one part of Mr. Robinson's paper, that he had in one or more cases obtained improved results by using a smaller number of tubes, and thus getting more steam space and more room in the combustion chamber.

On Friday morning the first paper read was by Mr. Wildish,

ON THE STRENGTH OF MILD STEEL PLATES AND RIVETS OF VARIOUS KINDS USED IN SHIPBUILDING.

This paper gave the results of recent experiments in tabular form. These were made at Pembroke in 1883 and the following year. The most striking fact in connection with these experiments is the considerable degradation that appears in the breaking strength of the remaining material in the sections through the holes punched the full size, which is shown to have been reduced about 21 per cent. by the punching. The elongation before rupture was also limited, being only ·1in. to ·2in., while the elongation with the drilled holes was from ·29in. to ·4in. This reduction in the tensile strength of the remaining material across the holes, caused by the punching, was not unexpected, the injurious effect of the punch being already well known. The exact percentage of reduction shown must not be regarded as applying generally to plates of other thicknesses, and having the holes about the same relative size and distance apart. Moreover, the size of the punched holes as compared with the thickness of the plates, and also the size, in relation to that of the punch, of the bolster or die used in making the holes, no doubt influence the strength of the remaining material in the section across the holes. With the drilled holes the breaking strength of the remaining material in the section was somewhat greater than for the solid or unperforated part of the plates. The next set of tests had reference to the strength of the steel plates when rivetted together by means of a single strap, like the butts in the outside plating of a ship. In plates with punched and countersunk holes, the mean breaking stress at the section across the holes amounted to 28·9 tons per square inch, showing that the material had not been injured by the method adopted in making the holes. In the plates with the holes punched the full size required for the snap rivets the mean breaking stress per square inch at the weakened section was 24·9 tons. The 24·9 tons just mentioned for the double rivetted straps, when compared with the 22 tons per square inch previously given for the punched but unrivetted plates, and with the stress for the solid plates, would appear to show that when ½in. plates are connected together with ⅝in. or ¾in. rivets in the manner described, their ultimate tensile strength at the section across the punched holes is increased by the rivetting, and is only 11 per cent. less than for the solid part of the plates. This recuperative effect apparently of the rivetting on the strength of the plates at the section across the punched holes is difficult to explain.

The next three sets of experiments were made to determine the single shearing stress of different sizes and kinds of iron screw and steel rivets when used in steel plates. The tests with the iron rivets were made to ascertain the shearing stress of the different kinds of screw rivets in common use. The continuous screw rivet, tapped into both plate and strap, and cut off flush—like the fastening adopted in certain parts of the upper structure of war-ships to avoid the danger of the rivet heads flying off in action—was first taken; then the hexagonal-headed screw, topped into the strap only; and lastly, the screw-pointed and countersunk-headed rivet, as used for attaching the outside plating to the stem and stern post. The countersunk heads extended right through the plates, and all the screws were cut with an ordinary Whitworth angular thread. The shearing stress of the screw rivet is much less than for the hammered rivet of the same nominal size, as was, of course, to be expected. The shearing stress of the continuous screw differed but slightly from the screw-pointed and hexagonal-headed rivets; and it would appear to be correct to take the following units for the shearing stress of the different sized iron rivets of these kinds:—¾in. rivet, 5·75 tons; ⅞in. rivet, 7·75 tons; 1in. rivet, 10·25 tons. The results for the countersunk-headed and screw-pointed iron rivets were superior to the others, and the following shearing stresses for this kind of rivet may be accepted:—¾in. rivet, 6·75 tons; ⅞in. rivet, 9·25 tons; 1in. rivet, 12·25 tons. After these tests with the iron rivets in steel plates precisely similar tests were made, except that steel rivets were used instead of iron. The mean results for the shearing stress per rivet, after allowing for accidental differences, were as follows:—

	¾in. rivet Tons	⅞in. rivet Tons	1in. rivet Tons
Continuous screw, or hexagonal-headed and screw-pointed rivet	6·25 ...	8·5 ...	11·75
Countersunk headed and screw-pointed rivet	7·25 ...	9·75 ...	13·5

These figures are practically in proportion to the net sectional area of the rivets, and, on the whole, they are about 12 per cent. in excess of the results obtained with the iron rivets in steel plates. We come now to the tests with the hammered steel rivets. These rivets were of three kinds, namely, pan-headed and countersunk-pointed, countersunk-headed and pointed, and pan-headed and snap-pointed; and there were twenty-four tests made in all. Referring first to the pan-headed and countersunk-pointed rivets, four tests were made for each size of rivet, and the results of the experiments furnish the following shearing stresses per rivet as units for general guidance:—¾in. rivet, 11·5 tons; ⅞in. rivet, 15·25 tons; 1in. rivet, 20·25 tons. Referring lastly to the tests with the pan headed and snap pointed rivets, the results appear to show that this kind of rivetting is not quite so strong as the pan-headed and countersunk pointed rivetting; and they furnish the following units of shearing stress per rivet for general guidance:—¾in. rivet, 11·0 tons; ⅞in. rivet, 14·75 tons; 1in. rivet, 19·0 tons. Comparing the foregoing results for the hammered steel rivets with those previously given for the screw steel rivets, it appears that the continuous screw and hexagonal-headed and screw-pointed rivets are about 44 per cent. weaker than the hammered countersunk rivets of the same nominal size; and the countersunk-headed and screw-pointed rivets are about 35 per cent. weaker. This shows the desirability in cases where the shearing stress is important, as, for example, in the connection of the outside plating to the stem in war ships, of continuing the body or shank of the rivet untapped for some distance in beyond where it might be sheared, to prevent this taking place at the parts already weakened by the thread. The shearing stress of the hammered rivets per square inch of sectional area—when finished—was practically identical for the different sizes, but was about 1¼ tons greater for the countersunk-pointed rivets than for the snap-pointed. The exact mean results from the tests were 22·6 tons per square inch of sectional area for the former rivets, and 21·4 tons for the latter. The tensile strength of the bars from which these rivets were made may be taken at 28 tons per square inch. We come now to a set of six experiments, to determine the double shear of steel rivets, such as would happen in drawing plates asunder when connected by a strap on each side. The plates used were ⅝in. thick, with four rivets in each, with ⅝in. and ¾in. pan-headed and snap-pointed rivets. The holes were punched in the plates, and drilled in the straps In two cases the plate broke across the rivet holes, and at a mean stress of only 23·1 tons per square inch of sectional area. But from the other four tests, the mean double shear of the ⅝in. rivet was found to be 16·1 tons, and the double shear of the ¾in. rivet, 21·2 tons. These figures are in exact proportion to the sectional area of the rivets, and they show that 21¼ tons may be taken as the unit for the double shear of a ¾in. steel rivet in steel plates, the stress for other sized rivets being proportioned to their sectional area.

The next set of experiments made had reference to the frictional resistance of rivetted joints.

	1in. rivet.	¾in. rivet.
With snap-head and point...	6·4 tons	4·72 tons
With pan-head and boiler point	7·36 ,,	4·52 ,,
With pan-head and countersunk point ...	8·55 ,,	6·25 ,,
With countersunk head and point	9·04 ,,	4·95 ,,

These results, as in the earlier experiments, are not in proportion to the sectional area of the rivets, but they go to show that on the whole the friction is greatest for the countersunk rivets.

Mr. Wildish's paper was followed by one by Mr. J. Milton, of Lloyds, entitled

SOME NOTES ON THE STRENGTH OF RIVETTED JOINTS.

In estimating the strength of the rivetted joints of boiler shells, the usual method is to calculate the proportion which the section of plate left between the rivet holes bears to that of the solid plate, and to consider this as the strength of the plate at the joint, also to calculate the sectional area of rivets exposed to shear, and to ascertain their strength by crediting them with a certain strength per square inch to resist shearing; then by comparing the result with the assumed strength of the solid plate, and with the strength of plate at the holes as obtained above, the strength of the joint is estimated. This method is only of value for comparing the strength of similar, or nearly similar joints, as in them it may fairly be assumed that the distribution of the stresses will be similar, and therefore their mean value will be nearly alike in all cases; but when we come to compare dissimilar joints by the same rules we shall be led astray, for it will in general happen that the distribution of the stresses will be sufficiently different to make a marked difference in the actual strength. This method of examining the efficiency of rivetted joints, by calculations of their sectional areas only, has led to the proposal of some forms of joints which have the appearance of possessing a large amount of strength because they have proportionally larger areas of material to be broken than ordinary rivetted joints, but the superiority of some of them, in my opinion, is not so great as their advocates claim for them. One very important point which is left out of consideration in these calculations, and to which Mr. Milton's paper was meant to draw particular attention, is the elasticity, or stretch, or yielding of the material due to the forces acting upon it, as this yielding considerably modifies the distribution of the stress on the different parts of the joint, and especially upon the rivets. It is well known that materials when exposed to direct tension elongate in direct proportion to that tension up to the elastic limit, and that, beyond that limit, especially in the case of mild steel, the elongation is very considerable. The following figures, taken from a diagram obtained by an automatic recording machine, introduced for such purposes by Mr. J. H. Wicksteed, of Leeds, show the elongation which takes place with mild steel before local thinning of the test piece takes place:—

Stress per square inch in tons.	Elongation of unit length per cent.
20	1
25	3·5
26	4·5
27	6·7
28	10·1
29	15·0
Ult. stress 29·5	Ult. elongation 25

Table II., for which he was indebted to Professor Kennedy, of University College, London, shows clearly the deformation of 1in. steel rivets exposed to a shearing strain.

Memorandum of Tests of Shearing Resistance of Rivet Steel.

Stress per square inch.	343	344	345	346	347	348
lbs.						
0	0·0	0·0	0·0	0·0	0·0	0·0
6,365	·010	·013	·016	·022	·055	·021
12,730	·022	·028	·030	·034	·066	·032
19,100	·034	·040	·042	·048	·078	·043
25,460	·055	·060	·060	·071	·091	·062
28,320	·066	—	—	—	—	—
31,830	·080	·086	·082	·091	·113	·083
35,010	·093	—	—	—	—	—
38,190	·113	·113	·108	·114	·140	·108
41,380	·141	—	—	—	—	—
44,550	·168	·152	·142	·170	·171	·155
47,740	·200	—	—	—	—	—
50,910	·242	·200	·196	·248	·238	·222
54,110	—	—	—	—	—	—
Breaking load per square inch ... lbs.	54,110	54,930	55,240	52,830	56,666	53,530
Breaking load per square inch ... tons	24·15	24·52	24·66	23·59	25·29	23·90

The author then proceeded to show that in double and treble-rivetted seams the strains were not properly divided among the rivets, so that all took their fair share; and this he illustrated by numerous examples. In 1878, some treble-rivetted lap joints were made by Messrs. R. and W. Hawthorn, and tested by one of Lloyd's surveyors, the joints being samples of those proposed for one of the first steel marine boilers made by that firm. The first joint was made with ¾in. plates, 1in. rivet holes pitched 4⅛in. apart centre from centre, the lap of the plate being 10½in., and the distance between the rows of rivets being 3⅜in. The width of joint taken in all cases was such as to give three rivets in each row. This joint broke by shearing the rivets with a force of 157 tons, giving a mean strength of 22 tons per square inch. This result was unexpectedly low. The second joint was then prepared, having the same pitch and lap, but the rivet holes increased to 1⅛in. diameter. This also broke by shearing the rivets at a force of 196 tons, giving again a mean shearing strength of 22 tons per square inch. The third joint was then prepared with a reduced lap, the distance between the rows of rivets being 2⅞in. instead of 3⅜in. The rivet holes were slightly increased in diameter to give each exactly 1 square inch area, but the pitch of holes remained the same, and the same description of rivets were used as in last experiment. This joint broke by tearing the plate at a force of 225 tons, while the rivets, of precisely the same quality as those in the other joints, withstood a mean stress of 25 tons per square inch without breaking, thus showing that merely lessening the distance between the lines of rivets increased the average strength of the rivets—by rendering the stress more equally distributed among them—by more than 13 per cent.

The discussions on these two papers were taken together. Professor Kennedy, of University College, called attention to the experiments he had made for the Institution of Mechanical Engineers. The most recent discoveries which he had made were that punching does not injure a soft steel plate, while drilling augments its strength by 10 to 15 per cent. Close rivetted seams are stronger than those with the rivets pitched far apart, because the metal between the rivet holes will bear a higher breaking strain than a similar section of the solid plate. The strength of machine rivetted seams was not greater than that of hand rivetted seams, but the plates did not slip on each other so soon. Therefore a machine-rivetted boiler would remain tight under strains that would set a hand-rivetted boiler leaking. Practically twice as much strain is required to make a machine-rivetted seam slip. There was a simple rule which was worth remembering: a steel or iron bar would stretch ·3 of the 0·001 of an inch in a length of 10in. for every 1000 lb. pull put on it.

Mr. Daniel gave details of the case of the boiler mentioned by Mr. Milton. It was made to Lloyd's rules, and would not stand the test. As the boiler was all bolted up great loss would have been incurred by Messrs. Hawthorn if the boiler were rejected, so all the holes were made larger, and in this way alone the strength of the sample joints tested was raised from 157 tons to 196 tons. The use of narrow butt straps still further strengthened the boiler. The pressure of the rivets may be regarded as constant, and the narrower the butt strap the higher is the load per square inch of surface, and the greater is the frictional resistance offered to the slipping of the plates on each other. After some remarks from Mr. Martell, Sir John Hay, and Sir E. J. Reed, Mr. West referred to the paper he read last year. He insisted on the necessity of experimenting on what might be called reciprocating strains where a joint is alternately pushed and pulled, as in the bottom of a ship, and he cited a remarkable instance where the rivets were all found loose at one side or the other of a number of transverse seams in the bottom of a ship which had met with tremendously heavy weather in the Atlantic. Mr. Kirk said that boilers were not free from reciprocating strains, as these were caused by expansion and contraction. The ultimate strength of a seam was of little importance to the boiler maker. We probably knew all that could be known in this direction. No doubt in old times boilers were over rivetted, but then they kept tight, and it was not a question of the strength of seams, but of their tightness. As to machine rivetting, he had found that the pull of an inch rivet was, at the most, ten tons, and it was quite useless to set up plates under a squeeze of seventy tons, the usual allowance for a 1in. rivet, and then take the pressure off before the rivet was cold, as the plates would come apart and leave the rivet loose. Mr. W. H. White said that the thing to be sought was getting the maximum strength out of the minimum weight of material. He referred to the use of steel rivets. At first these could not be got, but they were plentiful enough now, and of excellent quality. The way in which rivets were put in exercised an important influence on the strength of the plate. Thus, he knew of one case in which a given length of seam, which ought in the testing machine to have stood twenty-eight tons, gave way at eleven tons, the steel plates being damaged by the faulty use of the snap in closing the rivets. All experience went to show that the strongest and most trustworthy rivet was countersunk, and at Elswick they were using countersunk seams extensively.

The next paper read was by Mr. D. Purves, of Lloyd's,

On the Manufacture of Large Forgings for Stern Frames.

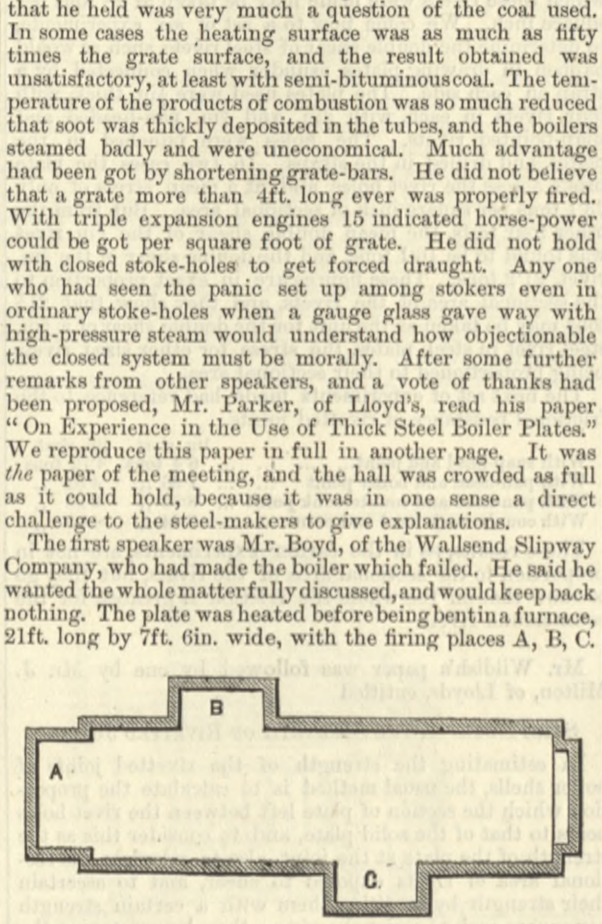
The importance of having sound and reliable forgings for stern frames cannot, the author stated, be too strongly expressed upon those responsible for the construction of our merchant steamers, but it has apparently been overlooked in many quarters. In this paper he proposed to notice the methods of welding together the pieces which go to make up a frame, and also the positions in which the welds are placed, and would endeavour to point out what, in his opinion, are the advantages and disadvantages of the various methods. As these frames are too large and cumbrous to be forged in one piece, they are usually forged in separate pieces, which are afterwards welded together, and as the welds are necessarily weaker than the solid forgings, it is well at the outset to have as few of them as possible, and to have those which are inevitable in the places where they are least likely to be strained. In practice it is found necessary to make the frames in at least four pieces, and it is also found that four pieces are quite sufficient for even the largest frame, so that only three or four welds are necessary in any frame. One of the most common ways of making these till quite recently was the V-screwed or butt weld, in which the two pieces to be united are fashioned of an obtuse V, very often little better than a straight butt. They are then placed nearly in contact in the fire, and when they are raised to a welding heat are drawn together by chains and screws. Such a weld with large masses cannot be perfect, as it is impossible to obtain sufficient power to draw the two parts together, for there can be no comparison between the closing effect of the static pressure exerted by the screws and that due to the impact of the heavy blows of a steam hammer; and another fault in this kind of weld, as usually made, is that the V is not deep enough. Another kind of weld is the V weld hammered instead of being merely screwed. If V welds of any description are used, the length of the V on each face should not be less than the width of the piece to be welded, and the parts should be very carefully shaped before welding is attempted, so that they will, when brought together, be first closed at the root of the V. The cinder has no chance of being shut into the mass of the iron as it has if the parts are so fitted as to be just touching all along, or if they are closed at the outside. If the angle of the V is made more obtuse than indicated, the parts are not well closed together by hammering, while if it is very obtuse the more they are hammered the less tendency there is to close them together. Another form of weld is the double-glut weld. In this form each of the pieces to be united is shaped an obtuse V, so that when they are brought together they leave two openings, one on each side, which are filled with the gluts. One of these is usually, but not invariably, made considerably larger than the other. The ends are raised to a welding heat at the same time as is the glut piece, and when the first glut is put in place it is hammered by a two or three-shafted hammer. The frame is then reversed and the other glut put in in a like manner. With this form of weld it is impracticable to use a heavy steam hammer, for when hammering is applied in such a case it is more a hammering tending to the separation than one tending to the mutual incorporation of the surfaces. When the wedge piece has become connected at a portion of its surface it is apt to be broken off from the first junction, and it may not be again brought into welded union with the butts. The surfaces of the weld ought further to be so disposed that the direction of impact of the hammering has a considerable component normal to the surfaces to be brought into union. There is also an objection to this multiplication of surfaces without a greatly increased area of effective section. In a transverse-glut weld each welded surface is less than the section of the post, and there are two pairs of surfaces to be made good. There is therefore more probability of having a defective junction, for unless both sets of surfaces are good neither is of value. A further form of weld practised in a few establishments for one of the welds of the frame is a scarph weld. This, if properly made and well hammered, cannot be improved upon; and, in his opinion, the next best form of weld is the long V weld properly closed together under a steam hammer. He had already stated that four, and only four, welds are requisite in stern frames, and he would now discuss their best position. In large frames two welds are made in the upper arch of the frame, as shown on the diagram. These welds are often made too close to the large mass of metal in the posts. This mass must exercise a prejudicial effect on the temperature of one of the parts to be united, and it is good practice to make them as far from the posts as possible. The same thing applies to the weld uniting the forward post to the keel-piece. The remaining weld is often made in the keel-piece itself. This is a most improper place for it; it should always be made in the after post, above the heel of the rudder. Many a steamer has lost her rudder-post through the failure of the weld in the keel-piece. When the foot goes, the post soon breaks off at the top of the screw opening, and the rudder goes with it. There is no reason whatever why keel-pieces should be welded in that place, and if it is but thoughtfully looked at for a moment, he believed no shipbuilder or shipowner would ever allow such a construction to be adopted where his interests are at stake. When the weld is in the keel-piece at the foot of the gap the bending moment acting upon it is, of course, the pressure of the rudder with a leverage, which is the length from the pintles to the centre of the weld, say from 2ft. to 3ft. On the other plan, when the weld is above the rudder-heel, the pressure is much less, and it acts now with only a few inches of leverage, and therefore properly made welds never give way there. The likelihood of failures is therefore greatly reduced by this better disposition of the weld; but there is another important advantage in having it at this place: it is above the rudder-heel, and even if the weld does give way, the rudder is still supported at the heel, and retained in its place.

A good deal of discussion followed this paper; but it cannot be said that it advanced the existing knowledge of the subject in any way. The old old question of the value of different systems of welding was handled at great length, and with little profit to anyone. Mr. Hall, well known in connection with steel stern frames, said that the right thing to do was to get rid of welds altogether by using cast steel; but his remarks did not excite any enthusiasm.

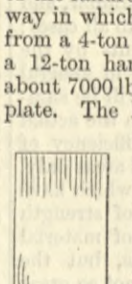
On Friday evening proceedings were resumed at 7 p.m., when Mr. Milton, of Lloyd's, read a paper "On the Efficiency of Marine Boilers." This we shall publish in full.

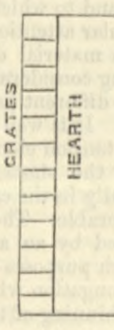
The discussion was begun by Mr. Kirk, who spoke in favour of small grates. Mr. Wright, of the Admiralty, referred to the use of forced combustion in ships of war, and stated that it involved a considerable waste of fuel, the consumption rising from 2 lb. per indicated horse-power per hour without forced combustion to $2\frac{1}{2}$ lb. or even $2\frac{3}{4}$ lb. with it. The smoke-box temperature rose to as much as 1100 deg., and the tube ends no doubt suffered a good deal. It was much better to get a good draught by the use of fans than by a high chimney temperature. Mr. Seaton stated that he had a great deal of experience with all sorts of pressure, and that he held that 150 lb. was a limit beyond which it was useless to go. Indeed, the saving effected by going any way above 110 lb. was not worth having; leakage became a great trouble at the higher pressures. As to the proportion which should exist between grate and heating surface, that he held was very much a question of the coal used. In some cases the heating surface was as much as fifty times the grate surface, and the result obtained was unsatisfactory, at least with semi-bituminous coal. The temperature of the products of combustion was so much reduced that soot was thickly deposited in the tubes, and the boilers steamed badly and were uneconomical. Much advantage had been got by shortening grate-bars. He did not believe that a grate more than 4ft. long ever was properly fired. With triple expansion engines 15 indicated horse-power could be got per square foot of grate. He did not hold with closed stoke-holes to get forced draught. Any one who had seen the panic set up among stokers even in ordinary stoke-holes when a gauge glass gave way with high-pressure steam would understand how objectionable the closed system must be morally. After some further remarks from other speakers, and a vote of thanks had been proposed, Mr. Parker, of Lloyd's, read his paper "On Experience in the Use of Thick Steel Boiler Plates." We reproduce this paper in full in another page. It was *the* paper of the meeting, and the hall was crowded as full as it could hold, because it was in one sense a direct challenge to the steel-makers to give explanations.

The first speaker was Mr. Boyd, of the Wallsend Slipway Company, who had made the boiler which failed. He said he wanted the whole matter fully discussed, and would keep back nothing. The plate was heated before being bent in a furnace, 21ft. long by 7ft. 6in. wide, with the firing places A, B, C.



The plate was not cold when it had been bent, the rolls were very near to the furnace. Mr. Colville, who made the plates, introduced his manager, who read a long explanation of his views. At first sight the affair seemed most mysterious, but he had no doubt that the true cause of the failure was that the plate had been spoiled by the way in which it was heated by Mr. Boyd. It was made from a 4-ton ingot, reheated and hammered down under a 12-ton hammer to a slab 10in. thick, which weighed about 7000 lb. It was reheated and rolled off into a boiler plate. The heating furnace was not of the proper construction, and the plate had to be taken out and turned end for end, and it was heated after all, unequally, as in the sketch, where the dark parts show the hottest places. As to the question of the strength of the steel, steel with a tensile strength of 34 tons to the square inch was quite as trustworthy as 30-ton metal. The proper way to make the heating furnace was as in the sketch, with a large number of grates opening into one hearth, so that the plates would be equally heated.





Mr. Denny held that there was nothing to be alarmed at. One swallow does not make a summer, and the failure of one boiler did not mean much after all. Such an event proved the value of the hydraulic test, and that was a good thing. There were no doubt peculiarities in thick steel plates, but would a reduction of strength from 32 tons to 30 tons get rid of them? He thought not. Let them have the strongest steel they could use, and not go back. He hoped that those present would suspend their judgment till they had the fullest information.

Mr. Kirk held that this was a most interesting case. It was not, however, by any means the first plate that had given way. A few years ago a case came under his own notice, when a tube plate of steel cracked because it was struck with a centre punch and a hammer. A shell plate also gave way, apparently without any reason. It was soft; Mr. Boyd's plate was hard. His experience was that it made no difference; a hard or soft steel would give way. His own view was that this cracking of steel plates was at present inexplicable. He did not agree with those who held that the plates were dragged asunder by the tensions set up in the plate. If so, there would be a reduction of area along the crack, but neither he nor anyone else had ever detected such a thing, neither did he think that the tearing theory was sound. He had done his best by wedging a cracked plate open to make the crack extend, but he could not succeed. Each crack took place suddenly, and went just as far as it meant to go at once and would not extend. There must be more carbon in thick plates than thin to keep up the tensile strength. After all, as far as shells were concerned, cast iron would do as well for a boiler as it would do for a cylinder, so that they might have as high a tensile strength as they liked. The material for the inside of the boiler, such as the furnaces and combustion chambers, was quite another matter. It could not be too soft and ductile. After all high carbon steel could not be very delicate. He took a bit of octagon tool steel and had each end screwed and fitted with a nut, he then had it heated red hot, put through a hole in a block of cast iron 5in. thick, screwed up the nuts tight, and left it to cool; when it was cold it was found that it had stretched $\frac{1}{16}$in. in 5in. This was done the second time with the same result. Now it was said that steel was very brittle at low heats; this certainly was not. As for thickness and its influence, plates $\frac{1}{2}$in., $\frac{3}{4}$in., $1\frac{1}{4}$in., all would crack now and then.

Mr. MacFarlane Gray said that Mr. Parker held that the plate went because it was of a steel so high in carbon that it would temper. Was it tempered in the boiler? That was a most important point. Again, he said that the crack was near the end of the boiler. Had it been damaged in forcing in the end, or had the rivetting in of the end stretched it?

Mr. Dick, of the Steel Company of Scotland, suggested that the crack was originally in the ingot. He called attention to the fact that if a test piece is broken slowly it will give a much better elongation and contraction of area than it would do if broken rapidly. He explained the whole occurrence by asserting that the steel had been worked at a dangerous temperature—nearly a blue heat, something a little over 250 deg.—at which its tensile strength is raised three tons per square inch, with a great accession of brittleness. If the plate were suffered to cool, no harm would accrue; but to work it at a blue heat was to ruin it. As to carbon, a half-inch plate with ·15 per cent. of carbon would stand 27 tons; while a plate $1\frac{1}{4}$in. thick would only stand 25 tons. To bring a plate of this thickness up to 32 tons it must have ·22 to ·24 per cent. carbon.

Mr. Raylton Dixon said that if, when a plate was being rolled, the mill stopped, a chilled place would be made across it, and it would crack there. His experience was that steel plates always cracked across, and not longitudinally.

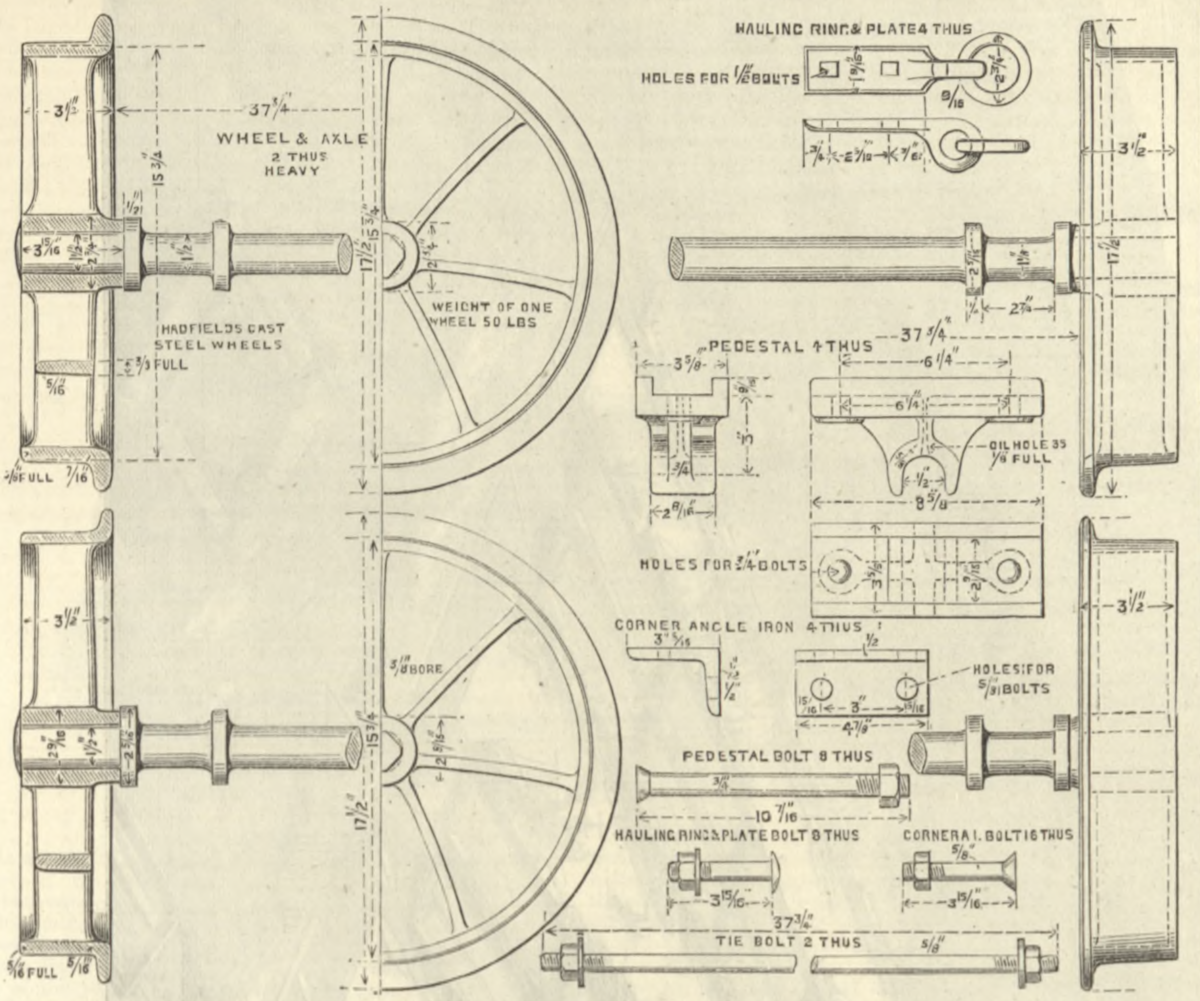
Mr. Martell held that the discussion up to that point was most inadequate. There were plenty of steel makers present who held their tongues. He was convinced that the steel makers always know why plates cracked. He remembered a case when Mr. Denny had several plates cracked, intended for one ship; he went to Dumbarton and investigated the whole matter. He insisted on sending for the steel maker, who would not come. He—Mr. Martell—then declared he would not leave Dumbarton till he came, which he did at last. Mr. Martell "cornered" him, and got out of him what he had done that made the plates break, and he promised he would not do it again.

Mr. Martell evoked no small laughter by his speech. He did not succeed, however, in eliciting any more information. The general opinion among the steel makers was that the plate had been badly treated, and among the engineers that it had not. We have dealt elsewhere with this question.

At a very late hour a paper by Mr. Joy on "Valve Gear" was read. We must postpone our notice of this for the present.

Glasgow Engineers' Association.—At the eleventh meeting of this Association a paper upon "Hydraulic Hoists," with special reference to a patent by Messrs. Stevens and Major, of Battersea, was read by Mr. A. Wilson, C.E. The cage is mounted on the top of a solid steel ram of a length equal to the travel, the cylinder being at the same time carried down to an equal depth. The weight of the ram and cage must be counterbalanced if economy of power is to be obtained, and the balancing is to be effected by compressional forces. For this purpose a balancing cylinder is introduced. This balance cylinder has an upper and lower compartment, with a piston or ram moving between them. The lower compartment contains precisely the same amount of water as the long cylinder of the lift, and this volume of water alternates between the lift cylinder and the balance cylinder, through a pipe connection, so that when the lift cage and ram are up, and the lift cylinder full of water, the balance ram is down and the lower portion of the balance cylinder empty, and when the lift ram returns, displacing the water from its cylinder, driving it through to the balance cylinder, the ram of the latter is forced upwards. Now, it is clear that a heavy load attached to the balance ram will, under these circumstances, counterbalance the lift ram and cage, and that the balancing will be effected from below the lift ram, and will therefore be of a compressional nature. The counterbalance is made slightly lighter than the lift ram and cage, that the preponderance of the latter may always bring it to the bottom of its travel when the driving pressure is removed. To raise the lift, water under heavy pressure is introduced to the upper compartment of the balance cylinder, and, exerting a pressure on the top of the balance ram, overcomes the slight preponderance of the lift ram, and also the resistance of the load in the cage, and the latter is therefore forced upwards. The removal of this pressure, by allowing the water to escape, allows the lift to descend. Should the valve-controlling gear fail from any cause, the ram cannot be driven out of the cylinder, for when the ram passes its proper limit, by virtue of its abnormal position it opens a free passage for the water, and this passage remains open till the ram returns, when the first downward movement again closes it. The variation, due to the immersion of the ram in the water in the cylinder, is compensated in the balance cylinder by the agency of two strangely-shaped levers carrying weights. The form and motion of these levers are so devised that the weights attached exert an increasing downward pressure on the balance ram as the lift ascends, and the amount of this increase of pressure balances the increased weight of the rising lift ram. The water used is not wasted. It is pumped from the pump tank into the accumulator, is forced by that into the balance cylinder, and is discharged from the latter into the pump tank.

