AN AMERICAN MARINE ENGINE.

STEAM engine economy is a hackneyed subject which, nevertheless, possesses a perennial interest. It has been discussed from the days of Watt to the present moment, and it will in all likelihood be discussed in future ages. The truth is that engineers do not like to be beaten; and the steam engine supplies them with an ideal. However near they may get to perfection they never attain it. However much a man does, he always leaves something to be done by someone else. However good an engine may be, it is at least possible that a better may be made, and it is, no doubt, to this fact rather than to a desire to effect minute savings in the consumption of fuel that the interest possessed by the subject is due. Mr. Neil M'Dougall has recently carried out a large number of experiments with steam engines of the highest type, and in this he has pursued the same plan as that adopted by Mr. Longridge, and other engineers to boiler insurance companies. It cannot be disputed that these trials are of the greatest possible value, and have done much to improve the type of machinery driving our cotton mills. In another place will be found a report concerning the results obtained by Mr. M'Dougall with engines the property of Mr. Ashworth. The results are very good indeed. The most noteworthy feature about them, however, is that they were obtained from unjacketted cylinders; and we may well ask ourselves, if such an economy as this can be obtained without jackets, why should they be used? But before we consider the point settled, we shall do well to bear in mind that perhaps still better results would be had with jacketted cylinders; and we understand that this is the case, and that Mr. M'Dougall has found in other experiments that jackets distinctly promote economy.

It seems somewhat remarkable that the value of the jacket has never yet been definitely settled. There is no such thing as uniform practice among engineers. Many of them use no jackets; others use jackets, but only as air spaces. We find one firm jacketting the high-pressure cylinder only, while others jacket the low-pressure cylinder only; each claims that he gets the best results. If the water condensed in jackets be disregarded, the economy due to their use is very marked; if it is included, the advantage disappears to a large extent. Thus we shall find an engine using but 14 lb. of steam per horse per hour. This represents the quantity passed through the cylinders, but the jackets at the same time probably condense 3 lb. of steam per horse per hour. Adding this to the weight passed through the cylinders, the consumption rises to 17 lb. of steam per horse per hour. If the jackets were not used 18 lb. of steam would, perhaps, suffice to produce a horse-power per hour. The saving due to their use is one-eighteenth, or a little over 5 per cent. Is this worth having, the extra cost of the engine being borne in mind? No one seems to know. The widest diversity of opinion exists on the subject. But this is not all. Instances are not wanting in which the use of jackets has been found to increase the consumption of steam; in other words, the engine was more economical without them than with them. While we find nothing like uniformity of results obtained with engines very nearly alike, we see engines of a different type, although embodying just the same principles, giving entirely different results—the unjacketted engine beating the jacketted, or *vice versâ*. As an example of our meaning, we may compare the performance of Mr. Ashworth's engines with those of the American man-of-war Trenton, which have recently been made the subject of an exhaustive series of experiments carried out by the officers of the United States Bureau of Steam Engineering.

The machinery of the Trenton consists of a compound three-cylinder engine, back-acting, and horizontal. There is one small cylinder, and two large cylinders, placed side by side with the small one between the large ones, which latter are duplicates. All the cylinders are steam jacketted on sides and ends. The steam from the small cylinders is exhausted simultaneously into receivers between it and the adjacent large cylinders. The main steam valves of all the cylinders are horizontal double-ported slides without vacuum rings on their backs or other pressure-relieving device, and work, consequently, with the full valve-chest pressure upon them. Those for the large cylinders are in halves, side by side, each half being worked by its separate valve stem, the purpose being to make them more easily handled than if they were in one. The large cylinders have no independent cut-off or expansion valves, the cutting off being effected by lap on the steam side, with sufficient lap on the exhaust side to give a proper cushioning. The small cylinder has an adjustable independent expansion valve on the back of the main steam valve, which is in one piece. The main steam valve of each cylinder is worked by two excentrics and the Stephenson link. The cut-off valve of the small cylinder is worked by a separate excentric. All the valves receive their movements from the arms of rock-shafts. The thickness of the metal of all the cylinders and of their jackets is 1½in., and the steam space between is 1½in. wide. The depth of the heads of the small cylinder is 8½in.; they are double shell, the inner one being 1½in. thick, and the outer one 1¾in. The heads of the large cylinders are 11in. deep; they are double-shell, and have the same thickness of metal as the heads of the small cylinder. Immediately in front of the cylinders, and on the opposite side of the crank shaft, are two channel plates, each containing two air pumps, together with their valve chests, reservoirs, and connecting passages, the valve chest covers being in the end passages of the engine-room. On the top of the channel plates are the guides for the main crossheads of the three cylinders. Each of the large cylinders has two piston-rods, one of which passes over and the other under the crank shaft, both being secured into the same crosshead. The small cylinder has but one piston-rod, which is secured into a cross tail working on guides between the cylinder and crank shaft. From the cross tail to the crosshead proceed two side rods, one passing over and the other under the crank shaft. This arrangement requires considerably more space than in the case of two piston-rods between the cylinder and crank shaft; consequently the small cylinder is pushed farther outboard than the two large ones by the difference of this space. There are two horizontal double-acting air pumps, one in each channel plate, and they are worked direct from arms forged on the lower piston-rods of the large cylinders. The feed pumps and bilge pumps, two of each, are horizontal and single-acting. The feed pumps are worked direct from arms forged on the upper piston-rods of the large cylinder. The bilge pumps are worked direct from arms forged on the side rods of the small cylinder. There are two surface condensers with shells of 1⅛in. thick metal, one placed above each channel plate, so that the crossheads move between the channel plates and condensers; the condensers, however, are connected, the two shells being merely for convenience of construction. The condensing surface consists of brass tubes seamless and tinned, made tight at each end into cast iron tube plates by means of wooden ferrules. The outboard end of each condenser is divided by a vertical partition into two water compartments, the inboard end consists of one water compartment. The injection or refrigerating water is received into one of the outboard compartments which extends from top to bottom of the condenser, and from this compartment it passes through one-half the number of tubes into the inboard compartment, whence it returns through the remaining half number of tubes to the other outboard compartment, and thence overboard. The exhaust steam surrounds all the tubes simultaneously.

The injection water is supplied by two centrifugal water circulating pumps of 4ft. outside diameter, with a suction pipe of 12in. diameter at the centre of one side; one pump to each condenser. Both pumps are upon one shaft, which is driven by two vertical independent steam cylinders of 11½in. diameter and 9in. stroke of piston, using steam without expansion. The pumps and their driving cylinders are placed between the condensers and the adjacent side of the vessel. There are two injection valves, and two outboard delivery valves—one of each to each condenser. The crank shaft is a "built-up" shaft, the cranks being forged separately from the shaft, which is in short lengths, upon which the cranks are secured. The crank pins are likewise forged separately and secured into the cranks. The following are the principal dimensions of the engine:—

Number of cylinders	3
Diameter of the small cylinder	58½in.
Diameter of the piston-rod of the small cylinder	8in.
Stroke of the piston of the small cylinder... ...	48in.
Length of the steam ports of the small cylinder	36in.
Breadth of the steam ports of the small cylinder (two at each end)	3½in.
Aggregate area of steam ports at one end of small cylinder	252 square inches.
Area of exhaust port of small cylinder (36 by 8in.)	288 square inches.
Diameter of the large cylinders (two in number)	78in.
Diameter of the piston-rods of the large cylinders (two to each cylinder)	6½in.
Stroke of the pistons of the large cylinders ...	48in.
Length of steam port of the large cylinders ...	70in.
Breadth of steam port of the large cylinders (two at each end of each cylinder)...	1$\frac{13}{16}$in.
Aggregate area of steam ports at one end of each large cylinder	254 square inches.
Ratio of the aggregate space displacement of the pistons of the two large cylinders, per stroke, to the space displacement of the piston of the small cylinder	3·5641915
Number of surface condensers	2
Number of tubes in each condenser	3772
Outside diameter of condenser tubes...	⅝in.
Length of condenser tubes between plate... ...	72in.
Aggregate area of condensing surface in both condensers	8640 square feet.
Number of air pumps—double-acting	2
Diameter of air pumps	16in.
Diameter of air pump piston-rod over brass casing	3¼in.
Strokes of air pump pistons...	48in.
Number of feed pumps—single-acting	2
Diameter of feed pumps	5in.
Stroke of feed pump plungers	48in.
Number of crank shaft journals...	4
Diameter of crank shaft journals	17½in.
Length of crank shaft journals:	
Forward and after journals...	27½in.
The two central journals	38in.
Number of crank pin journals	3
Diameter of crank pin journals	15in.
Length of crank pin journals	22in.
Diameter of crosshead journal	10in.
Length of crosshead journal	14in.
Length of connecting rods between centres ...	9ft.
Diameter of necks of connecting rods:	
Crank pin end...	9¼in.
Crosshead end...	8in.
Diameter of line shaft journals...	18in.
Length of line shaft journals:	
Forward journal	36in.
After journal	24in.
Width of all steam pistons	15in.
Width of packing rings in all steam pistons ...	11½in.
Number of thrust collars on line shaft	17
Inside diameter of thrust collars	18in.
Outside diameter of thrust collars	23in.
Diameter of the hub of the cranks	31½in.
Depth of the hub of the cranks	16½in.
Diameter of the boss of the cranks	27½in.
Depth of the boss of the cranks	10in.

There are eight cylindrical boilers placed on opposite sides of a fire-room in the fore-and-aft direction of the vessel, the floor of the fire-room being 10ft. wide. Four boilers are placed on each side, those on one side facing those on the other. The gases of combustion from all the boilers are discharged into one telescopic chimney, whose axis is over the centre of the fire-room. There are no steam drums, their places being supplied by two lengths of horizontal steam pipe of 15in. in inside diameter, one length over the other, lying within and extending the whole length of the up-takes of the boilers on each side of the fire-room. These pipes are of plate iron, and their surfaces are, of course, steam superheating surfaces. To furnish sufficient space for them, the upper portion of the up-takes had to be enlarged, so that the width, which between the bottoms of the opposite boilers is 10ft., is narrowed to 4ft. between the uptakes, whose projection at top from the front of the boilers is 3ft. The least space between the two central boilers on the same side of the fire-room is 8in., and the least space between the end boilers and the adjacent ones is 20in., to give access behind them. The length in the vessel occupied by the boilers is 52ft., and the breadth, including the fire-room, is 30½ft. The shell of each boiler is 12ft. in diameter and 10ft. 3in. in length. The plates of the cylindrical portion are of $\frac{11}{16}$in. thick iron, with double rivetted lap joints. The front end is of $\frac{11}{16}$in. thick iron, with double rivetted lap joints; and the back end is of ⅝in. thick iron. The back lower angle of the shell is rounded with a quadrantal arc of 23in. radius. Each boiler contains three cylindrical furnaces of 8ft. 1⅝in. extreme length, and 3ft. inside diameter. Each furnace contains a grate 6ft. 11in. in length by a mean breadth of 2·9ft., making a grate surface of 20·50 square feet. At the back of the grate is a brick bridge wall 9in. thick, extending 9in. high above the top of the grate, which is 1ft. 7¼in. below the crown of the furnace at the front, and 1ft. 9½in. at the back, making an inclination of 2in. in its length of 6ft. 11in. The thickness of the furnace metal is $\frac{7}{16}$in. The least water space between the furnaces and between them and the boiler shell is 6in., including thicknesses of metal. Each furnace has a separate back smoke connection 19$\frac{7}{16}$in. in the clear, lengthwise the boiler. The least water space between the connections, and between them and the shell, is 6in., including thicknesses of metal. All the flat surfaces are socket-bolted every 7in.; thickness of metal of back smoke connections, ⅝in. From the back smoke connection to the uptake there are returned for the central furnace of each boiler 60 tubes, and for each wing or side furnace 61 tubes—making 182 tubes for each boiler. All the tubes are of seamless brass, 3¼in. in outside diameter, 3in. inside diameter, and 8ft. in length between the tube plates. The distance between the axes of the tubes vertically is 4½in., and horizontally 4⅝in. The axes of the tubes of the top row for all the furnaces are in the same horizontal plane. The uptake is of plate iron, and its bottom projects 9in. from the front of the boiler; thence it inclines outward as it ascends, until at a height of 4in. above the top of the tubes it projects 30in. Above this point it is rectangular in cross-section, 36in. wide and 51in. high, containing the two steam superheating pipes. The uptake is in common for the four boilers on each side of the fire-room. The chimney at its smallest section is 9ft. 6in. in diameter, and has a height at full lift of 59ft. 8in. above the mean level of the grates. The following are the principal dimensions and proportions of the boilers.

Number of boilers	8
Diameter of boilers	12ft.
Length of boilers	10ft. 3in.
Total number of furnaces	24
Diameter of furnaces	3ft.
Length of furnaces	8ft. 1⅝in.
Length of grates	6ft. 11in.
Breadth of grates...	2·9ft.
Total area of grate surface...	492 square feet.
Total number of tubes...	1456
Outside diameter of tubes...	3¼in.
Inside diameter of tubes	3in.
Length of tubes in clear of tube plates ...	8ft.
Least diameter of chimney...	9ft. 6in.
Height of chimney above grates	59ft. 8in.
Total cross area for draft above bridge walls	52 square feet.
Total cross area for draft through the tubes	71·4 square feet.
Cross area of least section of chimney ...	70·8 square feet.
Heating surfaces in all the furnaces ...	1009·6 square feet.
Heating surfaces in all the back smoke connections	1375 square feet.
Heating surfaces in all the tubes calculated for their inner diameter	9148·3 square feet.
Heating surfaces in the uptake	365·0000 square feet.
Total water-heating surface in the eight boilers	11,895·0000 square feet.
Number of steam superheating pipes ...	4
Outside diameter of steam superheating pipes	1ft. 3½in
Length of steam superheating pipes ...	48ft.
Superheating surface in all the steam superheating pipes...	779·1168 square feet.
Superheating surface in all the boiler shells	185·8832 square feet.
Total steam superheating surface	965·0000 square feet.
Steam room in the shells of all the boilers	2004·3968 cubic feet.
Steam room in the steam superheating pipes	235·6032 cubic feet.
Total steam room...	2240·0000 cubic feet.
Total water room in all the boilers	4200·0000 cubic feet.
Square feet of water-heating surface per square foot of grate surface	24·1770
Square feet of steam superheating surface per square foot of grate surface	1·9614
Square feet of grate surface per square foot of cross area above bridge walls ...	9·4615
Square feet of grate surface per square foot of cross area of tubes	6·8839
Square feet of grate surface per square foot of cross area of chimney	6·9411
Greatest height of steam room in shells...	3ft. 3in.

The ship has a bronze screw of the Hirsch form, fixed and four-bladed. Each blade, when viewed in projection on a plane parallel to the axis of the screw, has its centre radial line perpendicular to that axis, with both its edges symmetrical on opposite sides of that line. The length of the blade at the periphery in the direction of the axis is 1ft., and at the hub 3·5ft., the edges of the blade tapering gradually from hub to periphery. The screw has an expanding pitch, increasing gradually from the front to the back edge of the blade in the direction of the axis, but the pitch is uniform radially. Thickness of the blade at the fillet of the hub, 8½in. The finished weight of the screw was 26,422 lb. The following are the dimensions of the screw:—

Diameter of the screw	19ft. 6in.
Diameter of the hub	3ft.
Number of blades	4
Initial pitch	23·35ft.
Final pitch	27·35ft.
Geometrical mean pitch	25·35ft.
Mean pitch in function of propelling efficiency.	26·50ft.
Length of the screw at periphery in direction of its axis	1ft.
Length of the screw at the hub in direction of its axis	3ft. 6in.
Mean fraction used of the geometrical mean pitch	0·290745.
Helicoidal area of the blades	113·4341 square ft.
Projected area of the blades on a plane at right angles to axis	84·7753 square ft.

The total weight of the machinery is 985·357 tons. The speed of the ship is about 12½ knots.

We have described this machinery at length, for the two-fold object of enabling our readers to draw their own conclusions as to the merits of this type of engine, and because similar engines are to be put into the Chicago—if she is built—instead of the abortions which, we think we may say, we have been instrumental in getting condemned. It will be seen that the three-cylinder system is here carried out as it has been in many of the ships designed by Messrs. John Elder and Co.

It would take up too much space to attempt to reproduce in full the very elaborate report concerning the performance of the machinery of the Trenton, to which we are indebted for the particulars given above. It must suffice to give the general results. The engines during trial had developed 2414-I.H.P.; the consumption of Welsh coal being at the rate of 2·29 lb. per horse per hour. The power developed was very small considering the size and weight of the machinery, and this is thus accounted for: "Although," says Mr. Isherwood, "the rate of combustion —11·3821 lb. of coal per square foot of grate surface per hour—was less than half of what is obtained with similar coal during the trial trips of the steamers of the British Navy, yet the boiler pressure—nearly 70 lb. per square inch above the atmosphere, with wide throttle valve—was as great as could safely be carried, while the steam was expanded only five times. Evidently the engine could not have worked off any more steam had the boilers been able to furnish it. The capacity of the cylinders and the pitch of the screw were adapted to the grate surface of the boilers for anthracite as fuel, but by lessening that pitch, and thus allowing the pistons of the engine to make proportionally more double strokes per minute, a great deal more steam could be worked off if the journals of the engine could be kept cool at the increased velocity. The abnormally slow combustion of semi-bituminous coal in the boilers of the Trenton was due to their very small calorimeter over the bridge walls, to the obstruction of the steam pipes in the uptakes, and, more than all, to the entirely too little area of hatch over the fire-room. Even this area, small as it was, was much diminished in effect by the boats and other objects placed over it on deck, thus greatly restricting the air supply to the furnaces. Neither could the firemen—much too few for forcing the fires to the utmost—be compelled to any extra effort, as in the case of the British Navy trials, where a large additional force of trained firemen are temporarily embarked for the special occasion, and stimulated by a bounty paid by the contractors for the machinery, or, as in the case of merchant steamers, where the fear of discharge from a desirable position produces the same effect." We do not quite understand the purport of this statement. We are told that the engines could not take more steam than they got, and this being the case, nothing would have been gained by harder firing.

Again, we find that in the low-pressure cylinders of the Trenton, in which condensation ought to have advanced still further, nothing of the kind took place, but, on the contrary, re-evaporation, and that to such an extent that of all the steam supplied from the boiler only 12 per cent. altogether was condensed in the long run. The re-evaporation in the large cylinder was, no doubt, due mainly to the influence of the jacket. Altogether a comparison of the results of the two experiments will be found suggestive and interesting. The weight of the water used per horse per hour could not be taken; but if we assume that the boilers evaporated 10 lb. per pound of coal, then we have a consumption of 22·9 lb. of water per horse per hour, and this, be it observed, in engines jacketted all over. It is true that the expansion seems to have been only 5 to 1—too little, perhaps, for the highest economy, but not much. Even at this low grade of ex-expansion, however, and with the jackets, the cylinder condensation seems to have been enormous. The report gives the following estimate:—

Pounds of water vaporised per hour in the boilers, on the supposition that each pound of combustible vaporised 11 lb. of water under the experimental pressure and from the experimental temperature ...	53,900·
Difference in per centum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator in the small cylinder at the point of cutting off the steam	23·574
Difference in per centum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator in the small cylinder at the end of the stroke of its piston...	20·197
Difference in per centum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator in the two large cylinders at the end of the stroke of their pistons	11·987

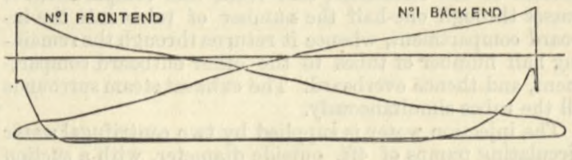
Here it will be seen that of all the steam made in the boiler no less than 23½ per cent. was condensed at once in the small cylinders in spite of the jacket.* The weight of steam condensed in the jackets is not given, but is apparently supposed to be included in the 23½ per cent. By the time the stroke of the small piston is finished the condensation has fallen down to 20 per cent.; but this is due, of course, to re-evaporation in the cylinder as the pressure falls, and this re-evaporation is continued throughout the passage of the steam through the engine—but it all represents loss. It will be seen that in the unjacketted cylinders of Mr. Ashworth's engines, the steam condensed in the cylinders amounted to 20·8 per cent., or as nearly the same condensation as that which took place in the high-pressure cylinder of the Trenton's engine. Thus, we have in one jacketted cylinder, effectually protected according to the advocates of the compound system from the influence the condenser, as much condensation as took place altogether in both cylinders of Mr. Ashworth's engine. The ratio of expansion in the small cylinder of the Trenton must have been comparatively little, while in Mr. Ashworth's engines it was nearly eleven-fold. Thus, everything was in favour of the Trenton's high-pressure cylinder; why should the result be so unsatisfactory?