CONTRACTS OPEN—WHEELS FOR SOUTH MAHRATTA RAILWAY.



CONTRACTS OPEN.

SOUTH MAHRATTA RAILWAY.

THE South Mahratta Railway Company requires 120 pairs of wheels 15¾in. diameter, and axles 1¼in. diameter, as shown in the engravings. Manufacturers tendering should name ports of delivery. Specifications can be procured on payment of £1 1s. Tenders to be in by 14th inst. to the company's offices, 31, Lombard-street, E.C.

THE TELEPHONE AND TELEGRAPH WIRE QUESTION.

THE Select Committee appointed to investigate the question of the control, regulation, and legal position of telegraphs, telephones, and other electric wires, have commenced their inquiry, and already taken valuable evidence with respect to the rights and privileges of the Postmaster-General and the various telephone companies. Mr. George Russell, Parliamentary Secretary of the Local Government Board, is the chairman of the Committee, his colleagues being Sir J. McGarel Hogg, Sir Alexander Gordon, Colonel Tottenham, Mr. T. A. Dickson, Mr. Firth, Mr. E. Dwyer Gray—who has on several occasions raised the question of telephones in the House of Commons—Mr. C. Kennard, and Mr. McCullagh Torrens. The inquiry is one of widespread interest and importance, and each sitting of the Committee has drawn together a large number of Post-office officials, telephone promoters, and experts, and other persons concerned mainly with the commercial aspect of the subject.

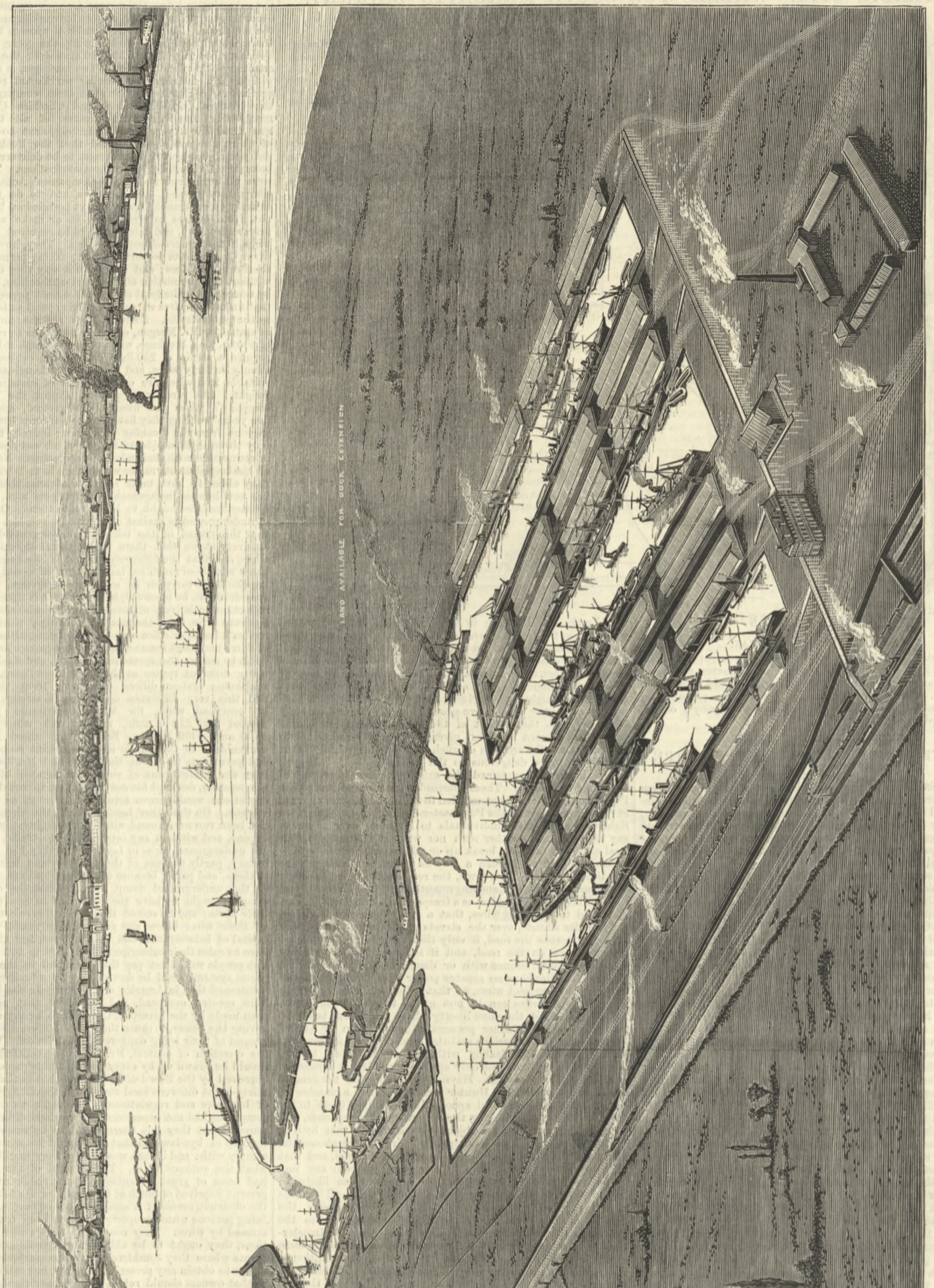
Mr. Robert Hunter, solicitor to the General Post-office, was the first witness examined, his object being to explain the legal powers of his department with regard to telegraphs, and its rights and attitude respecting telephones, and to make suggestions for an amendment of the existing law in both directions. He explained that the powers of the Postmaster-General and those of the telephone companies are based on an entirely different footing, the latter depending upon the general law, while the former rest upon special Acts of Parliament, viz., the Acts of 1863, 1868—transferring the telegraphs to the State—1869, and 1878. Under the Act of 1863 local authorities had a power of absolute veto upon the erection of electric wires, and although the Act of 1869 gave the Post-office a monopoly of the telegraphs, it gave no special powers as to the erection of wires. But the Act of 1878 created a right of appeal from the veto of local authorities to a magistrate or a county-court judge, and from either to the Railway Commissioners. As the law now stands with regard to above-ground wires, the Post-office must obtain in towns the consent of the road authority and the consent of the private persons upon whose buildings it is proposed to make attachments; and further, if the line is to be carried on poles, the consent of the occupier of every house within 30ft. of a pole; and in the country, in addition to these consents, the consent must also be obtained of the owners and occupiers of parks or pleasure grounds along the course taken by the wires. Although there is the right of appeal mentioned above, it seems that there is no appeal against a veto in respect to attachments on the erection of posts within 30ft. of a dwelling house. In recent times, and largely owing to the development of the telephone system, many difficulties have arisen, and with a view to simplifying the procedure and removing as many impediments as possible, Mr. Hunter offered various suggestions to the Committee, the principal of which were these:—(1) That a right of appeal should be given in all cases except with regard to attachments to private property, the Postmaster-General giving such notice of his intention to erect a wire as would enable all persons sufficiently interested to present their objections; (2) that such cases should be submitted to the county-court for final decision, the appeal to the Railway Commissioners being discontinued, it being considered unnecessary and merely giving rise to delay and expense; (3) that the provision requiring the consent of occupiers within 30ft. of a pole should be repealed or amended by greatly reducing the distance, such persons having an equal right to make objections with all other persons along the route of the wire. Private companies should, in his opinion, have the same right of appeal as the Postmaster-General with respect to overhead lines; but he would make no alteration in the law relating to underground wires, except to the extent of repealing the appeal to the Railway Commissioners. In illustration of the difficulties with which the Post-office authorities had to contend, Mr. Hunter cited a number of cases which had been submitted to county-court judges under the Act of 1878, and he also stated that the Electric Lighting Act, 1882, absolutely prohibits the suspension of electric wires above ground along, over, or across any street without the consent of the local authority, and even where such consent has been given, enables any individual to appeal against the erection of such wire on the ground that it is likely to prove dangerous to the public.

Mr. Hunter also explained the existing system in respect to telephone companies. These companies are licensees under the Post-office, and they are not entitled to any of the statutory powers at present possessed by the Postmaster-General, and have no more right than any private individuals to lay wires over or under any highway; and neither with nor without the consent of a local authority can they break up or otherwise interfere with a public thoroughfare in such a way as to cause a nuisance for any time whatever. In a town, the road authority is the owner of the surface of a street, and any unauthorised interference therewith can be proceeded against as a trespass; but it has been decided in regard to overhead wires, that a town authority having a right, under statute, over the streets cannot veto the erection of a wire across the road, if only that wire is not suspended from supports on the road, and if sufficiently high to avoid any possible interference with or danger to the public traffic. Rural authorities have no greater power than urban authorities in regard to overhead wires, so that unless nuisance or danger is created, such wires can be put up by telephone companies, but they have not the same liberty where a roadway is vested in a corporation or other persons otherwise than by Act of Parliament. Under various statutes special powers are given to local authorities for dealing with projections caused by the erection of wires, but these only apply where there is a nuisance or a probability of danger. Having thus indicated the general law as to telephones, Mr. Hunter mentioned that a number of corporations have obtained special Acts enabling them to lay down bye-laws for regulating the extension of telephones, and then he suggested that—subject to the proviso that both in regard to overground and underground wires for telephones the consent of the Postmaster-General must be obtained, and that the Postmaster-General should have power to veto any line likely to injure his wires, or to absorb space likely to be required for his use within a short time—all persons requiring or desiring to construct telephones above the ground should have the same rights and powers as the Postmaster-General has, and also that the Postmaster-General's licensees, but not other persons, should have the same rights as to underground wires as he possesses. In addition to the restrictions above mentioned on telephones, it should be remembered that there is a further check in the fact that no telephone can be established without a licence from the Post-office, and that may be refused on many grounds without any simple remedy. Indeed, this fact has given rise to a great deal of the recent controversy and dissatisfaction on the subject of telephonic enterprise.

Following Mr. Hunter, the engineer to the Post-office gave the Committee some information as to the nature and laying of telephonic and telegraphic wires, both overhead and below ground, and showed that the laying of lines underground involved a far heavier outlay than their erection overground. Further information on this point was given by subsequent witnesses, as will be seen later.

The first witness examined with special reference to the telephone wires question was Mr. J. B. Morgan, the managing director of the United Telephone Company, and a director of several provincial telephone companies. The United Company, he explained, was founded in 1880, when the Postmaster-General granted a licence to the company to work telephones for thirty-one years within a five mile radius of the General Post-office. By a later licence, viz., in November last, this limitation of area was withdrawn, but in this as in the former licence the Post-office stipulate for a royalty of 10 per cent. on the company's receipts. The company at present has in London a central exchange, eighteen district exchanges, and an exchange for the Stock Exchange, the total subscribers being 3747, and the subscription being £20 a year for each customer, this sum covering everything that is necessary for working and maintaining the telephone. They have 5000 miles of wires in the metropolis—almost all overhead—and during the year ending with February last they sent 15,565,406 messages; the average cost, counting each communication as two messages, is slightly over a penny. Mr. Morgan gave similar particulars respecting the operations of various other telephone companies, such as the National, the Lancashire and Cheshire Company, &c., mentioning that the total revenue of all the companies was £250,000 a year; and, referring next to the position of these concerns, he explained that the Post-office licence did not allow any written messages to be delivered, the system being strictly limited to verbal communications. The companies were all registered under the Companies' Acts, and had no compulsory powers, and therefore had to do their business entirely on sufferance, having to get permission, by payment or not, from owners to erect poles on or make attachments to private property, and being liable to be required to remove the wires if the owners objected to them. They, however, did run wires over private property without asking permission, just as the Post-office does; and in the same way they crossed streets without the permission of the local authorities, being advised by counsel that the local authorities cannot prevent their doing that unless the wires were so near the ground as to be dangerous to the public traffic. Some of the wires the company use are, as stated by Mr. Morgan, of such a nature as to require a strain of 800 lb. for a breakage, while others—phosphor-bronze wires—require a strain of 250 lb. Their aerial cables contain from twenty to forty wires, and the cables, although suspended from suitable iron wires, are quite capable of sustaining their own weight. As already mentioned, almost the whole of the company's wires are fixed above ground, and yet during five years' working they have had no accidents causing injury to persons from the breaking of a wire; indeed, they have had only three slight accidents, none of which was due to a breakage in connection with their telephone operations. Notwithstanding all the impediments under which they have laboured, the company claim to have made such an advance that the telephone has now become indispensable to business men, and therefore greater facilities ought to be given to them. On the question of underground as against overground wires, Mr. Morgan argued that this spread of the telephone, under great difficulties, conclusively shows that there is no general objection to overhead wires, and that the difference in cost is immensely in favour of those wires—so much so, indeed, that it would be practically impossible to carry on an underground system. An important consideration, he observed, in this respect is that there being no collection or delivery of messages, every subscriber must have a separate wire from the nearest exchange, wherever the subscriber's house or office may be. Therefore, although a number of wires may start from an exchange in a particular direction they begin to scatter and spread immediately, and finally there are as many different routes as there are subscribers. In this the telephonic system differs essentially from the telegraphic, and this very difference constitutes a strong case in favour of overhead wires, for while overground lines may be erected for £10 a mile, underground wires cost between £300 and £400 a mile. Besides that there is all the inconvenience to the public of the constant reopening of roads and pavements to get at the wires; and Mr. Morgan, speaking from the public point of view, as a member of the Liverpool Corporation, declared his conviction that in crowded streets such operations would prove actually dangerous, as well as inconvenient. On the other hand, he held, the wires could be and had been run overground without the slightest inconvenience to anyone, and without any interruption to traffic. There were a few underground wires in London, but they had not been satisfactory, partly because of the difficulty and trouble of getting at them, and partly because of the injurious effects on the wires of the underground damp. In any case, he contended, the company ought to have the option as to how they would lay their wires; and he stated that if they were compelled to put all their wires below the ground, they would require further capital of between one and two millions, and then they would have to raise their subscription from £20 to £80 or £100 a year. But people would not pay that sum, and in the end the telephone system would be destroyed. As a further argument he mentioned that in America and everywhere else telephone wires were erected overhead, and he added that no attempt had been made by the Liverpool Corporation, or any other authority having the power, to cause the removal of overhead wires on the ground of their being dangerous or a nuisance. With respect to the question of control, Mr. Morgan submitted that bye-laws should be drawn up by every proper municipal authority, to be approved by the Board of Trade, and that in the metropolis the thirty-eight different local authorities should agree upon one set of bye-laws and regulations in the same way. Hitherto the companies had not experienced any serious difficulty with town councils, but they felt there ought to be something like uniformity of bye-laws, so that they might know what they had to comply with; and if that was effected they would not care much what the authority was. The removal of the limit of radius had been of great advantage, but the public at large were at present deprived of much of the benefit of the telephone through the obstructiveness of a small number of people, some of them being persons whose property was not even touched, but only crossed by wires. They considered that, under proper regulations, they ought to be able to erect posts and make attachments where they considered them necessary; but they did not desire to obtain any prescriptive rights, but rather the contrary, so that owners should retain their proper rights. Incidentally in the course of his examination, Mr. Morgan stated that while the War-office had given the company some facilities for erecting overhead wires, the Office of Works had raised difficulties and the Admiralty had refused permission; and, further, that in connection with the Health Exhibition the company had had great difficulty because the authorities would not allow wires to be attached to or passed over some parts of the Museum buildings. Their only reason was a simple objection to overhead wires, and the company were going through a similar experience with regard to the forthcoming Inventions Exhibition.

Mr. Spagnoletti, telegraph engineer to the Great Western Railway Company, warmly supported the previous witness as to the convenience, safety, and economy of overhead wires, and the contrary in each particular with respect to underground wires. The great cost of the latter system would, in his view, render it commercially impracticable, and the present development of telephones was due to the ease with which the wires could be erected. He was unable to see what inconvenience would arise from wires passing over buildings, and modern improvements in appliances made it possible to suspend these wires with perfect safety. The Committee has not yet concluded the telephone part of the subject, and probably will not do so before the Easter recess.

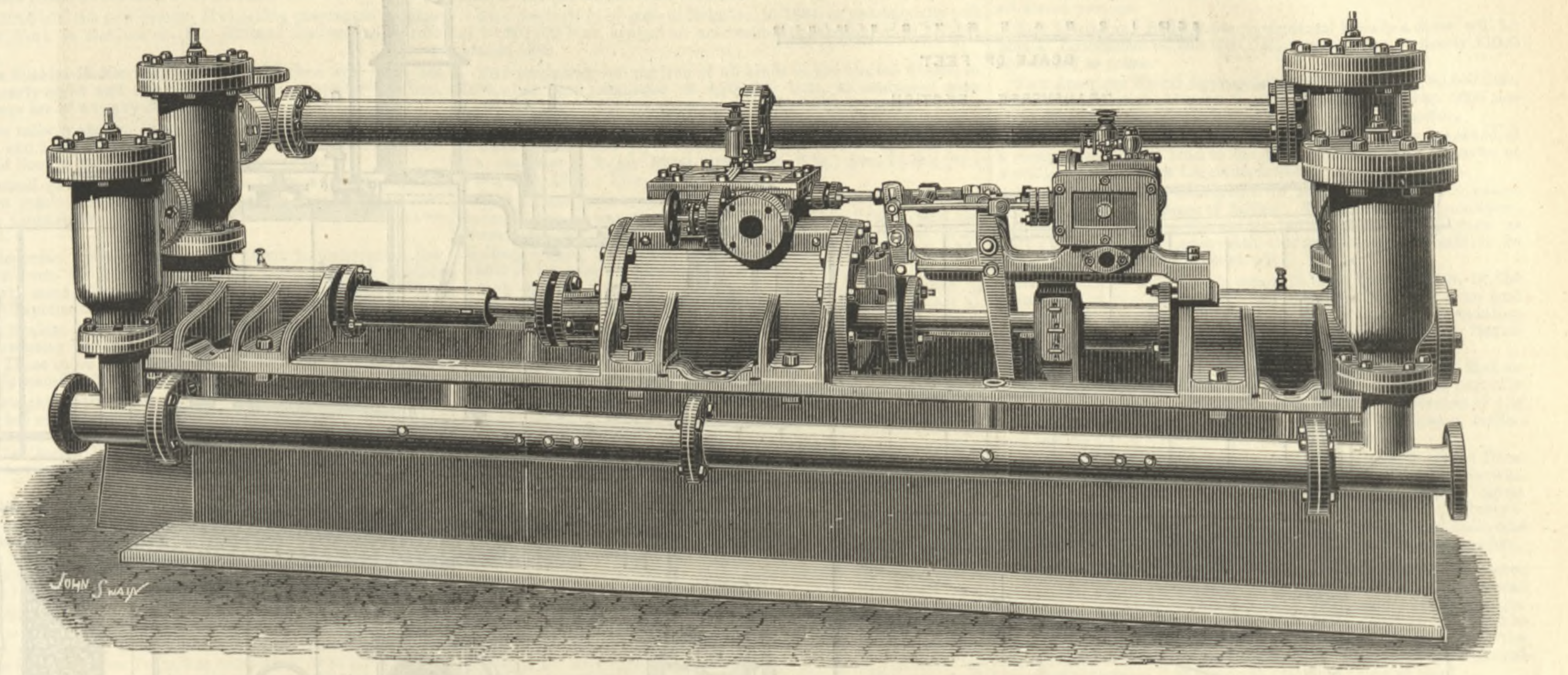


THE NEW DEEP-WATER DOCKS AT TILBURY.

(For description see page 262.)

DIRECT-ACTING STEAM PUMP.

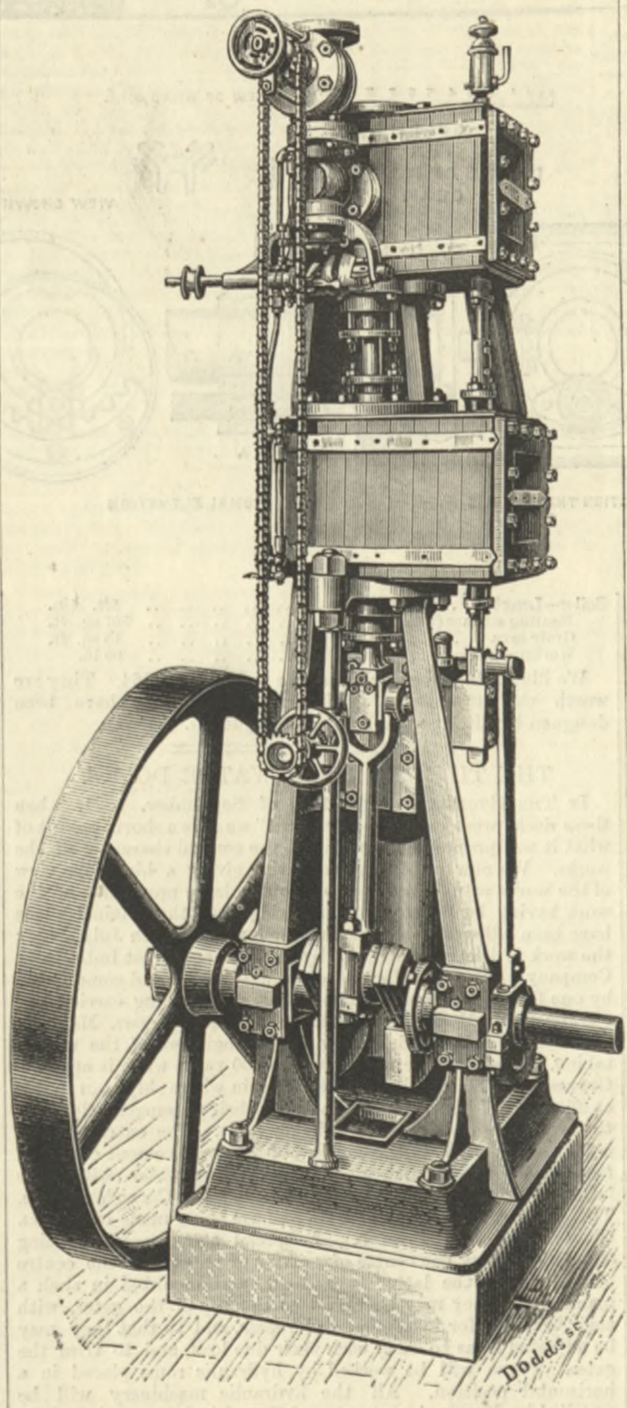
MESSRS. F. PEARN AND CO., MANCHESTER, ENGINEERS.



As the ability of English pump makers to meet the requirements of the Government in connection with the Suakim-Berber contracts has recently been brought into question, it will be interesting to give an illustration of a set of pumps put down abroad by an English firm for doing precisely the work required by the Government. The accompanying engraving represents one of the pumps of the direct-acting type, made by Messrs. F. Pearn and Co., of Manchester, designed to sustain heavy pressures, and specially constructed for one of the oil lines in the Caspian, where pumping has to be done through many miles of piping. In this type of pump special attention has been paid to simplicity of arrangement, accessibility of working parts, with general durability; and the cycle of operations may be described as follows:—The slide valve is worked direct from the pump crosshead by means of a lever carried on a fulcrum, to which lever are attached adjustable connections to actuate the slide valves. These are so regulated that the main valve closes the exhaust port, slightly opens the steam port before the piston reaches the end of its stroke, and also, by giving internal lap, the piston is slowed down and thoroughly cushioned before the termination of the stroke. The steam in all clearances is thus compressed, thereby adding to the economical working of the pump, and causing a sufficient pause to take place at the termination of each stroke, so that the pump valves are enabled to close quietly. The auxiliary cylinder is only used to complete the remaining stroke of the slide valve. Should the piston make a larger stroke than that adjusted for, steam is thrown directly on it, without the assistance of the auxiliary cylinder; the piston is thus effectively prevented from running up to the covers. The auxiliary cylinder is made as a separate casting, and not, as is frequently the case, boxed up in the main cylinder. This important feature, taken in connection with the fact that the whole of the actuating gear is outside, and open to view, affords special facilities for examination and for ready adjustment to suit the various speeds. A perhaps more important advantage than readiness of access, although this is at all times desirable, is that this arrangement meets one of the paramount requirements of shippers, where machinery is not always destined to be under the supervision of highly-skilled attendants; whilst with the working parts thus exposed to view, the risk of breakdowns through inattention is also considerably reduced. The sizes of the pump shown in the illustration are 5in. diameter of rams, 18in. diameter of steam cylinder, and 18in. stroke, which are precisely the dimensions of the pumps ordered in America for the Soudan. It may be added that when extreme steadiness and continuity of delivery is an essential requisite, so as to cause as little friction as possible in the delivery pipes, two of these pumps can be coupled together, each then accommodating itself to any varying pressure that may occur. This arrangement forms a duplicate plant, and either pump can be worked independently of the other. An advantage of this kind is particularly valuable in isolated districts where there are but few facilities for repairs; and pumps laid down on such lines as the above manifestly possess many strong recommendations for employment in the class of work contemplated by the Government in the Soudan.

VERTICAL COMPOUND ENGINE FOR ELECTRIC LIGHTING.

The construction of engines specially adapted for electric lighting has of late received considerable attention as a necessary consequence of the steady progress which electric lighting is, for many purposes, making, and the accompanying illustration represents a vertical compound of a new design recently introduced by Messrs. Deakin and Parker, of Manchester. One essential point in engines for this purpose is economy in the consumption of steam. Economy, no doubt, can best be attained by using high-pressure steam; but this in an ordinary engine would be extravagant. It is therefore necessary either to provide expansion valves, which involves a certain amount of complication, or else to compound with the view of securing the desired economy. The latter course is one which recommends itself as the most preferable, especially with high-speed engines, as the shock inseparable from the admission of high-pressure steam on to a large piston is a source of danger and of undue wear and tear on all parts of the engine. For ordinary pressures of steam Messrs. Deakin and Parker make a very massive engine with large surfaces throughout, and their vertical compound may be described as the same, with a high-pressure cylinder set on the top of the low-pressure cylinder and separated by a distance piece, in character with the rest of the frame of the engine. The piston-rod is carried through, up to the high-pressure cylinder, and at its lower end is forged into a solid rectangular block, shaped out from the front to receive the crosshead brasses. The cap of the crosshead is formed of a steel plate, lipped over at top and bottom to span the crosshead and tie it firmly. The cap is held in place by two turned steel bolts, whose inner ends secure a cast iron slipper slide to the crosshead, the whole being bolted up close and held by lock-nuts. The crosshead pin is fast in the forked end of the connecting-rod, and is bored out hollow, and fitted with two lubricating cups at the ends. These cups are supplied with oil

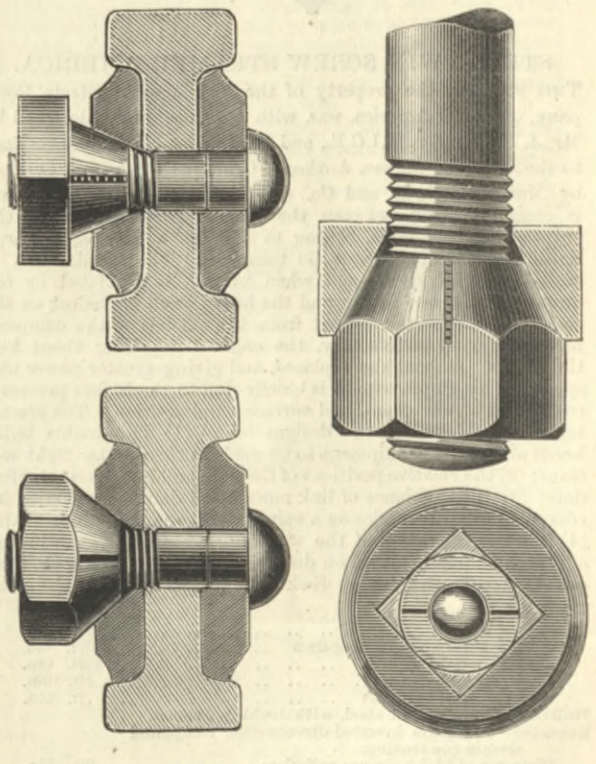


MESSRS. DEAKIN AND PARKER'S COMPOUND ENGINE.

from cups shown on the side of the frame, another similar cup at the back supplying the slipper slide with oil. The crank pin end of the connecting-rod is fitted with very large brasses of the marine type. The crank shaft is made of a steel forging, slotted out to form the crank, and finished bright in the webs, which also have a groove formed all round them to receive the wrought iron straps, which secure to them the cast iron balance weights. The crank pin is bored hollow, and thus forms an oil chamber, from which small radial holes supply oil to the brasses. This chamber is fed by a brass ring, into which oil is dropped from a fixed cup formed in the cap of the nearest main bearing, the oil being fed into the chamber by centrifugal force. These engines are in all cases fitted with two fly-wheels, so as to balance the rotating shaft and ensure steady running, without great weight. Both cylinders are provided with draw cocks and copper pipes, and clothed with silicate cotton, and finished with teak lagging bound with brass bands. The ends of the steam chests, as well as the pipe from high to low-pressure cylinder, are also clothed in the same way. One excentric operates both valves, carried on one steel spindle, but joined at a point between the two cylinders in such a manner as to facilitate the removal of either valve separately. These engines are governed by Messrs. Deakin and Parker's Acme governor, which was recently described in The Engineer, and one feature in this governor that is especially valuable for electric lighting is the speeder, by which the engine can be varied 10 to 15 per cent. from the speed at which it is constructed to run, so as to eliminate errors as to speed arising from slip of belts or slight variations in sizes of pulleys or other causes. Several of these engines, which run up to the high speed of 210 revolutions per minute, are now at work in Manchester and other towns, driving electric light installations, and they have given every satisfaction, both as regards economy and steady running; whilst the small space occupied by the special arrangement of the engines is a very considerable recommendation in crowded business centres.

THE GRIPPER LOCK NUT.

The accompanying engravings illustrate a new form of lock nut, patented by Mr. J. Heap, the one as applied to fish plates, and the other for ordinary work. The nut, whether hexagonal or square, is provided with a conical base, which, being split

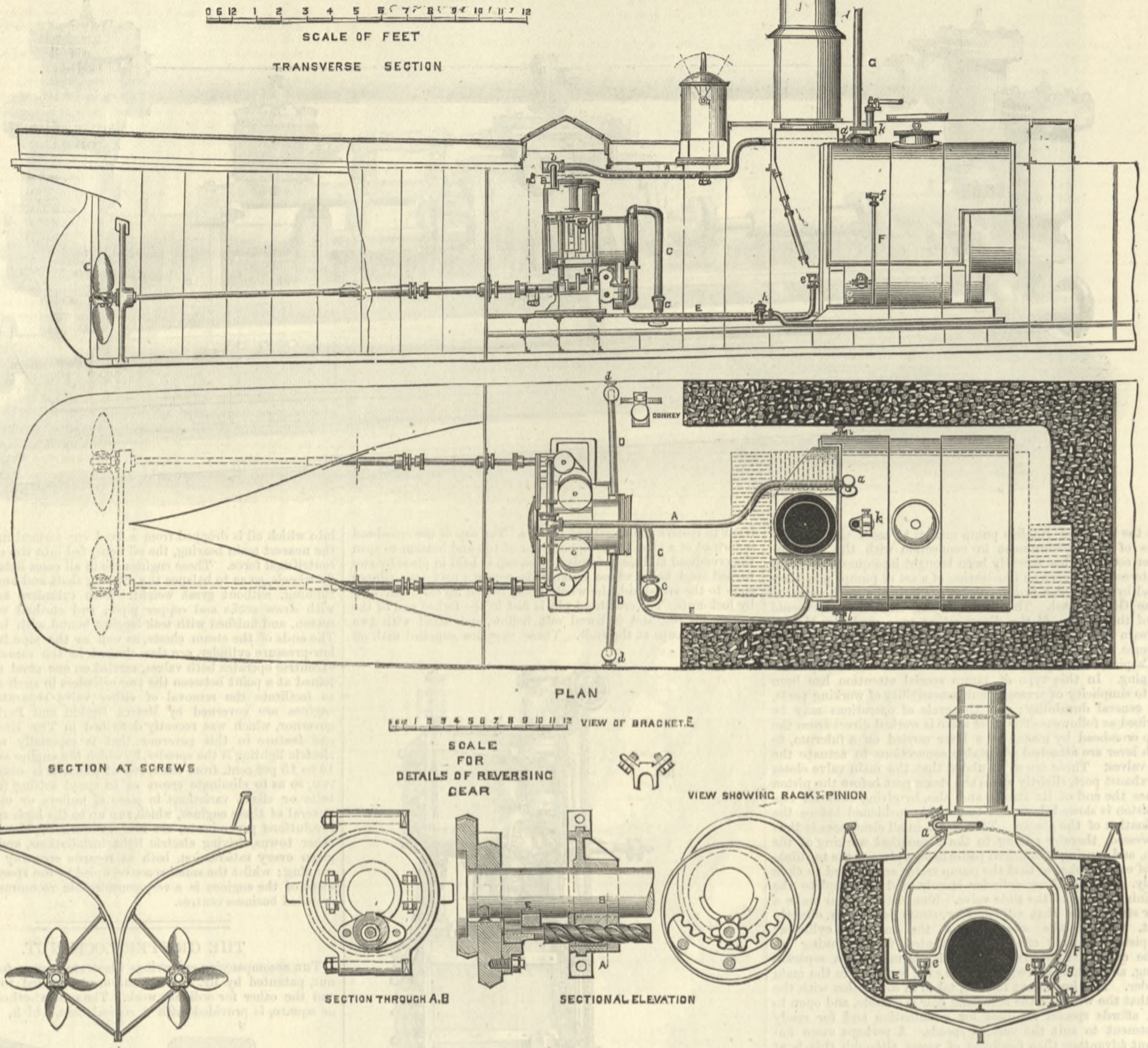


causes that part of the nut to grip the bolt tight, in proportion as the nut is tightened. It is made by Messrs. Shepherd and Ayrton, of Longsight, Manchester.

Belgian Iron Manufacture.—The iron trade of Belgium is becoming more and more dependent upon imported ores. The total quantity of such ores used in Belgium in 1883, according to the British Iron Trade Association Report, by Mr. Jeans, was 1,641,515 tons, against a consumption of only 192,308 tons of home ores. The output of the latter has decreased from a total of 527,300 tons in 1874, to one of 216,490 tons in 1883. The imported ores are chiefly received from the adjoining Grand Duchy of Luxembourg and the Bilbao district in Spain. The total production of pig iron in 1883 was 783,433 tons, against 726,946 tons in the previous year.

TWIN SCREW TUG-BOAT AMERICA.

MESSRS. COCHRAN AND CO., BIRKENHEAD, ENGINEERS.



STEEL TWIN SCREW STEAMER AMERICA.

This steamer, the property of the Autofagasta Nitrate Company, of South America, was, with her machinery, designed by Mr. J. F. Spencer, M.I.C.E., and built under his superintendence to the order of Messrs. Anthony Gibbs and Sons, of London, by Messrs. Cochran and Co., of Birkenhead. Her daily work is communicating between the pier at Autofagasta and the ships at the anchorage, towing to and fro a number of cargo lighters containing about 30 tons each. The speed, light, is stated to be 10 knots, and, when towing, is regulated by the number of lighters in tow and the heavy swell prevailing on the coast. The reports received from the officials of the company have been very satisfactory, the engines requiring about half the fuel of the boat she replaced, and giving greater power and speed. This improvement is chiefly due to the higher pressure, compound arrangement, and surface condensation. The special features embodied in the designs are :—(1) The double bulkheads allowing the shipment to be made in three water-tight sections; (2) the relative positions of the high and low-pressure cylinders; (3) the avoidance of link motion and double excentrics, by reversing the excentrics on a spiral sleeve on the crank shaft; (4) the concentration of the starting and steering gear in one cast iron standard placed on deck close to the towing hook, thus enabling one man to steer, work the engines, and attend to the tow rope.

Length overall	60ft. 0in.
do. between perpendiculars	57ft. 0in.
Breadth moulded	12ft. 0in.
Depth of hold	5ft. 10in.
do. keel to beams	7ft. 0in.
Hull :—Built entirely of steel, with double bulkhead.	
Engines :—Two pairs inverted direct-acting compound surface-condensing.	
Diameter of high-pressure cylinders	0ft. 7in.
do. low " "	0ft. 14in.
Length of stroke	1ft. 0in.
Diameter of crank shaft (steel)	0ft. 3in.
do. propeller shafts, manganese bronze	0ft. 3¾in.
do. piston rods	0ft. 1¼in.
do. steam pipes	0ft. 1¾in.
Travel of steam valves	0ft. 2⅞in.
Diameter of valve spindles (steel)	0ft. 1in.
do. feed pump	0ft. 1½in.
do. air pump	0ft. 6in.
do. circulating pump	0ft. 6in.
Stroke of pumps	0ft. 5in.
Cooling surface in condenser	196 sq. ft.
Propellers :—	
Diameter	4ft. 0in.
Pitch	6ft. to 7ft.
Surface of each propeller	5 sq. ft.
Four blades	
Boiler :—	
Diameter	7ft. 0in.
Boiler—Length	8ft. 6in.
Heating surface (total)	307 sq. ft.
Grate area	15 sq. ft.
Working pressure	90 lb.

We illustrate these engines above and on page 264. They are worth the attention of engineers, because they have been designed by Mr. Spencer and built by Messrs. Cochran.

THE TILBURY DEEP WATER DOCKS.

In The Engineer of the 23rd of September, 1881, when these docks were in the "paper stage," we gave a short account of what it was proposed to do, and of the general character of the works. We now publish an engraving giving a bird's-eye view of the works as now being carried out, a large proportion of the work having been done, and showing that the original plans have been adhered to. The first turf was cut 8th July, 1882; the work is being carried out by the East and West India Dock Company. Contracts for the work were let to, and commenced by one firm of contractors, but they are now being carried out vigorously by Messrs. Lucas and Aird, under Messrs. Manning and Baines, MM.I.C.E., who are the engineers of the undertaking. The entrance, which will be 100 yards wide, is opposite Gravesend. This leads into a tidal basin where ships can enter at all states of the tide and discharge their passengers close by the large hotel, which is now being built. The entrance lock is 80ft. wide, with walls composed of Portland cement concrete, faced below water with stock brick, above water with blue brick. The quoins and pointing cills are all of Cornish granite. The gates are of wrought iron, and are being made by Messrs. Clayton and Co., Preston. A special arrangement is being adopted to carry the centre of gravity of gates over the centre of the rollers, the latter being large, and mounted in such a manner that they may be raised to the top of the gates, with their bearings for inspection and repair, and so that they may be adjusted so as to carry each their due load, and to trim the gates. These will be worked by hydraulic rams placed in a horizontal position. All the hydraulic machinery will be supplied by Messrs. Armstrong and Co., with the exception of the cranes, which are being made by Messrs. Walker and Co., of Leeds. To the east of the lock are four large graving docks, the walls of which are built of concrete faced, where there is no wear and tear, with stock bricks. The altars are of York stone with blue bricks at the back. A timber coping will run round the graving docks, with eye bolts let in every few feet. The flooring of graving docks will be of pitch pine, and a dry pathway will lead round bottom of docks, to enable captains of vessels to examine the ships' bottoms without wetting their feet. The graving docks will be filled, either from the tidal basin or main dock, through large culverts, through which they can also be run out to low water. The remaining water will be pumped out by large centrifugal pumps—a notice of which appeared in The Engineer, vol. lviii., p. 452. There will be one pump to each of the four graving docks, two of their suctions being 7ft. in diameter and two 6ft. diameter. These pumps are so arranged that any can be made to pump any one dock, so that it will be impossible for any delay with the work in docking. To save pumping, there is a system of levelling culverts running from the bottom of each dry dock, so in the event of a vessel in No. 1 dry dock having finished repairs, and wanting to go out, and a vessel wanting to be docked in No. 4 dock, a large amount of water from No. 4 can be run out at low tide, and nearly all the remainder can be run off into No. 1, thus saving a large item in the cost of pumping.

There will be three caissons to the large and three to the small graving docks. These are built by Messrs. Green, of Blackwall. There will be three stops for the centre caisson, to enable the length of the dry docks to be altered to suit the varying lengths of vessels. They are ship caissons, worked with air chambers and water tanks, to prevent their jumping. The cloughs of the graving docks will be worked by hand, so as to avoid the results of accidental leakage of water under pressure past the valves of a hydraulic ram, and thus lifting the cloughs at a wrong time. The walls of the main and branch docks are similar to those of the lock, but with the exception that below water they are faced with fine concrete, instead of stock brick. The copings will be of granite. There will be a series of sheds down each jetty, and movable hydraulic cranes will run up and down the quays.

The hydraulic machinery will be worked from the engine-house at the north end of the docks. There will be three pairs of compound engines, made by Messrs. Armstrongs, and the pressure pipes from these will make a complete circuit round all the dock walls. There will be a new station on the London, Tilbury, and Southend Railway close by the engine-house, and those using the docks will walk along an overhead gangway over the various lines and down brows leading to the various docks. The goods will be brought by rail at the north end of the ground by a short length of railway now being made. Two canteens are being built, which will make ample provision for those using the docks.

A large quantity of the work, of which this is a brief account, is in a very forward state, a very large number of men and plant being employed. The works are of unusual magnitude, and there are many features in the construction of the walls, the arrangement and proportions of the culverts, the arrangements for controlling the level of the water in the docks and for pumping by any or all of the machinery from any of the docks, and of many other interesting engineering features, to which we shall refer more in detail at a future time.

RAILWAY MATTERS.

A LARGE number of signal lamps are being fitted on the Great Western Railway with electric lamps.

THE Great Western Railway Company is about to construct a subway from Praed-street station to Paddington station.

ON the 22nd ult. the new system of checking passengers' luggage from New York to stations on the Midland Railway came into operation.

FOR the Suakim-Berber Railway Messrs. Hulme and Lund are working nearly night and day on some large pumps for this line. These pumps are of a heavy description.

THE new railway station just built at Chatham for the London, Chatham, and Dover Company was opened on Sunday. Messrs. Naylor and Son, of Rochester, were the contractors.

THE Council of the Birmingham and District Railway Rates Association resolved on Tuesday that traders should take no part in a Rates Commission until the new Bills were either withdrawn or rejected.

THE Caledonian Railway Company is about to construct a line of railway from its Airdrie branch to Gartness, and another line from the same railway to Chapelhall, with branches to Calderbank and Chapelhall Ironworks.

FOR the Suakim-Berber Railway, Messrs. Aird, of Great Bridge, are now executing an extensive order for high-pressure tubes and fittings. These tubes are principally 3in. and 4in. lap-welded, and each tube is tested to 1200 lb. pressure per square inch.

THE shortsighted parsimony of the Government in railway engineering works has often been productive of great losses, but seldom has it been more evident than in the utter folly of stopping the construction of the Quetta Railway. This has now become painfully apparent, but luckily a good road has been made through the Bolan Pass.

THE Chicago, Milwaukee and St. Paul Railroad Company is about to undertake an enterprise which will rival that famous one of the Chicago and Rock Island. It intends to build a bridge across the Mississippi, which, it is claimed, will be on a more magnificent scale than the one already constructed by the latter corporation at St. Louis.

IT is stated in Adelaide and in Victoria that the construction of the overland line of railway is to be pushed on as rapidly as possible, and expected to be finished by about the time the South Australian line to Border Town was completed, or at all events by November, 1886. The contractors for the last section of the latter line hoped to conclude their contract by about June, 1886.

IN concluding a report on a very destructive collision which occurred on the 3rd of February at Leighton Buzzard station, on the London and North-Western Railway, Colonel Rich says:—"I would also strongly urge the desirability of mineral and goods trains being provided with more brake power. All engines, goods as well as passenger engines, should be fitted with brakes."

THE Government have granted a loan of £400,000 to Cape Colony for the construction of a railway from Hope Town to Kimberley. This line will afford very great help to the development of the colony, and will save the Government £2000 a month if the Bechuanaland operations are continued. The length to be covered is seventy-four miles, and it is thought the line can be in operation in eight months.

THE Midland Scotch express was delayed over two hours and a-half on Wednesday morning near Leicester on account of a London and North-Western goods train having caught fire at Market Harboro' Junction. Two large trucks of straw became ignited, and burnt with such fury that all traffic was blocked, both on the North-Western and Midland lines. The wagons were isolated, and the fire burnt itself out. No one was hurt.

ON the Western State Railway of Austria extensive experiments were made in 1883 in reducing passenger fares. The result was that the total passenger traffic increased 25 per cent. and the gross passenger receipts 4½ per cent. But this slight increase in receipts was more than balanced by the increased expense of handling so large a traffic. On the whole, the reductions paid on the suburban traffic, but involved a loss on the long distance traffic.

AT the annual meeting of the Birmingham Chamber of Commerce last week Mr. H. W. Elliott remarked that they did not desire the railway companies to sacrifice themselves for the interests of traders; but they did ask them to consider the state of things at present existing as compared with those which existed forty years ago, when the railways were first becoming the means for the transport of goods and the great carriers of the country.

IN 1884 the total receipts from the New South Wales railways, including tramways, were £2,302,013, an advance upon 1883 of £221,011. The estimated receipts for 1885 are £2,750,000. During the past year the train mileage run over 1480 miles of line in operation was 7,500,000. This year the number of miles in operation will be 1750, or 270 in excess of 1884; and the extra train mileage will be 1,900,000. The expenditure in 1884 was equal to 4s. per train mile, but provision has been made to make the expenditure for 1885 3s. 10½d. per mile, showing a reduction of 1½d. per mile, equal to £55,000.

A LARGE union goods station is about to be constructed in Berlin, devoted entirely to the handling of goods under custom house supervision. The arrivals by railroad of dutiable goods in transit amount to 60,000 tons annually, besides large quantities to be held in bond, and there are large shipments of manufacture for export under through bills of lading on which the Government pays drawbacks. The old accommodation is quite insufficient. The new buildings and yards in the north-west quarter of the city will cover an area of nearly 200,000 square feet, and will have direct communication with the river Spree, as well as with the Junction Railroad.

THE Bill promoted by the Birmingham Tramways and Omnibus Company, the object of which was to get powers to reconstruct their lines upon the narrow gauge system, has been rejected by the Standing Orders Committee of the House of Commons on the ground of informality in lodging it. Our Birmingham correspondent says, "As the present lease of the company expires this summer before a further Bill can be promoted, the Corporation of Birmingham will be free to reconstruct the lines and grant such leases or running powers as they see fit. This action of the Committee of the House has increased the prospects of the London Cable Company, who it will be remembered have offered to lease the tramways from the Corporation."

THE number of railway accidents in America recorded in each month of the past twelve years has been:—

	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884
January	178	108	131	60	147	75	113	62	223	137	168	147
February	133	90	211	91	56	67	88	64	149	89	184	110
March	112	88	122	109	58	49	61	65	113	99	142	115
April	101	59	60	56	69	46	50	71	63	81	106	88
May	79	89	54	64	46	50	37	46	85	94	120	76
June	90	83	61	52	49	56	64	56	73	72	91	71
July	90	64	73	79	53	54	81	78	102	92	119	89
August	150	73	114	78	98	75	79	112	129	139	144	89
September	106	89	116	106	84	76	78	124	144	153	158	100
October	88	81	88	103	82	61	104	120	131	136	174	105
November	76	82	87	96	83	68	86	145	133	125	122	96
December	80	74	84	88	66	63	69	135	113	148	112	105
Year	1283	980	1201	982	891	740	910	1078	1458	1365	1640	1191

During the twelve years covered by the table above, the railway mileage of the United States has increased from about 70,000 to 123,000 miles; and an increase in the number of accidents might naturally be looked for with so great an increase of mileage. That accidents should follow the mileage in direct ratio is not, however, to be expected.

NOTES AND MEMORANDA.

DURING February only 10 per cent. of the water supplied to London came from the chalk wells.

IN Greater London last week annual rates of 32·7 and 21·7 per 1000 of the population were recorded.

THE production of coal in Belgium, in 1884, is provisionally put at 18,300,000 tons, against an ascertained production of 18,177,754 tons in 1883.

THE production of pig iron of all kinds in the United States, in 1884, has been estimated at 4,200,000 tons, as compared with 4,595,510 tons in 1883—a decrease in 1884 of 395,510 tons.

THE regulations made under the Metropolis Water Act make it necessary that lead pipes should be of the following weight:—⅜in. diameter, 5 lb. per lineal yard; ½in., 6 lb.; ⅝in., 7½ lb.; ¾in., 9 lb.; 1in., 12 lb.; 1¼in., 16 lb.

THE highest flood state of the river Thames at West Molesey during February was 3ft. 6in. above summer level mark, and the lowest was 1ft. 3in. above that mark. The rainfall at West Molesey during the month was 2·32in., the rainfall during the whole of the year 1884 having only been 15·06in.

THE deaths registered during the week ending March 28th in twenty-eight great towns of England and Wales corresponded to an annual rate of 23·2 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The six healthiest places were Portsmouth, Derby, Bradford, Brighton, Bolton, and Birmingham.

IN London last week 2537 births and 1734 deaths were registered. The annual death-rate per 1000 from all causes, which had been 21·4 in each of the two preceding weeks, rose to 22·2, and exceeded the rate in any week since the end of January. During the first twelve weeks of the current quarter the death-rate averaged 21·6 per 1000, against 24·2, the mean of the rates in the corresponding periods of the nine years 1876-84.

THE number of miles of streets which at present contain mains constantly charged, and from which constant supply can be given, and upon which hydrants for fire purposes could be fixed, in each district of the metropolis, is as follows:—Kent, about 85 miles; New River, about 230; East London, 120; Southwark and Vauxhall, 130; West Middlesex, 92¾; Grand Junction, 74; Lambeth, 178; Chelsea, 71½, making a total length of about 981¼ miles.

THE total quantity of coal produced in France in 1882 has been returned at 20,046,796 tons, in addition to which lignite to the amount of 556,900 tons was likewise obtained. The men both above and below ground employed in the extraction of this quantity numbered 108,269, of whom 30,458 were employed above, and 77,811 under the surface. The number of collieries at work in 1882 was 252, and of lignite workings there were 56, making a total of 308.

THE Board of Trade have received, through the Secretary of State for Foreign Affairs, a copy of a despatch from her Majesty's Legation at Berne, enclosing a decree of the Swiss Federal Council in regard to the control and warranty of manufactured articles of gold and silver. This decree provides that the standard designations marked at the Swiss Assay-offices on gold and silver work are to indicate in decimal fractions the degree of fineness of the metal as shown in the degree. For gold, however, there may be admitted the following carat marks:—18 "karats," or 72-18k., for the standard 0·750; 14 "karats," or 56-14k., for the standard 0·583. To facilitate the introduction in Switzerland of the decimal or millesimal marking, existing marks are also to be allowed until the 30th of June, 1885. Copies of the marks may be seen at the Harbour Department of the Board of Trade on any weekday between the hours of twelve and four.

MR. THOMAS KAY, of Stockport, lately read a paper before the Manchester Literary and Philosophical Society in which he suggested a method of making sea-water potable by precipitation. He suggests that every ship's boat should be supplied with a quantity of citrate of silver, which should be used for precipitating the chlorides, leaving the sodium, potassium, magnesium, and other constituents in solution as citrates. The solution would be similar to ordinary effervescing draughts after the gas has escaped; it would be slightly aperient or slightly diuretic if taken in too large quantities, but still suitable for moistening the parched mouth. The expense of the silver would be but a small addition to the capital sunk in a ship, and the interest on it would be a small insurance premium against thirst in case of disaster. The value of the silver would not decrease, and could always be realised if disaster did not occur. The scheme seems practicable if the solution of citrates is sufficiently weak to be potable; only experience can prove this. The silver, being very portable, not easily identified, and easily reduced to metallic silver, would offer great temptations to petty larceny.

SOME interesting mementoes of the siege of Gibraltar have just been landed at the Royal Arsenal, Woolwich, from her Majesty's storeship Wye. They consist of three guns and a mortar, which have been recovered from the French and Spanish ships sunk in the bed of the Mediterranean. These vessels were no doubt sunk by the fire of the British under General Elliott, between the years 1779 and 1783. They are in a very fair state of preservation. Two of the guns, which are about 9ft. long, and of 6in. and 8in. bore respectively, have on the breech a shield bearing a cross, the whole surrounded by a wreath of laurel leaves. On the cascable of one of the guns is a griffin with extended wings and claws, there being a band of ornamental griffins round the muzzle, and an eight-pointed star on the chase. On the breech is the representation of a man's face with a large moustache, the mouth forming the touchhole. These guns bear no inscription. The third gun is a long brass 9-pounder, and has the words "Le Flambeau" on the chase, and round the breech is a partly-effaced inscription, of which the words "Strasbourg le 17 × bre 1767 par J. Bte Dartein Commisre des fontes de"—remain legible. The mortar is of brass, and is highly ornamented. On the breech is a shield surmounted by a crown, and surrounded by field-pieces and trophies of war. The war trophies thus singularly recovered after great lapse of time have been brought home by order of her Majesty's Government, to be preserved as mementoes of one of the greatest sieges on record.

"CHEMICAL Changes which Accompany the Hardening of Hydraulic Cements," forms the subject of a paper by H. le Chatelier, in the Bull. Soc. Chem., 42, 82-89. The setting of hydraulic cements is the effect of the crystallisation of dissolved substances; in ordinary mortars the act of drying in addition plays a part. The most important body concerned in the hardening of hydraulic cements is the compound $CaO.SiO_2+2·5H_2O$—this formula has not been obtained by analysis, but by analogy with the crystallised compound $BaO.SiO_2+3H_2O$—which is decomposed by water into free lime and a salt of silicic acid ($2SiO_2.CaO+Aq.$?); by carbonic acid and water into silica and carbonate of lime. The first decomposition is arrested when the water contains 0·052 per mil. of lime. The formation of this silicate by hardening is produced either by combination of the two constituents or by decomposition of silicates richer in lime, or perhaps by simple hydration of the anhydrous compound. The compounds of lime with oxide of iron or alumina which can exist in water in presence of excess of lime have the formula $R_2O_3.4CaO.12H_2O$ (R = Al or Fe), and are split up with water alone; but decomposition stops in presence of water containing, at 15 deg., ·225 and ·6 per mil. of lime respectively. Iron and alumina are important as fluxes in preparing the mortar by bringing the silica into combination with the lime. The absorption of carbonic acid is of no moment in the hardening of cement, calcium carbonate always forming a superficial layer. This layer is, however—as remarked in the *Journal* of the Society of Chemical Industry—important, for, as the carbonate gives up a minimum quantity of lime to water, the durability of the cement is thereby increased.

MISCELLANEA.

THE King and Queen of Belgium will open the Antwerp Exhibition on May 2nd.

A GAS explosion occurred in a colliery at McAlister, in the Indian territory, on Friday last, and killed everyone in the pit—in all eleven persons.

THE Wirral and Birkenhead Agricultural Society's show will be held at Birkenhead on the 17th, 18th, and 19th June; nearly £1000 are offered as prizes.

THE American Naval Appropriation Bill provides 1,780,000 dols. for the completion of a steel cruiser of not less than 5000 nor more than 6000 tons displacement, and armament therefor.

SOUTHAMPTON is waking up. The Corporation have approved of a recommendation to lend to the dock company nearly a quarter of a million of money for the construction of deep water docks.

THE Washington monument is reported by the *Scientific American* to be in danger of falling. The area of the foundation, exclusive of a space in the centre not directly loaded, is given as 8277 square feet, but even with this area the load is said to be 11 tons per square foot without wind.

NEGOTIATIONS are almost completed for the purchase, by the War-office, of the Sparkbrook factory of the National Arms and Ammunition Company, Birmingham, which went into liquidation three years ago. The Government repairing factory in Bagot-street, Birmingham, is inadequate to their needs.

THE Comptroller of the Bridgehouse Estates announces that on and after Monday, the 13th inst., London Bridge will be partially closed for the purpose of re-paving. During the execution of the work provision will be made for keeping open two lines of traffic, one leading to the City and the other to Southwark.

A SERIOUS colliery explosion occurred on the 27th ult. at Dombrau, in the coal district of Ostrau, Moravia, not far from Karwin. The number of deaths reported is forty-one. The *Times* Vienna correspondent remarks that this new disaster verifies the observations recently published by the eminent geologist, Rudolph Falb, who asserted that colliery explosions usually coincide with earthquakes.

THE *Electrical World* says it is asserted that refined petroleum in tin cases exerts an influence on the compasses of a vessel equal to the same quantity of iron or steel. The masters of the German ship J. Weisselholm and the schooner Maggie Dalling have sent in reports confirming the above statement; and in the latter case the captain asserts that his vessel went ashore through an error caused by cased petroleum. What do the marines think of this?

A COMPANY is being formed for the manufacture of Dement's printing apparatus, by means of which two operators of machines can print, space, correct, and justify matter dictated from shorthand notes. The first machine consists of a form of type writer which prints on a strip of paper, which passes to a second operator who cuts it, corrects and justifies, and makes up into pages which are laid down on stone. The process is said to be very rapid, and specially suited for law reports and similar work.

TRADERS in North Staffordshire view with suspicion certain clauses in the Manchester Ship Canal Bill. It appears that in dealing with the waterway passing through Runcorn and Ellesmere Port, the promoters propose to obtain powers which it is believed will enable them to impose a toll upon the importation of raw materials and the exports of manufactured goods, where none now exists. The promoters state that the clause has been misinterpreted; but the North Staffordshire Chamber of Commerce has appointed a committee to watch the Bill.

THE *Melbourne Leader* says:—"We are told that the new mallee roller is fast making its way among the holders of the mallee, and appears to be a decided success wherever tried. Mr. J. Keyte, Mount Arapiles, is using one on his block that he had made to order, weighing over three tons. He has already rolled down 300 acres, and so well has it been done that he intends clearing more land after the busy season is over. Not only does the roller break down the mallee, but the rabbits flee before it. After a period the broken mallee can be burnt, and thus serves the double purpose of clearing the land from scrub as well as destroying a vast number of rabbits."

ON Saturday last the s.s. Transition proceeded to sea from the Middlesbrough Dock, which has been built by Messrs. Raylton Dixon and Co., the launch of which we noticed a short time ago, and pointed out that she is the first vessel built of steel manufactured in Middlesbrough. Her dimensions are 267ft. by 36ft., by 19ft. 6in. moulded, with a dead-weight capacity of 2350 tons. The engines, which were built by Messrs. Blair and Co., of Stockton, are on the new triple expansion principle, having three cylinders, working direct on to three cranks, with a boiler pressure of 160 lb., and will, it is expected, show an economy in coal consumption which, by previous experience, may be taken as at least 30 per cent. The engines, which are of 140-horse power nominal, gave a speed of from 9½ to 10 knots, loaded with a full cargo of bowl chairs and railway material for Alexandria, with which which she proceeded direct, after a most satisfactory trial trip.

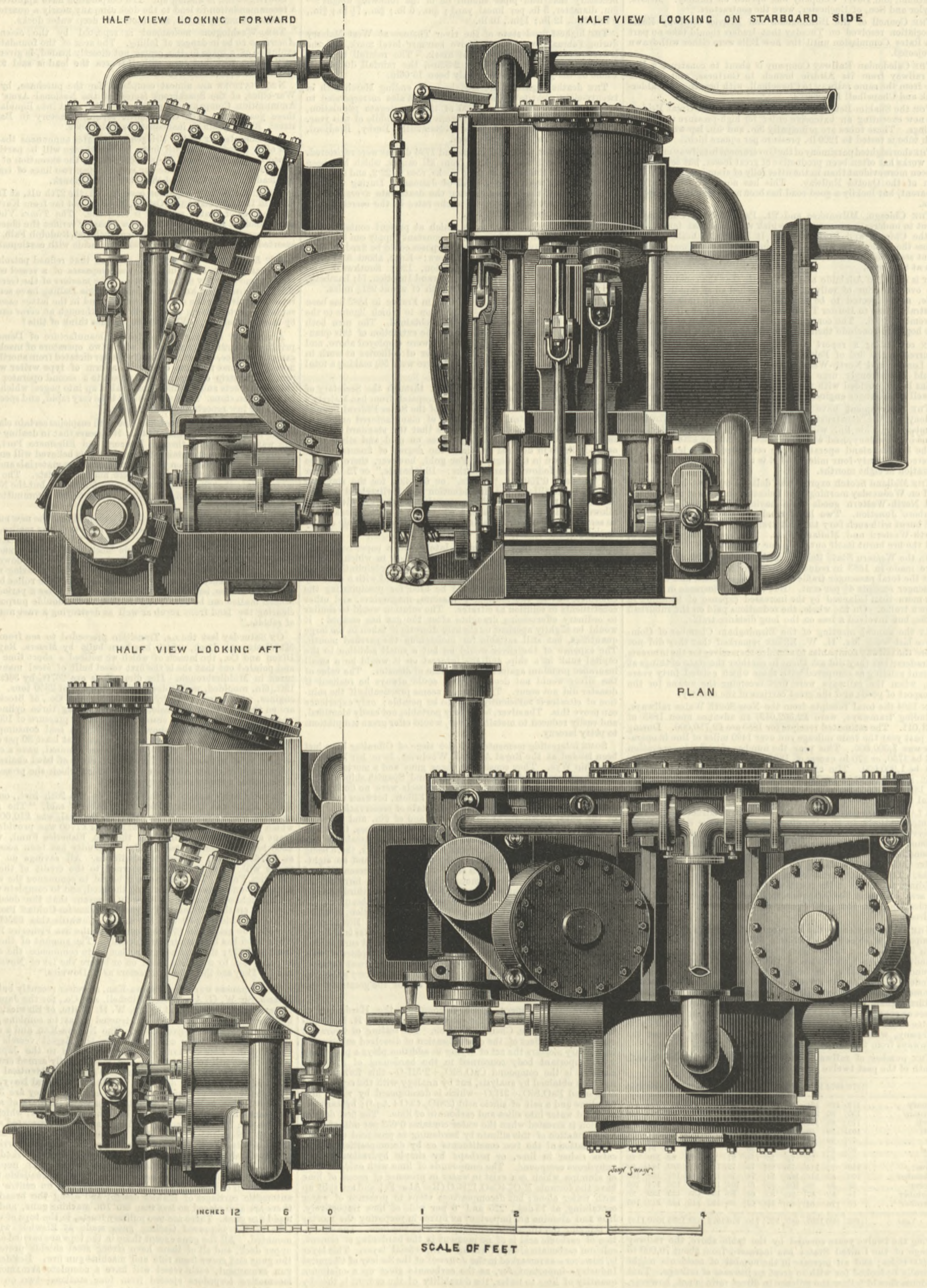
IN reply to a question in the House, on the 26th inst., on the Malin Head and Culdaff Piers, Mr. Hibbert said, "The gross estimate for Malin Head Pier, County Donegal, was £10,000, of which £9500 was for works. Towards this £7700 was provided by grant and £2000 by loan from the Sea Fisheries Fund, while £300 has been contributed locally. A tender has been accepted at £7765, subject to certain conditions. All savings on such works will, when realised, be returned to the credit of the Sea Fisheries Fund. The contractor is bound to commence the works in twenty-one days after executing the deed, and to complete them within eighteen months. I learn by telegram that the deed was executed on the 24th inst. The gross estimate for Culdaff Pier was £4000, of which £3680 was for works. Towards this £3500 was provided by grant and £250 by loan from the Sea Fisheries Fund, while £250 has been contributed locally. The amount of the contract is £2349; the contractors are bound to commence the works at once, and to complete them on or before the 1st of November next. They are the same contractors as at Downies."

THE Japanese war-ship, Naniwa-Kan, a cruiser recently built by Messrs. Sir W. G. Armstrong, Mitchell, and Co., for the Japanese Government, was designed by Mr. W. H. White, of Elswick, and, like the Esmeralda, has been constructed so as to combine great speed with great offensive power. The Naniwa-Kan and a sister ship, which is nearing completion, are the largest vessels ever built by the Elswick firm, and when delivered to the Japanese Government will be the swiftest and most heavily armed cruisers afloat. In dimensions the new cruisers are almost identical with the Iris and Mercury, despatch vessels of the Royal Navy, and the Leander class of partially-protected cruisers. They are 300ft. in length, 46ft. in breadth, draw 18½ft. of water, and are of about 3600 tons displacement. They have twin-screw engines, which are to develope 7500-horse power at least, and their estimated speed is from 18 to 18½ knots. The armament includes two 28-ton 26 centimetre guns, mounted on centre pivot automatic carriages, as bow and stern chasers. These heavy guns are worked and loaded by means of hydraulic mechanism, which is an improvement on that fitted in the Esmeralda. On each broadside there are three 15 centimetre guns of 5 tons each, also on centre pivot automatic carriages of Elswick design, and along the broadsides there are also placed no less than ten 1in. machine guns, and two rapid fire guns. There are two military masts, in the tops of which four of the improved Gatling guns made at Elswick will be mounted. All the guns except those in the tops are carried on the upper deck, and all of them have strong steel shields protecting the guns and crews from rifle and machine gun fire. Besides the gun armament, each vessel will have a complete armament of locomotive torpedoes ejected from four stations—two on each broadside, situated at a small height above water.

TWIN SCREW ENGINES OF THE TUG AMERICA.

MESSRS. COCHRAN AND CO., BIRKENHEAD, ENGINEERS.

(*For description see page 262.*)



TO CORRESPONDENTS.

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

A MILLWRIGHT.—*About 4-horse power will drive a pair of 4ft. stones with their share of the bolting machinery.*

J. L. (Barrow-in-Furness).—*We do not think your invention is new, and it does not work satisfactorily in practice.*

S. W. D. D.—*There are so many boot-cleaning machines already made that we cannot undertake to supply the particulars you ask for.*

F. R.—*So far as we can see your boiler is not new; one very similar is made for steam launches by Messrs. Burrell, of Thetford. Your steam chest is identical with theirs, and so is the arrangement, broadly speaking, of your furnace.*

TRANSMISSION OF POWER.—*Letters for "Chaff-cutter" on this subject await his application. They are from Messrs. Gardner and Co., Armagh; T. Thomas and Son, Cardigan; Warsop and Hill, Nottingham; and Harpers' Limited, Aberdeen.*

MEETING NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 7th, there will be no meeting, it being Easter Tuesday. Friday, April 10th, at 7.30 p.m.: Students' meeting. Paper to be read and discussed, "On Machines for Crushing Stone and other Hard Materials," by Mr. S. Tomlinson, Stud. Inst. C.E. Mr. John Brunton, M. Inst. C.E., in the chair.

THE ENGINEER.

APRIL 3, 1885.

STEEL BOILERS.

ONE of the most important papers read at the recent meetings of the Institution of Naval Architects was that contributed by Mr. W. Parker, the Chief Engineer Surveyor of Lloyd's Register of Shipping, upon the "Use of Thick Steel Boiler Plates." This paper, which we print *in extenso* in another page, describes the bursting of a steel marine boiler while under a preliminary hydraulic test, and the subsequent investigation into the cause of the rupture. It gives the conclusions arrived at by Mr. Parker, and it appears to have been brought forward at the meetings with a view to eliciting the opinions upon the subject of the various steel makers and steel users who usually attend the meetings of the Institution.

From the paper and the subsequent discussion it appears that the boiler in question was made by the Wallsend Slipway Company, a firm which has had an unusually extensive experience in the manufacture of such boilers, being one of the first to use mild steel for boiler-making purposes, and having made no fewer than 175 steel boilers. The steel was made on the Siemens-Martin process by Messrs. D. Colville and Sons, of Dalzell, Motherwell, who enjoy the reputation of producing a material second to none in the country. The plates were all tested at the steel works and fulfilled the requirements of both Lloyd's Register and the Board of Trade, the test piece cut from the particular plate which fractured withstanding a tensile stress of 29·6 tons per square inch, and having an elongation of 20 per cent. in a length of 8in., whilst strips cut from it were bent cold almost double. The boiler was 13ft. diameter, 16ft. long, and was intended to be worked at a pressure of 150 lb. per square inch. The cylindrical shell plating consisted of eight plates only, so that the individual plates were of excessive dimensions. The plate which gave way measured 20ft. long, 5ft. 6in. wide, and was 1⅛in. thick, its weight being about 2 tons 16 cwt. From the statement of the steel makers it appears that the plate was annealed at the steel works after it was rolled and sheared to size, being uniformly heated and allowed to cool, and that the test pieces were cut from the shearings of the plate after they had also been annealed. At the boiler works the plate was first drilled and was then heated in a furnace to the suitability of which some objection was raised on behalf of the steel makers. It was a large furnace heated from three firing places. When first taken out, the plate was found to be more heated at one end than at the other, and it was then turned end for end and replaced in the furnace. When again drawn out it was still not uniformly heated. It was then passed through a set of powerful vertical bending rolls, through which it passed six times before it became bent to the required curvature. By the time this operation was completed one end of the plate had become nearly cold, while the other end was at what is called a blue heat. The whole of the rivetting of the cylindrical shell, except that of the seams connecting it to the end plates, was performed by a machine rivetter, the end seams being rivetted by hand. On testing the boiler, at a pressure of 240 lb. per square inch, the shell gave way, tearing right across the whole width of the plate. The crack showed, moreover, that in its vicinity the plate possessed no ductility, as there was not the slightest stretch or draw at the fracture. It is worthy of notice that the crack at the outer edge of the plate coincided in position with the seam connecting the upper end plate to the tube plate, and it was suggested during the discussion that possibly the shell had become locally heated at this part, in order to properly close the seams.