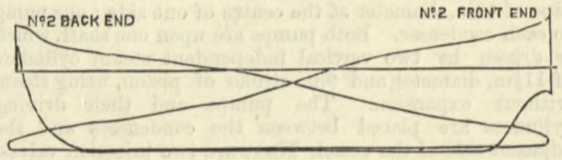
Our readers will do well to compare these figures with the results obtained by Mr. McDougall. They can draw their own conclusions as to the reason why the economy in the case of the unjacketted engines is greater than in the case of the Trenton machinery.

* The report estimates the evaporation at 11 lb. per pound of coal, which seems to us to be too high; but even if we allow for this the condensation is still very great.

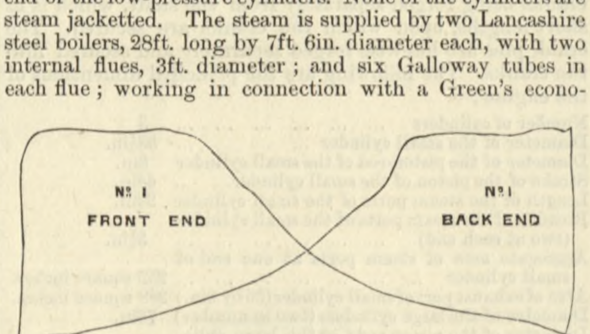
RESULTS OF ENGINE AND BOILER TRIALS.

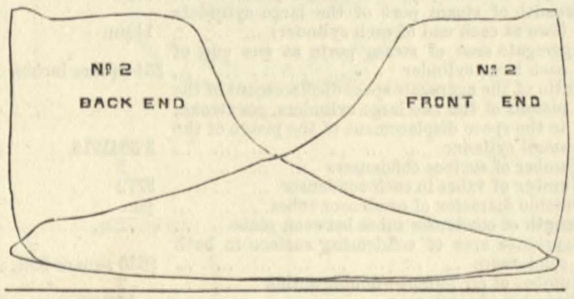
MR. N. McDOUGALL, M.I.C.E., chief engineer and manager of the Boiler Insurance and Steam Power Company, Limited, King-street, Manchester, carried out, last October, a series of experiments, the particulars of which are set forth in the following tabular statement. The engines in question drive the mills of Mr. John Ashworth, Astley Bridge, near Bolton; they are a pair of horizontal compound tandem engines, with cylinders 18¾in. and 34in. diameter, 5ft. stroke. The high-pressure cylinders are fitted with main and expansion slide valves, the latter controlled





by Corliss trip gear; there are common slide valves at each end of the low-pressure cylinders. None of the cylinders are steam jacketted. The steam is supplied by two Lancashire steel boilers, 28ft. long by 7ft. 6in. diameter each, with two internal flues, 3ft. diameter; and six Galloway tubes in each flue; working in connection with a Green's economiser of 224 pipes.





The boilers are hand fired. Reduced copies of the diagrams are given above. They were taken at 47½ revolutions per minute, the boiler pressure being 101 lb. per square inch. The piston rods, 4¾in. in diameter, work through both ends of all the cylinders.

1. Duration of trial	Wednesday, 17th, 9 a.m. to 5.30 p.m.; Thursday, 18th, 6 a.m. to 5.30 p.m.; Friday, 19th, 6 a.m. to 5.30 p.m.; Saturday, 20th, 6 a.m. to 8.30 a.m.	Total. 30 working hours.
2. Mean revolutions per minute		47·5
3. Mean piston speed in feet per minute		475
4. Mean indicated horse power	H.P. cylinders...	346·68
	L.P. cylinders ...	231·25
	Total	577·93
5. Mean boiler pressure per gauge—lbs. per square inch		100·4
6. Mean initial pressures in H.P. cylinders—lbs. per square inch	No. 1 engine ...	94·7
	No. 2 engine ...	94·4
7. Mean ratio of expansion, taking clearance into account		10·9
8. Total volume swept by pistons per I.H.P. per minute—cubic feet..		13·04
9. Mean vacuum in condensers per gauge—lbs. ...		13·375
10. Mean temperature of feed-water (Fah.) before passing through economiser...		51·1 deg.
11. Mean temperature of feed-water (Fah.) after passing through economiser...		254 deg.
12. Mean temperature of injection water (Fah.) ...		72·5 deg.
13. Mean temperature of discharge water (Fah.) ...		102·6 deg.
14. Total weight of water passed through engines —lbs....		304,484
15. Weight of water used per I.H.P. per hour—lbs.		17·56
16. Percentage accounted for by indicator		79·2
17. Weight of coal used for engines only; excluding the coal consumed for banking fires and getting up steam—lbs.		33,300
18. Weight of coal used per I.H.P. per hour—lbs.		1·92
19. Equivalent consumption under the usual working conditions, the feed-water being taken from the hot well, and leaving the economiser at 285 deg. Fah—lbs.		1·86
20. Weight of coal burnt per square foot of grate per hour—lbs.		15·41
21. Description of coal...		Common engine burgy containing 5 per cent. of moisture owing to exposure to the rain.
22. Percentage of ash		12·38
23. Weight of water evaporated per lb. of coal at observed temperatures and pressures—lbs. ...		9·14
24. Equivalent evaporation under usual working conditions—lbs.		9·44
25. Equivalent evaporation from 100 deg. to 212 deg. —lbs....		9·88

The figures furnished to Mr. Ashworth represent the results of the test from its commencement to its close, and agree very closely with the results of each of the three days' long trials taken separately, the power varying comparatively little, and the conditions of working being almost exactly similar. This particular trial is only one of a series which Mr. McDougall has had in hand some time, and which he hopes to be in a position to make public very shortly, when, of course, the fullest details will be given. All the coal was accurately weighed in suitable boxes on a platform scale. The water was measured in two large measuring tanks, specially prepared for the purpose. The capacity of the tanks was known by actual weighing when full. During the trial the tanks—which were connected by separate branches to the suction-pipe of the donkey pump—were filled and emptied alternately. No allowance was made for any coal that might be consumed during meal hours. There was practically none burnt, the engines being standing and dampers down. Indicator diagrams were taken from each cylinder every half hour, four Richards' indicators being used. These were specially tested for accuracy, both before and after the test.

CONTRACTS OPEN.

BOGIE CARRIAGES FOR THE INDIAN STATE RAILWAYS.

THE Indian Government desires to receive tenders for iron underframes, bogie trucks, and ironwork for underframes and bodies for iron bogie wagons, 25ft. long—wheels 2ft. 4in. diameter —as shown in the illustrations on the next page.

The work required under this specification comprises the construction, supply, and delivery in England, at one or more of the ports named in the conditions and tender, of iron underframes and ironwork for underframes and bodies, and bogie trucks, with all requisite bolts and nuts, washers, and rivets, complete, for putting the work together in India and fixing the bodies to the underframes, for 1000 bogie wagons, 25ft. long. The stipulations are those usual in Indian Government contracts.

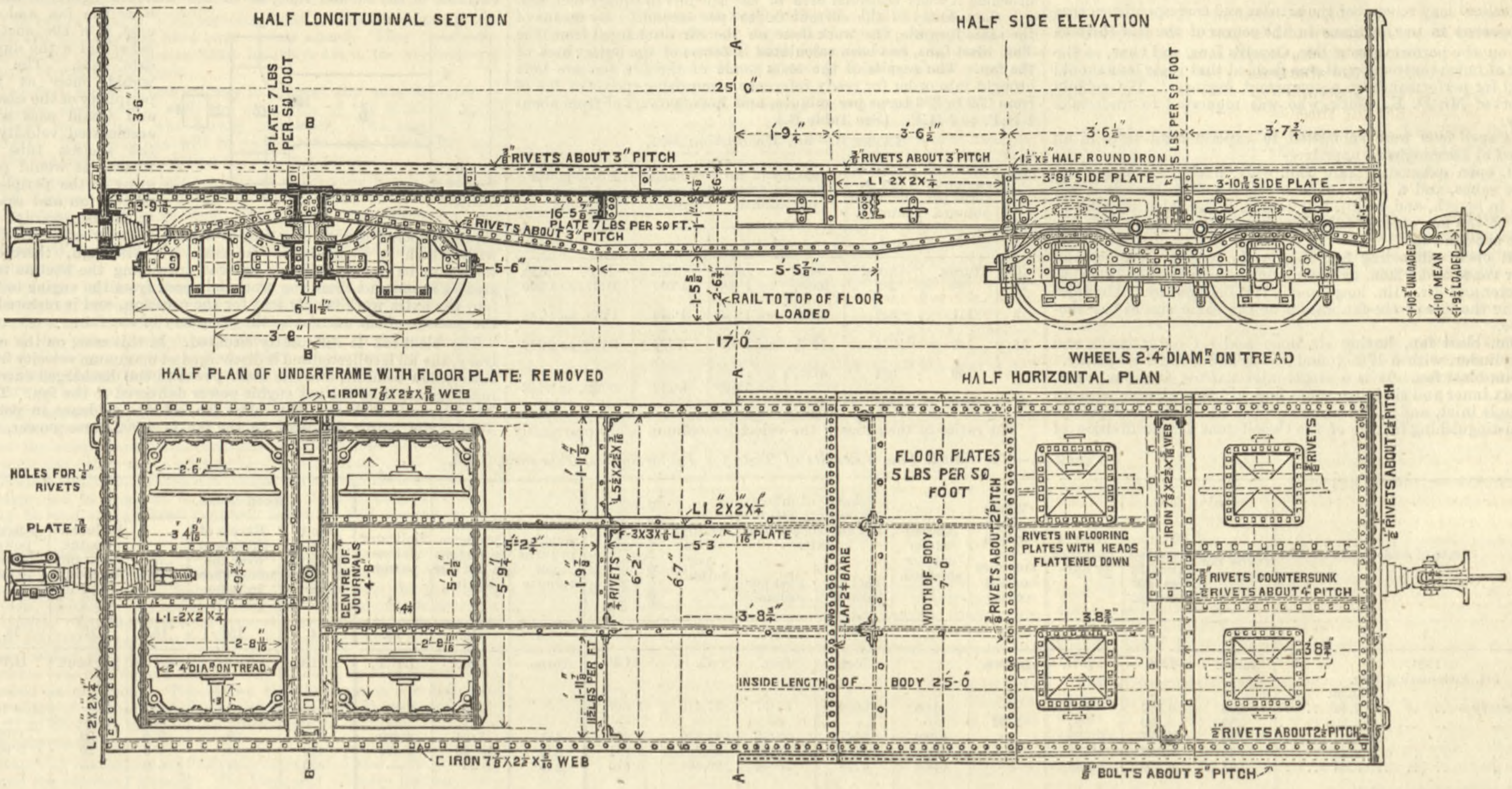
All fastenings, bolts and nuts, rivets, and washers are to be supplied in quantities sufficient for putting all the work together in India, with an allowance of 20 per cent. extra for waste. The contract does not include wheels and axles, bearing and draw and buffing springs, and axle-boxes. All these parts will form the subjects of separate contracts. No woodwork is required to be sent to India.

The intention of this contract is that every piece of iron shall be manufactured with such accuracy that any piece may be used without dressing of any kind in the place for which it is designed in any of the wagons. To ensure this, every piece must be made from a carefully-prepared metal template or gauge, and all holes in it, whether hereafter specially mentioned or not, must be drilled. It must further be drilled through the holes in the template, so that the corresponding parts of all the wagons may, without doubt, be exact duplicates of each other. All templates and gauges must be provided by the contractor at his own expense, and must be of such material, and made in such a manner, and be renewed as often, as the Inspector-General shall desire. Every detail must be tested by metal gauges at each stage of its manufacture, and be to the satisfaction of the Inspector-General.

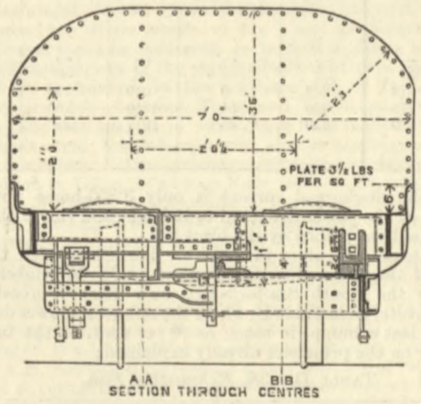
All channel and angle irons are to be made perfectly straight, and the channel irons perfectly square over the flanges by pressure, and not by hammering, before being used for the underframes. The plates forming the middle bars and headstocks must be perfectly flat and free from buckles, before being rivetted to the angle irons. The angle irons forming part of the middle bars are to be framed. All holes in the pieces of iron which form the underframe and bogie trucks must be drilled, except those in the floor, middle bar, headstock, and bogie end and cover plates, which may be punched, provided that all the holes in each plate are punched simultaneously, or through a template clamped and fixed to the plate which contains all the holes in the plate; if one or other of these systems of punching be not adopted, all holes in these plates must be drilled. The spring hanger brackets are to be forged out of the solid, and all holes through them are to be drilled, and the holes for the spring hangers bored out true; they are to be neatly squared up at the angles and the ends drawn down as shown in the drawings. The spring hangers are also to be forged out of the solid, the holes through them are to be drilled and the pins turned. The buffer heads may be dabbed on to the jaws under a steam hammer, but great care must be taken to secure a thoroughly sound weld over the whole surface. The buffer faces are to be made in the shape shown on the drawing, and must be faced up all over in the lathe. The buffer shanks must be forged solid with the jaws without a weld in their length, and must be drawn down under a steam hammer true to the form shown, and the round part must be turned. The coupling hooks, slide blocks, yokes, connecting rods, screws and nuts, buffer spring sockets, and buffer stop plates must be forged out of the solid, and the holes for the pins through the buffer jaws and hooks must be drilled, and the pins must be turned. The screw, nut, side rod, yoke, slide block, and pins connected with them may be left black, if in the opinion of the Inspector-General they are sufficiently neat and clean forgings. All holes in them must be drilled, but the joints and pins are to be made an easy fit, but if not forged clean and true they must be turned, bored, or planed on the parts tinted red on the drawing. All similar parts of the buffing gear must be interchangeable from one set to another. The spring sockets and the draw and buffer spring plates must be dressed off perfectly true to the dimensions given, and faced and turned inside. The knees and joint irons connecting the channel bars, &c., forming the underframe or bogie trucks may be made out of angle or channel iron as the case may be, but the edges of the knees and joint irons must be neatly dressed off, and the holes through them drilled. Great care must be taken that these knees and joint irons are fitted so that the whole breadth of each side bears against the parts which they connect. The towing irons and cord hooks are to be forged out of the solid, and all holes in them are to be drilled. Holes to get out the centre pins are to be made in the floor plates, and provided with ⅜in. thick plate covers, each secured by bolts ½in. diameter. The central bearing plates of the bogie must be of cast iron, bored and turned. The pin through them is to be of wrought iron and must be turned; the side bearings are to be of cast iron, and must be bored, turned, and planed so as to make good machine work. Generally all surfaces tinted red on the detail drawings are to be bored, turned or otherwise machined and finished up smooth and bright, whether mentioned in this specification or not, and all pieces of iron not bored or turned must be cleaned up with a file and finished off in first-class style. All rivets that are rivetted up in England which are found to be loose, or to have cracked heads, or to be in any other way defective, must be cut out and replaced by others. Generally all workmanship must be of the very best class. All nuts are to be square, and must fit so tightly on their bolts that they cannot be turned by hand. Whitworth's standard gauges must be used in turning all pins, boring all holes, and forging or finishing all bolt heads and nuts, and all bolts and nuts must be screwed to his standard pitch, the bolts to a length of three diameters.

The side, end, and floor sheets may be punched, provided the holes in each plate are punched either simultaneously or through a template clamped and fixed to the sheet which contains all the holes required in the sheet; the bars and angle irons connected with the sheets, and which are not part of the underframe, may

CONTRACTS OPEN.—BOGIE CARRIAGES FOR THE INDIAN STATE RAILWAYS.



be punched, provided the holes in each of them are punched through a template as above described, or they may be punched in the usual manner, provided every piece is gauged at the contractor's expense with a metal stud template made to the satisfaction of the Inspector-General, and is correct when so gauged. If one or other of these systems of punching and gauging the holes in the sheets, bars, and angles, be not adopted all the holes must be drilled. Any sheet, bar, or angle iron in which the holes are not accurately in their proper position will be rejected. All the sheets must be rolled carefully to the weights given. The floor and end sheets must be carefully flattened by planishing with the

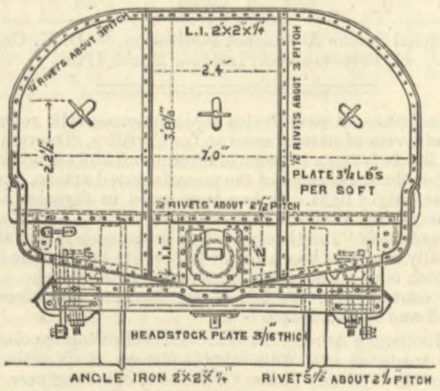


SECTION THROUGH CENTRES

hammer, so as to be without buckle or wave, and the side sheets must be bent accurately to the form shown on the drawings, to form a low side to the wagon.

All bolts and nuts, washers, and rivets are to be provided up to the numbers and weights named in the schedule attached to this specification.