After the accident the plate was taken out of the boiler and various test pieces were cut from it. These pieces showed a strength ranging from 29·5 tons to 34·2 tons per square inch, the elongations varying from 28·1 to 13 per cent. in a length of 8in. The two pieces showing the highest strength were taken from alongside the crack, their tenacities being 33·5 and 34·2 tons, and their elongations 13 and 16 per cent. respectively. Bending tests were also made from pieces just as they were cut from the fractured plate, from other pieces after they had been annealed, and from others which were heated and quenched in water. Those which had been annealed bent almost double without fracture, the unannealed pieces bent through angles of 49 deg. and 61 deg. before breaking, while the quenched pieces broke at the first blow of the hammer without any bending whatever. Some samples of the plate submitted to chemical analysis showed it to contain over ·3 per cent. of carbon, an amount which is high for boiler plates. Steel used for thin plates to stand the same mechanical tests as this thick plate did, should not contain more than from ·15 to ·18 per cent. of carbon. From these results Mr. Parker draws the conclusion that the material from which the plate was made contained sufficient carbon to enable it to take a temper, and that the plate must have become partially tempered by the heating and cooling to which it was subjected in the process of rolling it into its cylindrical form. The heating not having been uniform the tempering was not uniform. When the pressure was put on the boiler the more tempered or harder parts of the plate yielded less than the softer portions, and therefore became more strained, the stress becoming so unequally distributed that the breaking strain was produced on some parts of the material by a pressure less than one-fourth of that which would have been required had the tempering been uniform. An experiment was made to ascertain the effect of work in the shape of rolling upon the tenacity and ductility of steel. A slab containing ·33 per cent. of carbon was rolled in one heat down to ½in. in thickness, and its tenacity was found to vary from 35 to 41 tons per square inch, with an elongation of 21 to 24 per cent. When heated and quenched in water, this plate had a tenacity of 44 to 45 tons per square inch, with practically no elongation. If this slab had been rolled to 1⅛in. plate, its tenacity would have been between 30 and 34 tons per square inch.

It thus appears that with a given amount of carbon in a slab of steel, the thinner it is rolled the higher is the tenacity of the resulting plate; and as the mechanical tests required to be withstood by all steel to meet the requirements of the Admiralty, Board of Trade, and Lloyd's Register are irrespective of the thickness of the plates, it is the practice of steel makers to appropriate the charges of steel containing a low percentage of carbon for making thin plates, while those with a larger percentage are used for thick plates. In all cases, however, the amount of carbon in steel intended for boilers should not be sufficient to allow of the plate to be capable of tempering, and there is no doubt that the great confidence which is at present felt in mild steel, and which has enabled it to so completely supersede iron for so many purposes, has been won by its mildness—that is, its incapacity for acquiring a temper when heated and suddenly cooled.

The discussion which followed the paper was not so full and comprehensive as the importance of the subject demanded. It was stated by one of the steel makers present that the treatment to which the plate had been subjected in the boiler shop was faulty, inasmuch as it is dangerous to put work in the shape of bending or flanging upon steel when it is at a blue heat, as was done in this instance, unless the plates are subsequently annealed. It is pretty generally known that while steel is at this temperature its ductility is considerably impaired, so that it is then dangerous to manipulate it for fear of fractures occurring during the working; but the knowledge that the ductility is permanently affected—at least, until a subsequent re-heating to redness—is not so well known. It is generally considered that if the working at the blue heat is successfully withstood, there is no further danger; but if there is much loss of ductility, this cannot be too well known, as in very many important structures in which accuracy of fitting of plates is essential the plates are necessarily finally closed together at temperatures below red heat. As we have previously intimated, objections were also raised to the furnace in which the plate was heated, as the heating of the plate in it was not absolutely uniform. It is worthy of note, however, that very many hundreds of plates had previously been successfully heated in the same furnace without any difficulties arising. Further, on this point, and on that raised as to the temperatures at which the plates should be rolled, if the steel plates supplied for marine boiler shells require absolute uniformity of temperature, and also a very high temperature in order to be successfully rolled to their proper curvature, very different appliances will have to be introduced for the purpose than those which are at present to be found in the most modern establishments; for with such massive plates as those now in use, even at the comparatively low temperatures at which the plates were rolled in this instance, the heat radiated from them must render it very difficult for the workmen to approach sufficiently near to them to successfully bend them with the requisite accuracy, while the larger masses of comparatively cold metal forming the rolls must also, in some degree, cool the plates locally, especially near the ends where there is longer contact with the rolls during the reversal of the motion.

It was urged by some of the speakers that this one case of accident was not sufficient to justify any alarm at the gradual tendency there has lately been to use steel of high tenacity, that it would be extremely imprudent if, in a panic, the use of milder steel should become enforced, and that we should not throw away the advantages already gained by the use of stronger steel. To these views we also strongly hold; but at the same time we most distinctly wish to draw attention to the fact that stronger steel does not always mean stronger structures, and it is by the strength of the steel in the structure, and not its strength as shown by a test piece, that we should govern our practice. The boiler which gave rise to the paper is one of the strongest cases in point. Here the strength of the steel in the test piece was, say, 30 tons, against its strength in the structure of 7 tons; that is to say, the treatment which the plate received, and, it would appear, must necessarily receive before it can become part of the structure, was such as to render it non-uniform in strength and ductility, so that it broke down piecemeal. If it had been a milder steel—say, of 26 tons per square inch—and so incapable of taking a temper or of being injured by irregular heating, its strength in the structure must have more nearly approached that of the test piece. In such a case, therefore, the use of mild steel would produce a stronger structure. In other structures, however, in which it would be possible to so fix the plate to its position as not to alter its condition from what it was when delivered as an annealed plate from the steel works, it, no doubt, would happen that a strong or high steel could be more advantageously used than a milder one.

Before fixing the limits of strength, therefore, for steel for any structure, it is necessary carefully to consider all the conditions to which the material will be subjected before it becomes an integral part of the structure, as well as those to which it will be subjected as part of the structure. The latter considerations alone in some cases demand that the steel shall be as mild as possible, in order to withstand inevitable deformation without excessive straining; while in other cases, in which the strains are steady and regular, and moreover capable of being accurately ascertained beforehand, a harder steel may be most advantageously used. But the considerations as to the conditions to which the steel is subjected in forming it into the structure are too frequently overlooked; and it is too often taken for granted that the test-piece strength must necessarily be also the strength of the material in the structure. If this accident should prove to be the means of drawing greater attention to this very important consideration, it will prove to be very valuable.

ELECTRIC MARINE GOVERNORS.

WHEN we read, as we have recently done, of vessels like the Servia being so acted upon in a heavy sea as to expose their screws, all acquainted with marine matters must realise fully the racing certain to ensue, and the consequent risk to which the machinery of the vessel would be submitted. We have but to contemplate the possible results to heavy masses of machinery suddenly put into violent motion, and being as suddenly checked when the screw again obtains its grip in the water, to be able to estimate the strains brought upon each individual section of that machinery. With ships of great length, although they must be, comparatively speaking, free from exposure of the screw in what would be for shorter vessels very considerable seas, it is certain that, when subjected to extraordinary wave action, they are more liable to racing than the latter. Riding, so to speak, on the summit of two or more waves, their sterns must infallibly be out of water in the trough of the last following wave, and from this cause there is reason to apprehend for such ships a very frequent danger of racing during exceptionally heavy weather. As the tendency is in these days more and more to increase the length of vessels, it is desirable that the liability above pointed out should be counteracted by the most efficient means at command.

Of late years, no doubt, great strides have been made in the improvement of marine governors. It is no longer absolutely necessary, as in days within our own recollection, to supplement the mechanical action of such governors by manual attention, though we by no means say that it is not desirable at times that this should be given. We have now governors of a far more sensitive character than were formerly available; but still we think there are few marine engineers who would claim such perfection for them as not to admit the desirability of their further improvement, and we propose, therefore, to consider some of the means we have heard suggested for effecting this. It is the fact that, as at present constructed, no governor, except perhaps Dunlop's, can commence its action until increase of speed is attained. What is really the great desideratum is, that that increase should be foreseen, and the supply of steam checked, not only before, but some little time before the normal rate of speed is in the least augmented, this anticipatory action in a very full degree being rendered necessary by the fact that the compound engine always contains steam enough to set it racing even after the throttle is quite closed. To effect this end the governor must act correspondingly with the diminishing depth of water in which the screw is immersed. For every foot of such, or fraction of a foot, diminished depth there must be a simultaneous action on the throttle valve. We are acquainted with several devices for utilising this principle, but they all depend upon the action of the water column directly upon the valve itself, and this is found in practice to be either too slow or too impulsive to ensure that steadiness of action which shall ensure immunity from shock, either by acceleration of speed or from too sudden a check to it being given. What is needed, it appears to us, is an intermediate agent, instantaneous in action, but capable of modulation. We need instead a telegraph between the signalling force and the controlling medium.

Such it is certain may be given by the aid of electricity. By it the least variation in the depth of the water column may be conveyed to a sensitive governor, through whose action steam may be checked in proportion to the necessity indicated by the relative strength of the electric current. It is needless for us to point out here the many ways in which that strength may be increased or diminished at will. In principle, its action would be identical with that of the eye and the hand of the skilled engineer whose practice it was in days past to stand by his valve and act as his sensitiveness to the ship's motion dictated. In a principle so employed we see, we believe, the true method of obviating the disabilities to which our system of screw propulsion is most undoubtedly exposed—disabilities which render it necessary to give to every part of marine engines a strength in excess of what the normal exercise of power would require, and a consequent weight, which might be reduced if the possible strains to be incurred could be foreseen as we have indicated, and the danger of them met and checked in advance. But while stating our conviction that it is in the direction pointed out that the solution of this problem may be found, we may usefully refer to another proposition made during a recent discussion of the subject by practical men. This proposition was based upon the argument that, equivalent in significance of warning with the diminishing depth of the column of water at the stern of a vessel must be the alteration in the normal line of a ship's floatation; and we heard it argued, therefore, that any variation therefrom might be made by the action of a weight suspended vertically to the line of that floatation to give instantaneous action on the throttle valve. It is not difficult to see primary difficulties in the way of utilising this suggestion. In the first place we may ask, how could a normal line of floatation be maintained? It would of course be easy enough to establish this while a vessel lies in dock in readiness to put to sea; but every day's consumption of coal and stores would affect it so materially, that an engineer would daily have to adjust his governor to its variation. In such a weight also there would not only be the reaction certain to produce effect in a reverse direction to what is desired, but there would be a moment of inertia with it, during which the increase of speed we have named as the present danger would be seen to arise. In an efficient governor of existing design, we have a most sensitive, and yet powerful and well-regulated instrument, which it is only necessary to get to act in anticipation of speed to secure all that we could desire. This qualification, we consider, could be imparted to it instantaneously by the means we have pointed out before the varying depth of immersion could affect the propeller, and the least chance of racing would be anticipated and prevented. Well regulated, such an agency would work with all the intelligence of human control, while it would not be subject to the operations of those causes which must always render a control of that nature fallible. We are not aware that any attempt has been made as yet in the direction of our suggestion, but we believe it might usefully engage the attention of practical men.

THE SOUTH YORKSHIRE COALOWNERS AND THE RAILWAY COMPANIES.

South Yorkshire coalowners for many years past have recognised the disadvantages under which they are placed with other coal-producing parts of the country, in regard to the comparatively heavy railway rates they have to pay for the carriage of their coal to seaport towns for export. This matter has been frequently brought before the notice of the railway companies. About a month ago it was arranged at Barnsley that a deputation from South Yorkshire should wait upon the general managers of the North-Eastern and Manchester, Sheffield, and Lincolnshire Railways. In fulfilment of that decision, a deputation waited on those gentlemen on the 23rd ult., at York. The collieries of West Yorkshire are nearer Hull than those in South Yorkshire, though some of them to no great extent. Comparing the rates of carriage charged by the North-Eastern Railway from the West Yorkshire collieries, it is found that West Yorkshire owners are paying from 15 to 20 per cent. less than the rates from South Yorkshire, taking into account the mileage; that is to say, that South Yorkshire collieries are paying from 15 to 20 per cent. more per ton per mile, on an average, than the West Yorkshire coalowners pay. The South Yorkshire coalowners feel that this disadvantage should not exist. At the interview on Monday fortnight, it was also pointed out that the ports of Boston and Lynn had made extensive accommodation for the shipment of coal, and that the Midland and Great Northern Railways are carrying coals to those ports, a considerable greater distance than from South Yorkshire to Hull or Grimsby, at nearly one-half the rate per ton per mile South Yorkshire is paying. In fact, to Boston coal is carried an average distance of over seventy miles, whilst the average distance in South Yorkshire is only fifty-five miles, and that at rates for shipment of 9d. per ton less than the South Yorkshire collieries are paying for shipment at Hull or Grimsby. It is a great disadvantage to South Yorkshire coalowners that they are on an average fifty-five miles from the seaport towns, but instead of this disadvantage being recognised by the railway companies and concessions made, the coalowners have hitherto appealed in vain. Now that the Hull and Barnsley Railway will be opened in a few months, it is generally felt that a considerable concession will be made, as this railway was constructed principally for the development of the South Yorkshire coal trade. It is thought that the railway companies would do a graceful act if they would now give such a concession as would enable South Yorkshire coalowners to send a larger proportion of their coal for shipment than they have hitherto been able to do.

In the year 1884 the exports from Newcastle and Shields and other ports in the North-East of England amounted to 7,797,234 tons, independent of coke exports; and the coal sent coastways to London and the various ports in the United Kingdom from the same North-Eastern ports amounted to 6,698,874 tons, making a total of nearly 15,000,000 tons. Of course a great many of the collieries in Northumberland and Durham are only ten or twelve miles from the seaport towns; but there are, on the other hand, a number of collieries in Durham that are thirty-five or forty miles distant, and even these are placed upon an advantage as to rates with South Yorkshire coalowners. If we compare these figures with the meagre exports from the Humber ports of Hull, Goole, and Grimsby, which in 1880 amounted to 1,341,150 tons exported abroad, and sent coastways 210,705 tons, together very little exceeding one and a-half million tons, it is considered that with proper facilities and encouragement from the railway companies this amount of export might be doubled, trebled, or even quadrupled in a short time, and so benefit the colliery industry in South Yorkshire, and ultimately even the railway companies. It was represented to the railway companies that exporters from the Humber to Holland and North Germany were placed at greater disadvantages than formerly in disposing of the coal in these countries, owing to the very low rates at which the German and Dutch railways conveyed German coal to the large towns in Holland and North Germany, and that the trade in English coal was diminished on this account. The output of coal in 1884 in Northumberland and Durham amounted to 36,068,308 tons. It will be seen what a large proportion the coal shipped from these counties, amounting nearly to 15,000,000 tons, bears to the whole of the coal raised in these counties as compared with Yorkshire, which raised in 1884 19,220,144 tons, and only exported and sent coastways about one and a-half million tons. To the coalfield of Yorkshire may be added that of Derbyshire and Nottinghamshire, which raised in 1884 13,672,604 tons; these three counties comprising the great midland coalfield, and giving an output very little short of the output from the north-eastern coalfield of Northumberland and Durham. Owing to the depressed state of the iron and steel trades, the consumption of coal in Yorkshire, Derbyshire, and Nottinghamshire has not been equal to what it was formerly. The coalowners would therefore very gladly see further outlets for their coal, such as more liberal arrangements for export would secure to them; and it is considered that if the railway companies would give greater facilities, the coal trade of this great central midland coalfield would improve, and the railway companies, from the increase of traffic, would ultimately benefit.

SHIPPING FREIGHTS.

These are difficult days for shipping firms and shareholders in shipping companies. Even old-established lines whose steamers made their reputations years ago find it hard to make both ends meet, and shipping company after shipping company calls its shareholders together to hear the old story of dividends lost in unremunerative freights. Two years ago there was a great deal said and written about what was called "The Australian Freight Ring." The object of the combination was stated to be the abolition of competition in the freight market to the Australian colonies. This was done by chartering vessels and regulating the tonnage on the berth from time to time, so as to maintain high rates of freights. The "Ring" was condemned by some former lists as the middleman in shipping. "It neither toils nor does it spin. It does not build ships; but by virtue of the power which combination gives it, it contrives to levy a toll on the shipowners on the one hand, and on the Australian colonists on the other." Thus wrote one of the special organs, and even the sober-lined *Economist* broke out with: "Truly Australian merchants are a long suffering people. Were it not so, the league among shipbrokers, against which we have again and again protested in the interest of the commercial and ship-building classes, would have been broken up before this. It still flourishes, however. . . . There is not, and has not been for some time, a single sailing ship, open to make engagements for cargo, loading in London for Melbourne. If a broker, not being one of the favoured few, were to put on a ship to meet merchants' wants he would at once be run to death by the Ring. Knowing this, outside brokers hold aloof, and leave merchants to the tender mercies of the League." This was written in the end of 1883, and the whole of the controversy is now reproduced by a London firm of shipping and insurance agents, who have taken the bold course of organising an entirely new and independent line of first-class steamers, which are dispatched once every seven days from London, Liverpool, or Glasgow to Australasia. This firm have large connections in the Midlands, and they are now bringing the results of "the Ring" before their clients with a view to enlisting the practical co-operation of producers for the Australian colonies. They enclose with their communications a telling extract from one of their Australian firms, dated January of this year:—"All we can do," they write, "to break the Ring we are prepared to do, as German houses here are now securing orders for heavy lines that formerly went to England; and if Hamburg freights are not advanced or London freights reduced, the German manufacturers will have all the iron and cement business with Australia. We have lost contracts for 45,000 barrels of cement, through freight being procurable 50 per cent. less from Hamburg than from London. How long will this be stood by English manufacturers?" In a postscript the firm add:—"The above remarks equally apply to many other goods besides iron and cement."

CURIOSITIES OF GAS-LIGHTING.

Not uncommonly ordinary illuminating gas is passed through or over solid or liquid hydrocarbons, and increased light is obtained at the burners, to the intense satisfaction of the consumer who takes the trouble to adapt the necessary apparatus to the main pipe, and to keep up the hydrocarbon supply. No rose is without its thorn, says the proverb, and in the case of the use of other hydrocarbons to increase the illuminating power of gas, the thorn may be hidden. Mr. F. H. Varley, the electric lighting engineer, upon whose authority the following statements rest, tells us a curious story. A case once came under his notice in which twelve batswing burners, which had a gas meter to themselves because of the room being let out, were used to light a billiard table. The burners were then reduced to four, and the gas before reaching them made to pass through a carboniser containing crude benzol or coal-tar naphtha, said to give a saving of 50 per cent. in the consumption of gas. As the four burners of the same pattern seemed to the eye to give as good a light as the twelve previously used, a saving of 50 per cent. at least was expected. Everything was perfectly satisfactory until the gas bill came in, when it was discovered that, although only four burners had been going, more gas than before had passed through the meter. This was a surprise, and Mr. Varley, who had been instrumental in recommending the change, and who was loth to think his advice to be wrong, recommended a trial of another quarter of a year's duration, to see if it corroborated the first quarter's experience. The increased consumption continued; so to get at the cause of the phenomenon he tried the following experiment:—A measured quantity of common gas was passed through a washing-bottle filled with wool saturated with benzol; it was then collected in a bell glass over the pneumatic trough, when a reduction of the bulk of the gas was discovered, and on again passing the gas through the benzol vapour, a further reduction of its bulk was effected. It therefore became clear that the increased luminosity was not entirely due to admixture with the vapour of benzol, but that there was an actual condensation, or a change of the light carburetted hydrogen into a heavy carburetted hydrogen. The experiment was purely a qualitative test, and the exact amount of reduction was not accurately determined; but after several passages through the benzol, the gas lost at least 40 per cent. in volume. This shows that when the illuminating power of gas is increased by the addition of heavier hydrocarbons, experiments should first be tried to ascertain whether there be real gain or loss in the process. Had the naphthaliser been on the other side of the meter, the consumer would have effected an economy at the cost of the gas company. In consequence, he says, of the large mains now laid down by the companies, the pressure is less and the gas more attenuated; so the public get less gas than before, although the quantity appears to be the same when measured by the meter. Attenuation of the gas on his own side of the meter is better for the consumer.

PRIVATE BILL LEGISLATION.

For a few days all Parliamentary business is suspended, and as it happens, the past week has yielded comparatively little of interest in regard to private Bills and the proceedings of Select Committees. There has lately been much despondency among people who look to this kind of business as a harvest over the apparent shyness of companies and corporations to promote Bills, or, having introduced Bills, to show much fight, or spend much money over them. But a fair number of Bills are already grouped and set down for consideration immediately after the Easter recess, and so probably the prospect is not so bad after all. Meanwhile, a few Bills have survived the ordeal of Committees, and others have advanced a stage in one or the other House, and one—the Bill for improving Parliament-street—about which Lord Lamington has been so anxious, has been withdrawn by its sponsors. In the first-mentioned class are the Blackburn Water Bill (unopposed), respecting which Sir A. Otway was curious to know why so long as fifteen years was required to construct the reservoirs. The reply was singularly considerate, as coming from a town clerk, viz., that the Corporation did not wish to throw on the ratepayers the expense of the works till they were really needed. A similar scheme is a small one for Northwich, by which power has been given to provide for a supply of 20 gallons per head per day, at a cost of £30,000 odd. In the House of Lords the Bill for incorporating the East Usk Railway Company, a Bill for granting further powers to the Canada North-West Land Company, and some others, of minor importance, have been passed and sent to the Lower House; and in the Commons the East and West India Docks Bill, the Crystal Palace, South-Eastern and Metropolitan Railway Bill, and the London and North-Western Railway Bill are among the measures read a second time. A few days ago an attempt was made to bring on the London, Tilbury, and Southend Railway Bill, to which there is strong opposition, but the promoters, for reasons best known to themselves, again secured an adjournment. On the subject of promoting or opposing Bills at the expense of local rates, a Bill has been introduced to repeal the clause of the Act of 1872, which requires the consent by formal resolution of the owners and ratepayers of a district to such a course, and further to enact that an owner may give the same notice as a ratepayer can at present give to the Local Government Board or the Home-office objecting to such a resolution of consent being approved. Petitions from various quarters still come straggling in against the Railway Rates Bills, and in this connection we may mention that at a large gathering of the Association of Municipal Corporations on Tuesday these resolutions were passed:—"(1) That this association received with much satisfaction Mr. Chamberlain's statement to the deputation on the 19th inst., that it is his intention, if the Railway Bills should be pressed to a second reading, to oppose the same. (2) That in the opinion of this association the issue of a Royal Commission so long as the Bills are before the House is inexpedient, as tending to show that the Bills had not been unconditionally withdrawn or rejected, but that this association will hereafter concur in the subject of railway and canal rates being referred to a Commission, which, both in regard to its instructions, and especially its composition, will command the confidence of the general public." A hybrid Committee composed of eleven members of the House of Commons has been appointed to consider the Bill for the acquisition of further sites by the Post-office, seven of the members being nominated by the House, and four by the Committee of Selection.

Resuming our consideration of the Manchester Ship Canal Bill, the first of the remaining evidence taken before the adjournment of Parliament is that of Mr. J. W. Barry, C.E., on behalf of the opponents. He maintained that the preservation of the bar of the Mersey for navigation purposes depended on the salutary action of the ebb tide from the estuary, the flood tide taking in the sand from the bar, and the ebb carrying it back, and on the maintenance of that action and reaction the safety and welfare of the river depended. Again, the preservation of the tidal capacity of the upper estuary depended on the shifting of the channels and the fretting away of the banks, but if the estuary were allowed to silt up, the tidal capacity would be impaired and the bar would in consequence suffer.

Upon this evidence the question arose whether a fixed channel would do harm, and whether as, according to Mr.

Pember, the promoters held that their canal would not make a fixed channel, it was necessary to discuss the point. Thereupon Mr. Bidder, for the opponents, explained that his contentions were:—(1) That the preservation of the bar depended on the tidal capacity of the estuary being maintained; (2) that the fixing of the channel in any one position would cause the silting up of the estuary; (3) that the proposed works would so far fix the channel.

Mr. Barry, resuming his evidence, said the promoters' plan did not fulfil the conditions which he considered essential to the safety of the estuary. The canal was projected too far into the foreshore, and involved dredging operations which he could not but regard with the greatest alarm. He further expressed the conviction that if the main channel were permanently diverted to the Cheshire side of the river, Garston would be silted up.

At this point the noble Chairman again interposed by asking the promoters whether it was an essential part of the whole scheme that the depth outside the lock at Eastham, as proposed by their engineer, should be maintained.

Mr. Pember, after a consultation with the promoters, reminded the Committee that when the scheme was first put forward, the promoters were content to make a channel in the Mersey of only 12ft. at neap tides, but last year they went for a 20ft. channel, and had taken the same course this year, believing that at that level the channel would do no harm to the estuary. They still held to that view, but if the Committee thought it advisable and safer to raise the sill of the lock at Eastham by 4ft., that course would not, in their opinion, militate against the success of their scheme. They would have preferred a 20ft. sill, and a 15ft. sill might not be too much; but it would not be an essential blot on the scheme if the Committee raised the sill 4ft.

Mr. Bidder said it was no use for him to go on unless he knew what he was to examine his witnesses upon, and in reply,

Lord Cowper said if Mr. Bidder could not prove that the Bill as it stood would do harm to the estuary, the Committee would pass the Bill; if he proved that it was objectionable to carry the sill so deep, then the Committee could fix a limit upon that; thirdly, if he satisfied them that the Bill was objectionable altogether, then, of course, they would throw it out.

Mr. Bidder remarked that he must deal with the Bill as it was presented, and he further called Sir J. Bazalgette, C.E., and Mr. Henry Law, C.E., in corroboration of previous witnesses as to the probable bad effect of the scheme on the river.

At the next and last sitting of the Committee, the chief witness for the petitioners was Sir Frederick Bramwell, President I.C.E., who urged, first, that the only way to keep open the channel through the bar was by preserving the storage capacity of the whole estuary; and next, that the projected channel from the end of the canal at Eastham into the deep water—a length of about two miles—would cause a fixed channel and so endanger the maintenance of the capacity of the estuary. It had been said that this channel would really be a *cul de sac*, but in his view that would not be so, because the water would rush up with a strong momentum and pass alongside the wall forming the boundary of the canal; and then, again, when the ebb passed back there would be a suction, and the ebb also would cling to the canal side. The result would be a fixed channel beyond Eastham. Further, the exaggeration of the channel in one direction would cause a diminution in another, and consequently this scheme would be injurious to the Port of Garston on the other side; and another result of the project would be that the shifting channel across the sands would be stopped, the sands would by accretion silt up, the fretting process would stop, and the cubical capacity of the estuary would be diminished; and from all these causes the force of the water across the bar would be reduced.

Replying to the Chairman, Sir F. Bramwell said his real and substantial objection to this scheme was the amount of dredging involved, and the fixity of the channel, and also that the sill should be higher.

Mr. Stevenson, chief engineer to the London and North-Western Railway Company, and Mr. Rendel, C.E. (both predicting the destruction of Garston), and one or two other witnesses completed the engineering evidence against the scheme.

Subsequently, after a consultation, the Chairman announced that the Committee desired when they met again (on April 14th) to hear the learned counsel for the Mersey Docks Board and the London and North-Western Railway Company, on the question of the bar and the question as to Garston. After that they would hear the reply of the promoters on those two points, and then they would decide whether they would go on further with the Bill.

The several incidents mentioned in the course of this summary are regarded as having very much simplified the contest, and certainly they have put the main issues very clearly.

THE INSTITUTION OF CIVIL ENGINEERS.—The tenth annual dinner of the students of the Institution of Civil Engineers took place on Thursday last, the 26th ult., at the Holborn Restaurant, Sir Frederick Bramwell, F.R.S., President, being in the chair. Amongst the distinguished guests present were—Mr. Edward Woods, senior Vice-President; Mr. G. B. Bruce, Vice-President; Mr. Benjamin Baker, Member of Council; Mr. William Shelford, Mr. Henry Law, Professor Unwin, Professor Kennedy, Mr. James Forrest, Mr. Baldwin Latham, Mr. Richard Rapier, Mr. G. Chatterton, and Mr. J. W. Fraser. The chair was taken at 7.30. The dinner was served in the Venetian Saloon. As might be expected, the numbers present showed a marked increase over past years, owing to the exertions of the Students' Representative Committee, so that this year the gathering numbered 165 in all. At the conclusion of the repast, the usual toasts were enthusiastically drunk. "The Queen and Royal Family" was, in a few well-chosen words, proposed by the chairman, and received with cheers and musical honours. Mr. R. H. Thorpe, chairman of the Students' Representative Committee, next proposed "The Institution of Civil Engineers," and briefly alluding to the kindness which the students ever met with at the hands of the Institution, and for which they were most grateful, went on to describe the work which the committee had been engaged upon, and considered it a matter for congratulation that not only had the number of students' papers been materially increased during the present session, but also the average attendance at them had risen considerably, whilst the list of visits to works of interest was, through the great kindness of members of the Institution, of a most instructive and comprehensive character. After touching on various other matters, Mr. Thorpe proposed "Health and Prosperity to the Institution of Civil Engineers," coupled with the name of Sir Frederick Bramwell, who, in response, assured the students of the lively interest the Council, and he himself, always took in their welfare, and that they were always ready to accede to their requests when made with a view of promoting the improvement of the class. Having in a few well-turned sentences expressed his gratification at being present that night, "The Guests" was next proposed by Mr. T. C. Clifton, and Mr. E. Woods, in replying to the toast, gave some interesting records of his own experience in the profession. Mr. Wilfrid Stokes next proposed the health of "The Secretaries of the Institution," alluding to the unfortunate absence of Dr. Pole through slight illness, and also to the great kindness and attention which Mr. Forrest showed towards the students. Mr. Forrest, who was fortunately sufficiently recovered from his recent indisposition to be present, replied in felicitous terms.

INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

BREAKDOWN TACKLE FOR RAILWAY WORK.

By Mr. H. A. IVATT, Member.

CLEARING the line after an accident or breakdown is an important part of the duty of the locomotive department of every railway. It is a duty which is much more fully provided for at the present time than it was in the earlier days of railway service, but it is to be feared that there still remain some locomotive stations which are not so well fitted in this respect as they ought to be. The work to be done may be to clear a heap of more or less damaged wagons off the line as quickly as possible; or a locomotive may have to be got up from the bottom of an embankment; or possibly the more simple case of an engine off the road in a station yard has to be dealt with. In all cases the work must be done without delay and at short notice. It is, therefore, necessary to be prepared beforehand.

Under the old system on many railways no special provision was made for breakdown work, with the exception, perhaps, of keeping a travelling crane. The result was that when suddenly called upon to clear the line, nothing was ready. Jacks, sling chains, &c., had to be got from the shops or running shed, some packing hastily collected, and the whole thrown anyhow into a wagon or on to the top of a tender. No one felt certain whether the necessary tools were there or not, or whether the bars for working the jacks had been forgotten. With this arrangement, or want of arrangement, the men were kept running about looking for the various tools, valuable time was lost, and finally the men were hurried on to the engine and tender, each one finding a place for himself as he best could. In this state they were run out, perhaps for a distance of forty or fifty miles, in all kinds of weather, to the place where they were expected to work, and to work their hardest. Nothing could be worse than this. The men arrived cold and cramped, and unfit for work; it was often found that tools which were wanted had been left behind, and that others had been brought which were not required for the work in hand. It is always a source of surprise to the author that any one having work of the kind to do could go on from year to year making shift in this way, without some sort of provision for meeting emergencies. A travelling crane by itself is of little use—it must be supplemented by other suitable tackle. For carrying the other tackle required, together with the necessary number of men, two vans are wanted, so that the breakdown vehicles kept at a fully-equipped locomotive station will number three or four, including the crane.

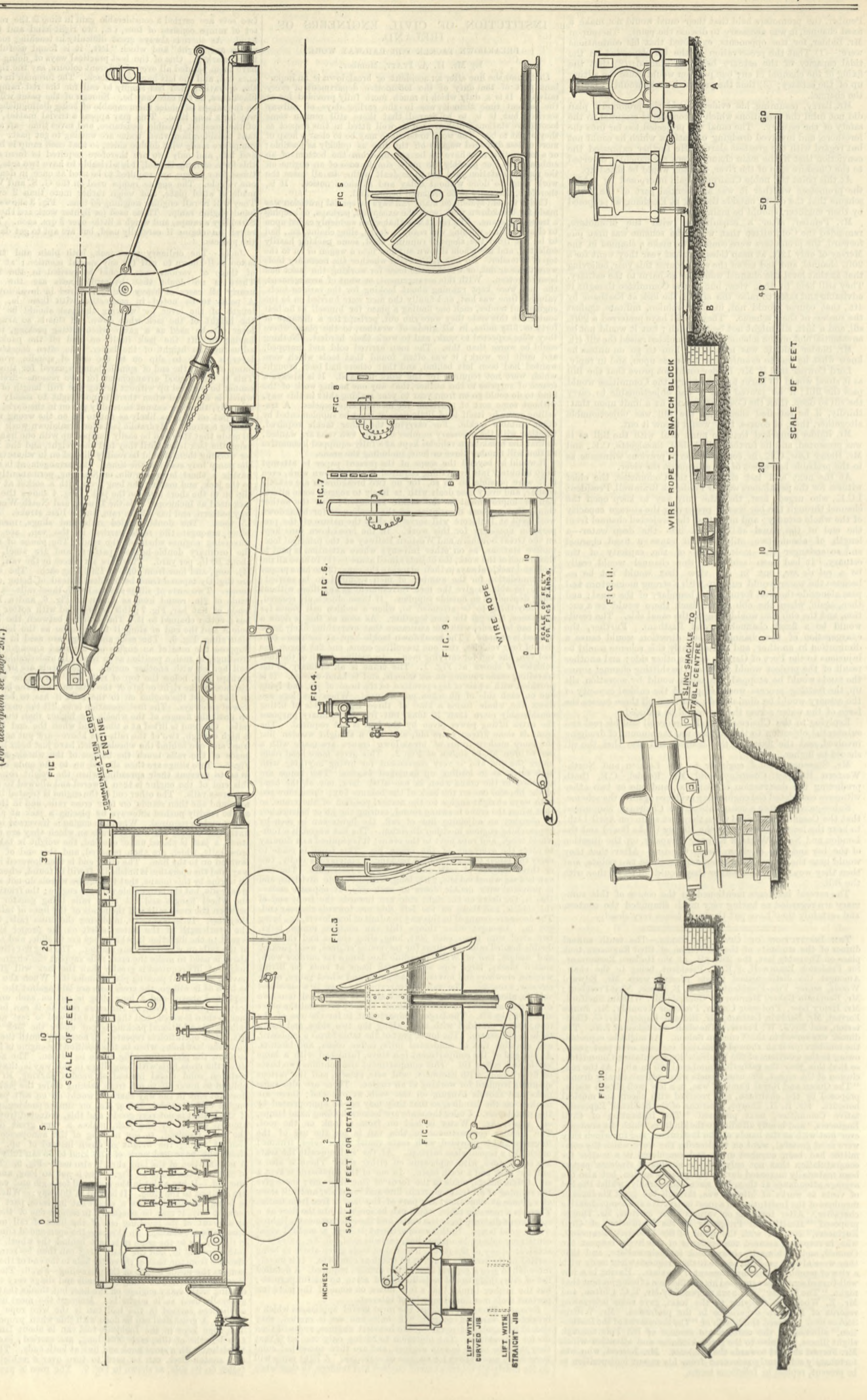
It would be beyond the scope of the present paper to attempt to go minutely into everything required for breakdown work, even if it were possible to do so, for no two breakdowns are exactly similar, and every case dealt with is likely to suggest some alteration or improvement in the tackle employed; but the author thinks that a short description of the appliances for breakdown work kept at Inchicore will serve to show the nature of the preparation necessary for this work. In the breakdown vans kept on the Great Southern and Western Railway at the principal locomotive stations, as on other railways where attention is paid to this branch of the work, the objects aimed at are:—(1) To have all the tools and tackle always in their places in the vans; (2) to have proper accommodation for the number of men required to be carried; (3) to be able to give the men refreshment at any time, without being dependent on outside supplies. If these objects are secured, the only thing to be attended to, when a sudden call comes for assistance, is to get the men together. As soon as this is done a start can be made, with the assurance that everything likely to be wanted is at hand. The breakdown tackle kept at Inchicore consists of four vehicles, viz., one travelling crane, one flat wagon, one tool van, one van for carrying men. An outline sketch of the four vehicles is shown at Fig. 1. The crane is an ordinary 10-ton travelling crane running on six wheels, and is hand-worked. It is provided with a pair of legs pivotted to the head of jib, and lying one on each side of jib when not in use. When the legs are down the whole forms a kind of three legs, capable of lifting considerably more than 10 tons, but for all ordinary purposes the extra lifting power given by the legs is not required. The crane is some fifteen years old, and has a straight wooden jib; the more modern forms of breakdown cranes are made with a curved iron jib, as shown at Fig. 2. This gives more head room under the jib, and is very convenient for lifting anything with high sides, as in loading up damaged wagons. Two lamps are attached to the crane when in use after dark, one at the head of the jib, and one on the back of the balance box; these show red both ways at right angles to the normal position of the crane, so that when the crane is swung round, causing the jib or balance box to obstruct an adjoining line of rail, the lights can be seen by approaching engines in either direction. The flat wagon is a four-wheel truck, and runs next to the crane; it is required as a dummy to cover the overhang of the crane jib. This truck is made to carry the larger pieces of timber packing, a platelayer's trolly, two or three lengths of rails, and some P.W. fastenings. The tool van is a six-wheel vehicle, 24ft. long, without inside divisions, and is provided with double doors at each side, at opposite ends—that is, the doors on the right side are towards the front end of the vehicle, and those on the left side are towards the rear end. The doors are arranged in this way to admit of long levers, &c., being got in. Amongst other things this van contains ramps, jacks, two steel wire ropes, each 50ft. long, sling chains and shackles, double-headed rails and slings for traversing engines, wood packing and wedges, two of Wells' paraffine flare lamps for outdoor work, snatch blocks, large rope slings, with loops at ends for lifting wagons, crowbars and levers, a road gauge and wheel gauge, cross-cut saw, axes, &c. The van for carrying the men is a six-wheel vehicle, about 27ft. 6in. long in the body. It is divided into two compartments; one of these is about 18ft. by 8ft., and the other about 9ft. by 8ft. The larger compartment is for the use of the men, and is provided with seats along the two sides, and has a table in the centre. The lower part of the table forms a cupboard, and contains tins of condensed milk, coffee, cocoa, and biscuits. At one end of the compartment is a stove, furnished with a large kettle and coffee tin. This compartment also contains two boxes of fitter's tools, with hammers, cold sets, chisels, and the various spanners required for working at an engine. There are also some picks and shovels hanging on the walls at one end; these are marked on the handles, so that they may not be appropriated by the platelayers. Under the seats are lockers holding hand lamps, oil, ropes, &c. Water is laid on from a tank on the roof. The smaller compartment in this van is for the use of the foreman, and is provided with seats round three sides, trimmed much like a second-class carriage. At the end opposite the seats is a small stove, with cupboards on either side. There is also a pull-out desk and a wash basin. In one of the cupboards is kept a set of time charts, made in the form of line diagrams; these give the running of all trains on main line and branches, and will show at a glance at what times any part of the line is free from traffic. There is a movable table, which can be screwed into the floor at a convenient distance from the seats, and the compartment is lighted with a good lamp. In this compartment is kept a medical chest containing splints, bandages, lint, carbolic acid, oil, &c., in case of accident to any of the men. The list of tools given above as being carried in the tool-van is not to be taken as complete. It is merely intended to give a general idea of the articles required. A detailed list of everything would be tedious, and serve no useful purpose; but the author thinks that a few notes on some of the more important tools mentioned may be of interest.

Ramps.—These are amongst the most useful appliances which a breakdown van can contain. If only one set is carried, they should be capable of re-railing the heaviest engines, and will then do for all vehicles. The objection to having only one set is that they must be heavy to suit engines, and are then somewhat cumbersome to move about for wagons or carriages. A light ramp will do for nearly all vehicles except engines and tenders, so that when two sets are carried a considerable gain in time is the result. A set of ramps consists of four, *i.e.*, two right-hand and two left-hand. As there is always great difficulty in teaching men which ramps are "right" and which "left," it is found useful to have them marked. One of the best practical ways of doing this is to have them painted all over of different colours, say the right-hand ones red, and the left-hand ones black. The foreman in charge of the operation then has simply to call for the red ramps or the black ones, as the case may be. Enough of the paint will remain on the ramps to render them capable of being distinguished in this way for a long time. This may appear a trivial matter, but it is of the greatest possible assistance, and saves time—an all-important consideration when trains are waiting to get past. Russell's ramps are made with double sides, so that each ramp is both right and left, and only two are therefore required to form a set. If this form of ramp is used, it is advisable to have two sets, as sometimes four ramps are required to be used at once in dealing with one vehicle. The engine ramps used on the G. S. and W. R. are made of steel plate, and weigh rather more than 2 cwt. each. They will re-rail engines weighing 36 tons. Fig. 3 shows a right-hand engine ramp. Those used for lighter work are the ordinary Stroudley's ramps, and weigh a little over 3 qrs. each. They will re-rail an engine if carefully used, but are apt to get damaged in the process.

Jacks.—The ordinary screw-jack, both plain and traversing, is too well-known to call for any special mention; at least ten of these of various sizes should be carried in the tool van. There is no doubt that hydraulic jacks are the best for nearly all cases of heavy lifting required in breakdown work. A point to be noted in connection with them is, that the length of the lever for working the jack should be equal to the height of the jack when down. If this is so arranged the lever can be used as a gauge when setting packing, instead of having to lift the jack itself on and off the packing while adjusting the height of the latter. As often constructed the lever is made to slip on to the end of spindle working the pump of jack, the end of spindle being squared for this purpose. This is not a good arrangement for two reasons—first, the jack cannot be pumped up without having the full length of lever on, which is awkward when there is no weight to steady the jack; secondly, the lever cannot be readily got on in the dark, and when it is put on it is as likely as not to be on the wrong square for making a stroke. Hydraulic jacks for breakdown work should be so made that they can be easily pumped up with one hand without using the jack lever until they feel the weight, and the lever used for working them should be readily slipped on in whatever position the pump may stand at the time. This arrangement is secured by having a short lever, say 6in. or 8in. long, permanently attached to the jack, and making the long lever with a socket at the end to slip on to the short lever on the jack. Fig. 4 shows the hydraulic jack used at Inchicore; it is the London and North-Western Railway pattern, and has a $2\frac{1}{2}$in. ram, and a 10in. stroke. It will lift 15 tons. The double-headed rails and slings, mentioned as being amongst the tools carried in the van, are used for traversing engines when off the road. The pieces of rail are of the ordinary double-headed pattern, and are steel, weighing about 80 lb. per yard. There are six pieces in the van, two about 7ft. long, and four from 10ft. to 12ft. long each. The ends of all are slightly tapered from both sides, instead of being cut square across. Two sorts of slings are used with these rails—a plain one made of $\frac{3}{4}$in. round iron, as shown at Fig. 6, and a longer one made of flat bar, Fig. 7; this is provided with cotter holes, and has a cotter chained to it. The distance between the last cotter hole A and the end of sling B is the same as the length of the plain sling, Fig. 6. The rails and slings are used in this way:—Suppose the case of an engine off the road amongst points and crossings, in such a position as to render it undesirable to try and pull her on with another engine. The wheels are in the ballast, perhaps 18in. below the top of rails, and the engine stands some distance to the right or left of the rails on which she is to be put, so that to get the engine on to the rails it has to be lifted and moved sideways. The first operation is to lift the engine straight up until the flanges of the wheels are higher than the top of the rails. One end is lifted at a time, and when the end being lifted is high enough, two of the rails—as above—are put across, one in front and one behind the wheels which have just been lifted. The heads of the rails touch the flanges of the wheels, as shown in Fig. 5. Two slings are then slipped on to the ends of the rails, so as to prevent their spreading when the weight comes on, and this end of the engine is then lowered and allowed to rest on the two cross rails. The other end of the engine is treated in the same way, and she then stands on four cross rails, and in this position can be readily pushed sideways by placing a jack at an angle at either end as required. When the engine is traversed in this way, until the wheels are over the rails on which they are required to stand, a jack is placed under one end, the weight is taken off the cross rails, which are then removed, and this end of the engine lowered on to the line. The other end is then lowered in the same way, and the operation is finished. It will be found, when traversing an engine by this means, that the engine wheels do not slide on the cross rails, but the latter slide with the engine; the friction between the wheel flanges and the cross rails being greater than that between the cross rails and the heads of the lines of rails on which they rest. It is necessary, in placing the cross rails, to see that the overlength of the latter is left on the proper side, having regard to the direction in which they are to slide, and the position of the rails on which they are resting. The long flat sling described above is used to make the cross rails support the engine when the height of lift required is greater than the jack will give without having additional packing placed under it. When the jack is up as high as it will go, the cross rails are laid against the wheels—as explained above—and a long sling is put on each end, and the cotter is put in as close to the cross rails as it can be got. The jack is then lowered, and the weight allowed to rest on the cross rails, while additional packing is put under the jack for a fresh lift. The operation is repeated, if necessary, until the cotter will go in the last hole; when in this position the engine is high enough to allow the plain sling—Fig. 6—to be put on. The advantage of using the cross rails with long slings in this way is, that the weight rests on solid metal instead of wooden packing, so that when obliged to lower off to put fresh packing under the jack the engine does not sink in the way that she would do on soft packing. An engine will often sink 5in. or 6in. on timber packing, particularly if the ballast is not very good; and this, deducted from the total amount of lift by the jack, makes a very great difference in the time required, to say nothing of the annoyance and vexation at seeing the weight go down instead of up, which only those who have had work of the kind to do can fully appreciate. A modification of the long sling is also used—Fig. 8. This is made of flat bar, the same as Fig. 7, but is not so long, and is open at one end. It has a slot in the open end for a gib and cotter, which are chained to the sling. It is used in this way:—When an engine is being traversed across a somewhat intricate part of the permanent way, it may be necessary to remove one of the end slings on account of its touching one of the lines of rail on which the cross rails are sliding. In this case the open-ended sling—Fig. 8—is slipped on to the cross rails just behind the wheel, the gib and cotter are put in, and the plain sling can then be removed. The distance from the back of the cotter hole to the end of the sling is the same as the inside length of the plain sling—Fig. 6. The author has found this method of using cross rails and slings very successful in dealing with many engines off the line, but thinks that it is not so generally used as it might be. Amongst the most useful of the appliances carried in the tool van is the wire rope and snatch block. A great deal can be done with this when properly worked. The rope kept in the Inchicore tool van is about 1in. diameter; two lengths of this, each 50ft. long, are carried; each length is furnished with a stout hook and link at both ends. The steel rope and snatch-block can be used to turn over a vehicle which has fallen on its side, as shown in Fig. 9. The rope is passed over the

BREAKDOWN PLANT, GREAT SOUTHERN AND WESTERN RAILWAY.

(For description see page 267.)



top of the vehicle and made fast underneath, a snatch-block is fixed to the rail or other point of support, in the required direction, the rope led through it, and hooked on to an engine. If the permanent way is not heavy enough to stand the strain on the snatch-block, a locomotive or heavy van placed over the spot where the block is attached will help to keep it down. The rope can be used in many other ways, as a pull in almost any direction can be got by placing the snatch-block in the right position. As a practical illustration of the use of some of the tackle referred to, the author thinks he cannot do better than briefly describe the re-railing of a passenger engine which ran off the turntable at Lismore station, in December, 1879. The table stands with one side next to very low ground; the engine was being turned, and when half-way round ran off the table—in consequence of the brake not being properly secured—and assumed the position shown in Fig. 10. The trailing wheels of the engine rested on the table wall, and the leading end was down in a ditch some 10ft. below. The draw-bar between engine and tender did not break, and the front end of tender was consequently lifted by it, as shown. The first operation was to cut the draw-bar, and let the tender drop on to the table rail. The table was then turned and the tender run out of the way. Then the wall on which the trailing wheels of engine rested was cut down to the level of pit of table, so allowing the trailing end of engine to drop about 3ft. This end of the engine was then secured to the turntable centre by means of sling chains and shackles, so as to prevent her running forward, as the slightest forward movement would have caused her to go down altogether, and the front end was lifted by jacks, and packed up, as shown in Fig. 11. When the engine was got into this position the turntable was lifted out and put on one side, by means of the travelling crane, and a temporary incline of old sleepers and packing laid through the table pit. A goods engine was then put opposite the table on the road at A, a snatch block was secured to one of the spokes of the driving wheel of the goods engine, and a wire rope led from the back of the dead engine round the snatch to an engine on the road marked C. This engine was then started, and the dead engine was pulled up the incline. The rails laid on the temporary incline were carried out from the table pit across the first road, B, and the pull continued until the dead engine stood over this road, but at right angles to the position in which she should be. The next operation was to get the engine turned round and put on to the line B. To do this the wire rope was attached to the buffer plank, led round a snatch block at the required angle, and a sharp pull given by an engine at the other end of the rope. This twisted the dead engine round nearly as far as was required, the temporary rails going with the wheels the greater part of the way round until the engine slipped off them; she then stood in a position of an engine somewhat badly off the road. The cross rails and slings were then used, and the engine put on the road, B, and run into a siding. The turntable was lifted back into position, and the work was finished. The gap in turntable wall had to be repaired afterwards, but this did not interfere with the working of the table. The table was in such a position as to render it impossible to get at the engine with a crane. If it had been possible to place two travelling cranes, one on each side, so as to get hold of the front end of the engine, the work would have been very much simplified, as she could have been lifted and run back on the table without any difficulty. In dealing with breakdowns no fixed rules can be followed; each case must be dealt with according to its own circumstances, and the man in charge of the breakdown tackle has to decide what method he will adopt. For instance, when several wagons are crushed and telescoped together, perhaps some on the top of the others, it is useless to begin in the middle, and try to put individual wagons right. The first thing to do in such a case is to straighten the wagons out by attaching an engine at one end and pulling until they are free; then each wagon can be dealt with separately. The way in which they are subsequently handled depends on the time at command. If trains are being delayed the line must be cleared at once, and such wagons as cannot be run on their own wheels are thrown over out of the way, to be loaded up at a more convenient time. No question of slight extra damage to vehicles must be allowed to interfere with handling them somewhat roughly, where delays to trains can be reduced by this means. It is useless to save £5 by refusing to turn over a wagon or two, and at the same time delay a fish train, which delay may cost the company £100.

The heavier class of breakdown work is that connected with re-railing locomotives. In ordinary cases of engines off the line it may be taken as a general rule that the best way of dealing with them is to pull them on by means of one or more engines. If the circumstances will admit of this method the ramps can be used, or in many cases a rail joint near the engine can be broken and the rails temporarily slewed to suit. If the engine is difficult to move, her own steam can be used to assist; it will do no harm, although the wheels may be somewhat up and down, and the coupling rods may not look quite so level as they should be. When the engine is off the road amongst points and crossings in such a position as to render pulling on out of the question, or where pulling might result in damage to the engine, she must be jacked on. The author remembers an instance where a goods engine and tender ran off the line at a pair of trap points, and stood in the ballast some 6ft. or 8ft. away from the ends of the trap rails. Another engine was brought up behind, a chain made fast between the two, and the engine was pulled straight back again on to the line, all the wheels mounting the ends of the rails as easily as they ran off. The operation was finished in five minutes from the time the chain was attached. There was a certain amount of good luck in getting all the wheels to take the rails, but the first thing to do in such a case as this was clearly to pull the engine back; if any of the wheels had missed the rails they would have been put on by jacks or ramps.

In another case—with which the author was not concerned—an engine and train of twelve wagons ran off at trap points on a branch line, and pulled up the permanent way for a distance of ninety yards. The men in charge of the train, and platelayers, having sent for assistance, made up some fires, concluding that the work of clearing such a wreck would at least take all night. On arrival of the breakdown gang, the foreman decided to try and pull the wagons back one at a time; this was done with perfect success. He then thought he might as well try the tender, and this was got on in the same way. Lastly, the chain was made fast to the engine, and by getting it to assist with its own steam it was pulled back to the points and on to the rails. The whole work was finished in less than two hours from the arrival of the breakdown gang. Instances such as these of engines getting off the road are of more or less frequent occurrence on every railway; the more serious cases where engines are turned over, or run to the bottom of an embankment, or over a bridge, are fortunately not so numerous, but when they do happen they are dealt with as the circumstances of the case may indicate. It may be by direct lifting, two or more cranes being used; or a temporary slope may be constructed and the engine pulled up in that way. The minor details and time occupied will vary greatly according to the skill of the man directing the work. Breakdown apparatus should always be under the charge of the locomotive foreman of the station at which it is placed, and it is his duty to see that the tackle is kept in the most efficient condition, and always ready for immediate use. He will see that he has one man specially appointed to keep the crane, jacks, and other tools clean and in working order; also that he has a special gang of four or five men amongst his shed staff told off for working the crane. On arrival at a breakdown he takes command of the work connected with clearing the line, and if he is well up in his duty he takes time to carefully look round before commencing operations—while his men are getting the crane or other tackle into position—and decides how to deal with the case in hand. Having determined what to do, he does it with as little delay as possible, and allows no one to influence him with suggestions, because he knows that even an imperfect plan of working followed through is better than two or three superior methods half tried. The position of a man in charge of breakdown work on a busy railway is no easy one. In addition to his ordinary locomotive work he is liable to be called at any moment to a breakdown. He must be intimately acquainted with the traffic over his district. When called to a breakdown he is expected to get the line cleared at once, and is worried by constant inquiries as to how long he will be. He is held responsible for seeing that he does not obstruct other lines of rail on which trains may be passing, or, if necessary to obstruct them, he is responsible for protecting the line about to be obstructed. He may have to work on a part of the main line where there are four lines of rail, and trains running on three of the four; and when the work is over he is expected to be able to give a clear account of the accident, and, if necessary, to furnish a sketch of the position occupied by the various vehicles before he moved them.

The following extract is from an article on "How to Manage Wrecked Trains," which was reprinted from the American *National Car Builder* in THE ENGINEER of July 29th, 1883:—"A large wreck is attended with something akin to the excitement of war. There is the same hurry and confusion. A big fire is built of whatever fuel comes handy; a crowd of half-frozen men gather round it if the weather is cold; no one knows how or when the next meal is to be obtained, all being on the alert to make the best out of the worst possible means. One poor fellow has injured himself by lifting; another has had a pick driven into his foot instead of into a tie; and another has been hurt, perhaps, by the recoil of a rope. A wrecking master must be largely endowed with the qualities of a military commander. He must be cool and self-possessed, and take time enough to form a definite plan before a move is made. He must never hitch on to an engine or car without knowing exactly what he is to accomplish by it. If the wreck is a large one, the president of the road company is usually present with a number of useless spectators. Instead of taking fifteen or twenty minutes to look over the ground and form an intelligent plan, as he would be capable of doing under other circumstances, the wrecking master, if he is a nervous and sensitive person, is apt to lose his head because the president is looking at him, and the train despatcher sending messages every fifteen minutes asking how soon the track will be clear. The result is that in his trepidation he hitches on anywhere, jerking as many cars off the track as he jerks on, and it finally turns out that between the original crash and the subsequent hauling and jerking, the cars are not worth picking up; and, as a last resort, they are got out of the way by setting them on fire and reducing them to ashes.

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"The subject of wrecking is deserving of considerable study, as anyone who has had the superintendence of a big job will be pretty sure to discover. It might be supposed that the civil engineer of a road would make a good wrecker, from his knowledge of the handling of heavy structures. But this is not so. In carrying on his ordinary operations he has plenty of time at his disposal, with powerful derricks and other necessary appliances, but give him a small wreck, with a flat car-load of timber, a few blocks and tackles, and four or five jacks, and he would despair of accomplishing anything. The experienced and capable wrecking master, in handling heavy engines and cars with the usual limited means at his command, displays an amount of engineering talent that is none the less practical and effective because it has not been acquired by a regular course of technical education."

LETTERS TO THE EDITOR.

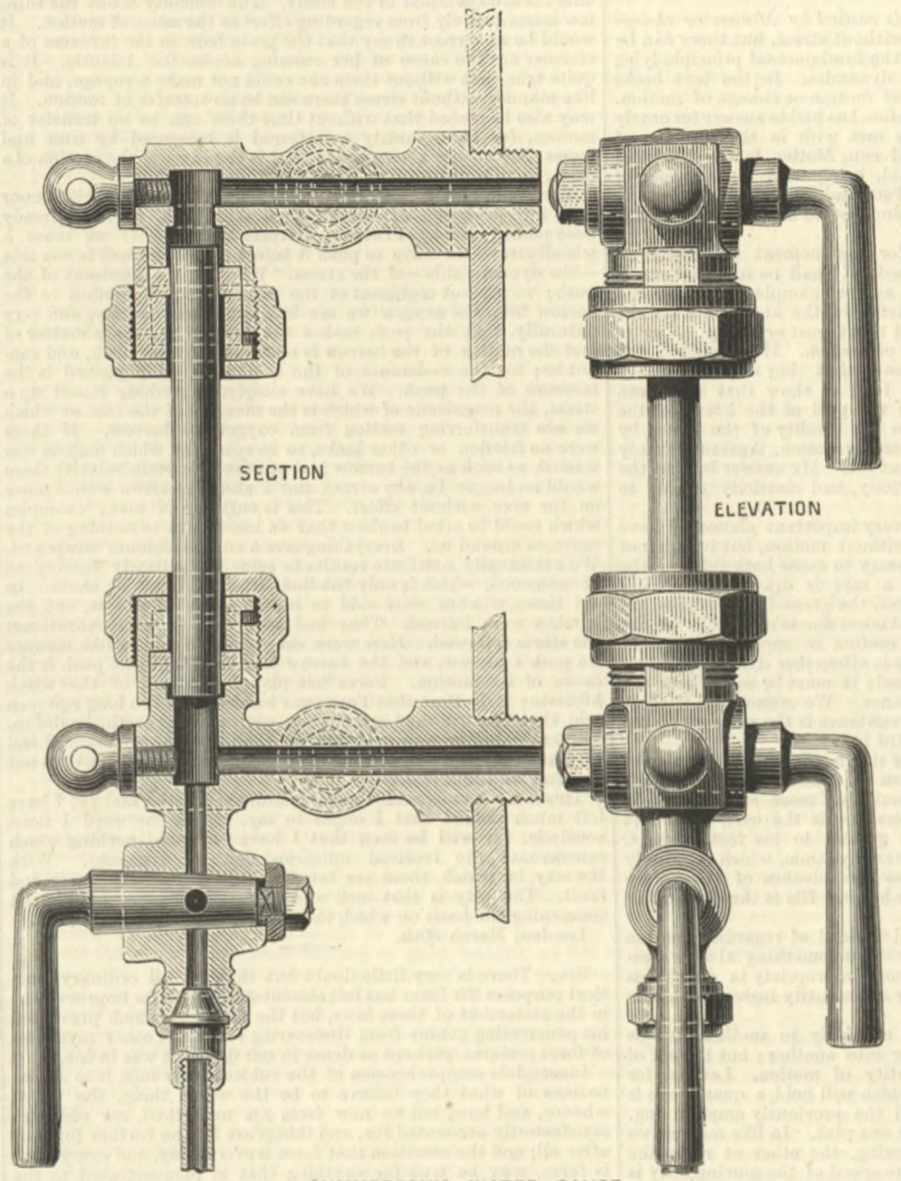
[*We do not hold ourselves responsible for the opinions of our correspondents.*]

WATER GAUGES.

SIR,—In the latter half of the year 1876 you were kind enough to give me an illustrated notice of a "Sentinel" safety valve. I enclose you tracing of my latest improvement in steam boiler furniture. You will see that the tracing represents a set of water gauge fittings.

The improvement consists in cutting a gap the full depth of the stuffing-box, so that the glass can be introduced without unscrewing the cap of the upper fitting. This gap is closed by a tongue, which is made in one piece with the gland. The gland-nut embraces the outer circumference of the stuffing-box in the usual manner. The advantages of this improvement are as follows:—(1) The attendant, when fixing a fresh glass, sees at a glance when he has got it the right length, and thus the danger of a short glass—obstruction at the upper end by packing—is avoided. (2) A fresh glass is more easily inserted, as it is not necessary with glasses of a short range to remove the cap of the upper fitting. This cap, which is dispensed with in the improved water gauge, frequently sets fast, and it is not uncommon to bend the upper fitting in trying to unscrew it. (3) A fresh glass is inserted with greater despatch on account of the broken glass and old packing being more easily removed from the stuffing-box.

Darlington, March 21st. THOS. R. SUMMERSON.



SUMMERSON'S WATER GAUGE.

THE LAWS OF MOTION.

SIR,—There is one sentence in my article on the laws of motion which you published yesterday which was inconsiderately written, and which does not represent my own real conviction. In fact, later in the article I state what is virtually a contradiction of the sentence I refer to. It is—"Any view of mechanics that leaves out of account the strain that is the invariable accompaniment of force or stress is so incomplete that it may, I believe, be described almost accurately as mere compilation of mathematical formulas consistent among themselves." Although I do believe that such a view is so incomplete that by itself it is useless for the thorough solution of any practical problem in mechanics, still I went beyond my intended mark in saying that it was altogether futile, except for the compilation of consistent mathematical formulas. I should like to state as succinctly as I can what I do hold on this important point.

(*a*) Let us define the mass of a certain portion of matter as its capacity for absorbing motion per unit change of velocity. The density, or mass per unit volume, we might call "volumetric specific capacity for motion" in the same way as we speak of specific heat, specific weight, &c. This is only the ordinary definition of mass expressed in words which to me makes its meaning clearer. The unit mass will be that mass, which, when it has absorbed unit motion, assumes unit velocity. The quantity of motion absorbed will be the mass multiplied by the change of velocity resulting from the absorption of motion. (*b*) Let us assume that when one portion of matter absorbs motion from another, all the motion which the latter possessed before the transfer and lost during the transfer still exists undiminished in the former after the transfer. Observe that it is only by assuming this that it is possible to attach any definite meaning to the definition (*a*) of mass. Then adopting the definition (*a*), and interpreting the results of our experiments according to assumption (*b*), we find:—(1) that every experiment on mass as measured according to (*a*) shows that the same identical portion of matter has at all times and under all circumstances the same mass, whether there be much or little motion absorbed into that portion of matter. (2) That every experiment interpreted by help of this definition of mass will show the loss of motion to be *nil* in every case of transfer of motion from one portion of matter to another. Now, definition (*a*) has no meaning unless coupled with assumption (*b*), and would also give a varying measure of the mass of any individual portion of matter unless the experimental result (1) is found to be universally verified; and moreover, the assumption (*b*) would be found to be mistaken unless the experimental result (2) is also found to be universally verified.

But if assumption (*b*) were really wrong, these experiments would not (1) invariably give the same mass measure to the same piece of matter; some experiments might give the same measure, but all would not do so. And even if the mass measure were always found the same under the most various circumstances, still experiment would (2) not invariably show the loss of motion to be *nil* in all mechanical actions, the possible variation of circumstances not only extending to different mechanical actions taking place at different times, but also including the measurement of the same action, or transfer of motion, relatively to various different fields or other masses used to define axes of reference.

We cannot extend our experiments and measurements *ad infinitum* so as to demonstrate absolutely that no contradiction of our fundamental assumption ever occurs in nature; but when the experiments have extended over a moderately wide range, the accumulation of evidence is sufficient to carry conviction to any ordinarily constituted mind.

The two mechanical facts that can be proved in this manner by experiment without any reference to strain are therefore, in my view—(A) The constancy of mass of each individual portion of matter—that is, the constancy of its carrying capacity for motion, this fact being conveniently named the conservation of mass; and (B) the indestructibility of motion, provided the field relatively to which the motion is measured be always the same, because by changing the field we can alter the measured magnitude of the motion as much as we like, this fact being conveniently termed the conservation of momentum.

Further than this we cannot go without consideration of strain. For instance, no rational treatment of transfer of motion by work done is possible without considering strain and strain energy. Furthermore, although we may arrive at the doctrine of conservation of momentum in force transfers of motion without reference to strain, still we cannot study the mode or mechanism of this force transfer of motion without first gaining a knowledge of strain. ROBERT H. SMITH.

The Mason Science College, Birmingham, March 28th.

SIR,—Years have elapsed since I first began, with your permission, to call attention in the pages of THE ENGINEER to the defective manner in which dynamics are taught in text books and colleges. The effect I produced was small, possibly *nil*, yet I cannot help thinking I may have done something to advance matters toward the great end which I now see in view. Need I say with how much pleasure I saw Professor Hudson at last take up his parable, and tell the world what manner of faith was in him. Professor Hudson was followed by Dr. Lodge. Nothing I have ever said has been more condemnatory of the system of teaching dynamics than Dr. Lodge's statements regarding Cambridge. Dr. Lodge was succeeded by Professor Smith; and by Mr. Lyon, whose position at Cambridge entitles him to be heard. Well, what do we find if we examine the writings of these four gentlemen? Anything rather than harmony; and if I may venture to say it, no inconsiderable confusion of ideas.

I have hitherto refrained from placing before your readers any definite scheme of Dynamics—firstly, because I wished to see something like a defence of existing systems of teaching; and secondly, because within the limits of a letter such as this, and of any reasonable length, it is quite impossible to do my subject, and I will even say myself, justice. But an opportunity has at last come. The professors have at last spoken out, and I no longer refrain from stating what I believe to be the true foundation of dynamics; and it will be seen that my propositions clear away in a moment the mysteries and confusion with which the subject is infested, and place Newton's accuracy above dispute. With your permission I will state my thesis now, and I shall be prepared to defend it when it is attacked.

(1) In the larger number of text books Force is said to be the cause of Motion, and by the word Force is meant push, pull, or effort. For the word Force I substitute the word Effort; but only because confusion already exists about the meaning of the word Force, which I do not wish to increase.

(2) *There is no such thing in nature as an isolated effort.* Efforts are always dual and opposite, and the dual efforts cause Stress. This, it will be seen, is simply Newton's third law in different words. Thus the horse's pull on the cart is one effort, the resistance of the ground to the movement of the cart is another effort. These two efforts are exactly equal and opposite, and their result is a stress on the trace.

(3) *Effort, and therefore Stress, is caused by Motion or change of Motion.* There may be motion without stress, but there can be no stress without motion. This is the fundamental principle lying at the root of the whole science of dynamics. In the text books we are told that force is the cause of motion or change of motion. This is an untruth; and its promulgation has had to answer for nearly all the absurdities and confusions met with in the teaching of dynamics. The proposition should run, Motion is the Cause of Force—force, as I have already said, being used in the sense of effort, and not in Tait's sense. Tait, indeed, talks of a totally different thing, and a thing useful and not to be despised, but it is not effort.

Here it may be well to stop for one moment to answer an objection which is certain to be raised. I shall be told that stress can and does exist without motion, as, for example, the thrust of a bridge on its abutments and the thrust of the abutments on the bridge. My answer is, simply, that this thrust or stress is due to gravity, and that gravity is a mode of motion. If my readers tell me that I cannot prove this, I answer that they cannot disprove it; and all analogy and experience tend to show that stress can only be caused by motion. Take the pull of the horse on the cart, for example. This is due to the vitality of the horse, by which his food is converted into muscular motion. Again the steady pull of a spring may be cited against me. My answer is, that the pull of the spring is due to elasticity, and elasticity is due to motion.