One wagon is to be built and rivetted up complete, and approved by the Inspector-General as a pattern, before the rest of the wagons



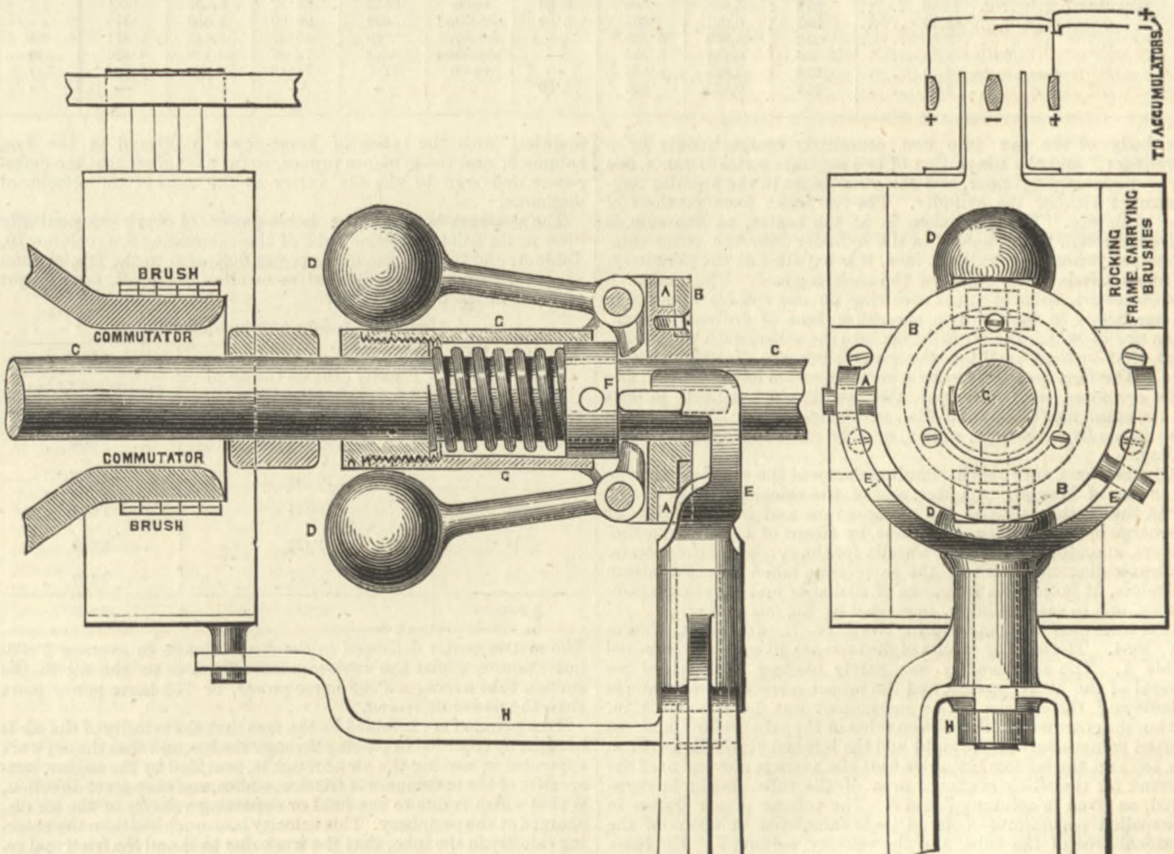
END ELEVATION

are proceeded with. The end sheets of all wagons are to be rivetted up complete. Each twentieth wagon must be completely erected, in order that the accuracy of the work may be tested, and should any inaccuracies be found in any wagon so erected, the whole of the similar work in the twenty wagons represented by the one so erected will be rejected. Generally all rivetting is to be done compatible with the mode of delivery hereafter specified. Tenders, addressed to the Secretary of State for India in Council, with the words "Tender for Ironwork for Bogie Wagons" on the envelope must be delivered at the India Office, Westminster, S.W., before 2 p.m. on Tuesday, the 1st April, 1884. If delivered by hand, they are to be placed in a box provided for that purpose in the Store Department.

SOME people interested in telephonic construction and transmission are pointing out that the chief objection to the separation of offices from works situated in the country, where rent and land are cheap, is overcome by use of the telephone. The telephone does not help personal inspection.

VOLK'S AUTOMATIC REVERSING COMMUTATOR.

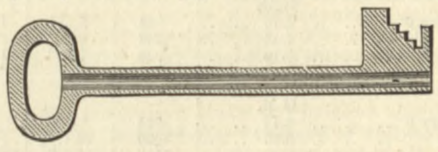
THE accompanying engraving illustrates an apparatus devised by Mr. Magnus Volk, of Brighton, for sending a current in one direction for charging accumulators from a dynamo when driven in either direction, as from a railway carriage axle, and at the same time altering the lead of the brushes proportionally to the speed of the machine, and connecting the accumulators only when the electro-motive force of the machine is sufficient to charge them. In the engraving similar letters denote similar parts. A is a loose ring or collar carrying two pins A' A"; B, part of sleeve connected with G; C, armature shaft; D, governors; E, rocking



fork, which actuates the frame by means of the arm H; F fixed collar on shaft, which acts on fulcrum for governor arms to shift along the shaft; G, sleeve carrying governor. The action is as follows:—The machine being at rest, keeps the circuit broken; when started the contact is not made until a predetermined speed is attained, this being fixed by adjusting the governor spring in the sleeve G, the rising of the sleeve causing one of the pins A' or A" to press against the forked lever E, rotating it on its axis, and by means of the arm H, which rotates the brush frame. When the direction of rotation of the machine is reversed, the loose collar A revolves a short distance, and brings the other pin on A into contact with E, so that the rising of the sleeve G will rotate E in the opposite direction, and consequently reverse the inclination of the brush frame. It will thus be seen that as soon as the speed of the generator falls to a little above that at which the electro-motive force is less than that of the secondary batteries being charged, the circuit is broken, and is not again completed until the speed of rotation in either direction is high enough to give an electro-motive force greater than that of the battery. The apparatus is as simple as it is ingenious.

BEEMAN'S CLEAR PASSAGE PIPE KEYS.

THE accompanying engraving illustrates an ingenious, because extremely simple invention, by which the accidental stoppage of



the pipe of a key by any substance is entirely avoided. Ordinarily, if any dirt or fluff collects in the pipe it has to be picked out before a lock or latch can be opened, but in Beeman's patent key this dirt simply pushes through the pipe when the key is inserted in the lock. It is evident that the additional cost of a key thus made is nominal, while the advantage is such that keys so made must have the preference.

DYNAMITE SHELLS.—A pneumatic dynamite gun is being tested at Fort Hamilton. The tests of dynamite shells at Sandy Hook prove the explosion of the dynamite to be less disastrous in its effect than was supposed. The dynamite shells were attached to wooden spindles, and were outside the gun, thereby preventing any premature explosion. When the shells struck, they were exploded, but with nothing like the effect that they would have if they explode after penetrating some substance. To give great disastrous results, the explosion must be confined within some thing it is to demolish. If a can of dynamite were dropped on the pavement, it would undoubtedly destroy everything surrounding it, but, if it were dropped into a building, the effect would be infinitely more disastrous. The Government is experimenting in propelling the dynamite shells from the gun itself, instead of outside.—*U.S. Army and Navy Register.*

REPORT OF RESULTS OF TESTS FOR PERFORMANCE OF THE CAPELL FAN.

By Mr. D. K. CLARK, M. Inst. C.E.

OUR readers may remember the articles and correspondence that have appeared in our columns in the course of the last thirteen months on the performance of Mr. Capell's fans, and that, as the outcome of much controversy, it was decided that these fans should be tested for performance by a competent engineer. We subjoin the report of Mr. D. K. Clark, who was requested to undertake the duty.

Four Capell fans were submitted to experimental tests in an open shed at Birmingham, namely:—

(1) 5ft. open exhausting fan, 26in. wide, having six inner and six outer vanes, and a 30in. cylinder with a 32in. suction tube, 5ft. 4in. in length, and a 10in. belt pulley. The inlet opening in the side of the fan case is only 29in. in diameter, being 3in. less than the suction tube.

(2) 3ft. open exhausting fan, 16in. wide, having six inner and six outer vanes and a 20in. cylinder, with a suction tube 19·656in. in diameter and 3ft. 11in. long, and a 7in. belt pulley. The inlet opening in the side of the fan case is of the same size as the suction tube.

(3) 30in. blast fan, having six inner and six outer vanes and a 16in. cylinder, with a 17in. round outlet and a 6in. belt pulley.

(4) 25in. blast fan. It is a single-inlet narrow fan, 5in. wide, having six inner and six outer vanes and a 12in. cylinder with an 11in. single inlet, and a 10in. round outlet, and a 5in. belt pulley.

The distinguishing feature of the Capell fans is the division of the body of the fan into two concentric compartments by a "cylinder," and the adaptation of two separate series of vanes, one series within the cylinder, and the other series in the annular compartment without the cylinder. The two series form portions of one structure. The air, taken in at the centre, at one side, is driven through "port holes" in the cylinder into the outer compartment, whence, in exhaust fans, it is expelled at the periphery, or in blast fans at the outlet of the enclosing case. The action of the successive series of vanes revolving on one spindle appears to be analogous to that of two successive fans of ordinary design, from one of which the air is driven into the other, with the advantage that in the Capell fan the propulsions are directly consecutive. The fans were driven by a portable steam engine having two 6¼in. cylinders, with strokes of 10in., and two driving belt pulleys on the crank shaft 30in. and 48in. in diameter. The 25in. blast fan was driven from the 48in. pulley, and the other fans from the 30in. pulley.

Observations were made simultaneously of the speed of the fan by means of Harding's counter, and of the velocity of flow of the air in the suction tubes of the exhaust fans and in the outlets or discharge openings of the blast fans, by means of Casella's anemometers, specially corrected by Casella for the purpose of these tests. Indicator diagrams were at the same time taken from the steam cylinders, at both ends, by means of Richards' and Thomson's indicators, one to each cylinder, connected by ⅜in. gas tubing.

The tests were conducted during two days—the 6th and 7th February, 1884. The leading results of the tests are given in the annexed Table A. The anemometer was partly blocked or shielded for several of the higher speeds, and the proper correction was made in calculating the speeds. The instrument was held about 12in. within the entrances to the suction tubes of the exhaust fans, and was shifted transversely to the right and the left and vertically between the top and the bottom, in order that the average movement of the current for the whole sectional area of the tube should be registered, as given in columns 7 and 8. The volume of air drawn in or expelled per minute—column 9—is calculated in terms of the sectional area of the tube, and the velocity, column 7. The barometer at the Town Hall stood at 29·75in. and the thermometer at 50deg. Fah., and it has been thought unnecessary to apply corrections to the observed volumes of air. The speed of the engine, the effective mean pressure on the pistons, and the indicated horse-power are given in columns 11, 12, and 13. The speed or number of turns per minute of the fan, which would have been made if there had not been any slip of the driving belt between the engine and the fan, is given in column 14; and the excess of this speed over the observed actual speed, column 2, is given in column 15, whence the percentage of slip, column 16, is calculated. A deduction from slip is to be made from the indicator power, and also for the internal resistance of the engine, which is taken at 15 per cent., to give the net power transmitted to the fan. The slip on the first day of the test is about 6 per cent., and is measured by 6 per cent. of (100 — 15 =) 85 per cent., or 5·10 per cent. of the indicator power. The sum of the two deductions is (15 + 5·10) = 20·10 per cent., or, as a round number, 20 per cent. of the indicator power, as entered in column 17. On the second day the belt was tightened up, and did not slip for the comparatively low pressure and speed of the first test of the engine. But, for the higher speeds that followed, the slip was about 12 per cent., making with the 15 per cent. of engine resistance, 25·2 per cent., or, as a round number, 25 per cent., as entered for the last two engine speeds in column 17. After having reduced the indicator power, column 13, in the ratio of the percentages, column 17, the remainders in column 18 express the net engine-power delivered to the fans.

The work momentarily done on the air in its passage into and through the suction tubes of the exhausting fans, as well as the work in the air discharged from the 30in. blast fan, are calculated in terms of horse-power. The results are given in column 10 of Table A. They have been calculated by means of the formula—

$$HP = \frac{A\,v^3}{465{,}300},$$

in which A = the sectional area of the conduit in square feet, and v = the velocity of the current in feet per second.* By means of the same formula, the work done on the air discharged from the 30in. blast fans, has been calculated in terms of the outlet area of the fan. The results of the tests made of the 5ft. fan are here brought into order for ready reference, comprising speeds of fan of from 252 to 396 turns per minute, and horse-powers of from about 1-H.P. to 4-H.P. (See Table B.)

TABLE B.—*5ft. Exhausting Fan.*

No. of test.	Speed of engine in turns per minute.	Speed of fan in turns per minute.	Velocity of inflow in turns per minute.		Velocity ratio cubed.	Horse-power delivered to fan.	
1	2	3	4		5	6	
No.	turns.	turns.	feet	ratio.	ratio.	H.P.	ratio.
16	84	252	2980,	as 1·000	1·000	1·117,	as 1·000
3	111	313	3547,	as 1·190	1·686	1·992,	as 1·783
18	140	374	4267,	as 1·432	2·936	3·029,	as 2·712
4	140	394	4738, }	as 1·520	3·512	3·939,	as 3·526
17	150	396	4324, }				

The ratios of the cubes of the velocities, column 5, are practically identical with the ratios of horse-power delivered to the fan, column 6; and the evidence proves, so far as it goes, that the horse-power delivered to the fan varies as the cube of the velocity of discharge.

The contrast between the horse-power of work momentarily done in the inlet or suction tube of the exhausting fan, column 10, Table A, and the relative horse-power delivered to the fan, column 18, is exhibited in the comparative results for the 5ft. fan brought together in the table C.

TABLE C.—*5ft. Exhausting Fan.*

No. of test.	Horse-power of work momentarily done on the air in the suction tube.	Engine horse-power delivered to fan.
No.	H.P.	H.P.
3	2·480	1·992
4	5·911	3·995
16	1·471	1·117
17	4·493	3·883
18	3·337	3·029
Averages	3·538	2·803

The motive power delivered to the fan is shown to average 2·803-horse power, whilst the work momentarily done on the air in the suction tube averages 3·538-horse power, or ·735-horse power more than the power delivered.

This paradox is explained by the fact that the velocity of the air is necessarily retarded in passing through the fan, and that the net work expended in moving the air through it, provided by the engine, irrespective of the resistances of friction, eddies, and changes of direction, is that which is due to the final or departing velocity of the air discharged at the periphery. This velocity is so much less than the entering velocity in the tube, that the work due to it and the frictional resistances together, is less than the work momentarily done on the air in the suction tube. A stream of air or of water passing through a conduit, which is constricted at one part of its course, approaches the constriction with accelerated velocity, leaves it with retarded velocity, and resumes the previous velocity, the energy appropriated in producing the acceleration being equal to the energy developed during retardation. In other words, energy is stored and restored. To apply this illustration to the case of the exhaust fan, the suction tube represents the constriction, having the sectional area 5·58 square feet, whence an enlargement takes place on the way to the periphery of the fan, where the area for outflow is 34 square feet.

* This formula has been deduced thus:—The work done on the air in foot-pounds per second is equal to—

$$\frac{w\,v^2}{2g} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which w is the weight of air passed in pounds per second, v is the velocity of the current in feet per second, and g is 32·2, the expression of gravity; but $w = \frac{A\,v}{13{\cdot}14}$ at the temperature 62 deg. Fah., and 30in. of mercury, in which A is the sectional area of the conduit in square feet, and 13·14 is the volume in cubic feet of 1 lb. of air at the given temperature and pressure; and substituting this value of w in the expression (1)—

$$\frac{A\,v}{13{\cdot}14} \times \frac{v^2}{2g} = \frac{A\,v^3}{846{\cdot}2} = \text{foot-pounds per second,}$$

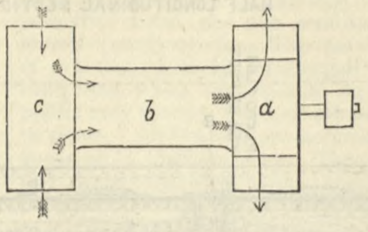
and—

$$\frac{A\,v^3}{846{\cdot}2} \times 60 = \frac{A\,v^3}{14{\cdot}1} = \text{foot pounds per minute.}$$

This quantity, divided by 33,000, becomes—

$$\frac{A\,v^3}{465{,}300} = \text{work done in horse-power.}$$

The approaching current in the conduit is represented by the atmospheric current which approaches the opening of the suction tube with accelerated velocity. To render the parallel complete, the fan case may be supposed to be applied, in duplicate, to the entrance of the suction tube, as in the annexed figure, in which a is the fan and its case, b is the suction tube, and c the duplicate case. The air would enter at the periphery of the case c, and would pass with accelerated velocity to the suction tube b, whence it would pass away to the periphery of the fan and case a with necessarily retarded velocity, leaving the case a with a velocity equal to that with which it would enter the case c. Although, therefore, work may be stored in the air current traversing the suction tube greater in amount than the work delivered from the engine to the fan, the extra work is only lent for the occasion, and is restored in the passage of the current to the periphery of the fan.



The blast fan is differently situated. In this case, on the contrary, the air is collected and is discharged at maximum velocity from the outflow conduit, and the horse-power in the discharged current must be less than the net engine power delivered to the fan. Test No. 10, made with the 30in. blast fan, affords evidence in point. Whilst the power delivered to the fan is 4·902-horse power, the power in the discharged current is only 3·805-horse power, or 80 per cent. of the power delivered to the fan, and this is the measure of the net work done by the blast fan.

The results of tests given in the table harmonise with those of the tests of the 3ft. exhausting fan made in November, 1883, certified by the South Staffordshire and East Worcestershire Mining Institute, as in Table D, where the net horse-power delivered to the fan—last column—is taken as 80 per cent. of the indicator horse-power on the principles already explained:—

TABLE D.—*3ft. Exhausting Fan.*

Date of test.	Turns per minute.	Velocity of inflow in feet per minute.	Volume of air discharged per minute.	Indicator horse-power of the engine.	Net horse-power delivered to the fan.
	turns.	Feet.	Cubic feet.	I.H.P.	H.P.
Nov. 1, 1883	601	4640	9,772	2·330	1·870
Nov. 3, 1883	699	6158	13,377	3·420	2·740
Feb. 6, 1884	611	4903	10,330	2·250	1·800

The National Smoke Abatement Institution, D. K. CLARK.
44, Berners-street, London, March 17th.

TABLE A.—*The Capell Fan.—Results of Tests for Performances, February,* 1884.

Date of test.	Speed of fans. Turns per minute.	Speed of fans. Circumferential speed in feet per minute.	Area of entrance or exit.	Water gauge within the entrance or the exit.	Anemometer open or shielded.	Velocity of inflow or outflow within the entrance or the exit. Feet per minute.	Velocity of inflow or outflow within the entrance or the exit. Feet per second.	Volume of air per minute.	Horse-power of work in the air moving through the suction tube or the exit.	Speed of engine in turns per minute.	Effective pressure on pistons in lbs. per sq. in.	Indicator horse-power.	Speed of fan. Due to ratio of pulleys in turns per minute.	Speed of fan. Excess of this speed over the actual speed in turns per min.	Speed of fan. Slip.	Deduct for engine resistance and slip.	Engine power delivered to fan.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
1884.	turns.	feet.	sq. ft.	inches.		feet.	feet.	cub. ft.	H.P.	turns.	lbs.	I.H.P.	turns.	turns.	per c'nt.	per cent.	H.P.
5ft. Exhausting Fan. H.M.																	
1.—February 6 .. .. .. 1.44	296	4,634	5·585	—	open	3082	51·37	17,210	1·627	—	—	—	—	—	—	—	—
2.— „ 2.5	352	5,530	·305	2·32	—	—	—	—	—	—	—	—	—	—	—	—	—
3.— „ 3.0	313	4,917	5·585	—	open	3547	59·12	19,810	2·480	111	7·24	2·490	333	20	6·0	20	1·992
4.— „ 3.23	394	6,190	5·585	—	open	4738	78·97	26,460	5·911	140	10·36	4·494	420	26	6·2	20	3·995
5.— „ 3.33	395	6,206	5·585	—	open	4728	78·80	26,404	5·873	140	—	—	420	25	6·0	—	—
3ft. Exhausting Fan. H.M.																	
6.—February 6	860	8,101	2·106	6·00	—	—	—	—	—	—	—	—	—	—	—	—	—
7.— „ 3.55	611	5,755	2·106	—	open	4903	81·72	10,330	2·463	150	4·84	2·250	645	34	5·3	20	1·800
30in. Blast Fan. H.M.																	
8.—February 6 .. .. .. 4.46	964	7,571	1·583	8·00	shielded	6050	100·83	9,577	3·488	—	—	—	—	—	—	—	—
9.— „ 4.47	1248	9,802	closed	10·25	shielded	—	—	—	—	—	—	—	—	—	—	—	—
10.— „ 5.19	940	7,383	1·583	—	shielded	6226	103·77	9,856	3·805	200	9·89	6·128	1000	60	6·0	20	4·902
25in. Blast Fan. H.M.																	
11.—February 6 .. .. .. 6.15	524	3,406	·545	—	shielded	4650	77·50	2,534	—	—	—	—	—	—	—	—	—
12.— „ 6.35	1609	10,470	·305	4½	—	—	—	—	—	—	—	—	—	—	—	—	—
13.— „ 6.35	1546	10,120	closed	8	—	—	—	—	—	156	3·78	1·827	1497	—	—	—	—
5ft. Exhausting Fan. H.M.																	
14.—February 7 .. .. .. 12.30	378	5,938	·305	3·00	open	5332	88·87	1,629	·461	—	—	—	—	—	—	—	—
15.— „ 12.45	382	6,001	·305	3·50	shielded	5400	90·00	1,650	·479	—	—	—	—	—	—	—	—
16.— „ 1.0	252	3,959	5·585	—	shielded	2980	49·67	16,645	1·471	84	5·05	1·314	252	0	0·0	15	1·117
17.— „ 1.15	396	6,221	5·585	—	shielded	4324	72·07	24,150	4·493	150	11·14	5·178	450	54	12·0	25	3·883
18.— „ 1.30	374	5,875	5·585	—	open	4267	71·12	23,830	3·337	140	9·31	4·039	420	45	10·7	25	3·029
19.— „ 1.30	444	6,975	·305	4·00	—	—	—	—	—	—	—	—	—	—	—	—	—

NATURAL COKE.—A new Mexico paper announces the remarkable discovery of a vein of natural coke at Los Cerrillos. The vein is 3ft. thick, and lies between a stratum of bituminous and anthracite coal. The coke has the appearance of the manufactured article, and burns with a clear, bright light. It has been tried in furnaces as being better, if anything, than the coke made in ovens. The *American Manufacturer* says "the theory of the phenomenon is that the vein was originally coal, and was brought to a white heat at the (it does not say which one) big upheaval thousands of years ago. Water coming in contact with the bed of the burning bituminous coal cooled it off and turned it into coke."

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—George S. Newton, chief engineer, to the Pelican; James G. Barrow, chief engineer, to the Téméraire, reappointed on recommissioning; James J. Warren, chief engineer, to the Alexandra, additional, for service in the Carysfort; Henry Loughrin, chief engineer, to the Euryalus, additional, for service in the Briton; William H. Davis, chief engineer, to the Euryalus, additional, for service in the Ranger; Edward Eckersley, chief engineer, to ths Belleisle, vice Gilbert; Joseph Langmaid, engineer, to the Britannia, additional, for service in the Wave; William W. Wootton and Edwin Little, engineers, additional, to the Alexandra, for service in the Téméraire; John Jones, engineer, to the Polyphemus, vice Wootton; James Barber (b), engineer, to the Pembroke, additional, for service in the Ajax, vice Little; Joseph E. Galpin, engineer, additional, to the Alexandra, for service in the Carysfort; Francis J. Moore, engineer, to the Excellent, additional, for service in the Glatton, vice Galpin; Joseph T. Purkis, engineer, to the Euryalus, additional, for service in the Briton; Henry T. Liversedge, engineer, to the Alexandra, additional, for service in the Téméraire, for temporary service; John A. Hicks, assistant engineer, to the Téméraire, reappointed on recommissioning; Richard W. Green, assistant engineer, additional, to the Alexandra, for service in the Téméraire; William F. Turner, assistant engineer, to the Alexandra, additional, for service in the Carysfort; George R. R. Perkins, assistant engineer, to the Euryalus, additional, for service in the Briton; Francis F. West, assistant engineer, to the Serapis, vice Perkins; and Joseph H. W. H. Ellis, assistant engineer, to the Briton.

RAILWAY MATTERS.

A RECENT Albany N.Y., paper says: "Train 49 on the Boston and Albany Railroad, last night, was reported two hours late at Becket on account of a hot draw-bar."

THE railway wagon building companies in the Birmingham district are all busy and have large orders ahead. They note with satisfaction that the Indian State Railways are in the market for a supply of wagon ironwork.

THE first sod of a new railway to connect the watering-place of Southsea, Portsmouth, with the main line of the South-Western Railway at Fratton, was turned last week. The cost is to be £55,000. The terminus will be in Granada-road, East Southsea, where the ceremony of cutting the sod took place.

THE stress upon the bridge cable in pulling the Brooklyn Bridge Cable Railway cars has gradually stretched it, until at the end of February it was more than 100ft. longer than when the cars were first started. A piece of the cable 30ft. long was then cut out, and it was then re-spliced in time to draw the cars as usual in the morning.

SPEAKING of the railway rates from South Staffordshire, our Birmingham correspondent says:—"There is hardly any branch of manufacture in South Staffordshire in which there is more complaining of the present excessive rates than the iron founding and cast hollow-ware making. The result of the current excessive freightage charge is to throw orders into Scotland which would otherwise help to keep the operatives of South Staffordshire busy."

THE annual report of the Birmingham Borough surveyor, referring to the extension of New-street railway station, states that the works have made considerable progress, as also have the tunnels and other works connected with the extension of the West Suburban Railway. From the length of tramway lines under completion and in prospect it is clear that Birmingham will before long be one of the best supplied towns in this respect in the kingdom.

FROM the report of Mr. Purser, the engineer and general manager of the Ottoman Railway, it appears that in the past half-year this company had the benefit of the traffic over the new Tireh branch, which was opened in September, and is about thirty miles in length. The harvests were generally heavy, so that the receipts were £60,000 higher than for the corresponding half of the previous year, which was a very unfavourable season. This additional revenue was earned at a cost of only £20,000, so that £40,000 was secured as net profit. This shows that the branch is bringing its fair share of traffic; and this is confirmed by the reduction from 54·21 to 45·44 per cent. in the percentage of working charges on the Smyrna section.

RAILWAY extensions are being contemplated and carried out all round the Sheffield district. The Dore and Chinley Railway, now under the consideration of a Parliamentary Committee, will open up a lovely country to Sheffield and Manchester, and will at the same time revive business in several of the declining districts of Derbyshire. On the Manchester, Sheffield, and Lincolnshire Railway new lines have been constructed—from Dinting on the one side, and Hadfield on the other—to give better accommodation to Glossop without delaying the through expresses from London and Sheffield to Manchester. The opposition having now been withdrawn to the Hull, Barnsley, and West Riding Junction Railway and Dock Bill—the object of which is to construct short additional railways and other works, &c.—the new Bill is now reported as an unopposed one to the Committee of Ways and Means.

PROGRESS is being made with the railway between Tokio, Yeddo, and Koumagai, Japan. It is 36 miles long, and is the first section of the road the whole length of the island of Nippon. The construction of the line will soon be pushed as far as the important city of Takaskai, one of the principal silk centres of Japan. Thence it will go to Aomori, at the northern end of the island. The country traversed between Tokio and Koumagai is very rich and fertile; the stations, all of which have been made as economically as possible, and the rolling stock, except the engines, have been made in Japan. The existing railways in Japan are—From Yokohama to Tokio, 18 miles; Kobe to Otsu, 58 miles; Tsongara, province of O-omi, to Sekigahara, province of Mino, 41 miles; Tokio to Koumagai, 38 miles; in all 155 miles. There is in course of construction a road to unite Mayè-bashi to Tokio, 81 miles long. The first named three belong to the Japanese Government, the rest to the Nippon Tetsudo Kwaisha, or Japanese Railway Company.

THE Odessa correspondent of the *Times* writes:—"The St. Petersburg newspaper *Rooskaya Koorièr* states that at the last meeting of the Co-operative Society of Russian Trade and Commerce a M. Korianden presented a very interesting report upon the project of connecting the Black and Caspian Seas with the Persian Gulf by means of a railway through Persia from Resht, situated within a few miles of the Persian side of the Caspian Sea, to Abooshér, on the Persian Gulf, which the Shah's Government has proposed to construct at its own cost, and which it is calculated would amount to 125,000,000f. The construction of that line would, according to M. Korianden, increase Russian commerce in the Indian Ocean 50 per cent., and put into Russian pockets for freight 35,000,000 roubles a year. Java alone requires 10,000,000 poods (over a million and a half tons) of kerosine yearly, and hence that island would probably become a very extensive market in that direction for the sale of that article. In M. Korianden's report a suggestion is thrown out for the construction also of a railway from Batoum to Bagdad." Still more recent discussion of the subject in St. Petersburg takes into consideration the English feeling in the matter, more especially since the Merv events.

DURING the five years ending 1881 there were 452 miles of railway constructed in Italy, and the total capital expended upon them had increased from £97,987,000 to £107,131,000. The total mileage is 5449, and the average cost per mile £19,825. The receipts from passengers increased from £2,748,000 to £3,194,000; from merchandise and minerals, from £3,355,000 to £4,264,000; and miscellaneous sources, from £73,000 to £207,000; making the total £7,666,000, representing an increase of £1,490,000. The working charges per mile were identically the same in 1881 as in 1877, viz., 66·6 per cent; but during the five years they had fluctuated between 60·3 and 66·6 per cent. The total of the working charges in 1877 were £4,088,000, and for the year 1881 they were £5,389,000, being at the rate of £911 and £980 per mile for the two years respectively. The number of passengers carried has increased during the five years from 28,055,000 to 34,040,000, and the freight moved from 7,501,000 to 9,838,000 tons. The rolling stock of the whole of the railways consisted, at the close of 1881, of 1529 locomotives, 4701 carriages, and 26,592 wagons.

ON Saturday afternoon last a collision occurred upon the London, Tilbury, and Southend Railway at Stepney station. The 2.8 train for Southend left the Fenchurch-street terminus, and was followed by the North Woolwich train of the Great Eastern Company, which runs on the same line for a considerable distance on its way to Plaistow. The Great Eastern train was a little late, and the driver had a right to expect that the Southend train had cleared and left the Stepney station before it reached it. This station is on a curve, and the Southend train had stopped at a part of the platform so far round the curve beyond the station that its tail could not be seen by the driver of the Great Eastern train in entering the station. This caused him to go on, but on rounding the curve he saw the last carriage, and applied the brakes and shut off steam, though not in time to prevent a collision of such violence as to throw several of the carriages off the line, and injure several passengers. The driver and stoker of the Woolwich train, having applied the brakes and shut off the steam of their engine, succeeded in jumping off on to the platform before it reached the tail of the Southend train; but for the efficient action of the continuous brake the accident would have been very serious, as the driver of the advancing train had only a few yards in which to pull up.

NOTES AND MEMORANDA.

THE carbonic acid present in the atmosphere of Cape Horn is said to be but 2·56 in 10,000 volumes as compared with the average of 2·84 over Europe.

WOOD paving blocks are prepared by M. Mallet, of Moissac, by boiling them in a solution of sulphate of copper, sulphate of zinc, and chloride of sodium mixed with heavy mineral oil, linseed oil, and tallow, and afterwards compressing them by about one-tenth of their original volume.

IN reply to a correspondent, asking how to make Babbitt metal linings stay in new cast iron shells, the American *Mechanical Engineer* says:—"Clean the shells, wet with muriate of zinc and one-tenth sal ammoniac; put a piece of block tin in the shell, heat until the tin melts, rub the tin over the iron with a piece of wood, and throw off the surplus. The Babbitt ought to hold to shells thus tinned."

DURING the week ending March 1st, 1884, in twenty-nine cities of the United States, having an aggregate population of 6,550,400, there died 2519 persons, which is equivalent to an annual death-rate of 20 per 1000, or a little less than the average rate for the month of February, which was 20·3 per 1000. For the North Atlantic cities the rate was 19·1, for the Eastern cities, 20·9; for the Lake cities, 16·6; for the River cities, 18·4; and in the Southern cities, for the whites 16·2, and for the coloured 32·1 per 1000. The American *Sanitary Engineer* says that of all the deaths 36·4 per cent. were of children under five years of age.

THE report on the mineral statistics of the United Kingdom for 1882, prepared by the Inspectors of Mines, shows that during 1882 156,499,977 tons of coal were raised, of the value, at the mine, of £44,118,409; 226 oz. of gold, realising £863 at the average market price; and 372,544 oz. of silver, of the value of £80,426. The quantity of iron ore raised was 18,031,957 tons, representing a value of £5,779,285 at the mine, and of metal contained in this ore 6,513,281 tons, of the value of £18,237,186. The total value of the minerals raised in 1882 was £54,879,507, and of the metal contained in the ores £20,558,050.

DR. EGGER, a German experimenter, has found that with a zinc-carbon battery an exciting liquid composed as follows gives the best result, viz., sulphuric acid, 200 cubic centimetres; bichromate of potash, 25 to 50 grammes; nitric acid—34 per cent.—100 cubic centimetres; water, 200 centimetres. The *Electrician* says he has found that with 50 grammes of bichromate the current remains very constant for a considerable period of time, there being no very marked diminution after seventeen hours' working. He also found that the use of the bichromate of potash very materially lessens the nitrous fumes usually given off by this kind of cell.

Nature says a remarkable occurrence is reported from Bona, Algeria. An isolated mountain, Jebel Naiba, 800 m. in height, is rapidly decreasing in altitude, and round its base a considerable cavity is being formed. The whole mass of the mountain is evidently sinking. The neighbourhood of Bona must, however, have already been the scene of a similar phenomenon. Lake Fezzara, which measures over 12,000 hectares in extent, did not exist during the time of the Romans. Its depth in the centre, is only 2·60 m. Investigations which were made in 1870 showed that the remains of a Roman town now lie in the lake. This town has therefore probably sunk in the same manner as the mountain.

SOME people will make calculations as though, like punsters, they could not help it. In view of the recent project to fill up the Desert of Sahara by connecting it with the Mediterranean Sea, a correspondent writes to the *Scientific American*, enclosing the following results of this sort of pastime. Somehow he comes to the conclusion that it would require 4000 years for the waters from the Mediterranean to fill the valley of the Jordan, which is 1000ft. below the former, the water to flow through a passage 100ft. wide by 25ft. deep with a velocity of 4 miles an hour. With a channel 100 times this capacity it is possible, he says, to limit the period of filling to forty years. At the same rate it would take 40,000 years to fill up the Caspian Sea to the sea level, and thousands of years to fill up the Sahara, so if M. de Lesseps wants to see this sea he will have to get it in hand without much loss of time.

THE French chemists Mallard and Le Chatelier have been lately investigating the question of the temperature at which various explosive mixtures of gas and air become ignited. Their experiments dealt with hydrogen gas as well as carbon gas, mixed with air in different proportions. The temperature was recorded by a pyrometer heated in a Plorot melting furnace. The interior of the pyrometer was connected with a gas reservoir and with the air in such a manner that the mixture to be tested could be admitted as soon as the desired temperature had been arrived at. In order to prevent mistakes, repeated experiments were made at degrees of heat which were purposely fixed a little under or over the point of ignition, as already ascertained. It was found that 70 per cent. air and 30 per cent. hydrogen gas ignited at 1026 deg. to 1028 deg. Fah. The introduction of carbon gas raised the point of ignition for 70 per cent. air and 30 per cent. carbon gas as high as 1202 deg. to 1215 deg. Fah. By the introduction of more carbon gas the point of ignition can be further raised to 1337 deg. Fah.

THE secretary of the American Iron and Steel Association estimates last year's production of pig iron as equal to that of 1882—4,623,323 tons. The consumption of pig iron during the year was about 4,948,323 tons. The year commenced with 383,655 gross tons of domestic pig iron unsold. There were imported during the year 325,000 gross tons, all of which went into consumption. Adding the estimated production of 4,623,323 gross tons to the estimated importation, and taking no account of the balanced stock at the beginning and end of the year, the total, 4,948,323—the year's consumption—is found to be the result. The production of steel rails in 1883 fell below that of 1882. There were also made probably 100,000 tons less iron rails than in 1882. The total rail tonnage of 1882 was 1,507,887 gross, of which 203,495 tons were iron rails, and 1,304,392 tons steel rails. The total rail production for 1883 is estimated at 1,300,000 gross tons, of which 1,200,000 tons were steel rails. The American import of steel rails for 1883 was about 100,000 gross tons, as compared with 200,000 tons in 1882. In round numbers the consumption of rails in 1883 was 300,000 tons less than in 1882.

AT a recent meeting of the Berlin Physical Society, Professor Schwalbe described a peculiar ice formation he had observed in the Harz towards the end of December last. Under a temperature of from +2 deg. to +3 deg. C. by day and −1 deg. to −2 deg. C. by night, he perceived, on a road covered with gravel and withered leaves, swellings of the surface at various spots, which, on closer inspection, proved to be ice protuberances rising from the ground and pushing up its topmost stratum. Similar swellings were found by Professor Schwalbe on rotten twigs lying on the ground. In these the rind over a large surface was pushed from the wood by ice excrescences of soft, brilliant, asbestine appearance, and uncommonly delicate to the touch. They adhered in large numbers to the body of the wood, and reached as great a length as 1 decimetre. Professor Schwalbe brought some of these withered and rotten twigs with him to Berlin, and it was in his power to produce on them at any time the phenomenon just described. For this purpose all that was needed was to moisten the twig thoroughly, in such a manner, however, that no water dropped off, and then to let it cool slowly in a cold preparation. Ice excrescences also appeared of themselves on twigs lying in the garden whenever the temperature fell below 0 deg. C. in the night. In reference to the explanation of this phenomenon, Professor Schwalbe favoured the view of Le Conte, who had described the matter thirty years ago, and considered it as an instance of capillary action. In the process of slow cooling the water in the pores became frozen into a small capillary tube, which sucked the water up, and this in turn becoming congealed shot continually further upwards. In this way the little stone or the withered leaf lying on the road, or the rind on the rotten twig, was pushed constantly further away from the substratum, and lifted upwards.

MISCELLANEA.

THE International Health Exhibition will be opened on Thursday, the 8th of May, at 3 p.m.

THE preparations for the holding of the Royal Agricultural Society's show at Shrewsbury in July next have been started. Several hundreds of loads of timber are already upon the racecourse.

THE remarkable excellence of the engravings of the *English Illustrated Magazine*, published by Messrs. Macmillan and Co., is well sustained in the April number, which contains, amongst others, some interesting views of old Western London.

AT the first lecture of the course at the Society of Arts, "On the Alloys Used for Coinage," on the 17th, Dr. W. Chandler Roberts, F.R.S., stated that the gold coinage of this country is estimated to consist of no less than 700 tons of an alloy of gold and copper.

A BILL to purchase the Coventry Gasworks is to be promoted by the corporation of that city. The Gas Company has agreed upon a twenty-four years' purchase. The cost of the undertaking will be £168,000. The corporation expect to make a profit of from £2000 to £2500 per annum.

WE are informed that large and comprehensive work on the history, discovery, practical development, and future prospects of metalliferous mines in the United Kingdom, under the title of "British Mining," by Mr. Robert Hunt—the keeper of Mining Records—will be published early next month by Messrs. Crosby Lockwood and Co.

THE Corporation of Stafford have resolved, subject to the sanction of the Local Government Board, to construct a new pumping station and other buildings at Ensor Moor, for the supply of water to the town. The borough surveyor estimates that the total cost will be £13,835. The annual expenditure will probably be £1794, and the annual income £2000. Thus there will be a resultant yearly profit of a little over £200.

ADVICES from Havana state that American capitalists are largely interested in mines abounding in a sort of liquid pitch—chapapote—on the northern coast of the province of Pinar del Rio. Large quantities of the product are now regularly shipped to the States, and to facilitate its transportation a railroad is planned along the coast though a section having an abundance of chapapote, and is to connect other large mines by railroad with the port of Mariel. What this natural pitch is being used for is not mentioned.