(4) I now come to another and a very important clause. I have said that there can be no stress without motion, but it does not follow that motion should be necessary to cause both sides of the stress. Thus, for example, when a cart is drawn, the horse's motion supplies one side of the stress, the ground's resistance the other side of the stress; but this last is not due to motion.* On the other hand, when two bodies in motion in opposite directions come into collision, the stress set up is altogether dynamic.

As I have said, every effort is dual; it must be so. There can be no effort where there is no resistance. We cannot pull if there is nothing to pull against, and the resistance is the measure of the effort. This, again, is Newton's third law.

We have, then, dual effort—never single effort—and one side of this effort may be, and very often is, static, while the other side of the effort is always dynamic, or more strictly speaking, kinetic. Thus, when the horse pulls the cart, his effort is dynamic; the resistance of the ground to his feet is static. Professor Hudson treats it as if it were dynamic, which is entirely wrong. The ground does not cause the advance of the horse; that is due entirely to motion in the horse. His is the dynamic or kinetic effort.

Now, let us go a step further, and instead of regarding motion as a condition, regard it as an entity—as a something always associated with matter. There is no more impropriety in doing this than there is in speaking of gravity as an entity instead of a condition.

Motion may be transferred from one body to another, just as water can be poured out of one jug into another; but the act of transfer does not affect the quantity of motion. Let us, for example, have two jugs, each of which will hold a quart; one is empty, the other full. We half-fill the previously emptied jug. The result is that each has now in it one pint. In like manner we have two masses of matter, one moving, the other at rest; the weight of each body is a pound. The speed of the moving body is 10ft. per second. They come into contact, and the result is that both go on moving at 5ft. per second. We say that the momentum of the first was $1 \times 10 = 10$. After the transfer we say that the momentum of each is $5 \times 1 = 5$; and we add the two together and say that we have $5 \times 2 = 10$. On this fact is based the theory of the conservation of energy. The quantity of motion in any system cannot be altered by any internal transference of motion from one member of the system to another. Thus we may have twenty jugs of a quart capacity each. We start with five of them full. We may do what we please in the way of dividing this among different jugs; but the quantity of water remains always the same. So we may have twenty bodies, five of which are in motion. It matters nothing in what way we transfer motion from one to another, the whole quantity of motion is the same. This is called the principle of the conservation of energy. Motion is energy. I now come to another fundamental proposition—

(5) *There can be no transfer of motion without the production of a stress.* I have already explained what I mean by the word stress—see paragraph (2).

(6) *The amount of the stress is, other things being equal, the measure of the rate at which motion is transferred in terms of time.* Here I differ from Tait, who using the word force, states that it is the rate at which motion—he says momentum, but they are practically synonymous terms—is transferred. This is in all respects a defective definition; stress is not the rate, but the *measure of the rate* at which motion is transferred. Thus, when the stress is doubled, the quantity of motion poured into a body in a given time is doubled. For example, the stress due to gravity is sufficient to give a pound weight a momentum of 32·2 at the end of one second; if the force of gravity were doubled, the velocity at the end of one second would be 64·4, and so would be the momentum.

If I am asked why the transfer of motion is always accompanied by a stress, I answer that I cannot tell. I only know that it is so; but why, no one can explain any more than it is possible to say why iron is, as has been shown by Mr. Hughes, inherently magnetic.

Now, let me apply what I have said to the case of a railway train. The seat of original motion is to be found partially in the coal, but much more largely in the oxygen. The quantity of motion in the oxygen is very much in excess of that in the carbonic anhydride, which results from its combination with the coal. This motion set free appears in the furnace as heat. Then it is transferred to the water in the boiler and becomes steam, the motion of the steam is then transferred to the driving wheel of the engine, and we have a "couple" between it and the rail; that is to say, a dual effort, resulting in a stress. One side of the stress is virtually static, due to the earth, the other side is dynamic or kinetic, due to the motion in the steam, and as soon as the stress has reached the amount corresponding to the rate at which motion has to be transferred from the steam to the engine, and thence to be dissipated in the heat of axle friction, rolling friction, gravity resistance, &c. &c. &c., the train will move at that rate. The train is not caused to move by the pull on the tie bar, but that pull is one side of the stress which is inseparable from the transfer of motion.

Newton's third law cannot be accepted as true by any one who believes that pull, or push, or effort, or force is the cause of motion. The consequence is that it is eluded, and explained away, and shoved out of sight. This is the source of the whole difficulty. Teachers try to reconcile the third law with everyday experience, and they fail. To most men the pull at one end of the rope is greater than the other; the train does not pull quite so hard one way as the engine pulls the other; the horse always draws a little more strongly than the cart hangs back; the arrow in its flight acts on the air more strongly than the air acts on it; and so on. Dr. Lodge does not, so far I can see, believe that resistance was meant at all by Newton. He holds that all that Newton meant was that the momentum lost by one body was gained by another. This is quite true, but it is not the whole truth, and if it were, the fact is the same; the time being constant, the stress must exist or the transfer of motion cannot take place. Explain away, paraphrase, do what we may, Newton no doubt stated what is perfectly true, that the resistance to an effort is always equal to the effort. The difficulty about the third law arises entirely from regarding effort as the cause of motion. It would be as correct to say that the grate bars in the furnaces of a steamer are the cause of her running across the Atlantic. It is quite true that without them she could not make a voyage, and in like manner without stress there can be no transfer of motion. It may also be stated that without time there can be no transfer of motion, for the quantity transferred is measured by time and stress; but no one assumes that time is the cause of the motion of a train.

The origin of the mistake is easily found. It took its rise in our own interpretation of our personal sensations, as has already been pointed out by, I believe, Herbert Spencer. If we move a wheelbarrow, we have to push it before us. This push is one side—the dynamic side—of the stress. We are quite cognisant of the push; we are not cognisant of the transmission of motion to the barrow from the oxygen we are breathing; and we say, and very naturally, that the push makes the barrow go. As a matter of fact the motion of the barrow is not caused by the push, and cannot be; for the resistance of the barrow to being pushed is the measure of the push. We have simply, by pushing it, set up a stress, the magnitude of which is the measure of the rate at which we are transferring motion from oxygen to barrow. If there were no friction or other leaks, so to speak, by which motion was wasted, as soon as the barrow had acquired a certain velocity there would no longer be any stress, and I and the barrow would move on for ever without effort. This is only one of many examples which could be cited to show that we know next to nothing of the universe around us. Everything save a small residuum escapes us. We continually attribute results to some immediately antecedent phenomenon, which is only the link, after all, in a long chain. In old times witches were said to be the cause of storms, and the witches were burned. They had been seen to use incantations; the storm followed. Here were cause and effect. In like manner we push a barrow, and the barrow moves. Hence the push is the cause of its motion. Force has played the part of the witch hitherto; it is time that Force was burned. Not so long ago men said that because they saw the sun go round the earth, he did so. We know better now. In time we shall come to understand and to teach that the pull of a railway engine on a draw-bar does not do what we think it does.

This letter has extended to an inordinate length; and yet I have left much unsaid that I ought to say. With one word I must conclude. It will be seen that I have advanced nothing which contravenes the received numerical laws of dynamics. With the way in which these are taught there is little reason to find fault. The pity is that such wild confusion of ideas should exist concerning the basis on which they rest. Φ. Π.

London, March 30th.

SIR,—There is very little doubt but that for all ordinary practical purposes Sir Isaac has left absolutely no room for improvement in the statement of these laws, but the darkness which prevented his penetrating genius from discovering for us the other mysteries of force remains perhaps as dense in our day as it was in his.

Incomplete comprehension of the subject leads men into explanations of what they believe to be the whole thing, the what, whence, and how, but no new facts are unearthed, nor old ones satisfactorily accounted for, and things are left no further forward after all; and the assertion that force is everything, and everything is force, may be true for anything that is demonstrated to the contrary.

It is very convenient to assume that there are such things as molecules, and assuming that there are molecules, they appear to be capable of affecting each other as though they had motion which kept them perpetually battering about against each other, causing each one to preserve a certain amount of space to itself corresponding to the violence of the collisions and the pressure of opposing forces. In opposition to this repelling force there is an attractive force exerted between each molecule and every other molecule in the universe, but chiefly its immediate neighbours. These forces equilibrate when the distance apart of all the molecules is the same—if the molecules are all alike—and the amount of space which each molecule may be said to have to itself corresponds to the conditions. It is therefore impossible for the molecules to move forward in any given direction *en masse* unless the distance between the molecules in that direction increases *seriatim*, so as to give each molecule a freer scope to move in that than in any other direction—that is to say, visible motion can only be imparted to any body when the distance between any one molecule and the contiguous molecules is throughout the mass to be moved greatest in the direction in which the motion is being produced. The motion, acceleration, or retardation having been produced, the molecules must have again assumed the relations of equilibrium.

It follows from these considerations that when motion is given to a mass by, say, a push, there is during the acceleration a compression throughout the mass—except the body be an irregular solid, in which case the molecular displacements may in some parts merge into displacements in which the molecules recede from each other—corresponding at every point to the inertia of the mass to be moved in advance of the point. If a system of forces acts upon a body so as to be in equilibrium, the equilibrium is the result of a balance of compressions or extensions, or both, within the mass. The forces each produce motion until the relative positions of all the molecules determine equilibrium, and the force, beyond producing this effect—or this amount of transformation—must remain in abeyance as potential energy, or must overflow, so to speak, by transformation into energy or motion of some other kind. He who can explain the existence of inertia and all about the atom may be able to give us the whole reason why the train follows the engine; but it must be remembered that it is impossible to have an equal strain at both ends of the draw-bar, even if it be a hypothetical one, and without inertia; for, as has been already explained, the strains are not equal for any two successive molecules in the mass until the motion has been established to a certain degree, when the force finds other outlets than in producing visible motion, such as friction, &c.

It should always be borne in mind that all causes are really effects, and that all effects are causes; hence, everything is cause and everything is effect. Potential energy, heat energy, electrical energy, radiant energy, and visible motion, what are these things? Are they not all but different aspects of the same thing—force? and is there anything that is manifested to any of our senses except by a physical impression, *i.e.*, by force? Then what is force? May it not be everything short of time and space? May it not even be time and space? Who shall say? R. SNOWDON.

Widnes Foundry, Widnes, March 30th.

SIR,—In reply to your correspondent "An Old Student," "A." and "R." are two parties engaged in a tug of war. "A." is the stronger, and sets "R." in motion. There is one force F transmitted along the rope, the pull of the "A." party; action and reaction are relative phases of that force, or a portion of it. The pull exerted by the "R." party may be termed "reaction," and an equivalent part of the pull exerted by the "A." party, "action," both being equal to a portion of the total force F. If the parties are of equal strength, there is but one force F along the rope, and "action" and "reaction" are phases of F referred to separate localities or masses. H. A.

Staines, March 30th.

PREVENTING INCRUSTATION IN STEAM BOILERS.

SIR,—We note in your issue of 20th inst. a letter from "Steam User." "Steam User" does not appear to clearly follow our description of the apparatus contained in your issue of the 6th inst.; we would therefore add that our boiler cleaner collects the deposit and mineral matters in a receptacle placed outside the boiler, from which they are blown off, a constant circulation taking place through the apparatus, based on the laws of gravity as applied to waters of different temperature. "Steam User" is of opinion that the most efficient contrivances are those dealing with the water before it enters the boiler. In this view we differ from "Steam User," both on the grounds of economy and the manner in which the deposit of mineral matters held in suspension takes place. As regards economy, since efficient cleansing of water from matters held in suspension can only take place with the water at a high temperature, it follows that the most economical method is to deal with the water after it has entered the boiler, and not incur the extra cost of fuel which "Steam User's" method must entail. In other words, the maximum of economy is produced by utilising the force already generated. As regards practical proof, we can only say that many hundreds of these boiler cleaners are at work in the United States, and we have many letters from firms having them in use as to their efficiency in preventing formation of scale deposits. THOS. VEASEY AND CO.

Wool Exchange-buildings, Coleman-street, E.C.,
London, March 26th.

SIR,—Three months ago I placed in the boilers under my charge, after being thoroughly cleaned, a few bundles of lime tree bark—from young trees—and found after a month's working that there was hardly any incrustation in the boilers, it all having fallen to the bottom in a fine powder or adhered to the bark in a thick mud. I do not know whether it would act the same with all waters, but it is a hint that would be worth trying by those who spend money in different substances, said to prevent scale. The boiler I had cleaned yesterday, after having been three times washed out in three months, looked so well that I determined to send this to you in hopes that it may be profitable to some of my countrymen. JAMES G. SCHULTZ.

Russia, Viatka Government, Elabouga, Oushkoffs
Chemical Works, March 12th.

OBSTRUCTING THE MIDLAND RAILWAY.

SIR,—Permit me to correct an error in one of your paragraphs relating to railway matters, respecting the obstruction of the Midland Railway from Leeds to Barrow in transporting, as you put it, a large screw propeller for a steamer in this town.

The article in question is a large steel stern post and rudder frame, with projecting arms, one on either side, at right angles, for supporting the twin-screw shafts. The total weight is about eleven tons. SUBSCRIBER.

Mulhouse Works, Grosvenor-road,
Belfast, March 30th.

RAILWAYS FOR INDIA.

SIR,—We noticed your remark about the work being done for the frontier railways of India, and the expedition with which it is being turned out. As proof of this, we may mention that on the 26th of February we secured, in competition, a contract for a large number of wagons for the said railway, the stipulation being that we were to turn out the lot, with a considerable quantity of our light permanent railway, complete within a month; and last Monday, the 23rd inst., the whole was finished, inspected, and forwarded for shipment.

When it is considered that we had to cast the wheels, which are of steel, and roll the iron required, in the time, some idea may be formed of the expedition necessary.

London, March 30th. KERR, STUART, AND CO.

REMOVING CROSSHEADS.

SIR,—In last week's issue of THE ENGINEER I notice, in your Selected American Patents—311,769—a device for removing crossheads, the same thing I used in 1866 on board the P. and O. Company's steamship Northan, and since then I have made and used the same in Brazil. It is no new thing, and the public should know it. I trust you will insert this in your valuable paper.

AN OLD SUBSCRIBER.

6, High-terrace, Darlington, March 24th.

ROYAL INSTITUTION.—The following are the probable arrangements for the Friday evening meetings after Easter, 1885, to which members and their friends only are admitted:—Friday, April 17th: Professsor S. P. Langley, Allegheny Observatory, Pennsylvania, "Sunlight and the Earth's Atmosphere." Friday, April 24th: William Carruthers, Esq., F.R.S., "British Fossil Cycads and their Relation to Living Forms." Friday, May 1st: The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., M.R.I., "Water Jets and Water Drops." Friday, May 8th: W. F. R. Weldon, Esq., Fellow of St. John's College, Cambridge, "On Adaptation to Surroundings as a Factor in Animal Development." Friday, May 15th: Professor Burdon Sanderson, M.D., LL.D., F.R.S., "Cholera: its Causes and Prevention." Friday, May 22nd: Walter H. Pollock, Esq., M.A., "Garrick." Friday, May 29th: J. J. Coleman, Esq., F.C.S., together with Professor J. G. McKendrick, M.D., F.R.S., "The Mechanical Production of Cold, and the Effects of Cold on Microphytes." Friday, June 5th: Professor Dewar, M.A., F.R.S., M.R.I. The following are the lecture arrangements after Easter, 1885. Lecture hour, three o'clock. Subscribers of two guineas are admitted to all these courses; a single course, one guinea or half-a-guinea:—Professor Arthur Gamgee, M.D., F.R.S., Fullerian Professor of Physiology, R.I., eight lectures on "Digestion and Nutrition," on Tuesdays, April 14th, 21st, 28th; May 5th, 12th, 19th, 26th; June 2nd. Professor Tyndall, D.C.L., LL.D., F.R.S., M.R.I., five lectures on "Natural Forces and Energies," on Thursdays, April 16th, 23rd, 30th; May 7th, 14th. Professor C. Meymott Tidy, M.B., F.C.S., M.R.I., three lectures on "Poisons in Relation to their Chemical Constitution and to Vital Functions," on Thursdays, May 21st, 28th; June 4th. William Carruthers, Esq., F.R.S., four lectures on "Fir-trees and their Allies, in the Present and in the Past," on Saturdays, April 18th, 25th; May 2nd, 9th. Professor William Odling, M.A., F.R.S., M.R.I., two lectures on "Organic Septics and Antiseptics," on Saturdays, May 16th, 23rd. Rev. C. Taylor, D.D., Master of St. John's College, Cambridge, two lectures on "A Lately Discovered Document, Possibly of the First Century, entitled 'The Teaching of the Twelve Apostles,'" with illustrations from the Talmud, on Saturdays, May 30th, June 6th.

* This is not strictly true. The ground, that is to say, the earth, is moved in a direction opposite to that in which the horse is proceeding. As, however, the mass of the earth is infinite compared with that of the horse and cart, all but the most rigid purists will pardon me when I call the resistance of the earth static.

EXPERIENCE IN THE USE OF THICK STEEL BOILER PLATES.

By Mr. W. PARKER.*

AN ordinary cylindrical boiler of 13ft. diameter and 16ft. long, designed for a pressure of 150 lb. per square inch, for which the scantlings were amply sufficient, burst under the hydraulic test. The pressure was applied very carefully, and when it had reached 240 lb. the fracture occurred, extending completely across one of the shell plates, and to a slight extent also into the adjoining plate, as shown on the diagram. The boiler was constructed entirely of steel, made on the Siemens-Martin process by a firm who enjoy the reputation of producing a material second to none in the country. The plates were all tested at the steel works, and fulfilled the requirements of both Lloyd's Register and the Board of Trade. I find from our surveyor's report that the sample from the particular plate which failed, which was 1¼in. thick, stood a tensile strain of 29·6 tons per square inch, with an elongation of 20 per cent. in a length of 8in., whilst strips cut from it were bent almost double cold. In fact, the material appeared, from the mechanical tests applied before it left the steel works, to be in every respect suitable for the purpose for which it was intended. One remark, however, may here be made, namely, that the plate in question was exceptionally large and heavy, viz., 20ft. long, 5ft. 6in. wide, and 1¼in. thick, weighing about 2 tons 16 cwt. This material was built up into a boiler by a company who have had an unusually extensive experience in the manipulation of steel, having turned out no fewer than 175 boilers of this material. The plates were treated precisely as other steel plates have been treated in the same works, and with all the appliances which experience has shown to be necessary; all the holes were drilled, and the plate was then heated in a furnace and bent to the required curvature in a pair of powerful vertical rolls in the usual manner. Under these circumstances it appeared at first sight astounding to find the material tearing under a pressure which represents a strain of 6·7 tons per square inch only, or less than one-fourth of the strain which the original sample withstood. In addition to this the appearance of the fracture indicates that the plate did not possess any ductility, stretch, or elongation whatever. Neither the steel makers nor the boiler-maker have as yet afforded any satisfactory explanation of the occurrence. It is without doubt a most serious affair, especially in view of the high pressures which have now become so common. On hearing of this accident the committee of Lloyd's Register instructed me to investigate the matter, endeavour to ascertain the cause of the accident, and, if possible, recommend some measure to prevent such an occurrence in the future. My investigations were only completed last Tuesday, and as such a serious matter as this, which bears upon the safety of life and property at sea, must naturally give rise to no little speculation amongst engineers and steel makers, and has already produced great consternation in many quarters, I have taken this opportunity of laying before you a short statement of the facts as they have come before me, the results of my investigations, and the conclusion which I have arrived at, with a view to eliciting from the various steel makers and steel users here the benefit of their views and experience. Upon my visit to the boiler-making works I was fortunate enough to find a sister boiler to the one which had burst, ready for testing. This boiler was tested in my presence to 300 lb. per square inch, and was carefully measured and gauged and found to show no signs of deflection or yielding. I also ascertained from an examination of the testing appliances that an abnormal pressure could not possibly have been exerted at the time of the testing of the first boiler. Seeing that the plates that broke had stood all the mechanical tests required before leaving the steel works, and that when worked into the form of a boiler shell it gave way at less than one-fourth of its original strength, it appeared at first sight that the plates had been in some way injured, or had undergone some material change from the time they left the steel works until they were rivetted into the form of a boiler shell; therefore it became necessary to look carefully into the mode of manipulation of the plates in the boiler-shop, and especially the heating and bending of them. One of the plates was bent in my presence. It was heated in an ordinary plate furnace, but when taken out was far from being of an uniform heat; the end of the plate near the door of the furnace was at a black heat, which gradually increased towards the other end to a dark red heat. Then the plate was turned end for end and again placed in the furnace with a view to heating it as far as possible uniformly, but when again drawn out of the furnace it was seen that the heat was not at all uniform, one end being of a dark red or nearly black heat, which gradually cooled down to a blue heat at the other end. In this condition it was passed through a set of powerful vertical rolls, and bent to the required curvature. The plate passed through these rolls six times, and by the time the operation was completed one end of the plate was quite cold, while the other end remained at a blue heat. It was thought that this unequal heating of the plate may have set up in the body of the plate excessive strains of a dangerous character, and that these strains were aggravated by rolling the plate at a dangerous heat, it being well known that the ductility of all steel becomes lessened when worked at a blue heat, and it is, I think, generally admitted that it is far safer to work steel cold, or red hot, than at any heat between these two points. Steel plates, and especially large ones, must be injured by such treatment, but as to the intensity of the strains set up, or their exact locality, nothing definite can be said. To ascertain the nature of the material as it stood test pieces were cut from the fractured plate, both close to the fracture and apart from it, and subjected to tensile test at one of Lloyd's proving houses, with the following results, which the engineers have kindly communicated to me:—

Samples.	Breadth.	Thickness.	Area.	Total tons.	Square inch. Tons.	Extension in 8in. per cent.	Extension in inches.	Contracted area.
	in.							
S. I. X.	1	1 17/64	1·26	40·5	32·14	27·34	2 1/16	11/16 × 7/8 & 1/32
S. C. H. I. ..	1	1 17/64	1·26	41·75	33·1	26·59	2⅛	29/32 × 27/32
S. 2	1	1 17/64	1·26	41·5	32·93	21·27	1 11/16	1 1/32 × 13/16
S. C. H. 2 X...	1	1 17/64	1·26	39·5	31·35	23·4	1⅞	1 × ¾
S. XX.	1	1 17/64	1·26	37·5	29·7	21·8	1¾	13/16 × 1
S. IXX.	1	1 17/64	1·26	37·25	29·56	26·6	2⅛	31/32 × 25/32
S. XXX... ..	1	1 17/64	1·26	38·5	30·5	28·1	2¼	11/16 & 1/32 × 15/16
S. I. XXX ..	1	1 17/64	1·26	38·25	30·3	27·34	2 1/16	29/32 × ⅞

From these tests it appears that the proved tenacity of the plate ranges from 29·5 tons to 33·1 tons, while the elongation ranges from 21·8 per cent. to 28·1 per cent. in a length of 8in. I may say that I corroborated these tests by others made from the same plate for my own information in London—the positions of these test pieces are shown on the diagram—and they were also corroborated by other tests made for the information of the steel makers. This range of about 4 tons in the tensile strength of a plate of homogeneous metal like mild steel is very unsatisfactory. I obtained samples of the plate, and submitted them to five eminent and independent metallurgists, who have kindly furnished me with the results of their chemical analyses, which are as follows:—

Carbon.	Silicon.	Sulphur.	Phosp.	Manganese.
·36	·015	·055	·087	1·05
·27	·016	·044	·076	·641
·33	·010	·038	·065	·612
·30	·018	·044	·063	·648
·26	·005	·038	·067	·650

* Institution of Naval Architects.

The most striking feature in these analyses is the large proportion of carbon shown to exist in the plate. It is particularly high for boiler plates. Material used for thin plates, say, from ½in. to ⅝in. thick, to stand the same mechanical tests as these thick plates did, would not contain more than from ·15 to ·18 of carbon; and these facts led us to further experiments. In view of the great difference in the amount of carbon required in steel for a thick plate and a thin one to stand the same mechanical tests, it was deemed desirable to make an experiment which would determine to what extent work in the shape of rolling, and especially rolling thin plates, which, during the latter part of the operation must of necessity be rolled, comparatively speaking, cold, affected the tenacity and ductility of the material. A slab of steel containing about the same amount of carbon as the plate that ruptured, viz., ·33, was obtained at the steel works where the plate was made, and rolled at one heat down to ½in. in thickness. This material, had it been rolled down to 1¼in. plate, judging from the carbon it contained and the tests of the broken plate, as well as the opinion of the steel makers, would have had a tenacity of from 30 to 34 tons per square inch. It was found, however, that when rolled down to ½in. thick its tenacity was increased to from 35 to 41 tons per square inch, with an elongation of from 21 to 24 per cent. in a length of 8in. Other pieces were made hot and quenched in water. These, when tested, broke at a tenacity of from 44 to 45 tons, and had, practically speaking, no stretch at all. Pieces were cut from the fractured edge of the plate, as shown on the diagram, and subjected to tensile, bending, and temper tests. They showed a tenacity of 33·5 to 34·2 tons per square inch, but they stretched only 13 and 16 per cent., and broke with a crystalline fracture, as will be seen by the specimens produced. They bent cold to a considerable degree, but when made red hot and quenched with water, instead of bending, as pieces of a thin plate of similar tenacity and ductility would do, they broke under the first blow of a hammer without any bending whatever. The material was so high in carbon as to take a temper and become quite hard and brittle. Further cold bending tests were made from pieces of the broken plate, both before and after being annealed; those which were tested before annealing bent fairly well, strips ¼in. square bent to an angle of 49 to 61 deg., the fracture showing a considerable amount of alteration in form; while those pieces which were tested after annealing bent much better, in fact, almost double. Strips, however, that were heated and quenched in water broke short without any bend whatever at the first blow of a hammer, and thus corroborated the previous experiments made in London. These experiments point to the fact that the plate which gave way must have become partially tempered by the heating and cooling to which it was subjected for the purpose of rolling it into its cylindrical form. The heating not having been uniform, the tempering could not have been uniform, and the variations in the temper no doubt have caused the variations in the strength and ductility shown by the different parts of the plate. The hardest part of the plate yielding less than the rest became naturally more strained, and hence the plate tore at its hardest part at a pressure only a small fraction of that which it would have borne if its yielding had been uniform.

Having thus placed before you the nature of this accident, and the steps taken with the view of unravelling the supposed mystery, I now venture to state what inferences may, in my opinion, be drawn from the results of the investigation. I think it will be acknowledged that a material which is so high in carbon as to take a temper and break short as described, even if it possesses high qualities of tenacity and ductility before being tempered, must be looked upon as unreliable and altogether unsuitable for use in marine boilers. It would appear that the desire to obtain high steam pressures, and to use steel of a higher tenacity consistent with a large amount of ductility, has caused the marine engineering world to unknowingly drift into using a material of an unreliable and unsuitable character for the shells of marine boilers, more especially when the usage which such plates receive in heating and bending is considered, for except among steel makers, it does not appear to have been generally known that the thicker a plate is the more brittle and erratic in its behaviour it must become, as compared with a thin plate made to stand the same mechanical tests as far as tenacity and ductility are concerned, as, otherwise, I feel convinced that the increase in tenacity from 29 to 32 tons for thick boiler shells would not have been advocated. So far as I am concerned, and the Society which I represent, I may say that it has always been our endeavour to discourage the use of steel of high strength. The rules of Lloyd's Register require boiler plates to have a tensile strength of from 26 to 30 tons, and have done this from the commencement of the use of steel, because we felt that the higher the tenacity arrived at the more likelihood there would be of the plates giving trouble, and our whole desire has been to keep the material mild. We have, however, had considerable pressure brought upon us by manufacturers and engineers to allow a strength of 32 tons per square inch for thick boiler shell plates. This accident and the investigations which have followed clearly point out that engineers have been drifting towards the use of an unreliable material, or at all events a material which is too near the verge of danger to be pleasant, a state of things that should not exist with steam boilers. I would therefore urge, in order to remedy this growing evil, that the tenacity of steel plates for boiler shells—which are becoming thicker every day—should in no case exceed 30 tons; and that a temper test should be insisted on from every thick plate, and the practice of using enormously large plates should be discouraged; while more care should be exercised in uniformly heating and bending these plates. I have conferred with the principal steel makers in the kingdom on this subject, and am able to say that they agree with me, and are decidedly of opinion that steel plates over an inch in thickness, and having a tenacity of more than 30 tons, must contain so much carbon as to render them unsuitable for boiler-making purposes, although they may possess the necessary tenacity and ductility to withstand the usual tensile and cold-bending tests. I venture to hope that this paper will be made the subject of a discussion, with a view to obtaining further opinions respecting the important points in question.

THE PHYSICAL SOCIETY.

AT the last meeting of the Physical Society, March 14th, 1885, Professor Guthrie in the chair, Captain Abney read a paper upon "Recent Researches on Radiation." In general a hot body loses heat in three ways—by conduction, by convection, and by radiation. In the case of the carbon filament of an incandescent lamp, the loss of heat by conduction is insignificant, and a series of experiments has been made to determine the amount of radiation—that is, the energy expended as radiant heat for every unit of electrical energy expended in the lamp. Mr. Crookes has investigated the subject of radiation in high vacua, the cooling bodies being thermometer bulbs, and has come to the conclusion that at pressures between forty-millionths and one-millionth of an atmosphere the radiation varies as the mean molecular free path. On the author's experiments incandescent lamps of thin glass were exhausted to different degrees, the radiation being measured by a thermopile. It was found that from forty-millionths to ten-millionths of an atmosphere the radiation increases uniformly with decrease of pressure, but that beyond this point it becomes nearly constant. A more important question is to determine the amount of radiation for any particular ray under the above conditions. This was effected by placing a small thermopile in the different parts of the spectrum. Plotting the results, with watts as abscissæ and radiation as ordinates, the curves for each kind of ray are found to be very accurately hyperbolas with vertical axes. This result gives a method for rendering identical the quality of the light emitted by two lamps. We have only to find the radiation corresponding to a particular kind of light for one lamp, and then by examining the curve corresponding to that ray for the other lamp, find for what number of watts the radiation is the same.

Professor J. A. Fleming read a paper on "Characteristic Curves of Incandescent Lamps." The author has collected a number of statistics connecting the life, resistance, efficiency, and potential difference of incandescent lamps, and has examined them with a view of showing the mutual relations of these variables by empirical equations. A curve, showing the relation of any one of them to any other is called a characteristic curve of the lamp. Among the various results arrived at was the confirmation of the law announced by Professors Ayrton and Perry at the last meeting of the Society, that for a certain class of lamps the potential difference, minus a constant, varies as the cube-root of the efficiency, the latter quantity being measured by candles per horse-power. The constant—which in the lamps examined is about 28·7—is nearly the potential difference at which the lamp begins to emit light. Hence the law may be put into this form: The effective potential difference varies as the cube-root of the efficiency. Using the results obtained, the author then solved the problem of determining the conditions for a minimum cost per candle, and obtained a result closely agreeing with that communicated at the last meeting by Professors Ayrton and Perry. In answer to Lord Rayleigh, Dr. Fleming stated that he had not calculated the increase of cost due to a variation from the most favourable conditions. It had been shown, however, by Messrs. Ayrton and Perry, that the increase of cost due to a variation of potential difference amounting to 3 or 4 per cent. upon either side of the value corresponding to least cost was very small.

Mr. C. Cleminshaw described some "Further Experiments in Spectrum Analysis." These consisted of methods of obtaining the inversion of the sodium line in the spectrum of the lime-light. The first consisted in concentrating the rays from the slit by a lens, just beyond the focus of which is a spoon, in which sodium is ignited by a Bunsen flame. In the second method the burner and sodium are introduced between the lime and the slit, and carbonic acid is introduced into the flame. The result in either case is to cause the immersion of the D line. Professor Guthrie, alluding to the pale blue flame produced by common salt in a coal fire, suggested that there might be more than a mere mechanical action produced by the carbonic acid. Mr. Cleminshaw, however, believed that the action was purely mechanical.

An abstract of a communication by Dr. John Hopkinson, on "Sir W. Thomson's Quadrant Electrometer," was read by the Secretary. According to Maxwell, the deflection produced by a given difference of potential between the quadrants is given by the formula

$$d = \lambda(A - B)\left(C - \frac{A + B}{2}\right),$$

where A and B are the potential of the quadrants, and C that of the needle. Dr. Hopkinson finds, however, that the constant λ should be $\frac{\lambda}{1 + k C^2}$, the quantity k being due to and depending on the unsymmetrical position of the needle with respect to the quadrants.

PAINT MILLS.—Messrs. Follows and Bates, of Manchester, have for the last two or three years been gradually developing, in addition to their ordinary horticultural appliances, a business in paint mills and drug machinery of all descriptions, from small bench machines to the large granite mills driven by power. During a visit to their works the other day I was shown a special paint mill of large size which had just been completed for a customer, and as the arrangement of the mill is something new, a short description may be interesting. The mill is a horizontal granite roller mill with six rollers, and the novelty consists in having two complete mills in one frame. The rolls, which are made of polished red Aberdeen granite, 2ft. 4in. long and 14in. diameter, are carried in two sets one over the other, and are run at different speeds. The colour is fed from the top, and is carried over the first three rolls, when it is taken it is taken off by a doctor, passed over a cold water tank, and then delivered on to the second set of rolls, and after passing these, is again taken off by a doctor and delivered into a receptacle. The first set of rolls will deliver 8 tons of white lead per day, and the second set, which are fixed for the finest grinding, deliver the finished paint, which is thus completed in one operation. The mill is very compactly arranged, occupying only about 4ft. by 4ft. 6in., and weighs from 3½ tons to 4 tons. In drug machinery the firm have also just completed a specially designed screw press for extracting essences. In this the chief feature is an ingenious ratchet arrangement, which enables the operator with a 2ft. handle to bring a pressure of six tons upon the plunger. The materials are placed in a strongly constructed box, with the front side opening upon hinges, so that the crushed substance can be readily removed, whilst the extracted liquor is delivered through a spout.