THE Government are about to try the experiment of sinking artesian wells in India. The recent activity in railway works in the North-West Provinces has induced this step, and the necessary stores have already been shipped per the last two steamers of the British India Company's line. The initial attempt will be made at Agra with tools and appliances manufactured by Mr. Wm. Speller, of Artois Works, Blackfriars, to whom were entrusted both the contracts issued in the matter.

THE Rev. Mr. E. Mainwaring Sladen, a large owner of property in Wittersham, Kent, where there has been for a long time only a very scarce and polluted supply of water, has generously offered £1000, in addition to the sites necessary for the erection of a small pumping station and reservoir, towards securing a copious and pure supply of water for the inhabitants. The necessary plans, &c., have been prepared by Messrs. Bailey Denton, Son, and North, of Whitehall-place, and will be submitted for adoption to the Tenterden Union, who, it may be safely presumed, will be only too pleased to avail themselves of this very judicious liberality.

THE Dickson Manufacturing Company of Scranton, Pa., has recently completed an enormous spur-wheel, it being the second of its kind made. The wheel is 43ft. in diameter at pitch-line, is 4⅝in. pitch by 12in. face and has 352 teeth. The total weight is 62 tons. This is a cut-gear, the teeth being all milled to exact templates. The *American Mechanical Engineer* says, the machine for cutting it was devised by the superintendent of the Dickson Works, Mr. Sidney Broadbent. The wheel itself was laid out by E. D. Leavitt, Jun., Cambridgeport. Mass. The time occupied in cutting the teeth was 215 working hours, say 21½ days.

IN their monthly report on the London water supply, Messrs. Crookes, Odling, and Tidy say:—"Of these 175 samples of water, the whole were, without exception, clear, bright, and well filtered. In respect to their degree of freedom from organic matter, the condition of the samples examined during the month has been on the whole excellent—and exceptionally so for the season of the year. In one sample only was the proportion of organic carbon at all excessive; while the mean amount afforded by the samples of Thames-derived water was 0·14 part in 100,000 parts of the water, corresponding to about $\frac{2}{10}$ths of a grain of organic matter in a gallon."

ACCORDING to *Kranick's Zeitschrift für Metallwaaren Industrie*, the introduction of steam into enclosed spaces for the purpose of extinguishing fire has been successfully tried in Berlin. The owner of a steel pen factory in that city, in consequence of repeated outbreaks of fire in the drying-room, had steam pipes placed in three of the rooms, this appliance being shut off by short soldered pipes of an easily-flowing alloy of lead and tin, arranged to work automatically. One day a hissing noise made the fireman aware that one of these appliances had been called into action. It was found on investigation that the contents of the drying-room had become ignited, but that the steam thus set free had extinguished the fire before it could spread.

AT a recent meeting of the Paris Society of Engineers, M Périssé read a paper on the cost price of engines and machines—as exemplified by a locomotive, a tender, a water-tube boiler, a multitubular boiler, a small steam engine, a centrifugal pump, machine tools, and spinning and weaving machinery—in England, Belgium, France, and Germany, in which he came to the conclusion that the cost of manufacture was dearest of all in France, because coal was dearer and not so good, labour was dearer than in Belgium or Germany, transport was higher, and also general expenses. Coal in France costs more than double the price in England. The difference in labour between France and Germany was stated to be 34 per cent. of the price paid in France, and 50 per cent. of that in Germany.

MESSRS. RICHARD GARRETT AND SONS have obtained a first-class certificate and gold medal, for their flanged boiler-plates, and a silver medal for their compound portable and semi-portable engines, at the Calcutta Exhibition. Messrs. Le Grand and Sutcliffe, of Bunhill-row, London, have been awarded a first-class certificate and silver medal for their Norton's "Abyssinian" tube wells and pumps. W. H. Baxter and Co., of Albion-street, Leeds, have also been awarded a gold medal for their patent knapping motion stone breaker. The Pulsometer Engineering Company has also been awarded a gold medal for the Deane steam pump exhibited by them. Messrs. John and Henry Gwynne have also been awarded for their "Invincible" patent centrifugal pumps a gold medal and first-class certificate; and their "Invincible" direct-acting centrifugal pumping engines have gained a silver medal and first-class certificate.

THE first sod of the Cardiff Waterworks' extensions was cut by the Mayor and Corporation of Cardiff on the 14th inst., when Mr. Bird, the present mayor, turned the first turf of the Llanishen reservoir with a silver spade presented to him by the engineer. This storage reservoir, which is situated about four miles from Cardiff, and is capable of holding 300,000,000 gallons of water, is part of an extensive scheme for supplying Cardiff with water direct from Taff Fawr on the Brecon Beacons. The total cost of the undertaking is estimated at £300,000, and includes a 24in. gravitating main from Taff Fawr to Llanishen, the construction of compensation reservoirs on the line of route, and the storage reservoir at Llanishen. The works were designed by Mr. J. A. B. Williams, A.M.I.C.E., of Cardiff. The contract for the Llanishen reservoir is let to Messrs. Hill Bros., of Beckenham, for £53,000. The contractor's engineer is Mr. J. C. Dudley, and the clerk of the works is Mr. J. T. Jones.

HIGH SPEED AIR COMPRESSING MACHINE.

MESSRS. DUBOIS AND FRANCOIS, SERAING, BELGIUM, ENGINEERS.

FIG. 1.

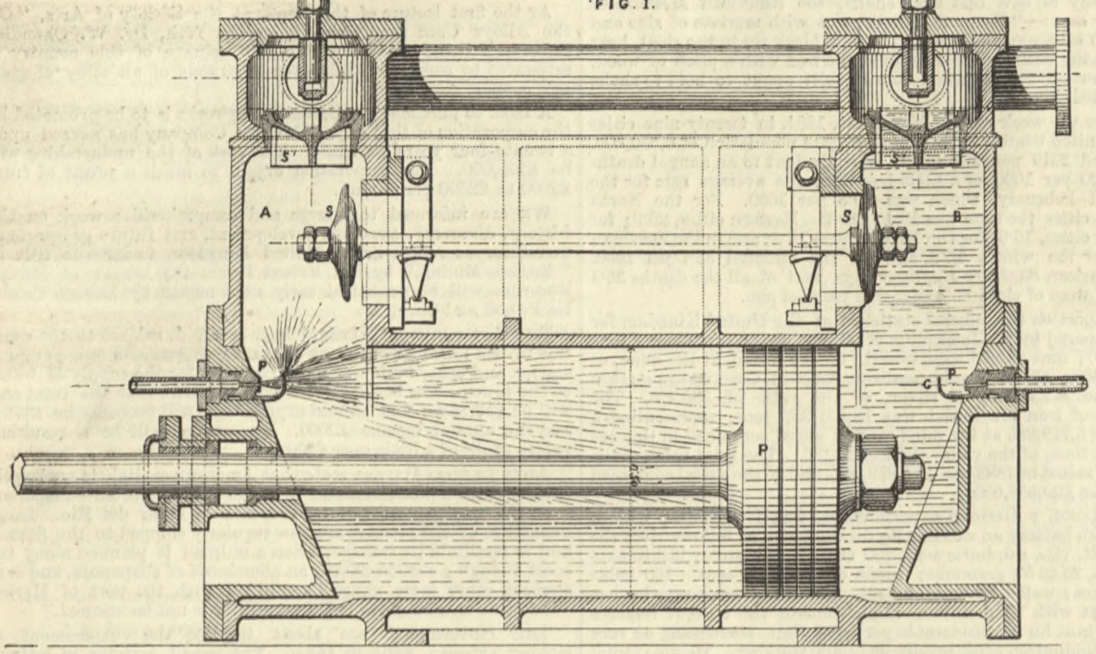


FIG. 2

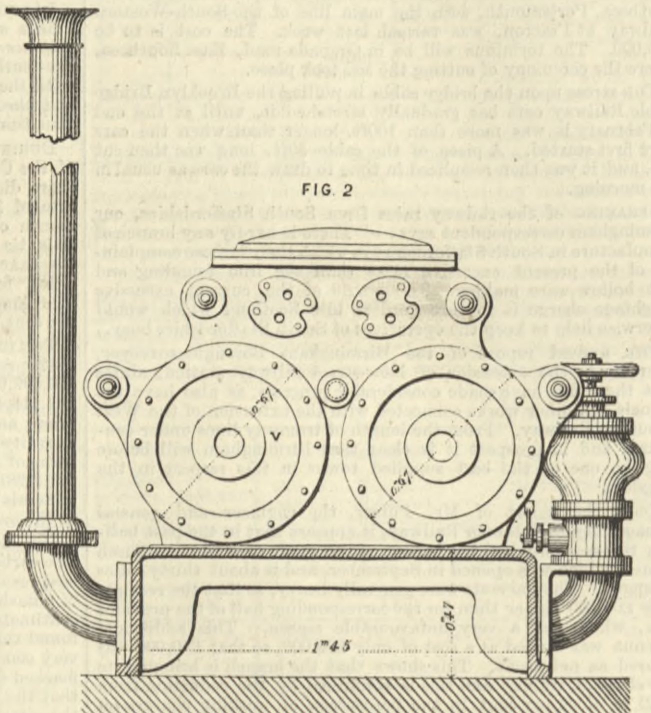


FIG. 3

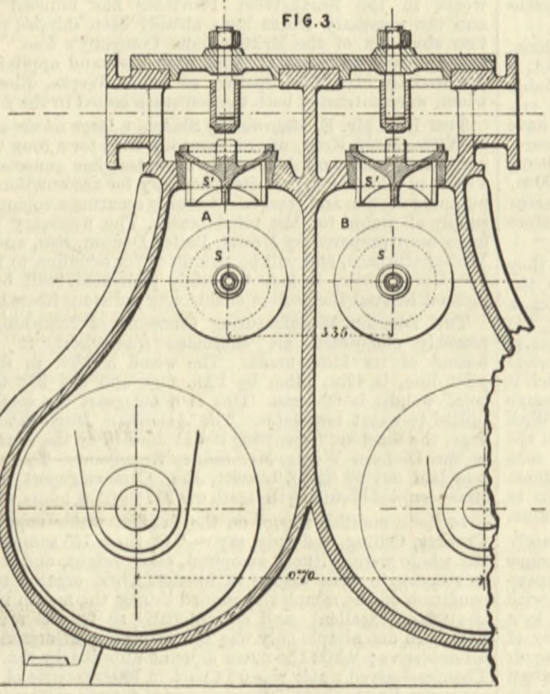


FIG. 4.

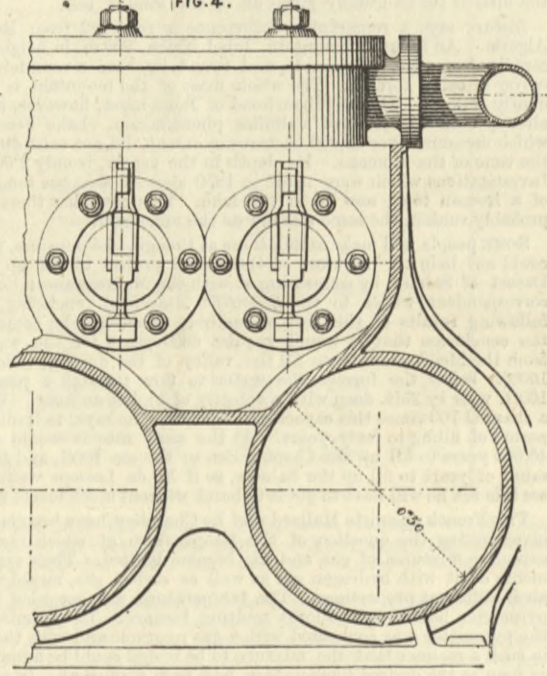
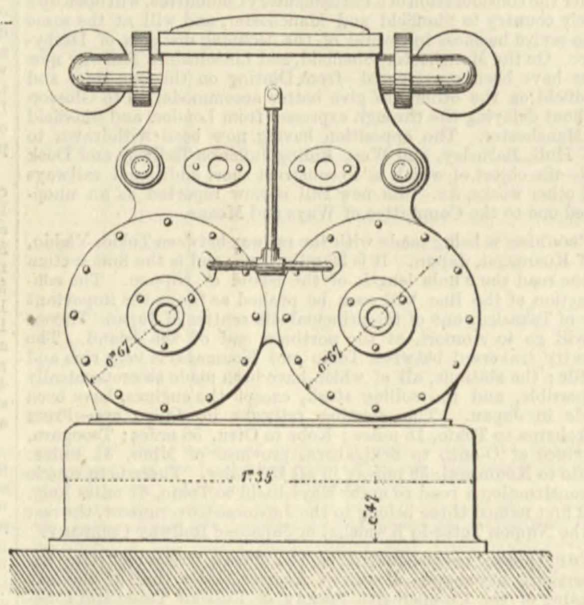


FIG. 5.



We illustrate above, and on page 242, an air compressing machine. Our engravings are copied from *Annales Industrielles.* The engravings are so clear that they require little description. It will be seen that a liquid piston is used for compressing the air; the metallic piston displacing water alternately at each end of the cylinder.

It is claimed for this machine that the great objection to the liquid piston system, namely, the putting in motion, with much splashing and disturbance, of large bodies of water, is quite avoided; the quantity used by Messrs. Dubois and François being quite small. The two spray cocks *p p* are supplied with water under considerable pressure, and a little oil can be sent in with it, which serves to lubricate the rubbing surfaces.

The volume of air compressed is equal to 92 per cent. of the space swept by the compressing piston; at 30 revolutions the volume is 94 per cent.; at 40 revolutions, 92 per cent.; and at 50 revolutions, 86 per cent. of the whole; 40 revolutions is the working speed corresponding to a piston speed of 315ft. per minute. The diameter of the compressing cylinder is 18in. nearly; the stroke a little under 4ft.; the air is compressed to about 75 lb. on the square inch.

Figs. 1, 3, and 4 are enlarged sections through the compressing cylinders. Figs. 2 and 5 are end views. An elevation and plan will be found on page 242.

THE WESTINGHOUSE AIR BRAKE COUPLINGS.

Mr. George Westinghouse, Jun., has lately patented a further improvement in his brake, which we illustrate herewith. While the original coupling is retained, duplicate rubber hose are used between the coupling and the iron train pipe. A ball valve works in a tee-piece, which is placed at each end of the hose, and forms the junction between the duplicate hose and the coupling and the iron train pipe respectively. As will be seen from an inspection of Fig. 4 this ball valve seats itself and prevents any serious escape of air when a hose bursts. Trains fitted with this arrangement will not be stopped by the automatic action of the brake should a hose give way. The ball valves will virtually stop the leak by closing both inlets to the damaged hose, and the other hose being available, the train can proceed as though nothing had happened. A train can only be stopped by both hose bursting, which is an unlikely coincidence. When both hose are in good condition the ball valve will have no tendency to block up either passage, and will maintain a central position, where it will not interfere with the free passage of air through the train. Figs. 4 and 5 show the tee-piece containing the ball valve in detail. The brake pipe or coupling is screwed into the nozzle, which is suitably threaded internally, while the hose are attached to the nipples of the usual form. It is obvious that if the hose attached to the left-hand nipple burst, the ball valve will seat itself as shown, and thus shut off all communication to the defective hose, preventing any escape of air, and leaving free communication open throughout the train by means of the other hose. The brakes would thus be perfectly under control. In order to prevent the ball valve closing against one of the seats upon the first application of the air pressure to an empty car, a small leakage hole is provided in one of the seat valves, so that if the first rush of air should seat the valve, it will come off again. The arrangement shown in Fig. 1 will probably be found somewhat awkward to handle, and the plan shown in Fig. 3 seems preferable. Although this arrangement is more costly than the ordinary method of coupling, it effects some saving in the renewal of hose, as they need not be removed until they have actually burst, while under the present system the hose needs careful inspection, and must be removed at the least suspicion of decay if annoying and unexpected stoppages are to be prevented. As the couplings themselves are unaltered, cars fitted with the duplicate hose will interchange perfectly with those fitted only with the old arrangement.—*Railroad Gazette.*

FIG. I

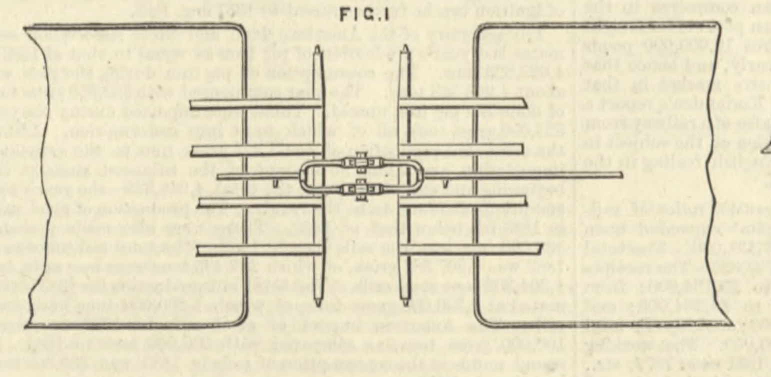


FIG. 4

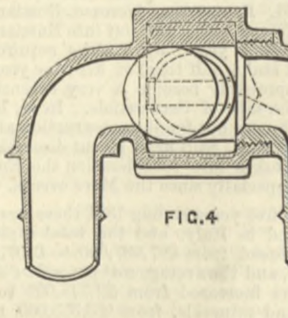


FIG. 2

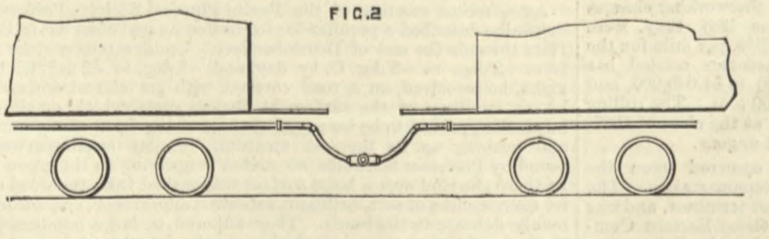
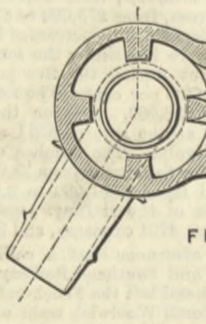


FIG 5



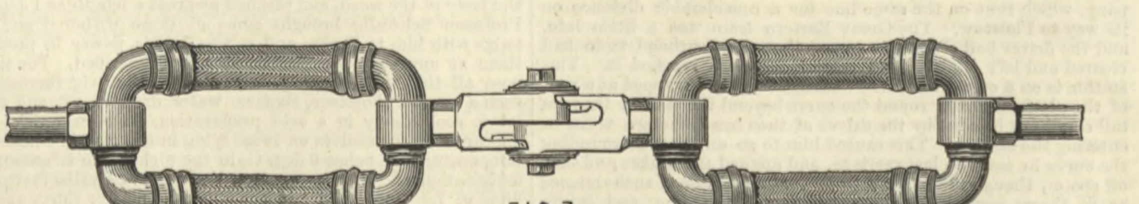
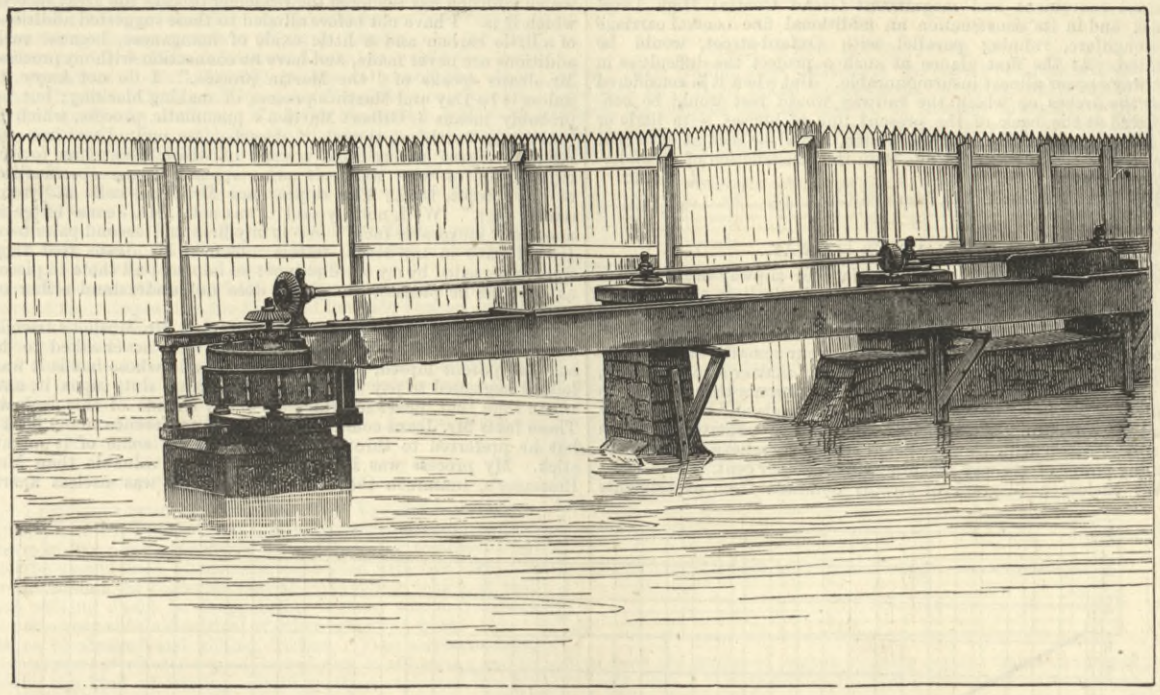
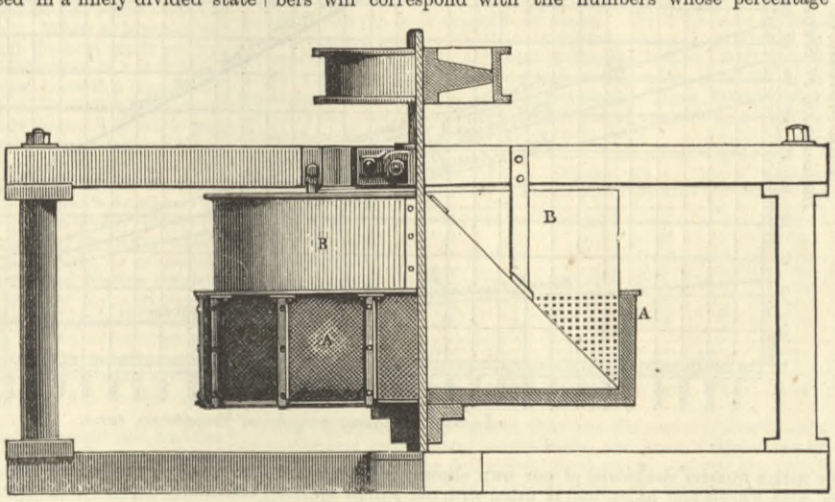


FIG. 3

APPARATUS FOR COOLING CONDENSING WATER.



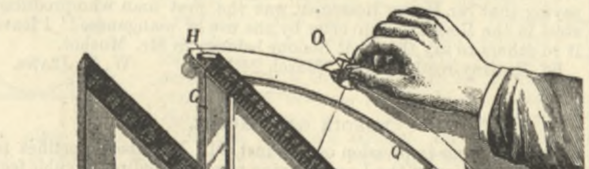
THE accompanying engravings illustrate a very ingenious system of cooling condensing water, which consists in scattering it high in the air as it is returned from the hot well to the condensing pond; the scattering fan or basket, as we may call it, being driven by a lay shaft and bevel wheel, or by a belt. The principle adopted for obtaining the effect is centrifugal force. Water flowing into a central chamber is dispersed in a finely divided state from the machine, and by its rapid rotation is forced through the atmosphere to a distance of nearly 20ft. from the machine. The quantity of water flowing into the machine is consequently distributed over the area of a circle about 40ft. diameter, falling in drops into the pond or reservoir. The essential parts of this machine are—a circular basket A, revolving round and surrounding an inner stationary vessel B. The sides of A are made of wire cloth stretched on a suitable framework. The water to be cooled is conducted into the vessel B, from which it is at once discharged through numerous small holes in the lower part of the vertical sides of said vessel against the revolving basket A, and is thrown off from A in the form of drops. In practice this cooler has given the undernoted results:—Water entered cooler at 95 deg., temperature reduced by 20 deg.; water entered cooler at 100 deg. to 110 deg., temperature reduced by 25 deg.; water entered cooler at 110 deg. to 120 deg., temperature reduced by 30 deg. The machine was so placed that the top of the basket was 4ft. from the surface of the water in the pond. Weight of the machine complete, 8 cwt.; diameter of basket, 3ft.; size of reservoir required, 40ft. diameter; indicated horse-power required, three to four; water cooled per minute, 300 gallons; revolutions per minute, 300.



In the case of ponds which are at some distance from the engine, it is found desirable to make the launders or troughs conveying the water to the cooler as wide as possible in order to reduce the velocity of the water entering the cooler. The machine at present is only made in one size, capable of cooling 300 gallons of water per minute. The machine is manufactured by Messrs. Duncan Bros., engineers, Queen Victoria-street, E.C.

THE "PERCENTOGRAPH."

THE device shown in the accompanying engraving is for reducing common fractions to decimals, and is particularly designed to be used by railroad and other transportation companies for determining percentages and proportions in dividing



rates, revenues, or expenses on the basis of mileage; but the uses to which it may be put are extensive, as will be readily seen from the description, which we take from the *Scientific American*.

A stationary triangle A has a percentage scale B arranged along its hypothenuse; a similar triangle C is fitted to slide in the fixed triangle, and is likewise furnished with a scale D on its hypothenuse, which represents a series of numbers the percentages of which are to be ascertained. The numbers in the scales B and D increase from the right upward to the left, the former extending from 0 to 100 and the latter from 0 to 1000, or from 0 to any number higher than 1000 according to the value given to the graduations. Thus, if each graduation is made to count 2 instead of 1, the scale D will indicate 2000 as the highest number. In the engraving the scale D is marked off to indicate both 1000 and 2000 at the end, two sets of numbers being used, one double the other, to mark the graduations. When the scale D is moved against the scale B the graduations will exactly register with each other, and the percentage numbers will correspond with the numbers whose percentage of 1000 or 2000 they represent. The base of the movable triangle is provided with a slot E, and a set screw by means of which it may be adjusted and held in any given position. The vertical side of the stationary triangle is provided with a stretched cord G, or equivalent device, which serves as a marker on the scale D. This cord is connected to set screws H I, and is arranged at right angles to the base of the triangle. A second cord K is attached to a collar loosely mounted on the pin I, and its other end is attached by a set screw O to a slide that moves on a segmental bar Q, the circle of which is drawn from the pin I. This cord is used to mark the percentage on the scale B, and also to mark the numbers on both scales.

If it be desired to ascertain the relative proportion of railroad lines, in interest aggregating, say, 1400 miles, move the scale D until 1400 intersects cord G on its upper edge, then tighten set screw. The cord K is then moved until it intersects the number of miles of road forming a part of the 1400 miles, when the relative proportion will be indicated on the stationary scale B. Thus, if cord K be moved until it intersects 490 miles, the scale B will indicate 35 per cent., and remaining distance, 910 miles, in proportion, forming the total of 100 per cent. From this it is obvious that the percentage which any part of 1400 bears to the whole will be indicated on the scale B by moving the cord K to the number of miles required—of the 1400.

In many instances there are roads which from their position demand an arbitrary proportion, and will not prorate on mileage basis. The percentograph provides for this emergency. For instance, if line Springfield, Mass., to New York demand 20 per cent. of any rate on business to Petersburg, Va., thus leaving 80 per cent. for lines New York to Petersburg, Va., move the cord K until it intersects 80 per cent. on the scale B, then move scale D until 388 miles intersects cord K—distance N.Y. to Petersburg, Va.,—then move cord K until it intersects 98 miles —N.Y. to Philadelphia—and scale B will show 20·2 per cent., and so on each road its proper proportion of the 80 per cent., as indicated. The patentee is Mr. S. J. Tucker, of Richmond, Va.

LANG'S WIRE ROPE.

THE following extract from the *Journal of the Royal Agricultural Society* affords a good description of the rope we now illustrate. Lang's rope is made by twisting the strands and the rope both in the same direction:—"The difference in construction and wear will be readily understood by reference to the accompanying illustrations, which represent old and new ropes. Whilst a soft material like hemp must be twisted in opposite directions, in order that the particles may cohere together, the rigid character of steel renders this unnecessary. In looking at the two ropes, it must be evident that in Lang's patent there is a much larger wearing surface, and that more equally exposed to friction. Again, under the ordinary twist the strands of the rope and the rope itself are 'laid' in opposite directions, and the wires are worn on the crown of the strand; a small part only of the rope being thus exposed to friction, the wires on each side of the worn part retain their full strength. The result is that many ropes have to be taken off, consequent upon the wires breaking upon the crown of the strands when otherwise only slightly worn. This is seen in Fig. 25, all the broken parts being on the crown of the strands. By Lang's patent the strands and the rope are laid in the same direction. There is thus a much larger surface exposed to friction, and the cause of wires breaking upon the crown of the strand is removed. The working of the rope round drums, pulleys, and curves bends the wires obliquely, and thus the greatest possible amount of wear is secured, since the wires will not break until they become too weak for their work. At the Derby Show in 1881, these ropes, made under John Lang's patent, were exhibited for the first

FIG. 1

FIG. 2

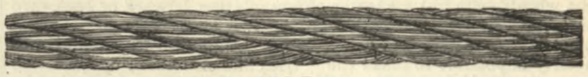


FIG. 3

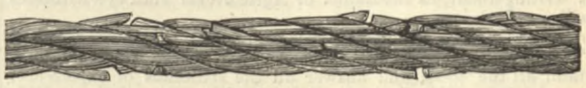
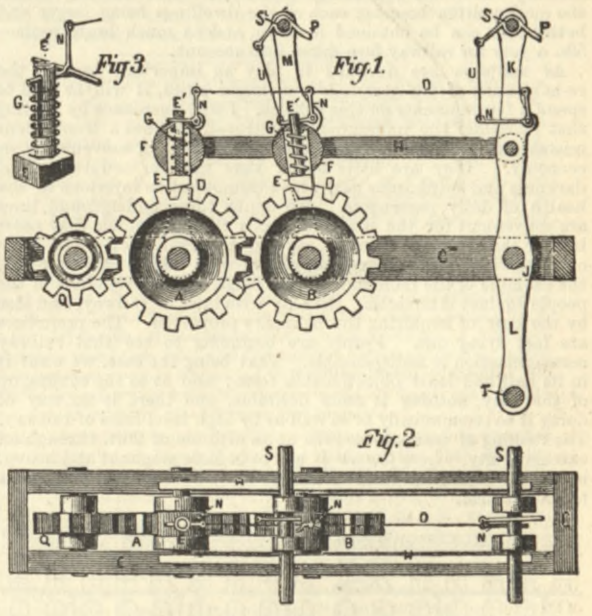


FIG. 4

time. The judges were favourably impressed with the merit of the new invention, but having no actual experience of durability, were not in a position to recommend a medal. The evidence that has been forthcoming in the interval has proved so conclusively the superiority of wear for this rope over the ordinary construction, that on this occasion the judges had no doubt as to the propriety of awarding a silver medal."

MECHANICAL MOVEMENT.

THE device herewith illustrated consists of a pair of toothed wheels geared together, and so arranged that continuous rotatory motion is communicated to the wheels, one pawl acting on one of them when the lever moves in one direction and another pawl acting on the other wheel when the lever moves the other way, the wheels thus driving in the same direction, but turning in opposite directions. On a suitable frame C are geared two spur-toothed wheels A B. Pawl levers D are set so as to act on the teeth of the wheels for driving them in opposite directions. The pawls are formed on the ends of short rods E, that are fitted to the sockets F of the pawl levers for being worked by them, and they rise and fall in the sockets in order to pass over and drop into the teeth for working the wheels, the springs G forcing them down. The pawl levers D are connected to a working bar H, which is to be reciprocated by power applied to it in any approved way. A lever L may be pivotted to the frame C, and have one arm K worked by hand and the other by the feet.



One or both of the pawl levers may have an arm M, by which the power may be applied by hand, the lever L being dispensed with. The pawls are connected to trip levers N, by which they may be raised out of contact with the wheels, when it may be required, to permit the working lever to be shifted to a more favourable point for starting the machine. The trip levers are connected to a rod O, worked by a hand lever P, on the power lever, when it may be worked at the same time that the hands are employed on the power lever, the hand lever being connected to any one of the trip levers by a rod U. The power may be transmitted from the wheels A B by a pinion Q. An important feature of the device is that power may be applied by long or short strokes, which may be varied within a considerable range, according to the number of teeth the pawls may be made to take at each operation. The leverage of the transmitting gear may thereby be varied, according as the work is light or heavy. This invention has been patented by Mr. Frederick Kubec, of Riverside, Iowa.—*Scientific American.*

COMPOUND LOCOMOTIVES.—The *Railroad Gazette*, commenting on the 300 mile run made by Mr. Webb's compound locomotive on the 26th of last October, says:—"As English expresses go, the train was neither exceptionally fast or heavy. It would be interesting to know the average indicated horse-power and resistance of the train, so that some idea might be formed as to the consumption of coal per indicated horse-power. Assuming the average resistance at 14 lb. per ton of gross weight of train, the average indicated horse-power would be 420, and the consumption of coal per hour being 1207 lb., the average consumption per indicated horse-power per hour would be 2·87 lb., which figure does not show any remarkable economy as compared with results obtained from the ordinary form of locomotive when carefully worked. It is, of course, possible that the resistance exceeded 14 lb. per ton, but this seems an ample allowance for a line which, for the greater part of its length, is nearly straight, and has few gradients exceeding 16ft. to the mile, except in the last 60 miles, where grades ranging from 40ft. to 70ft. to the mile are common." It will be seen that our contemporary attaches about the same value to the performance that we have done.

LETTERS TO THE EDITOR.

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

CLIMBING TRICYCLES.

SIR,—In reply to Mr. Aldridge, I certainly do adhere to my test, and shall welcome the least vestige of reasoning that will demonstrate it a false one. I can make no other form of tricycle that will even begin to climb such obstacles; and, with regard to inclines, how is it he does not know already that the incline was steeper than has ever been known or exhibited for a tricycle to mount? There is no machine anything like as easy for ten miles per hour, combined with the steepest hill climbing. It has no loss of power, being perfectly direct action, and no one who has tried my recent improvement for a moment hesitates to exclaim at the astonishing gain experienced. But as for Mr. Alridge, will he tell me how to become so sufficiently self-assured as to be able to write against a machine one has never tested, never ridden, and never even seen? For surely he would not make statements knowing them to be utterly false. I was perfectly astonished to read, "If the wheels were put a quarter of a revolution forward or backward the test would fail." If Mr. Alridge had any spot of practical mechanical experience in his nature, he would well know that it was utterly impossible to make the "trick" he describes; and, what is more, it conclusively shows that he has never even seen what he is writing about, as thousands of Agricultural Hall eye-witnesses will readily know.

He commences by stating that my public challenge demands "his contrary assertion." One can get through the challenge, stand all the tests, and answer all the criticisms of experience, but the "assertion," which can be equally well made by a child, is to be conclusive. And so Mr. A. has asserted that the stairs were "not ordinary stairs," when everyone who saw them knows they were, save being as wide as, say, those of the Charing-cross Hotel. The machine is wanting "free pedals!" yet strangely enough that is one of the advantages claimed for it, and was shown at the Hall. The "National" is also wrong as to "height of wheels!" still more strange, for they are the usual height, 45in. He again gratuitously informs us that it is "not double driving." This, in the face of all the machines being fitted with the most powerful double-driving system ever known, and both wheels having no other connection with the crank.

Who would have thought it possible for a man to take up his pen against a leading article in a scientific paper to contradict it, and proceed to inform your readers, with absolutely no knowledge of the subject he is writing about. As he presses me with a challenge about his ideal machine, I am willing to take him ten miles in an hour, and up one of the steepest hills in England, and should he succeed in keeping level with me, I will pay all expenses. At any rate he will then be able to satisfy himself as to the merits of the "National Royal Direct Action" far better than by making assertions in the dark.

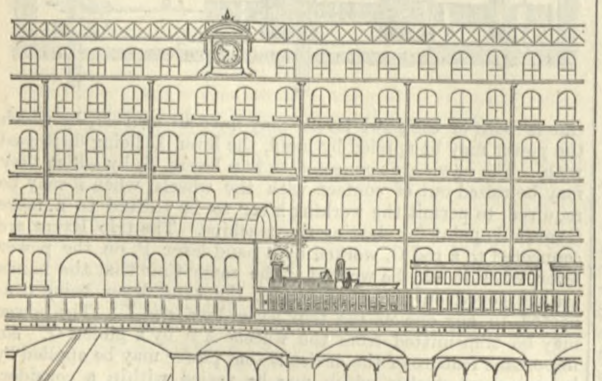
H. J. LAWSON.

National Cycle Works, Limited, Coventry, March 26th.

HIGH LEVEL RAILWAYS IN CONNECTION WITH CITY IMPROVEMENTS AND IMPROVED DWELLINGS.

SIR,—In a letter addressed to Mr. Samuel Morley, M.P., in November last, I in brief terms sketched out a plan by which those whose occupation admits of their residing at a distance equal to thirty, forty, or fifty minutes measured by time, could be accommodated with a cottage and garden in an airy locality, under sanitary conditions immensely superior to those existing within the metropolitan bounds; each of the dwellings being larger and better than can be obtained in town, and at much lower rents—52s. a year for railway fare taken into account.

As railways are destined to play an important part in the re-habitation of the people of our larger cities, it will be well to spend a few moments on this subject. I will commence by stating that I consider the underground Metropolitan lines a tremendous mistake, whether viewed from the point of health, convenience, or economy. They are little better than monster sewers, full of darkness and sulphurous gas, which cannot but be injurious to the health of daily passengers. No doubt these underground lines are convenient for the neighbourhoods through which they pass; but for the centre of London, say Oxford-street, they are of little or no service. The original projectors were scared into following the example of the mole in his burrowings, by the prejudices of the people against intersecting the City with lines of railway, and also by the cost of acquiring the necessary properties. The prejudices are fast dying out. People are beginning to see that railway communication is indispensable. That being the case, we want it in its best and least objectionable form; and as to the cutting-up of the City, nothing is more desirable, and there is no way of doing it so economically or so well as by high level lines of railway. The rushing of trains to and fro at an altitude of 20ft. through an extensive city, where the air is apt to become stagnant and heavy, is, in its beneficial results, almost tantamount to a continuous thunder storm.