KING'S COLLEGE ENGINEERING SOCIETY.—At the meetings held on Tuesday, 10th and 17th ult., Mr. Collis's paper on "Fuel" was read and discussed. The lecturer commenced with a review of the chemical questions involved in the subject, describing various methods for determining the calorific values of different fuels, and giving formulæ for determining the highest temperatures obtainable with a given fuel under special conditions, but stating that these could not be considered quite accurate, as they were based on the assumption that the specific heats of the products of combustion were the same at the high temperatures as at the lower ones, which probably is not the case. Mr. Collis next discussed the questions which had to be considered in regulating the supply of air to furnaces, and the great evils which arose in marine boilers by the use of too short furnaces and too small tubes. He next described the various great advances which had been made within the last few years in the economy of fuel, giving details of the regenerative furnaces of Stirling and Siemens and of the Siemens recuperator. Mr. Collis regretted that, while economy of fuel was carefully studied in manufactures, it was quite forgotten in the kitchen grate and in ordinary domestic fire-places, which were more or less encased in iron, this, as a good conductor, tending to cool the fire. For this reason he advocated grates like those constructed by Mr. Fletcher, of Warrington, in which the only parts of iron were the fire-bars, the rest being all of fire-brick. The lecturer next described the various kinds of fuel, commencing with the solid forms, namely, coal, lignite, coke, peat, and wood. He gave tables of data referring to the different kinds of coal, and the source of their supply, and described the methods in present use for manufacturing coke, and the different qualities of fuel obtained by them. Mr. Collis then reviewed in detail the great advantages to be derived from the use of liquid fuel, especially for marine and metallurgical purposes, and advocated the method of burning it by admitting the liquid into the furnace as a vaporous mixture, produced by injecting it by superheated steam, and allowing this jet to impinge upon a dash-brick or ridge on the floor of the furnace, combustion being thus materially assisted by the rush of the fuel against this intensely heated surface, whilst eddies are produced very favourable to the thorough mixture with the air, which is necessary to complete combustion. The steam being also itself to a certain extent dissociated, the oxygen and hydrogen thus evolved recombine in the flues and produce heat, which is then carried forward and distributed, instead of being all developed at one point. The lecturer stated that the principal liquid fuels obtainable are petroleum and creosote, of which the former occurs in considerable quantities in the shales of Dorsetshire and other districts. The objections which had been raised to liquid fuel, on the ground of its being more dangerous, were very much over-rated, although a certain amount of care is necessary to ensure the lighting of the jet. The lecturer then described the methods of using gaseous fuel, giving details of various gas producers, amongst others the systems of Kidd, Wilson, Siemens, and Dowson, illustrating his remarks by diagrams. He then reviewed the question of cost, stating that gas for heating purposes can be produced at half the price of illuminating gas, but that it is not adapted for storing, and should therefore be used as produced. He then passed to the advantages which gaseous fuel was found to possess over solid, stating that where 20 cwt. of coal was formerly required to melt 1 ton of steel, enough gas can now be obtained from 12 cwt. to perform the same work.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, March 20th.

THE Trunk lines are in constant danger of another war of rates because of the insufficient traffic. This city has been quite recently threatened with a loss of its shipping by the efforts of the Philadelphia Elevator interests, who are offering to serve the shipping interests at from one-fourth to one-fifth the price of like services here or at Brooklyn. This move has given our merchants something to think of. The volume of business is still far below last year's volume, in the relation of 70 to 100. No very great activity is immediately probable. The export trade in cereals and meals is of moderate proportions. Prices of staples in all leading markets are remarkably uniform. Trade centres are without features of special interest. Manufacturing centres are gathering in business and orders slowly. Travelling agents representing every interests report fair prospects, but no urgent present demand. The restriction policy in production will of necessity be continued. Labour strikes will not cause serious trouble this season. Steel rails were sold here this week at an equivalent of 26 dols. 50c. at mills. Several large lots are wanted, but buyers are inclined to stand out for improbable terms. The Trunk lines will want some fifty thousand tons in all, for repairing and for branch lines.

The B. and O. Company has reached the suburbs of Philadelphia with its new line, but it is not yet known the exact point of entrance to that city. The company will continue their line to New York either by purchase or lease of existing lines.

Metal quotations to-day are:—Tin, 17¼ for futures; tin-plate, 4.40 dols.; copper, 10.81 dols. 11c. Heavy exports: Lead, 3.70 dols.; spelter, 4¼ dols.; Southern pig iron, 15 dols.; Pennsylvania iron, forge, 15.50 dols. and 16 dols.; foundry, 16 dols. and 18.50 dols.; merchant iron, 1.50 dols.; 1·75 No cent.; plate iron, 2c.; bridge, 2¼; beams and channels, 3; and Bessemer pig, 19 dols. and 20 dols.; old iron rails, 17.50 dols. offered.

The railroad purchasing agents are making inquiries for extensive requirements, and orders are looked for on a large scale by mid-April. Bridge construction is contemplated, and manufacturers are opening negotiations for a summer's work. No lower level of prices is possible, and the railroad interests will take advantage of this favourable condition to make important improvements.

Throughout the New England and Middle States the lesser industries are more active, and in the North-Western States enterprise is waiting for the breaking up of the winter.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THERE has this week been rather more activity at the ironworks as the result of the desire of ironmasters to clear up orders before the holidays. Again, they have desired that this week the men should have as good a pay as possible.

The whole of next week will be an idle time at most of the works. Masters welcome the temporary suspension, and in the interval repairs to plant and machinery will be carried out. At a few establishments where pressing orders are in hand a restart will take place on Wednesday night, but such cases are not numerous.

The quarterly meetings take place next Wednesday and Thursday, and new business is held over. Expectations are not bright as to the aspect which those gatherings will probably present. Inquiries by merchants and by consumers will doubtless be fairly numerous, but it is thought that the prices which merchants will be prepared to give will leave makers only poor profits.

Complaints are made of the tactics of merchants in their attempts to bear the market. Manufacturers question whether all the offers are genuine which merchants so freely state that they are receiving to fill orders at prices never before so low. Certain makers who, yielding to this sort of pressure, consented to take a less price than they first asked, have, upon receipt of the specifications, been lately chagrined in finding them to be exact copies of specifications executed, say, three months before. In such cases makers are wont to believe they might have obtained their own price if they had stuck to it.

Marked iron makers do not consider that the announcement of lower quotations at the quarterly meeting would bring out any more orders. The present figure of £7 10s. for bars, with 12s. 6d. extra for the Earl of Dudley's make, is likely to be redeclared. His lordship's prices in that event will be:—For rounds, £8 2s. 6d. lowest quality; £9 10s. single best; £11 double best; and £13 treble best. Rivet and T-iron, £10 10s. for single best; £12 for double best, and £14 for treble best. Angles, and also strips and hoops from 14 to 19 w.g., £8 12s. 6d. lowest quality; £10 single best; £11 10s. double best; and £13 10s. treble best. Strips and hoops of ⅜in. and 20 w.g., £9 12s. 6d., £11, £12 10s., and £14 10s., according to quality; and of ⅝in., £10 12s. 6d., £12, £13 10s., and £15 10s., respectively.

The New British Iron Company's prices for bars are likely to be re-named as:—Best Corngreaves, £6 10s.; Lion, £7 10s.; best Lion, £9; best best scrap Lion, £10; best best best Lion, £11; best charcoal, £11 10s.; best Corngreaves plating, £7; Lion plating, £8; best Lion plating, £9 10s.; best Lion turning, £11; best Lion rivet, £9; best best Lion rivet, £10; best Lion chain, £9; best best Lion chain, £10; best Corngreaves horseshoe, £6 10s.; and Lion horseshoe, £7 10s.

"Have prices touched bottom?" is a question asked by unmarked iron makers, but there is no safe reply. Possibly an outbreak of hostilities with Russia would early decide the question in the affirmative. In the present state of uncertainty all that can be said is that every succeeding week reveals prices lower than those previously accepted.

Sheets—singles—are selling for less than £6 10s.; galvanising doubles may be had at £7; and lattens at £8. A few years ago the last class of iron was realising not £8, but £18 per ton. Very capital bars are abundant at £6 10s.; and common may be had down even to £5. The extras, once so strictly adhered to on the small sizes of bars, appear to have largely vanished, and sections which formerly came under this head are now executed at the same price as the thicker gauges.

Sheet prices in Shropshire are better than in Staffordshire, but even among the Shropshire makers there is much complaining. Birmingham galvanisers quote £11 7s. 6d. for 24 gauge of corrugated sheets in bundles delivered Liverpool, but some buyers declare they are purchasing at less. Stamping sheets are in good demand, and high qualities of the Baldwin-Wilden brand are quoted at £13 per ton.

Pig iron is unimproved. Consumption is declining and stocks are still going up. Prices continue very unsatisfactory, and to keep old customers together some makers find themselves compelled to accept rates which are profitless. At the quarterly meetings all-mine pigs will it is anticipated be reannounced at 60s. for hot blast, and 80s. for cold blast. Selling rates will, however, be as they have throughout the quarter been, between 2s. 6d. and 5s. per ton less than these figures. For this there is no help with hematites imported from the west coast, from Lancashire, from South Wales, and other districts selling at less than 54s. Common pigs are supposed to be 37s. 6d. down to 35s., but I hear of sales at shillings under these rates. Northampton pigs are 39s. delivered at stations and Derbyshire pigs 40s. upwards.

Coal is a drug on the market, and the prices at which forge sorts are being sold by the Cannock Chase masters are surprisingly low. The figures range from 4s. 6d. per ton to 5s. 6d., delivered into boats, while mill coal is 6s. 6d.

The associated masters on Cannock Chase are formally discussing the advisability of giving notice for a reduction in wages. They are not, however, as yet unanimous in their views, are inclined to await the taking of some steps by the South Staffordshire masters to drop wages. Definite action upon the Chase is, therefore, for a while postponed

Some pipefounders hereabouts will try for the contract for 2000 tons of 25in. main piping required for the Hull Corporation Waterworks, but the advantages possessed by founders who are upon the coast will possibly spoil our chances of success. This district is more likely to benefit from the enquiries from the India-office for wheels and axles, axle-boxes, switches, and springs. The railway fastening firms at Darlaston are busy upon orders for the Suakim-Berber line. The production of the water pipes for the line is being rapidly pushed forward, and in every case they are tested under Government inspection before they leave the works.

The contract for the sixteen Bastier pumps and horse gears for the War-office has been obtained by Messrs. Joseph Evans and Sons, of the Culwell Engineering Works, Wolverhampton. The pumps are intended for raising water from a depth of from 65ft. to 70ft. They will be constructed on the chain principle, and will be manufactured throughout with a special view to lightness. The framework and base will be composed of wrought instead of cast iron, so that these portions will only be about one-fourth of the usual weight. A special make of wrought iron suction tubes is also adopted, and the discs of the chains, instead of being of cast iron, will be of red rubber. The first pump is to be delivered at Woolwich by April 20th, and the whole by April 27th.

The Government order for tripod pumps has been secured by a London contractor. It is not yet known to whom the contract for steam pumps will fall, since the authorities are this week considering the alternative designs which manufacturers submitted, as desired, when they tendered for pumps upon the Worthington model.

At the annual meeting of the Institute of Iron and Steel Works' Managers, held at Dudley on Saturday, Mr. R. Smith Casson, president, said that the attempts which had been made to increase the service rendered by the Grand Junction Canal had been unsuccessful. The cost of raising the walls by 3ft., and making slight alterations to the tunnels and locks to permit steamers of 120 tons burden to travel between Birmingham and London, would be about £6000 per mile, or a net total of £1,000,000 sterling. The rate of carriage on goods to London, if it were 7s. 3d. per ton, would, he believed, pay a handsome profit to the company. South Staffordshire was now paying 15s. per ton for the carriage of iron to London. To prevent the possibility of the canal being amalgamated with the railway companies, it had been proposed that the various corporate bodies in the district should be joint purchasers. The Corporation of Birmingham had, however, refused to co-operate.

The notice of the nut and bolt manufacturers of Darlaston for a reduction of 10 per cent. in wages expires on Saturday, and the men announce that they have no intention to ask for a further extension of time. It has been agreed to ask Mr. Wiley to receive another deputation. If these pacificatory proposals prove futile, the novel movement which has been going on for some time past will have proved a failure.

The operatives in the forged chain trade employed around Cradley Heath are on strike attempting to secure an advance of wages by getting all the masters to concede to what is termed "the 4s. list."

Merchants in the hardware trade are in some instances this week countermanding the execution of orders previously placed until Anglo-Russian affairs assume a more definite appearance.

Birmingham cartridge manufacturers are not pleased at the large supplies of cartridges which our Government are drawing from America. This foreign buying is deemed the more unsatisfactory, since except for orders, estimated at two million cartridges for China, which are being executed by a Smethwick firm, local manufacturers have but little to do.

So severe is the competition of steel, that certain of the North Staffordshire iron makers are earnestly considering whether it is not advisable to begin making steel on their own account. Orders for large and special sections, such as channel and girder iron, are leaving the district and going to the steel-masters. The merchant mills are running betweem four and five turns a week. The plate mills are, however, only working irregularly. The bar makers report a somewhat improved demand from the Australian, Indian, and South American markets. Crown bars are about £7 to £7 10s. and commoner descriptions £5 7s. 6d. to £5 15s.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—There is no very material change to report in the condition of the iron trade of this district; throughout all branches it continues very unsatisfactory, with an absence of any early prospect of improvement. With the close of the quarter there has been the usual indisposition to buy, but apart from this, a spirit of distrust and uncertainty as to the future is for the moment prevalent, and adds, if anything, to the dulness and depression which have so long prevailed.

The iron market at Manchester on Tuesday, being the only one held this week, brought together a moderately good attendance, but only a very small weight of business was reported. Pig iron still meets with only the most limited inquiry, and as the current actual requirements of consumers continue extremely small, very little disposition is shown to buy forward. On the other hand sellers are less disposed than they were a few weeks back to book for long-deferred delivery. Lancashire pig iron makers still hold to 40s. for forge and 40s. 6d. for foundry, less 2½ delivered equal to Manchester, as the minimum basis on which they are prepared to entertain business, but beyond occasional small sales to regular customers, they are doing practically little or no business at these figures. The leading makers of Lincolnshire iron decline to come below about 40s. 6d. and 41s., less 2½ for delivery here, but they are practically out of the market at these figures, or they are undersold by one or two district brands to the extent of 1s. and 1s. 6d. per ton.

In the finished iron trade there is, if anything, a little more animation. Recent war preparations have resulted in orders being placed which have helped to give temporary activity to some departments, and although, on the other hand, the threatening complications with Russia tended to stop the opening of the Baltic shipping trade, the more re-assuring prospects of the last few days have led to orders, which were held back, being given out. In the home trade makers here and there report orders coming forward rather more freely, and merchants appear to be sending in specifications on account of contracts better than of late. In the general condition of trade there is, however, still no appreciable improvement, and although the further downward movement in prices seems to have been checked, no advance is obtainable, and £5 7s. 6d. for good qualities of bars delivered here remains the average basis of prices.

The members of the Manchester Geological Society had a very interesting excursion to Sheffield and the district last week, the party, which was very numerous, being taken down by special train. The first point of interest was the works of Messrs. John Brown and Co., where they were shown some of the processes connected with the manufacture of heavy compound armour plates. These, however, are already so well known that any general description here is unnecessary, but it will be interesting to refer to a supplementary process which has recently been introduced for securing a more perfect weld in the compound plates. Previously the plates after the steel face had been put on were simply rolled down to the requisite thickness, but adopting apparently the Whitworth theory of compression, the plates, before they are passed on to the rollers, are subjected to a powerful hydraulic pressure of upwards of 4000 tons. This pressure, which reduces the thickness of the heavy plates about 2in., has been found to very much improve the welding of the iron and steel, the whole mass of the metal is operated upon—a closer fibre being produced right through the body of the plate—and not simply the surfaces, as is practically the case under the rolling process. The difficulty which was long felt in utilising the scraps cut off the compound plates, owing to the presence of both iron and steel, has been overcome in a very simple manner. The scraps are re-heated and the steel face is then sawn off, so that the iron and steel can again be used separately.

From Sheffield the party proceeded to the company's collieries at Aldwarke, where an opportunity was afforded for a practical investigation of two questions which are at present largely occupying the attention of mining engineers, one with reference to safety lamps, and the other with reference to lime cartridges as a substitute for gunpowder in getting coal. Mr. C. E. Rhodes, the manager of the collieries, who for a considerable time past has been going thoroughly into the testing of safety lamps, and for this purpose has constructed special apparatus at the collieries, with which a number of important experiments have recently been made subiected a number of lamps to a similar trial to test their trustworthiness when exposed to an explosive current. The usual results were obtained with the Davy lamp, which fired the surrounding gas when exposed to a current travelling at 6ft. per second; and the Clanny and Stephenson were scarcely any better, the former firing in a current travelling at 7ft. and the latter at 12ft. per second. The Williamson and ordinary Muesler also fired in velocities of 14ft. and 17ft. respectively, the lamp which apparently stood the best test being the Muesler with shield, which in an explosive current travelling at 30ft. per second went out, and in a current at 40ft. burned slightly at the bottom of the chimney during the whole of the experiment. This burning, however, it may be added, often occurs, but it is so slight that I understand, even when gunpowder is placed upon the horizontal gauze, it will not affect it. The lime cartridge experiments took place in the long wall workings of the Swallowwood seam. A piece of coal, twenty yards in length, was experimented upon. It was holed to the depth of 4ft. 6in., and ten holes were drilled near the roof to the same depth. Each of these holes was charged with six to seven lime cartridges, and, after being stemmed, water was forced in by means of a hand pump. In about an hour the full effect of the lime cartridges was felt, and a fall of coal of about 40 tons resulted. The result of the experiments went to prove that lime cartridges, if allowed sufficient time, will do their work; but generally the process was regarded as a very slow one, and several of the members stated that at their collieries lime cartridges had been tried, but that ultimately they had been abandoned. It seems scarcely probable that lime cartridges in their present form will be voluntarily adopted as a substitute for gunpowder in getting coal under ordinary conditions; but under conditions where the firing of shots is absolutely dangerous, as in the case of a very fiery seam, such as the one at the Aldwarke Main Colliery, where the dispensing with gunpowder has become imperative, the lime cartridge process affords a means of getting coal which, though slow, is undoubtedly efficient, and in many cases will be very valuable.

In the coal trade the general course of business remains much the same as last reported. For house fire coal a fairly good demand, which is certainly better than it was at the commencement of last month, is kept up, and prices are well maintained. Common round coals for ironmaking and steam purposes are, however, still very bad to sell, and are quite a drug in the market, with extremely low prices taken to effect sales in bulk. Engine classes of fuel are in moderate demand, with no very excessive supplies generally in the market, but in the Manchester district a reduction of 6d. per ton has been made this month in the delivered rates for burgy and slack. With the above exception, there has been no actually announced reduction in prices this month, but a want of firmness characterises prices to a very considerable extent. At the pit mouth best coal averages 8s. 6d. to 9s.; seconds, 7s. to 7s. 6d.; common coal, 5s. 3d. to 5s. 6d.; burgy, 4s. 6d. to 5s.; and slack from 3s. to 4s. per ton, according to quality.

The shipping trade has been quiet, with good steam coal delivered at the high level, Liverpool, or the Garston Docks quoted at 7s. to 7s. 3d. per ton, and inferior qualities to be got at about 6s. 9d. per ton.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

I ATTENDED the interview between the coalowners and the colliers' representatives on Friday last. Mr. J. D. Ellis, the chairman of John Brown and Co., who own the Aldwarke Main and Car House Collieries, was in the chair, and there was a most influential attendance of South and West Yorkshire colliery proprietors. The miners' deputation was headed by Mr. Benjamin Pickard, Mr. Edward Cowey—the president of the Yorkshire Miners' Association—and other miners' officials from Barnsley. All that the miners' representatives did was to urge the employers to withdraw their notices. This the masters firmly declined to do, and the interview ended with the rupture wider, if possible, than before. The miners' representatives reported the result of their interview to the delegates at the miners' conference on Monday, when it was decided to resist the reduction, and we are therefore face to face with a stoppage of pits which will inevitably deprive at least 40,000 people of employment, though householders and large consumers will not be inconvenienced, as there is abundance of coal to meet all demands for a month. The Wigan coalowners are alive to the situation, and are making known their ability to send any quantity of coal; but outside sources, though they may benefit by the absence of Yorkshire competition, will not be largely called upon for supplies for Yorkshire use.

On Thursday the Manchester Geological Society had an enjoyable excursion to the Atlas Works—Messrs. John Brown and Co.—where they were received by Mr. J. D. Ellis, chairman and managing director, who accompanied them through several of the leading departments. They witnessed the casting of an "Ellis" compound plate for H.M.S. Hero, the Bessemer process, the making of tires, and visited the hammer and other shops. They were afterwards taken to the company's collieries at Aldwarke Main, where they were met by Mr. C. E. Rhodes, the manager, and Mr. J. C. Duncan, the secretary to the company. After inspecting the surface arrangements, which are exceptionally complete, a number descended the mine, where they had an opportunity of seeing the lime-cartridge process for getting coal. They also witnessed a series of safety lamp experiments. The members, who numbered fifty-two, were much pleased with their visit.

A distinguished party, including the brother of an Indian prince, and several Eastern "notables," visited the cutlery works of Messrs. Joseph Rodgers and Sons, and the gun works of Messrs. Thomas Firth and Sons, Norfolk Works.

250 Wallace spades have been supplied to the Guards, for use in the Soudan, and 1000 have been sent out as a reserve to Suakim. It appears that when inspected by the Duke of Cambridge, previous to their departure for the East, the Guards asked to be supplied with these useful implements, in consequence of their experience of them in the campaign of 1882. Messrs. Lucas and Son, of the Dronfield Foundry, near Sheffield, are the sole manufacturers of these spades.

Messrs. Charles Cammell and Co. are removing the bricks from the walls which once contained the Dronfield Steel Works—now established at Workington—leaving only the chimney stacks. The bricks are to be used in the erection of the new building, to hold the immense forging press, to be put up at Grimesthorpe by the company. About a million of bricks, it is estimated, will be required for the building, and another million to build a wall around the ground.

Wars usually bring an accession of orders to the surgical instrument makers, and there is a slight improvement in some departments; but a war with Russia would at once make this branch exceedingly busy. Cutlery and silver-plated goods are but languidly asked for, and there is no improvement in the iron and steel trades.

Eight local firms are to exhibit at the Inventories, to be opened on the 4th of May next, by the Prince of Wales.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

No change of moment has taken place in the Cleveland pig iron trade during the past week. The amount of business done has been but small, consumers apparently buying only sufficient to cover their immediate requirements. They expect that prices will be reduced shortly, and that they will then be able to buy more advantageously. Meantime prices for No. 3 g.m.b. are steady. Merchants offer at 34s. per ton for prompt delivery, and 34s. 3d. to 34s. 6d. for forward delivery. Makers quote 34s. 3d. to 34s. 9d.; they are not selling much at present, and are not anxious to do so, as they look for better things when the shipping season has fairly set in. Forge iron is in good demand, and can be freely sold at 33s. 3d. per ton.

Warrants are offered by some holders at 33s. 6d. per ton, but buyers are not forthcoming.

The stock of Cleveland pig iron in Messrs. Connal and Co.'s store at Middlesbrough has not altered during the past week, the quantity held on Monday last being 50,832 tons.

Shipments of pig iron from the Tees have improved during the last few days, but are still less than in the corresponding period of recent years. Up to Monday last 68,285 tons had been exported. Last year the quantity was 77,394 tons, and in February of the present year 63,456 tons.

In the manufactured iron and steel trades the demand has slightly improved. Specifications for plate and bar iron have been given out more freely, and the mills are working a little more regularly. Steel plate and rail makers are fully occupied for the present. Messrs. Bolckow, Vaughan, and Co. have booked an order for 3700 tons of rails for the Suakim-Berber Railway. Prices are the same as quoted a week since.

The annual meeting of Messrs. Bolckow, Vaughan, and Co. was held at Manchester on Thursday last. A dividend of 2½ per cent. was declared on ordinary shares. The chairman reported that large orders for steel plates had been secured by the company, and that the borings for salt at Eston and at Middlesbrough were making satisfactory progress.

Messrs. Armstrong, Mitchell, and Co., of Newcastle, have secured orders for two large cruisers for the Japanese Government, which are to be proceeded with at once. The same firm have two other war ships in hand for the Japanese, one of them being nearly finished.

The accountant to the North of England Board of Arbitration has issued his report for the two months ending February 28th. It shows the make of plates, bars, rails, and angles to have been 62,460 tons, and the average net selling price £4 18s. 11d. per ton. The above output is about 2500 tons more than for the two months ending December 31st, 1884.

A great demonstration of pitmen hitherto employed by Messrs. Bolckow, Vaughan, and Co., was held at Bishop Auckland on Saturday, the 28th. The object of the men was to consider their position, in view of their employers having stopped six out of their fifteen collieries within a twelvemonth. The following remarkable resolutions were unanimously adopted, viz.:—(1) "That this meeting condemns as mean and un-English the tactics of the officials of the firm, in taking advantage of the state of the labour market to exercise their power over the men in a tyrannical manner, and pledges itself if such be not put a stop to, to take joint and united action in defence of their integrity and manhood." (2) "That this meeting expresses its strongest disapproval of the inhuman and arbitrary policy pursued by Messrs. Bolckow, Vaughan, and Co., in throwing numbers of their men out of employment while the remaining portion are overworked, in order to supply the diminished production caused thereby; it preferring that what work may be found should be divided, as far as possible." The leaders of the men in the above movement do not seem to have understood how largely cost of production is affected by dead charges. The employers, under pressure of slack demand and low prices, have evidently closed those pits which did not pay, thereby getting rid of the dead charges upon them as far as possible. The remainder they are now able to keep in full operation, which is the important element in cheap production. Had they not sacrificed some, all would probably soon of necessity have been stopped. The men are, however, as usual, unable to look at the matter from an economist's point of view. To them it is a case of wilful neglect of fairness, justice, and so forth, and not of simply yielding to inexorable necessity. The maligned officials have no doubt considered the pecuniary interest of the shareholders who pay them. The pitmen seem to think they should first have considered their workmen's interests. The men are clearly in the wrong and will certainly have to submit. Nevertheless, they have a valid claim on public sympathy on the ground that they are being so heavily punished by the bad times, and are so helpless to contend against them.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

ALTHOUGH the iron trade, as a whole, has shown little improvement in the course of the week, a firmer tone has prevailed in the market. The shipments of Scotch pigs turned out several thousand tons larger than had been anticipated, and this fact tended to strengthen prices, which had suffered a relapse towards the close of last week. A considerable speculative business took place at the advancing rates, when the market again became quieter. The trade with Canada has now begun, but it is not expected that it will be very large. Germany is taking much less iron than usual. Rather more is going to Australia, but the demands of other countries are comparatively small. In the Scotch foundries a large amount of Cleveland iron is being used, and the arrivals are much greater than they were at this time last year. There are ninety-two furnaces in blast, against ninety-three twelve months ago. The addition for the week to the stock of pigs in Messrs. Connal and Co.'s Glasgow stores is smaller than for a succession of weeks.

Business was done in the warrant market on Friday at 41s. 5½d. cash. On Monday forenoon transactions occurred at 41s. 6d. cash, and 41s. 8d. one month. In the afternoon the quotations advanced to 41s. 8d. cash, and 41s. 10d. one month. Transactions took place on Tuesday from 41s. 7½d. to 41s. 6½d. cash. To-day—Wednesday—sellers were scarce, and quotations were from 41s. 7d. to 41s. 8½d., closing with buyers at 41s. 7½d. cash.

The market values of makers' iron are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 51s. 3d.; No. 3, 46s. 6d.; Coltness, 54s. and 50s. 6d.; Langloan, 53s. 9d, and 49s. 9d.; Summerlee, 51s. and 46s.; Calder, 51s. 6d. and 46s.; Carnbroe, 48s. 3d. and 45s. 6d.; Clyde, 46s. 6d. and 42s. 6d.; Monkland, 42s. and 39s. 9d.; Govan, at Broomielaw, 42s. and 39s. 9d.; Quarter, 41s. 9d. and 39s. 6d.; Glengarnock, at Ardrossan, 48s. 3d. and 42s. 3d.; Dalmellington, 46s. 6d. and 42s. 6d.; Eglinton, 42s. 9d. and 39s. 6d.; Shotts, at Leith, 51s. 3d. and 50s. 9d.; Carron, at Grangemouth, 48s. 3d. and 47s.; Kinneil, at Bo'ness, 44s. and 43s.

The total import of Middlesbrough pig iron up till Saturday last was 86,937, showing an increase since the 1st January of 21,392 tons.

In some departments of the manufactured iron trade considerable activity prevails. Founders engaged on railway castings have been doing well, and locomotive engineers are busy, the bulk of their work being for India and the Colonies.

The coal trade, as a whole, is dull, although merchants report that steam coals are in rather better demand. At Glasgow the shipments have been comparatively good, amounting to 26,000 tons; at Greenock they were 3982 tons; Irvine, 1158; Ayr, 8493; Troon, 7794; and Grangemouth, 4498 tons. The f.o.b. quotations of coals at Glasgow are: Main coal, 5s. 9d. to 6s. 3d.; ell, 5s. 3d. to 7s.; Hamilton ell, 6s. 9d. to 7s. 3d.; splint, 6s. 3d. to 7s.; steam, 7s. to 8s.

The wages of colliers are now being reduced all over the mining districts. In the Lanarkshire and Ayrshire districts the reduction is at the rate of 6d. a day; whilst in Fife and Clackmannan it amounts to 10 per cent. Deputations of the miners in the last-named counties have waited upon the employers requesting them to withdraw the notice of reduction; but the reply in every case was that the state of the trade required it, and that no compromise could be made. A meeting of the Executive Board of the Miners' Association of Fife and Clackmannan was held at Dunfermline on Saturday—Mr. James Innes presiding—when Mr. Weir, the secretary, was instructed to write Mr. Connel, the coalmasters' secretary, suggesting that, in view of the Baltic trade setting in immediately, the reduction be withdrawn. Should this appeal be unsuccessful, as is most likely, a conference will be asked for to give the representatives of the men an opportunity of discussing the subject. It is estimated that at present in Fife and Clackmannan there are 400,000 tons of coal at the pit heads, and the general opinion seems to be that stocks are heavier than at any former time.

Notices have been posted at the Mid and East Lothian collieries that, dating from the 1st inst., a reduction will be made in the miners' wages equal to 12 per cent., the pay of all other workers above and below ground being curtailed to the same amount.

During March fifteen new vessels were launched from Clyde shipyards aggregating 13,667 tons, compared with eighteen vessels of 26,820 tons in March, 1884. The work of the three months is forty-two vessels of 38,512 tons against forty-two aggregating 627,600 tons, in the first quarter of last year. The new tonnage placed during the month is over 20,000, including the orders for six torpedo cruisers, given to Messrs. Thomson, of Clydebank, and eleven Nile stern-wheel steamers building by Messrs. Elder and Co. Messrs. W. B. Thompson and Co., of Whiteinch, have contracted to build two iron four-masted sailing vessels, of 2200 tons each, for Messrs. Bordes and Sons, of Bordeaux; and Messrs. Denny Brothers, of Dumbarton, are laying down the keel of a steamship of 5300 tons and 5000 indicated horse-power.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

COAL finds in North and South Wales are the order of the day, and in face of the rapid exhaustion of some districts, this must be regarded as of national importance. In the North, in the Ruabon district, a very important find has been made. In the South, in various quarters, notably in the Garw valley, and at Neath, most important seams have been struck within the last few days. This week the 7ft. seam was struck at the Rhondda-Merthyr Colliery by Mr. E. Lewis.

There is little or no elasticity in the house coal trade, and secondary seams are not in demand. All that can be said is that prices remain moderately firm. An order has been issued to wind up the Rhondda Mountain Steam Coal Company; also the Bishwall Coal and Coke Company, Gower's-road, Swansea; and I hear that the Neath and Merthyr Colliery Company has come to the determination to close its working. Fortunately in other valleys there is more hopeful life, and I am glad to know that trade in most of the ports is well maintained. Cardiff keeps up its high averages, and Swansea is brisk. Newport remains, as I stated last week, rather quiet. I was pleased to see, however, a day or two ago on a personal visit to Newport, a good deal of promise. In railways, building, and dock improvements, a good deal is being done. Newport will oppose the Risca Bill strongly. The contention is that though great virgin coal-fields remain in Monmouthshire which would secure the future of Newport, yet this line will warp it into the direction of Cardiff. This is a view purely from the Newport side, and I need scarcely add is far more gloomy than likely. Newport has not much reason to fear a single line, but every reason to prompt the formation of others.

The Severn Tunnel is rapidly approaching completion, and I hear that Mr. Walker will be ready by July. I am glad to see that the same able contractor has secured the contract for a new dry dock at Swansea. This will be known as the Prince of Wales Dry Dock. It will be 600ft. long, and large enough to take the biggest ship that is afloat. The cost of equipping this and the other that is in formation will be £75,000.

Mr. Broadhurst, M.P., has accepted an invitation to address the Rhondda colliers about May or June.

Some little signs of contention are abroad. In the first instance, we have the Middle Duffryn dispute, which still remains unsettled; then the Tylacoch wages case, which is in the courts; next the colliery enginemen are moving, and meetings are to be held respecting the 2½ per cent. reduction in particular. This week, also, a circular letter has been issued calling a meeting of house and steam coal men in the Llanrabon district. At this will be discussed the expediency or not of terminating the sliding scale, to obtain results of the Birmingham meeting, and to have fuller details of the 2½ per cent. reduction. Mass meetings are being organised to support the Middle Duffryn colliers.

The South Wales ports have been visited by an important deputation of Government officials with a view to the purchase of coals for the Admiralty. At Cardiff a rigid inspection of the docks, and the appliances for rapid loading were shown, and much satisfaction was expressed thereat. There is a good deal of hopeful anticipation in Wales about this visit. Captain Frazer has resigned the Cardiff Harbour mastership, and has been succeeded by Captain Pomeroy.

The iron and steel trades remain quiet. Dowlais is working off the first order of 3000 tons of steel sleepers, and I shall not be surprised to hear of other works being employed in the same direction. In rails the consignments have been a little better. Rails for India amounting to 1600 tons left last week, also a good cargo for Oporto, and 950 tons to Suakim.

In tin-plate there is not much variation, and will not be until the meeting which takes place at Swansea after the despatch of my parcel. A meeting of the Tin-bar Makers' Association was held at Gloucester on Tuesday last, when it was decided to retain the price of Siemens and Bessemer bars for the ensuing quarter at present prices.

Prices paid for all kinds of sheets are still low. An effort will certainly be made to improve them, and as stocks are small, this will likely be successful.

Notices have been posted up at Llynvi and Tondu Works that contracts will cease in four weeks from date.

Patent fuel is in good demand, and prices are gone up 3d. per ton.