Some years ago I conceived the idea of a high-level line so planned that a company could afford to acquire property such as the north or south side of Oxford-street, and turn it to so good account as to show a satisfactory dividend. In the case of the underground lines, all the advantage derived from the millions of bricks used in the construction, to say nothing of the cost of excavation, is simply—the tunnel; whereas in the high level line, a plan of which I have had drawn, and of which the above illustration is a reduction, the arches on which the line rests are turned into magnificent shops or warehouses, 12ft. in height at the lowest part, 16ft. high at the centre of the arch; with superior basements in addition. Abutting upon the one side of the line would rise a row of houses fronting another thoroughfare; these might be six stories in height, with shops and basements equal in size to those under the arches. Thus every yard of the space under the line—save and except the thickness of the piers on which the arches stood, and the breadth of the streets over which the line passed—would bring in a perennial and very handsome revenue; as would also the houses abutting upon the line, with frontages facing the other thoroughfare. Into a grand trunk central line, like that I have sketched, not only might the London and North-Western, Great Western, Midland, Great Northern, and other provincial lines converge; but from it—as the ribs from the spine—might spring lines on the high level plan, towards model townships planted at distances of ten or more miles out from the centre of the city.

Such a railway as here suggested, running from Cheapside to Hammersmith, along the south side of Oxford-street, would form a most convenient and magnificent Grand Central High Level Line; and in its construction an additional fine central carriage thoroughfare, running parallel with Oxford-street, would be created. At the first glance at such a project the difficulties in the way appear almost insurmountable. But when it is considered that the arches on which the railway would rest would be constructed at the back of the present line of houses, with little or no interference with the street traffic, it will be seen at once that the process is a much easier one than the construction of an underground line.

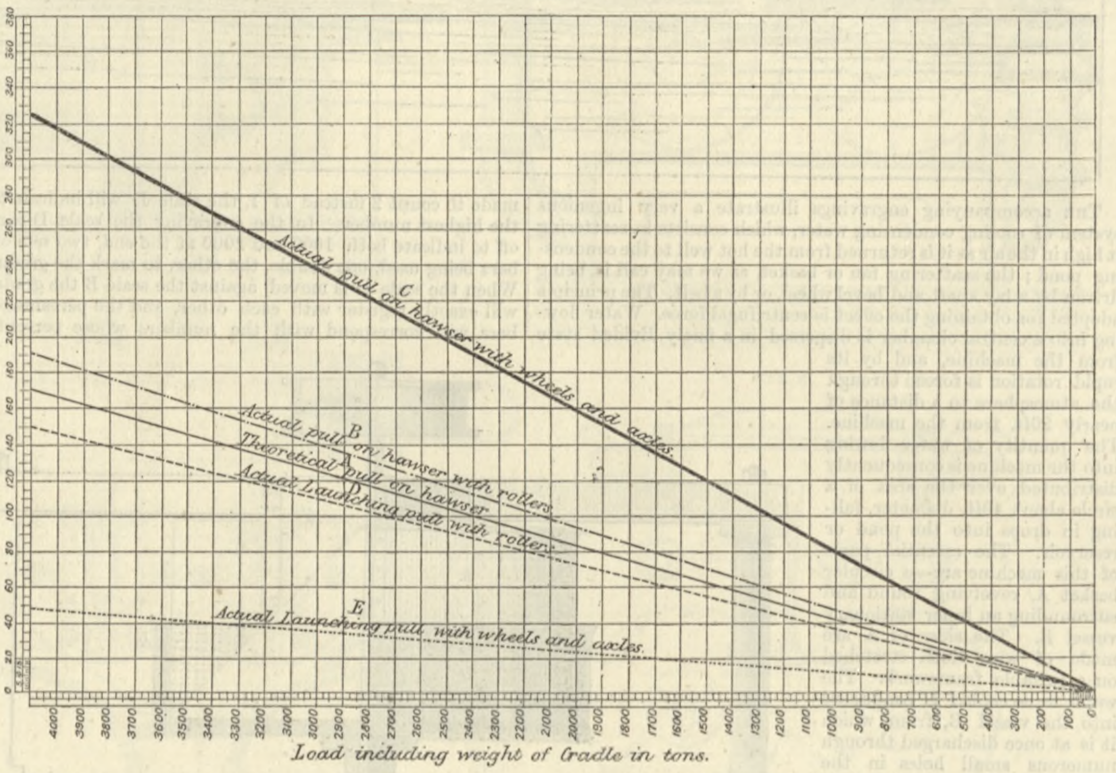
R. SCOTT.

12, Paternoster-buildings, March 18th.

AYR HARBOUR SLIPWAY.

SIR,—In your notice of the Ayr Harbour slipway in your issue of the 22nd ult., you state your surprise that rollers are not used for the carriages of slipways in place of wheels and axles, "which would reduce the power required to haul a vessel about 35 per cent." We beg to say that we quite agree with your remarks on this subject, and having given our attention to this matter some time ago, we have proved by a careful series of experiments that the gain in hauling power by using rollers instead of wheels and axles is fully what you state, and in October of last year we patented a system of rollers which will, we have every reason to believe, increase the hauling power of slipway machinery over 50 per cent.

We enclose a diagram of strains obtained from experiments



made with a quarter size model of our own slipway as at present fitted with wheels and axles, and if fitted with our patent system of rollers, the results you will observe are as follows:—In the diagram the line A shows the theoretical pull on hawser if there were no friction, the incline being 1 in 24. B shows actual pull on same with rollers, and C the pull when the ordinary wheels and axles are used. Following the vertical column, and taking the load at 2000 tons, we find on line A the theoretical pull on hawser $\frac{2000}{24} = 83\frac{1}{3}$ tons, and the actual pull with rollers is shown on line B as 95 tons, as against 159 tons on line C with wheels and axles. Another advantage attending the use of rollers consists in the greater launching power they confer, which is also illustrated in the diagram by the line D, which shows the launching power with rollers, and E with wheels and axles. Again, taking the load at 2000 tons, we find the launching power shown by line D with rollers is 73 tons, and on line E with wheels it is only 24 tons. Rollers of various forms, sometimes spherical, are used for slipways on the Continent and in the United States, but so far as we are aware they have not been hitherto employed in this country. It would appear from our experiments that they offer a great many advantages over the ordinary plan of wheels and axles.

DAY, SUMMERS, AND CO.

Northam Ironworks, Southampton, March 11th.

"THE CREATORS OF THE AGE OF STEEL."

SIR,—The above is the title of a book published by Mr. W. T. Jeans, the writer of a letter on the same subject, which appeared in your last week's impression. Both Mr. Jeans' book and his letters are specially framed to destroy my reputation as an inventor, and to exhibit me as a metallurgical jay, parading in borrowed plumage. With his book I have dealt already in the technical papers, and I now proceed to deal with his utterances as set down in his letter which appeared in your columns last week. The object of Mr. Jeans is to prove that I did not invent the Spiegel process, which I patented on 22nd September, 1856, but that Mr. Bessemer had, earlier in that year, invented and patented that process; and at the conclusion of his letter Mr. Jeans says, "I shall take care that in the new edition of 'The Creators of the Age of Steel,' now in preparation, the exact facts as to his—Mr. Bessemer's—honourable priority will—shall?—for the future be placed beyond contradiction by any sane man."

Now, without waiting for the hatching of Mr. Jeans' historical egg, and which may possibly be addled, I call upon him to produce his proofs. If he can extract anything out of Mr. Bessemer's patents of prior date to 22nd September, 1856, indicating that Mr. Bessemer knew of my process, or in any manner alluded to it in his claims, then I will at once declare that Mr. Bessemer, and not R. F. Mushet, was the true inventor. This is a fair offer, and should Mr. Jeans fail in the task he so triumphantly promises to accomplish, he will, so far as I am concerned, stand before the world as defeated. I do not envy Mr. Jeans his position. It is not enough for him to slander me for the time present as an impostor, claiming another man's invention, but posterity, in the future undying volume of "The Creators of the Age of Steel," is to view me as a metallurgical quack, building a tottering reputation upon Mr. Bessemer's invention, and receiving, in 1876, the Bessemer gold medal on false pretences.

Mr. Jeans may please himself, but I candidly tell him that I will review his second edition, and in my second edition of "The Bessemer and Mushet Process," I will insert every letter I have on the subject, and every fact in connection with it, so as to show him in the eyes of posterity as the man who tried to blacken my character as an inventor, and as an individual, and signally failed.

I do not desire, as Mr. Jeans asserts, to ignore or conceal any claim or suggestion contained in Mr. Bessemer's patents; but when he suggests—not claims—the addition of a little carbon in one patent, and a little oxide of manganese in another, this can hardly constitute the claiming of an addition of a triple metallic compound of iron, carbon, and manganese, to Bessemer metal, which addition has rendered the Bessemer process the great success which it is. I have not before alluded to these suggested additions of a little carbon and a little oxide of manganese, because such additions are never made, and have no connection with my process. Mr. Jeans speaks of "the Martin process." I do not know it, unless it be Day and Martin's process of making blacking; but he probably means I. Gilbert Martien's pneumatic process, which is practically worthless, though it decarbonises melted cast iron. I refer Mr. Jeans to my book, a copy of which I sent him for an explanation of why Martien's name appears in my specification of 22nd Sept., 1856. This appearance Mr. Jeans calls an "inexorable fact." Well, nobody said it was not. Mr. Jeans' letter is another "inexorable fact." As to my first and second patents of 1856, I have in my recent letters informed Mr. Jeans that they were superseded by my third patent; so he may pull them to pieces as much as he pleases, though he does not understand either of them.

"Is it any wonder," says Mr. Jeans, "that Mr. Mushet's friends would not pay £50 for his patent." They were never asked to do so. My patent lapsed, because the trustees in whose hands it was lodged neglected to pay the third year's stamp duty upon it, and worse than that, never informed me or my friends of this neglect. These facts Mr. Jeans could have learned by reference to my book; but he preferred to throw mud at me, hoping some of it might stick. My process was in this respect more valuable than Mr. Bessemer's, inasmuch that the latter process was useless apart from mine; and as all the processes of making cheap steel are essentially dependent upon mine for their success, it is no boast for me to say that my process is the most valuable.

The six gentlemen who constitute Mr. Jeans' repertory of creators, to my utter exclusion, have all great merits, well set forth by Mr. Jeans as long as he takes truth and fact for his guides; but inasmuch as my process is the key of their success, which not one of them can dispense with, I am certainly an even more important creator of the age of steel than any one of the six; and this is a fact which cannot be disproved.

As Mr. Jeans has, in 131 pages of his book, only been able to do Sir H. Bessemer, as he says, "scant justice," his new edition will necessarily be swollen to portentous dimensions. May I ask Mr. Jeans to spare a corner for my "manganese incident," which is another "inexorable fact."

R. F. MUSHET.

March 22nd.

SIR,—With reference to the first use of manganese in the Bessemer process, Mr. Carulla, like a good many other metallurgists, seems to be unaware of the fact that Sir Henry Bessemer used the following words in his patent of January 4th, 1856:—"When the metal is required to form steel, I put into the furnace (converter) during the process of refining about 1 or 2 per cent. of oxide of manganese;" and "When the refinement of the iron is desired to be carried to the extent of depriving the metal of its carbon as far as practicable, and thus produce soft malleable iron, I entirely omit the use of manganese." As that statement was recorded in the Patent-office seven months before Mr. Mushet ever heard of the Bessemer process, and eight months before Mr. Mushet took out his first manganese patent for the worthless process of Martien (not the Bessemer process), am I not justified in saying that Sir Henry Bessemer was the first man who produced steel in the Bessemer converter by the use of manganese? I leave it to others to say that that honour belongs to Mr. Mushet.

68, Rattray-road, Brixton, March 24th. W. T. JEANS.

LENOIR GAS ENGINE.

SIR,—In your impression of 21st inst. Mr. Pinchbeck certifies to the consumption of the Lenoir engine never exceeding 50 cubic feet of gas per brake horse-power per hour at the works. Mr. Pinchbeck's information is valuable, as he speaks from personal observation, but I find a very different result from trials made by M. Tresca in 1861. Testing an engine with a cylinder 11·3 diameter and giving nearly 2-horse power on the brake, this gentleman found a consumption of 95·7 cubic feet per brake horse-power per hour, which varied in another trial to 121·25 with same engine. Another Lenoir engine with cylinder 6·3in. and 1-horse power on the brake showed a consumption of 101·6 cubic feet per brake horse-power per hour. Taking the heating power of gas at 6000 calories per cubic metre, or, say, 670 foot-pounds per cubic feet, 3·8 cubic feet should give one horse-power theoretically. M. Tresca would therefore have an efficiency of about 4 per cent. against about 13 per cent. for the same sized engine of the present day, but the 50 cubic feet would give 8·5 per cent. The last would be looked upon as an extraordinary result at the time, and I think had it been reached outside the works there would have been more of these engines now working. I hope through your columns we may find a little further light thrown on this discrepancy by others who have some information on the subject.

W.

Fulham, March 22nd.

THE GAILLET AND HUET PROCESS FOR SOFTENING AND PURIFYING WATER.

SIR,—The pamphlet on this subject reviewed by you in last week's ENGINEER was in no way intended as a literary treasure, but was compiled solely to draw the attention of manufacturers and steam users to the process, fuller and detailed information being supplied on application at my office.

The clerical errors you point out have been corrected, but I must ask you to excuse me—for the present—supplying the information you ask regarding the rate of precipitation, as I will be in a position in two weeks' time to substantiate my remarks by practical results. I am now fitting up two complete plants in London, one for Mr. James Duncan, Clyde Wharf, Victoria Docks, to purify the feed water for twenty-six boilers, 185,000 gallons daily, and the other for Messrs. Cordner, Allen, and Co., general engineers and electricians, Stanhope Works, Fulham; the latter application will be all the more interesting, inasmuch as the clarification tank will be illuminated by the electric light, thus showing the progress of the clarification or precipitation, from the time the muddy Thames water enters the tank at the bottom till its exit at the top, pure and ready for use.

The water at Messrs. Duncan's Works is drawn from a well, and is charged with carbonate of lime, sulphate of lime, chloride of magnesia, chloride of soda, and organic matter.

Messrs. Cordner, Allen, and Co.—who are manufacturing for us—have at their disposition the high and low tide Thames water, as well as a supply from the waterworks. Backed by these two applications, I shall not only be more able to reply to your very practical questions, but can put you in the position of experimenting yourself on the genuineness of a process which has been a long felt want by steam users and manufacturers in general.

11, Queen Victoria-street, London, A. HOWATSON.
March 24th.

THE NATURE OF FRICTION.

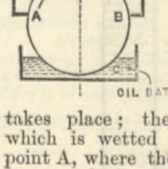
SIR,—I read your article on friction in THE ENGINEER of February 22nd with much interest, and have been disappointed to find that none of your correspondents have attempted to account for some of the unexplained phenomena connected with this force. I venture to submit the following partial explanation, which, if well founded, will no doubt be disappointing to many who may expect to find some very subtle electrical or other agency at work.

First, as to statical and sliding friction. Your correspondent, Mr. Stephenson, attributes a good deal of this to adhesion; and in some cases this kind of friction may be partly contributed by this force. Thus, if two clean surfaces of, say, lead, or of some colloid substance—such as glass, glue, or india-rubber—be rubbed together with a degree of pressure, the surfaces may in some points cohere or adhere, and to keep the surfaces moving over each other force must be supplied sufficient to shear these connections; at other points the resistance is more likely to be as I shall shortly explain. But this cohesion or adhesion is only what is commonly enough known as seizing, and only exists when there exists an unbroken continuity of substance—that is to say, when the surface at some point or points has become obliterated altogether. When a locomotive wheel slips, there is a tendency to seize; but the heat produced by the motion, being produced in the actual substance of a very thin layer of the surfaces in contact, possibly even fuses this layer, and the welding hot particles are scattered in exceedingly minute globules, which in the dark may be plainly seen. The rail being thus lubricated with semi-molten material, seizure cannot take place, and the very thing to restore the grip is sand, which is also the very thing to prevent adhesion. There can be no adhesion between two dry bricks, yet there can be considerable friction. A fly can walk with the greatest ease up the perpendicular surface of the most highly polished mirror, yet the points of its claws, which are exceedingly fine, are anything but favourable to adhesion. There can be little doubt but that this kind of friction consists simply of an interlocking of the inequalities of the surfaces in contact, and though the surfaces may be highly polished, and capable of reflecting light perfectly, these, maybe, ultra-microscopical inequalities yet nevertheless exist to some extent, and it must be apparent to everyone that the more swiftly the surfaces pass over each other the less the retarding force due to this cause will be.

There is also the friction of liquids in pipes, or what not, and the friction of lubricated surfaces. I believe these to be one and the same phenomenon. Everybody knows that the friction of the liquid is increased as the diameter of a pipe is lessened, and in capillary tubes it must be very great and be greatly affected by very small variations in the size of the tubes. This friction is said to be due to the rubbing of the liquid against the walls which contain it, and to the friction of its own particles, or molecules—according to taste, I suppose—against each other. I am inclined to think it partly the result of churning caused by rough and undulating walls, and partly due to the viscosity of the liquid; here Mr. Stephenson's adhesion theory is partly applicable. The very thin layer of liquid which is in absolute contact with the walls I believe to be almost as stationary as the walls themselves, and hence the reason why friction is greatest in channels which relatively have most surface.

It would be interesting to know whether, with a constant difference of pressure between inlet and outlet, the friction remains the same, whether these pressures be equally raised or lowered; if increased pressure notably increased the friction, and *vice versa*, it would greatly tend to establish the theory, that liquid friction is a rubbing of particles, for it would increase the pressure between them. Increased heat, by partly destroying the viscosity, would lessen the friction undoubtedly, and this enables us to understand why a certain degree of temperature is best suited to a particular lubricant in lubricated bearings.

For the sake of making clearer my remarks on this part of the subject, I annex sketch of a bearing, such as you described in your article. As soon as a new journal has run awhile, its surface



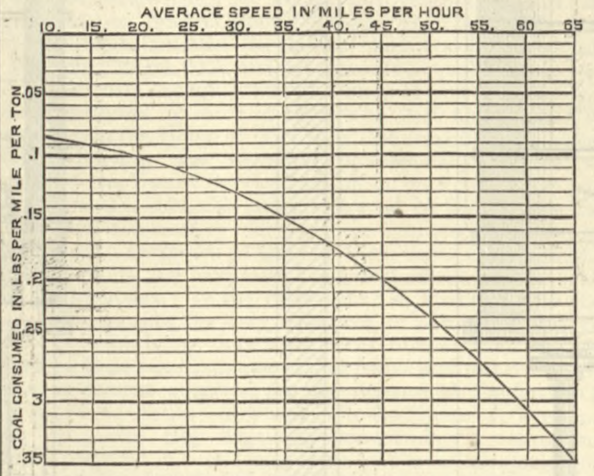
becomes smoothly polished by the grinding action of the prominent portions of the surface against each other, which will contribute in the first instance a little friction in accordance with the first principle I have explained. The wear of the shaft and its step both contribute to minimise the pressure at A and B, and cause it to be greatly concentrated towards the crown E, where the load comes on. Imagine now what takes place; the oil in the oil bath touches the journal, which is wetted by it as it revolves, and on reaching the point A, where the pressure is small, all except a thin film may be scraped off. This thin film, which is partly in absolute contact with the surface, is carried forward almost as if a part of it, and after a turn or so a thin layer of the liquid is carried by the friction—which, as I have previously said, becomes very great in capillary channels—between the brass and its journal, and this liquid film supports the whole of the load, and, so long as the rotation continues, is maintained so as to keep the surfaces separate; for if its thickness decrease the friction increases, and the moving surface brings round with greater force its film; so it adjusts its thickness according to the load, the speed, and the supply of lubricant. It is now evident that a pressure gauge situated at E would record—just as you say was accidentally discovered—a pressure depending upon the extent of surface, the rate of wearing, and the load, and at successive points on either side of this the pressure would diminish, until at about A and B it would become *nil*. Now as at the crown of the bearing the pressure may be so great as to render the film exceedingly thin there, the heat which is produced in the very substance of the film may be so great as to decompose it or volatilise it; then a portion of the surface is dried, and the bearing will shortly seize, and this will especially take place if there be strainings so as to cause undulations of the surfaces and heighten at particular points an already great pressure.