I hear that the Maenchechog Railway is to be closed for all traffic on and from the 1st of April.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

*** *It has come to our notice that some applicants of the Patent-office Sales Department, for Patent Specifications, have caused much unnecessary trouble and annoyance, both to themselves and to the Patent-office Officials, by giving the number of the page of* THE ENGINEER *at which the Specification they require is referred to, instead of giving the proper number of the Specification. The mistake has been made by looking at* THE ENGINEER *Index, and giving the numbers there found, which only refer to the pages, in place of turning to those pages and finding the number of the Specification.*

Applications for Letters Patent.

*** When patents have been "communicated," the name and address of the communicating party are printed in italics.

24th March, 1885.

3750. CHIMNEY POTS or TALLBOYS, C. H. Hardiman, Southampton.
3751. FIXING of LAWN TENNIS POLES, T. Eastman, Fareham.
3752. ENAMELLING and PURIFYING CASKS, J. Death, jun., Cheshunt.
3753. LOCKS, J. Mallol, Birmingham.
3754. UNIVERSAL SCREW WEDGE COUPLING, D. Faulds, Barrow-in-Furness.
3755. PHOTOMETERS, H. D. Taylor, Bootham.
3756. DREDGING MACHINES, P. de Monicourt, Glasgow.
3757. WASHHAND BASINS or LAVATORIES, W. Miller, Glasgow.
3758. CONTROLLING the SPEED of ENGINES, R. H. C. Neville, Lincolnshire.
3759. BURNER for GASSING YARNS, J. W. Dawson, Manchester.
3760. LAMP BURNER, E H. Hickok, New York.
3761. EXTRACTION of PHOSPHORUS from PHOSPHIDE of IRON, W. P. Thompson.—(*L. Imperatori, Germany.*)
3762. HANDSPIKES or PINCH BARS, W. P. Thompson, (*W. Schug, Germany.*)
3763. BLOWING ENGINES, T. G. Bedstone and J. Forrester, Liverpool.
3764. ELECTRIC FUSES, J. Macnab and D. Hickie, London.
3765. CARBONS for INCANDESCENT ELECTRIC LAMPS, G. Davidson, R. C. Jackson, and J. B. Duncan, London.
3766. EXPOSING SENSITISED PLATES, A. H. Dawes, London.
3767. COUNTERS for INDICATING the NUMBER of MOVEMENTS of PARTS of MACHINES, W. Chadburn, London.
3768. APPARATUS for LIFTING MALT LIQUORS, J. Clayton, London.
3769. FILAMENTS for INCANDESCENT ELECTRIC LAMPS, G. Davidson, R. C. Jackson, and J. B. Duncan, London.
3770. CUTTER for SHAPING the TEETH of WHEELS, R. Gough, London.
3771. CLEANSING of STREETS and ROADWAYS, E. J. C. Edmonds, London.
3772. COOKING STOVES, C. Unger and P. Gerlach, London.
3773. MEASURING LAWN TENNIS COURTS, C. Hulbert, Watford.
3774. TUBE ROLLING MACHINE, E. Tangye, London.
3775. METALLIC SAFETY FUSE, E. Tangye and R. J. Connock, London.
3776. HYDROGEN GAS, A. H. Reed.—(*G. E. Moore, United States.*)
3777. DRAUGHTMAN'S TOOLS, A. H. Reed.—(*T. G. R. Christian, United States.*)
3778. PHOTOGRAPHIC PAPER, A. M. Clark.—(*E. and H. T. Anthony and Co., United States.*)
3779. LAWN TENNIS SCORING, C. A. Bowdler, London.
3780. FASTENERS for SASHES, R. W. Pyne, London.
3781. AUTOMATIC OILERS, H. J. Allison.—(*J. S. Hall, United States.*)
3782. DECORATING PORCELAIN, H. J. Allison.—(*C. F. Haas, United States.*)
3783. BREECH-LOADING FIRE-ARMS, R. S. Chaffee, London.
3784. EXTRACTING the WATER of CONDENSATION from SUGAR BOILING APPARATUS, W. Walker, West Dulwich.
3785. GAS ENGINES, J. Atkinson, Hampstead.
3786. AUTOMATIC EXHAUSTER for COMPRESSED AIR ENGINE, A. A. E. G. de V. de Cumptich, London.
3787. TRUSSES for BRIDGES, G. H. Pegram, London.
3788. WARP LACE MACHINES, J. C. Johnson, London.
3789. ELECTRICAL SIGNALLING APPARATUS, B. J. B. Mills.—(*F. E. Lyster and G. J. Schermerhorn, United States.*)
3790. BRIQUETTES or FUEL BLOCKS, W. Black, Glasgow.
3791. FLOATING VESSEL for MANUFACTURING BRIQUETTES, &c., W. Black, Glasgow.
3792. PERFORATING and STAMPING MACHINE, A. C. Thomson and J. Bryce, Glasgow.
3793. STENCILS and DIES, A. C. Thomson and J. Bryce, Glasgow.
3794. DISTANT SIGNAL LAMPS, H. J. Winspear, London.
3795. PARALLEL VICE, G. F. Redfern.—(*H. de Montigny and W. Schnorr, Saxony.*)
3796. ROSE ENGINES, G. F. Redfern.—(*A. Zemann and W. Putzker, Austria.*)
3797. VALVES, R. Small, London.
3798. ELECTRIC BATTERIES, W. R. Lake.—(*H. L. Brevoort and I. L. Roberts, United States.*)
3799. SEWING SAW PLAIT, O. Robinson, London.
3800. BEATERS for DRESSING FLOUR, &c., C. Lampitt, London.
3801. IMPRESSING DIES, R. P. Keates, London.
3802. WALLS, &c , W. H. Johnson, London.
3803. COLOURING MATTERS, H. J. Haddan.—(*The Farbenfabriken vorm. Fr. Bayer and Co., Germany.*)
3804. WASTE-PREVENTING VALVE and SYPHON, J. J. Day and T. I. Day, London.
3805. ELECTRIC GOVERNORS, J. Swinburne, Brockley.
3806. COLLAPSIBLE BILLIARD TABLES, E. J. V. Earle, London.
3807. CLEARING MUD from the GROOVES of TRAM RAILS, W. Rayner and W. C. Edwards, London.
3808. STEEL, W. E. Wynne.—(*H. W. Oliver, jun., and J. P. Witherow, United States.*)
3809. FIRE STOVES, J. J. Carpenter, London.
3810. STOPPERS for BOTTLES, A. R. Stocker, London.
3811. VELOCIPEDES, D. Wiggins, London.
3812. COURT PLASTER, A. J. Newling, London.
3813. ELECTRIC SIGNALLING APPARATUS, F. B. Herzog, London.
3814. SPHERICAL ROTARY ENGINE, J. Corry and J. F. Sleat, London.
3815. DRYING TEA, &c., G. Greig, London.
3816. SIGNAL APPARATUS, B. J. B. Mills.—(*F. E. Lyster and G. J. Schermerhorn, United States.*)
3817. FURNITURE, H. Sans, London.

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3818. AUTOMATIC EXPANSION GEAR, T. N. Robinson and J. P. Fielden, Manchester.
3819. CARDING WOOL, &c., C. Rhodes, Halifax.
3820. INSERTING CENTRES in LAPS of COTTON, G. C. Swindells, W. Hibbert, and J. Mellor, Manchester.
3821. COMBINED CHAIRS and SLEEPERS, S. Rideal, Manchester.
3822. GAS LAMPS, J. Roots, London.
3823. PRINTING DADOS on PAINTED WALLS, &c., J. Baber, Liverpool.
3824. BOILERS, J. L. Walker, London.
3825. CUTTING CHENILLE, J. McGhee, Glasgow.
3826. HYDRAULIC APPARATUS for ROLLING MILLS, J. Riley and J. Swaine, Glasgow.
3827. SUPERSEDING the USE of OILS, &c., J. H. Salter and T. A. Burrows, Oxford.
3828. FORGING or SHAPING NAILS, &c., B. P. Walker, C. B. Ketley, and T. D. Clare, Birmingham.
2829. MOVING, FIXING, &c., SLIDING SEATS of VEHICLES, W. Angus and D. Lewars, Newcastle-on-Tyne.
2830. SPRING WIRE BAND for GARTERS, &c., J. Jackson, Birmingham.
3831. APPLYING DRAG to BOBBINS, &c., W. J. Adeley, Belfast.
3832. VEHICLES for CHILDREN, F. Pearson, jun., London.
3833. BAROMETER and SIGNALLING APPARATUS, W. Colomb, Dublin.
3834. FASTENING COLLAR, &c., STUDS, W. Charles, Shepherd's Bush.
3835. LATHE CARRIERS, &c., T. Humpage and C. A. Bullock, Clifton.
3836. SINKS and TRAPS, W. M. Brown and H. Clayton, Halifax.
3837. WHEELS for LOCOMOTIVES and VEHICLES, P. U. Askham, Sheffield.
3838. AUTOMATIC COUPLING, G. W. Rhoades, London.
3839. WHITE LEAD, E. V. Gardner, London.
3840. VENTILATING CLOSET, &c., H. Heron, London.
3841. VELOCIPEDES, J. K. Starley, London.
3842. TURNING OVER the LEAVES of MUSIC BOOKS, G. V. Collins, Cornwall.
3843. WHEEL TIRES, R. B. Black and W. Jones, Glasgow.
3844. PACKING for STUFFING-BOXES, R. B. Black and W. Jones, Glasgow.
3845. THERMO-ELECTRIC GENERATORS, H. Woodward, London.
3846. DECOMPOSING SULPHATE of IRON, B. Biggs and T. Terrell, London.
3847. DRIVING BANDS for ROLLER MILLS, A. Mechwart, London.
3848. DRIVING the ROLLERS of ROLLER MILLS, A. Mechwart, London.
3849. TRIMMING HATS, J. H. Johnson.—(*G. Hourbette, France.*)
3850. SHUNTS or CONTACT VARIERS for MAGNETS, G. A. Mason, London.
3851. TELEPHONES, P. M. Justice.—(*F. Blake, United States.*)
3852. STAPLES, P. M. Justice.—(*J. Thomson, United States.*)
3853. BELLS for BICYCLES, B. J. B. Mills.—(*E. K. Hill, United States.*)
3854. ELECTRIC GOVERNORS, W. Hartnell, London.
3855. PRODUCING COMPOUND MIXTURES, C. T. Kingzett, London.
3856. DIPPING SHEEP, F. B. Rendle, London.
3857. ELECTRICAL SWITCHES, S. Z. de Ferranti, London.
3858. BELT FASTENER, W. R. Lake.—(*J. J. Roberts, United States.*)
3859. EXTRACTION of METALS from STONES, W. L. Wise.—(*V. Popp, France.*)
3860. FOLDING BEDSTEADS, C. McWhirter, London.

26th March, 1885.

3861. WINDING MACHINES, W. H. Hayhurst and F. L. Jones, Blackburn.
3862. REFRIGERATOR, W. L. Baker, London.
3863. PREPARING FIBRES, J. V. Eves, Belfast.
3864. TAKING-UP MOTION for LOOMS, E. Barlow, Manchester.
3865. SODIUM, J. Anderson, Dundee.
3866. SHAPING BUTTER, R. F. Kerr, Glasgow.
3867. VELOCIPEDES, M. J. Wheatley, South Shields.
3868. FIRE GUARDS, J. C. Gray, Birmingham.
3869. LITHOGRAPHIC PRESSES, G. Maskell and J. Appleyard, Bradford.
3870. CONDENSERS for GAS, R. Dempster, jun., Manchester.
3871. DRAWING CORKS from BOTTLES, F. T. Marwood, Blackburn.
3872. BEAN CUTTER, C. F. Anderson, London.
3873. GAS LAMPS, H. Defty, Manchester.
3874. MAKING BLANKS FOR SHOE-NAILS, J. O. Kollen, Glasgow.
3875. OPENING and CLOSING WINDOWS, H. W. Ibbotson, London.
3876. MAKING CLAY PIPES, &c., R. C. Robinson, London.
3877. SKIMMING LIQUIDS, H. Long, London.
3878. BURNERS for HURRICANE LAMPS, P. Koeppen, London.
3879. SAND BLAST APPARATUS, B. J. Round and W. Wham, Birmingham.
3880. JOINING HOOP IRON BANDS, W. B. Jones.—(*M. I. Jones, Australia.*)
3881. COTTON GINS, H. J. Allison.—(*C. T. Mason, jun., United States.*)
3882. MANUFACTURING PRODUCTS COMPOSED of CAOUTCHOUC and GRANULATED CORK, L. S. Hoyt, Massachusetts.
3883. PROJECTILES, G. Blunt and W. M. Richards, London.
3884. WINDOW-FASTENINGS, H. J. Haddan.—(*F. W. Poestges, Germany.*)

3885. Rotary Apparatus, W. I. Last, London.
3886. Pottery Ware, R. Boote, London.
3887. Twenty-four Hour Clock, W. Foster, London.
3888. Electrical Batteries, L. P. Meeriam, London.
3889. Blue and Violet Colouring Matters, J. Imray.—(*I. Boas-Boasson, France.*)
3890. Tricycle, J. White and J. Asbury, London.
3891. Railway Carriage Lamps, I. Blake and M. Dain, London.
3892. Hand-fire Extinguishers, H. H. Lake.—(*E. H. Lewis, United States.*)
3893. Securing the Covers of Cock and Valve Boxes, J. G. Hogg, London.
3894. Producing Liquid Soaps, &c., C. T. Kingzett, London.
3895. Chromates, J. J. Hood, London.
3896. Furnaces, J. H. Johnson.—(*M. Perrett, France.*)
3897. Artificial Stone, J. H. Johnson.—(*I. Brandstätter, Austria.*)
3898. Time-keepers, G. W. Warren, London.

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3899. Raising and Lowering Show Cases, &c., H. Emmanuel, Surbiton.
3900. Writing Slates, T. W. Barber, Ulverston.
3901. Securing Card Clothing to the Bars of Carding Engine Flats, N. Whitley, F. W. Thomson, and H. Hoyle, Halifax.
3902. Miniature Harmonium, W. Brierley.—(*J. Schoenner, Germany.*)
3903. Rising and Sinking Platforms, J. L. Baker and T. N. Cox, Hargrave.
3904. Brackets for Suspending Lamps, C. Phillips, Birmingham.
3905. Soles for Boots, Shoes, and Slippers, J. Booth, Birmingham.
3906. Metallic Bedsteads and Cots, J. and P. H. Middleton, Smethwick.
3907. Washers or Thumbscrews, C. T. Smith, Birmingham.
3908. Regenerating Waste Gases, A. T. D. Berrington, Ebbw Vale.
3909. Lighting Gas Lamps Automatically, J. J. Butcher, Newcastle-upon-Tyne.
3910. Boilers for Kitchen Ranges, &c., T. Wood, Stapleton.
3911. Water Taps, C. L. Rice, Cardiff.
3912. Preventing Accidents with Wheeled Vehicles, G. W. Cramond Dublin.
3913. Bank Runners, J. Conibear, Redditch.
3914. Gas Regulators, D. and F. H. Orme, Manchester.
3915. Bedding Axle-boxes in India-rubber, J. Allen, London.
3916. Rendering Cements Luminous or Damp Proof, E. Ormerod and W. C. Horne, London.
3917. Indicating Twenty-four Hours on Twelve-hour Dials, J. E. Floyd, London.
3918. Detonating Fog Signals for Railways, W. F. Ruston, London.
3919. Photographic Restraining or Developing Solutions, A. G. Brookes.—(*T. S. Nowell, United States.*)
3920. Pulleys and Drums, R. R. Gubbins, London.
3921. Paper, G. P. Barnes, Dulwich.
3922. Imitation Bronzes, G. Tuck.—(*C. Wagenführ, New York.*)
3923. Nickel and Cobalt, H., H. A., and W. W. Wiggin, and A. S. Johnstone, London.
3924. Self-feeding and Smoke-consuming Furnaces, L. W. Sutcliffe, London.
3925. Drinking Glasses, A. Buttard, London.
3926. Bearings for Velocipedes, &c., W. Bown and J. H. Hughes, London.
3927. Drawing and Spinning Yarn, &c., D. Morrison, Glasgow.
3928. Shelves, Racks, Brackets, &c., W. Dickson, London.
3929. Valve Gear, S. G. Browne, London.
3930. Preventing or Curing Asthma, H. J. Haddan.—(*L. Schulze, Prussia.*)
3931. Smoothing Irons, H. J. Haddan.—(*F. Beauquis, France.*)
3932. Fire-proof Floors, J. Homan, London.
3933. Treating Alkali Waste, &c., F. S. Newall, London.
3934. Obtaining Sulphur from Sulphuretted Hydrogen, F. S. Newall, London.
3935. Stoppers for Bottles, W. G. Walker, London.
3936. Stoppers for Bottles, W. G. Walker, London.
3937. Regulating the Supply of Gas, J. H. Hayes, London.
3938. Telephones, G. Binswanger.—(*J. Ochorowicz, Paris.*)
3939. Uniting the Ends of Driving Belts, S. Rowbottom, London.
3940. Thread Breaking Attachment for Twisting Machines, A. M. Clark.—(*F. Haggas, United States.*)
3941. Dynamo-electric Machines, J. Swinburne, Brockley.
3942. Electric Measuring Instruments, J. Swinburne, Brockley, and S. Evershed, Kenley.
3943. Electrical Contact Devices, W. R. Lake.—(*F. Bechtold, Austria.*)
3944. Galvanic Batteries, W. J. S. Barber-Starkey, London.
3945. Alarm Extincteur of Fires in Chimneys, D. Putzeys, London.

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3946. Milk-carrying Cans, H. A. Stuart, Fenny Stratford.
3947. Roadways, W. Footman, Oxford.
3948. Tube Couplings, J. P. Annett and H. G. Willmer, Southampton.
3949. Gas Lamps, H. Brocklesby, Manchester.
3950. Currant Washing, &c., Machines, B. Tupholme, Sheffield.
3951. Securing, &c., Jewellery, W. J. Ginder, Birmingham.
3952. Production of Glass Articles, J. Hill, Burton-on-Trent.
3953. Reaping, &c., Machines, M. Jenkinson, Nottingham.
3954. Brakes for Two-wheeled Vehicles, J. Westaway, Lewdown.
3955. Corn Screen, M. Jenkinson, Nottingham.
3956. Spiral, &c., Stairs, H. Steven and W. More, Glasgow.
3957. Reeling Machines, W. Cunningham, Glasgow.
3958. Sewer Traps, H. Steven and W. More, Glasgow.
3959. Manufacturing Metal Boxes, D. Smith, jun., London.
3960. Heat Engines, Sir W. Thomson and W. H. Watkinson, Glasgow.
3961. Breech-loading Fire-arms, G. Jeffries, London.
3962. Stair Rod Eyes, C. W. Torr, London.
3963. Draw-bar Gear, &c., J. Trippett, T. and H. Ocarls, Sheffield.
3964. Making Beetles for Finishing Cloth, J. McKean, Castleblaney.
3965. Constructing Concrete Walls, E. L. Ransome, London.
3966. Machines for Stretching, &c., Fabrics, L. Lindley, London.
3967. Electrical Current Changers, J. Mackenzie, London.
3968. Opening, &c., Electric Circuits, J. Mackenzie, London.
3969. Fusible Connections for Electric Circuits, J. Mackenzie, London.
3970. Electrical Circuit Closers, J. Mackenzie, London.
3971. Gas Engines, J. Mackenzie, London.
3972. Steam Engines, T. Green, London.
3973. Separating Broken Grain, R. Reynolds, London.
3974. Cardigan Jackets, B. W. Russell and T. Huxley, London.
3975. Thrashing Machines, G. A. Spokes, Northampton.
3976. Chain Links, C. F. Veit, London.
3977. Scouring, &c., Vegetable Substances, L. A. Groth.—(*A. Eberz, Germany.*)
3978. Saddles, J. A. Lamplugh, London.
3979. Water Heaters and Purifiers, W. Fairweather.—(*G. H. Babcock, and L. Pine and the Babcock and Wilcox Company, United States.*)
3980. Preparing Paper, D. C. Simpson, Glasgow.
3981. Winding Clocks, &c., W. Gillett, London.
3982. Sizing Paper Pulp, H. H. Lake.—(*L. Lacoste, France.*)
3983. Boots and Shoes, T. Shillock, Birmingham.
3984. Ship and other Lamps, H. Trotter and G. Field, Birmingham.
3985. Adjustable Chairs, &c., C. Baker and G. H. Clack, London.
3986. Pots or Vases for Plants, P. Lawrence, London.
3987. Portable Electric Lamp, A. V. Rose and G. F. Rose, London.
3988. Spinning Flax, &c., T. Blain and J. Thompson, London.
3989. Ovens, R. A. Gilson, W. J. Booer, and G. Smith, London.
3990. Line Dividers, A. G. Dawson and F. E. Adams, London.
3991. Automatic Switches, T. J. Jones and R. Belfield, London.

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3992. Burners for Mineral Oils, L. H. V. Luchaire, Paris.
3993. Loom Crank Arms, J. Gullery, Belfast.
3994. Combined Railway Sleepers and Chairs, &c., T. Williamson, Wishaw.
3995. Petroleum Lamps, W. E. A. Hartmann, Swansea.
3996. Automatic Camera and Changing Box Combined, A. Cowan, London.
3997. Granulating Machines, T. Clark, Aberdeen.
3998. Securing the Traces to the Hames in Harness, T. Switzer, Dublin.
3999. Portable Supports for Tarpaulins of Wagons, H. Williams, Glasgow.
4000. Metal Cocks or Taps, S. W. Smith, Brighton.
4001. Alarm Guns, J. W. Caldicott, Birmingham.
4002. Polishing, Colouring, and Ornamenting Capsules, G. A. Bedart, France.
4003. Sharpening the Knives of Looms, E. Greaves, London.
4004. Line-throwing Guns or Fire-arms, J. G. Orchar, Glasgow.
4005. Line-throwing Guns or Fire-arms, D. R. Dawson, Glasgow.
4006. Burnishing the Soles and Edges of Boots, &c., A. Sellers, Halifax.
4007. Bolts, &c., H. Theaker, Sheffield.
4008. Stoppering Bottles, E. Stiff and G. J. Chambers, London.
4009. Discharging Centrifugal Machines, E. Furness, London.
4010. Flag and Lamp Signalling Practice, H. Roberts and J. H. Steward, London.
4011. Screws and Boxes, &c., D. Stanford, Birmingham.
4012. Cocks, Valves, Cisterns, &c., S. Napper, London.
4013. Indicating the Boiling Point of Water, J. Bannehr, London.
4014. Safety Sash Ventilation Bolt, F. R. Wildegose, London.
4015. Production of Embroidery, &c., in Hose, G. Padmore, jun., Leicester.
4016. Collecting Float Gold in Mining Operations, M. Vesenmayer, London.
4017. Ovens for Baking, &c., W. H. and D. Thompson, London.
4018. Adjusting Door Knobs to Spindles, E. and E. H. Ludlow, London.
4019. Military and other Helmets, W. A. F. Blakeney, Glasgow.
4020. Keys of Accordions, &c., W. Spaethe, London.
4021. Portable Harmoniums, &c., W. Spaethe, London.
4022. Lubricators, J. H. Johnson.—(*A. Bachmeyer and Co., Prussia.*)
4023. Expanding Gases and Vaporising Fluids, &c., C. J. Ball, London.
4024. Registering the Monies Received by Cashiers, J. N. Maskelyne, London.
4025. Carbonate of Soda, J. J. T. Schloesing, London.
4026. Getting Coal or Stones in Mines, &c., T. H. Bell and W. Ramsay, London.
4027. Relieving Ice from Cells, A. G. Christiansen and A. Ingram, London.
4028. Machinery for Washing, &c., Wool, W. Cook, London.
4029. Fabrication of Soda Crystals, E. Brunin, London.
4030. Pulleys and Drums, A. B. Perkins, London.
4031. Means of Rivetting, O. Imray.—(*F. Prasil, Bohemia.*)
4032. Preparing Moulds for Casting, H. Gibbons, London.
4033. Metallic Loops for Cloth Buttons, C. D. Abel.—(*L. Friedberg, Germany.*)

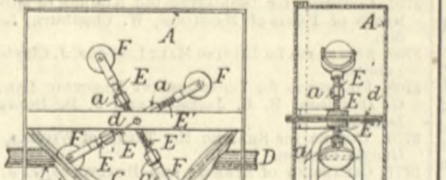
SELECTED AMERICAN PATENTS.

(*From the United States' Patent Office Official Gazette.*)

312,106. Gas Meter, *Gustav Fajen, Milwaukie, Wis.—Filed March 18th, 1884.*

Claim.—(1) In a meter, the combination, with a grooved semicircular plate and a flexible strip, the two forming together a curved passage way, the outer wall of which is flexible, while the inner wall is yielding, of a wheel the spokes of which carry at their free ends rollers the contour of which is convex, corresponding to the concave contour of the inflexible wall of the passage way, substantially as set forth. (2) In a meter, the combination of the case A, pipes D D¹, curved and grooved rigid plate B, flexible strip

312,106

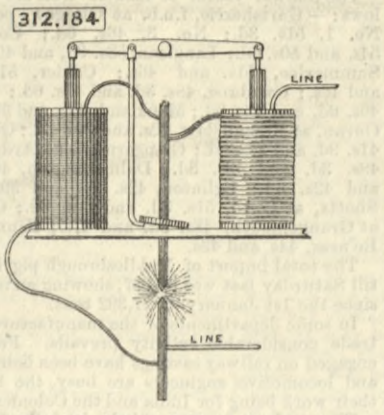


C, secured to plate B, and forming therewith a fluid-tight passage, and the wheel E, having arms E¹ and rollers F, substantially as set forth. (3) In a meter, the combination, with the fluid passage B C, of the wheel E, having shaft *d*, screw-threaded arms E¹, and rollers F, and balancing nuts *e*, adjustable upon the screw-threaded arms, substantially as set forth.

312,184. Electric Arc Lamp, *Charles F. Brush, Cleveland, Ohio.—Filed August 7th, 1880.*

Claim.—(1) In an electric lamp, the combination of solenoid or axial magnet helices or equivalent magnets, one helix located in the main circuit and the other helix located in a constantly closed shunt circuit of comparatively high resistance, with the feeding carbon of an electric lamp, and devices operated by the simultaneous co-action of said magnet helices to move the feeding carbon to establish the arc and regulate the length of the arc, substantially as set forth. (2) In an electric lamp, the combination, with the feeding carbon, of solenoid or axial magnet helices or equivalent magnets, one helix located in the main circuit and the other helix located in a constantly closed shunt circuit of comparatively high resistance, and devices operated by the simultaneous co-action of said magnet helices, to move the feeding carbon to establish the arc, regulate the length of the arc, and the feed of the carbon, substantially as set forth. (3) In an electric lamp, the combination, with the feeding carbon, of solenoid or axial magnet helices or equivalent magnets, one helix located in the main circuit and the other helix located in a constantly closed shunt circuit of comparatively high resistance, and devices operated by the simultaneous co-action of said magnet helices, and adapted to grip and move the carbon holder of the feeding carbon to establish the arc and regulate the length of the arc, substantially

312,184

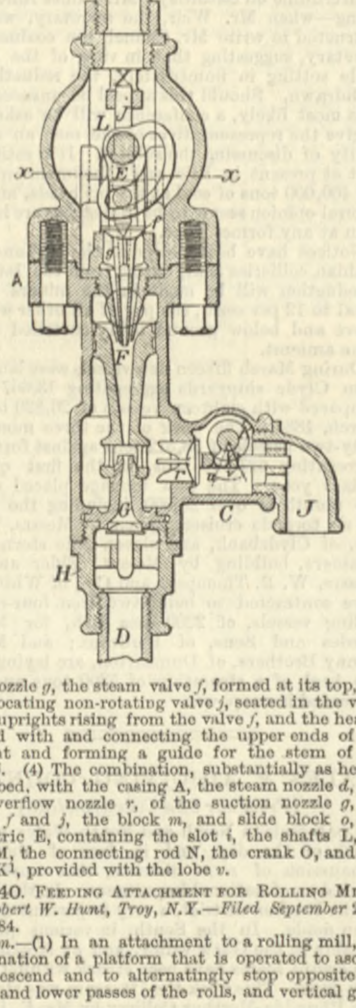


as set forth. (4) In an electric lamp, the combination, with the feeding carbon, of solenoid or axial magnet helices or equivalent magnets, one helix located in a constantly closed shunt circuit of comparatively high resistance, and devices actuated by the simultaneous co-action of said magnet helices, and adapted to grip and move the carbon holder of the feeding carbon to establish the arc, regulate the length of the arc, and feed of the carbon, substantially as set forth.

312,591. Injector, *Otto Westphal, Backau-Magdeburg, Prussia, Germany.—Filed September 8th, 1884.*

Claim.—(1) In an ejector, an overflow valve *r*, formed integral with its stem, said stem being provided with a slotted hole *u*, the ends of which form teeth engaged by the lobe *v*. (2) The combination, substantially as herein described, of a steam valve *f*, the suction valve *j*, and the overflow valve *r*, of the lever M, which when moved back and forward causes the steam valve *f* and the suction valve *j* to open and to close once, and the overflow valve *r* to open and close twice and to leave it closed whenever said lever is at either of its end positions. (3) The combination, substantially as hereinbefore described, in an injector, of the suc-

312,591

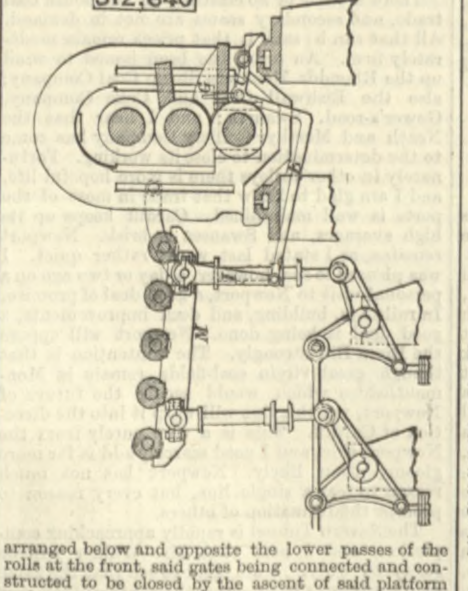


tion nozzle *g*, the steam valve *f*, formed at its top, the reciprocating non-rotating valve *j*, seated in the valve *f*, the uprights rising from the valve *f*, and the head *i*, formed with and connecting the upper ends of the upright and forming a guide for the stem of the valve *j*. (4) The combination, substantially as herein described, with the casing A, the steam nozzle *d*, and the overflow nozzle *r*, of the suction nozzle *g*, the valves *f* and *j*, the block *m*, and slide block *o*, the excentric E, containing the slot *i*, the shafts L, the lever M, the connecting rod N, the crank O, and the shaft K¹, provided with the lobe *v*.

312,640. Feeding Attachment for Rolling Mills, *Robert W. Hunt, Troy, N.Y.—Filed September 29th, 1884.*

Claim.—(1) In an attachment to a rolling mill, the combination of a platform that is operated to ascend and descend and to alternatingly stop opposite the upper and lower passes of the rolls, and vertical gates

312,640



arranged below and opposite the lower passes of the rolls at the front, said gates being connected and constructed to be closed by the ascent of said platform and opened by the descent, substantially in the manner as and for the purposes set forth. (2) In an attachment to a rolling mill, the combination of a platform operated to ascend and descend, so as to alternately stop opposite the upper and lower passes of the rolls, vertical gates arranged on a horizontal bar below and in front of the lower passes of the rolls, and an arm and pivotted lever at each side of the platform, connecting said bar with the platform, said parts being constructed and arranged to operate substantially in the manner as and for the purposes set forth. (3) In an attachment to a rolling mill, the combination of the vertical gates G G G, arranged on the bar U with reference to the lower passes of the rolls as shown, the curved levers E E, hinged at their fulcrum ends to a support, and at their other ends hinged to an arm on each side of the platform M, with the said gate bar U, arranged between and at its ends pivotted to said curved levers intermediately to the hinged ends of the latter, the said parts being constructed and arranged to operate substantially in the manner as and for the purposes set forth. (4) In an attachment to a rolling mill, the combination of the platform M, constructed to be actuated as shown, the arm I, hinged to each side of the platform, the curved pivotted or hinged levers E E, and the rod U, the said parts being arranged and constructed to operate substantially in the manner as and for the purposes set forth.

312,663. Hoisting Block, *Frederick Shickle, St. Louis, Mo.—Filed August 4th, 1884.*

Claim.—(1) In combination, substantially as described, the frame A, the sheaves B D, the chains C E, the pinions G I, and the gears H F. (2) In combination, substantially as described, the frame A, having the eye *a*, the sheaves B D, the chains C E, the pinions G I, and the gears H F. (3) The combination, in a hoisting block, of the frame A, the sheave B, the shaft

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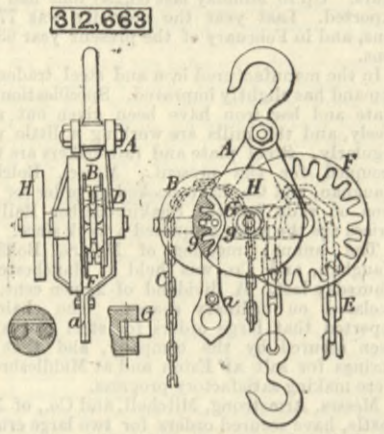

b^3, having the pinion G, constructed as described, and the gear H, substantially as set forth. (4) The combination of the shaft b^3, having the teeth *g g*, arranged as described, and the gear H, substantially as described. (5) The combination of the shaft b^3, having the teeth *g g*, arranged and held loosely in the shaft, as described, with the gear H, substantially as described. (6) In a hoisting block, the combination of the frame A, having the eye *a*, with the sheave D and chain E, substantially as described. (7) The combination of the pinion G, constructed with the two pins *g g*, as described, with the internal gear H, substantially as described.

312,668. Pulley Sheave, *William H. Snelson, Chicago, Ill.—Filed July 1st, 1884.*

Claim.—(1) A pulley sheave having a body and bearing face composed wholly of glass, substantially as described. (2) A pulley sheave consisting of the hub C, the arms B, the rim *a*, the rigid flange A, the glass body D, the detachable flange A¹, provided with

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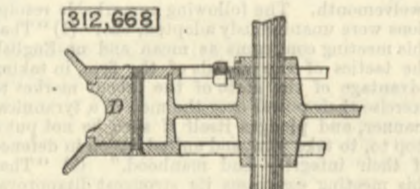

the annular groove a^3, and the clamping screw bolts E, substantially as described. (3) A pulley sheave having the sides or flanges provided with the openings $4a$, substantially as and for the purpose set forth.

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