Applying this hypothesis, it will be evident that the crown of such a bearing as that sketched is the worst possible place for introducing the oil. If the oil were introduced by oilways with longitudinal grooves cut in the surface of the step at about A or B, the effect would almost equal that of the oil bath. Several other practical deductions present themselves, but I must terminate an already too lengthy letter, lest I find my effusion committed to your waste-paper basket. R. SNOWDON.

Widnes Foundry, Widnes, March 22nd.

HIGH SPEED LOCOMOTIVES.

SIR,—After reading your articles in the last two issues of THE ENGINEER on "High Speed Locomotives," I think, while on the subject, the enclosed diagram may be of interest to some of your readers, as showing the rapid increase in the consumption of coal when a locomotive attains a very high speed. The diagram is pre-



pared from the results of engines running regular trains on some of our main lines. It is understood that the trains run on an average road, where the gradients would fairly balance one another.

London, March 24th. C. HODGSON.

SCOTCH CINDER PIG.

SIR,—At the present time the following outcome of some experiments lately completed may interest many of your readers. For a long time Carron pig was out of the market, but as the output increased beyond the makers own requirements, they were obliged to find an outlet for their superfluous make. With the view of contrasting Carron brand with that of other makers, I purchased in the open market, through an eminent Glasgow broker, small parcels of No. 1 grade of some different high-class brands, in which, it is understood, no cinder is being introduced. These brands were carefully sampled, and subjected to chemical analysis by a chemist of repute with the following results:—

Constituents.	No. 1. Per c'nt.	No. 2. Per c'nt.	No. 3. Per c'nt.	No. 4. Per c'nt.	No. 5. Per c'nt.	Carron. Per c'nt.
Iron	92·62	90·26	92·26	91·60	90·70	92·12
Carbon combined ..	·71	·60	·45	·82	·85	·90
Carbon as graphite..	2·97	3·27	3·12	2·44	2·69	2·88
Silicon	1·06	3·39	2·15	1·61	2·83	1·76
Manganese	1·87	1·77	1·30	2·58	2·13	1·58
Phosphorus	·50	·44	·44	·69	·54	·47
Sulphur	·03	·04	·04	·03	·04	·04
	99·76	99·77	99·76	99·77	99·78	99·75
Total carbon ..	3·68	3·87	3·57	3·26	3·54	3·78

From this table it will be seen that the deleterious constituents of the several brands vary considerably, and that if the value of pig iron is mainly to be determined by chemical analysis, the prices to-day ruling for the different brands would be materially modified.

Chemical analysis, however, does not altogether determine the value of pig iron. Its mechanical properties are also most material factors in determining the value. The six brands of No. 1 Scotch pig iron before referred to I had tested by an eminent expert to ascertain the mechanical properties, with the following results:—

	These results are the average of ten tests of each sample.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	Carron.
Pulling stress.						
Ultimate stress per square inch ..	lbs. 24,298 tons. 10·84	lbs. 29,268 tons. 13·06	lbs. 29,472 tons. 13·15	lbs. 27,763 tons. 12·39	lbs. 24,803 tons. 11·07	lbs. 27,914 tons. 12·46
Ultimate extension in 10in.	per c'nt. 0·61	per c'nt. 0·65	per c'nt. 0·77	per c'nt. 0·61	per c'nt. 0·64	per c'nt. ·75
Thrusting stress.						
Ultimate stress per square inch ..	lbs. 125,962 tons. 56·23	lbs. 133,682 tons. 59·67	lbs. 127,714 tons. 59·01	lbs. 138,054 tons. 61·63	lbs. 124,369 tons. 55·52	lbs. 126·701 tons. 56·56
Ultimate depression in 2in. ..	per c'nt. 7·03	per c'nt. 12·61	per c'nt. 11·90	per c'nt. 6·54	per c'nt. 7·92	per c'nt. 9·70
Bending stress. Stress	lbs. 724	lbs. 792	lbs. 800	lbs. 776	lbs. 688	lbs. 793
Ultimate deflection	·29	·27	·32	·28	·28	·32
Specific gravity or density	7·1165	7·0815	7·1146	7·1367	7·0679	7·0895

One of the properties of Scotch pig iron most highly valued is that of being able to work up a large proportion of scrap or other hard iron. The relative value of this property in the several brands tested is indicated by the resistance to thrusting. A reference to the above table shows how this property varies in the different brands. It will also be found that different samplings of the same grade of the same brand vary considerably, both chemically and mechanically. Thus it is evident that every brand of pig iron should stand on its own merits. The original reports on the tests can be seen here.

DAVID COWAN,
Manager for Carron Company.
(Incorporated by Royal Charter).
Carron, Falkirk, N.B., March 26th.

THE CAPELL FAN.

SIR,—As the report of Mr. D. K. Clark, C.E., on this fan is now in your hands, a few words as to how it came about that these tests were made may not be out of place. In September, 1883, the new fan was brought to the notice of the South Staffordshire and East Worcestershire Mining Institute, at Dudley. It was tested for quantity and water gauge with closed inlet, and gave very high results. In the discussion which followed I was pressed very closely as to the power required to obtain the high air speeds shown by my fan. I was quite aware that any statement I made would not be accepted, so I simply proposed that power tests should be made, and promised to arrange for them. After many inquiries as to transmission dynamometers, it was decided that an indicated engine test would be most acceptable to mining engineers. Those tests were carried out on November 1st and 3rd, and the engine was run with the fan on November 5th, 6th, and 7th, to follow up the various points which came out as trials went on. The report of the South Staffordshire Institute was severely criticised in your paper, and after a warm controversy it was suggested by you that an engineer of experience should carefully test the fans and report on them. This has been done, and the report is before you. In comparing the 3ft. fan with the 5ft. now tested, it is well to note that the inlet of the 3ft. fan is 19¾in. to 36in. diameter, while the 5ft. fan has its inlet 29in. to 60in. diameter. A novel arrangement of the inner fan appears to have made a difference in this 5ft. fan, and will require to be carefully considered. The air was measured in a 32in. tube, which reduced the velocity, as the inlet proper was only 29in., and in open fans the velocity of the air entering is affected by contraction at any point. The work done by the fan, I take it, is the work done in passing the given volume through the inlet proper, as the suction tube might be 4ft. diameter when the actual work, if taken by the velocity at the mouth of the inlet and at the mouth of the 4ft. suction tube, might differ in the proportion of eight to one. I merely mention this as the employment of a tube larger than the inlet alters the open water gauge and the air speeds, and makes results vary a little from the trials of the 3ft. fan. If the figures appear strange to your readers, I can only say that I have long been aware of their puzzling character, and have afforded every facility in my power to have them investigated. If the method of measuring the air is found to be faulty, the same rule will apply to every other fan. I believe that if any error exists in the measurement of the horse-power of air, it will be found in estimating the value of M as applied to air in rapid motion. G. M. CAPELL.

Passenham Rectory, Stony Stratford, March 25th.

[The report in question will be found on page 236.—ED. E.]

BREAKAGE OF PROPELLER SHAFTING.

SIR,—The report of the nature of accidents happening to propeller shafting which your correspondent Mr. Greenhill suggests should be made, will not only be interesting, but will show designers of engines where and how construction may be modified to prevent as far as possible the recurrence of accidents which are so often, and I may say so regularly, taking place. If such a list should be ever published, I will venture to state that of the number of breaks taking place at the fore or engine end of the shafting, by far the most will be found to have happened at the pin of the aftermost crank. The reason is easy to find. A shaft out of line struggles to straighten itself at every revolution; the amount of springing in the line of shafting, occasioned by the bending of the vessel's structure, is continued across the aftermost bearing in the base-plate as a fulcrum, and finds relief in the first weak place that it comes to, the web of the after crank ultimately breaking the pin. This shows the need of some slightly flexible joint between the crank and the thrust block; a joint can be more easily managed there than where there is a thrust and pull on it. Some forms of joint would also guard against another danger—end pressure on the cranks, from the unskilful or careless adjustment or non-adjustment of the thrust blocks. LOG CHIP.

March 26th.

THE COST OF DREDGING.

SIR,—In collecting some data about the costs, &c., of "Dredging," there appears to be an error in the figures supplied in Mr. John Ward's letter to your paper of the 7th inst., p. 190. The total expenses are therein represented at £673 17s. 2d., instead of £770 17s. 2d., as I make it. CAMERON BROCK.

9, Victoria-chambers, Victoria-street, London, S.W.,
March 21st.

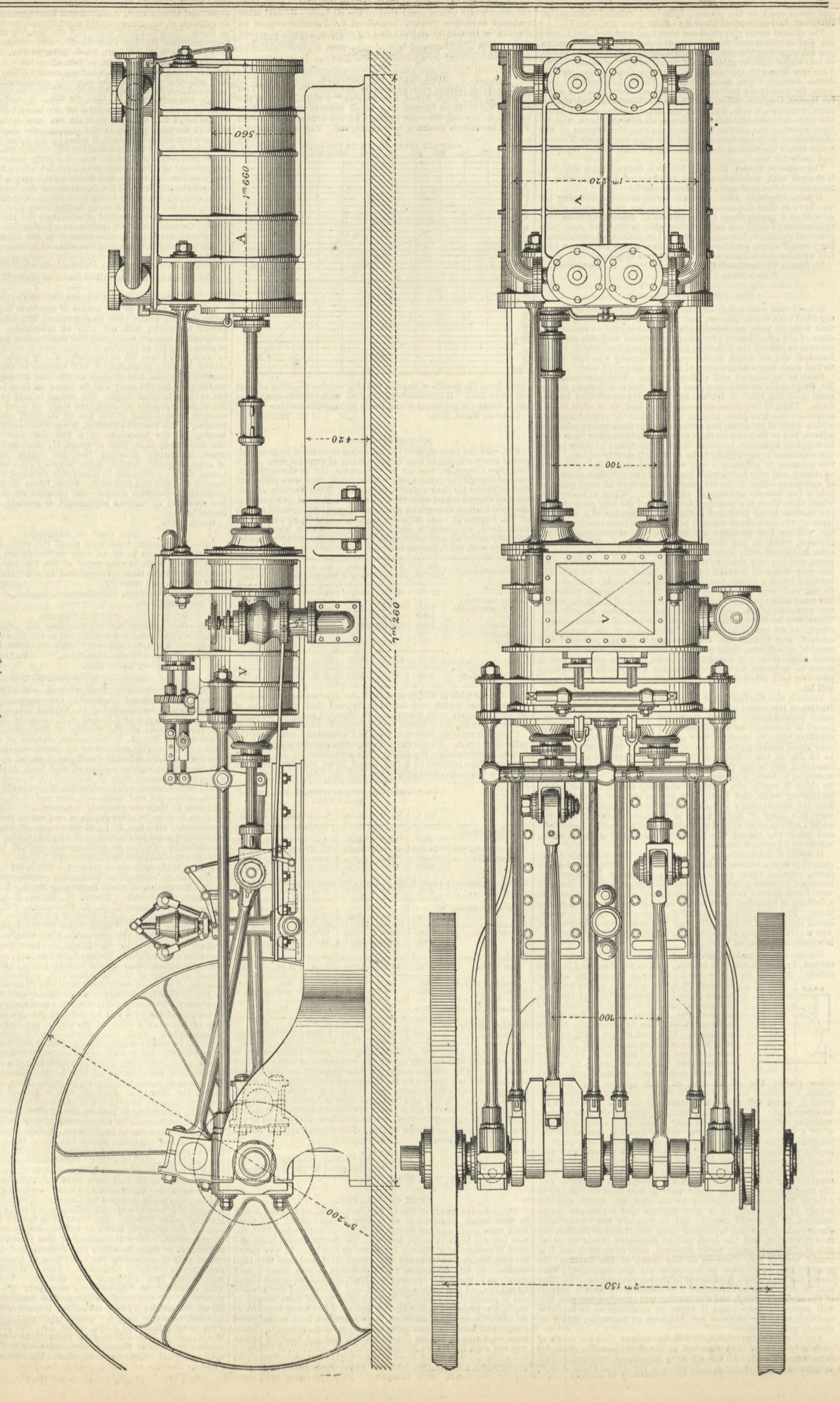
STEAM HAMMERS.

SIR,—Our letter of the 8th inst. does not refer to your correspondent's letter and description, but to the hammers themselves; and anyone interested can easily verify our statement.

Steam Hammer Works, Openshaw, B. AND S. MASSEY.
Manchester, March 26th.

GENERAL ENGINEERING CONSTRUCTION.—The fifth of a course of lectures on "General Engineering Construction," by Mr. J. W. Wilson, jun., vice-principal of the Crystal Palace School of Practical Engineering, was delivered on the evening of March 13th, in the reading-room of the Society of Engineers, Victoria-street, Westminster, Mr. A. T. Walmisley, member of Council, in the chair. The lecturer commenced by considering the general nature of a roof, with its different conditions of thrust and stress. After referring to the various sources of roof load, he proceeded to the subject of accessory roofs of different kinds; and then referred in detail to the nature and construction of principals for timber roof work, compound roof work, and iron roof work, directing special attention to their various parts, junctions, &c. The lecturer then went on to describe other details of roof work; purlins of different dimensions; wind ties, &c.; and the various coverings in use. After mentioning some points connected with the subject of erection, he concluded by referring to some special roofs of large span. The lecture was illustrated by diagrams and models.

ROYAL METEOROLOGICAL SOCIETY.—The usual monthly meeting of this Society was held on Wednesday evening, the 19th instant, at the Institution of Civil Engineers, Mr. R. H. Scott, F.R.S., president, in the chair. Messrs. W. Bailey, M.A., W. L. Bloire, A. L. Ford, H. Leopold, A. F. Lindemann, F.R.A.S., and Rev. E. B. Smith were elected Fellows of the Society. The President read a paper entitled "Brief Notes on the History of Thermometers." He stated that the subject had been handled in a comprehensive manner by M. Renou, a few years ago in the Annuaire of the French Meteorological Society, so that he should merely mention some of the leading points. The name of the actual inventor of the instrument is unknown. The earliest mention of it, as an instrument then fifty years old, was in a work by Dr. R. Fludd, published in 1638. Bacon, who died in 1636, also mentions it. The earliest thermometers were really sympiezometers, as the end of the tube was opened and plunged into water, which rose or fell in the tube as the air in the bulb was expanded or contracted. Such instruments were of course affected by pressure as well as temperature, as Pascal soon discovered. However, simultaneously with such instruments, thermometers with closed tubes had been made at Florence, and some of these old instruments were shown at the Loan Collection of Scientific Apparatus at South Kensington, in 1876. They are in the collection of the Florentine Academy, and in general principle of construction they are identical with modern thermometers. Passing on to the instrument as we now have it, Mr. Scott said that most of the improvements in construction in the earliest days of the instrument were due to Englishmen. Robert Hooke suggested the use of the freezing point, Halley the use of the boiling point, and the employment of mercury instead of spirit, and Newton was the first to mention blood heat. Fahrenheit was a German by birth, but was a *protégé* of James I, and died in England. Réaumur's thermometer in its final form owes its origin to De Luc; while the Centigrade thermometer, almost universally attributed to Celsius, was really invented by Linnæus. Celsius' instrument had its scale the reverse way, the boiling point being 0 deg., and the freezing point 100 deg. Mr. Scott then gave a brief account of some of the principal forms of self-registering and self-recording thermometers. After the reading of this paper, the meeting was adjourned, in order to afford the Fellows and their friends an opportunity of inspecting the exhibition of thermometers and of instruments recently invented. This exhibition was most interesting, and embraced 136 exhibits. The thermometers were classified as follows:—(1) standard; (2) maximum; (3) minimum; (4) combined maximum and minimum; (5) metallic; (6) self-recording; (7) solar radiation; (8) sea; (9) earth and well; (10) thermometers used for special purposes; (11) thermometers with various forms of bulbs, scales, &c.; and (12) miscellaneous thermometers. In addition to these there were also exhibited various patterns of thermometer screens, as well as several new meteorological instruments, together with drawings, and photographs.



HIGH SPEED AIR COMPRESSING MACHINE

MESSRS. DUBOIS AND FRANCOIS, SERAING, BELGIUM, ENGINEERS.

(For description see page 238.)

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PARIS.—Madame BOYVEAU, *Rue de la Banque.*
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NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

TO CORRESPONDENTS.

*** *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.*

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

*** *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.*

E B. LINCOLN (Boston, U.S.).—*For information on the strength of springs as used on railway and other wagons and carts, carriages, &c., see* THE ENGINEER, *December* 1*st*, 1876.

P. P. C.—*Many makers mark their patterns of interchangeable parts with some letter or other distinctive device, which they register as a trade mark. These marks have been held entitled to protection.*

C. F. R.—*The great weight of the engines and boilers, and the necessity for obtaining space for them, renders it impossible to put them far back in the hull. If the ship has a fine run aft, as she ought to have, the machinery would bring her too much down by the stern, and the hull would also be too narrow to provide sufficient room.*

W. H. (Birmingham).—*If you will take the trouble to read our first article "On High Speed Locomotives" once more, you will find that we have carefully explained why it is that the power increases so rapidly with the speed. Any elementary work on photography will give you a list of substances affected by sunlight. If the sun's rays are allowed to fall on a thermopile a current of electricity will be produced. We suppose this statement will answer your question as to whether the sun's heat can be directly converted into electricity. Read Tyndall "On Heat as a Mode of Motion."*

WHEEL VALVE WITH ASBESTOS SEATING.

(*To the Editor of The Engineer.*)

SIR,—Would some of your readers kindly inform me who are the makers of Rhodes' patent wheel valve with asbestos seating? C. W.

Leicester, March 25th.

SLAG GLASS BOTTLES.

(*To the Editor of the Engineer.*)

SIR,—We should esteem it a great favour if any of your readers could oblige us with the names of those firms in this kingdom making glass bottles from blast furnace slag. H. AND C. D.

London, March 25th.

SAND AND EMERY PAPER MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—I want some information upon emery and sand paper making machinery, and shall be glad if you will allow me to ask through your columns where I can get it, or the names of makers of such machines.

Barcelona, March 21st. J. J. B.

VALVE FOR AIR UNDER HIGH-PRESSURE.

(*To the Editor of The Engineer.*)

SIR,—Could any of your readers inform me through your columns as to what is the best form of small air valve, such as is used for instance in air guns and in similar cases where great compression is used? I wish to find the most perfect form I can. Some form of balanced valve would be best, as it should be capable of instantaneously opening at the pull of a trigger. EOLUS.

Redcar, March 13th.

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Advertisements cannot be inserted unless Delivered before Six o'clock on Thursday Evening in each Week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of THE ENGINEER, 163, *Strand.*

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 1st, at 8 p.m.: Ordinary meeting. Paper to be read with a view to discussion, "Experiments on the Composition and Destructive Distillation of Coal," by Mr. William Foster, M.A., F.C.S. Thursday, April 3rd, at 8 p.m.: Special meeting. Sixth and concluding lecture "On Heat in its Mechanical Applications"—"Heat-action of Explosives," by Captain Andrew Noble, C.B., F.R.S., M. Inst. C.E.

SOCIETY OF ARTS.—Monday, March 31st, at 8 p.m.: Cantor Lectures, "The Alloys Used for Coinage," by Professor W. Chandler Roberts, F.R.S., Chemist to the Royal Mint. Lecture III. Methods by which accuracy of weight and "fineness" of the alloys is ensured. Tuesday, April 1st, at 8 p.m. Foreign and Colonial Section. "The Rivers Congo and Niger Entrances to Mid-Africa," by Mr. Robert Capper. Major-General Sir Frederick John Goldsmid, K.C.S.I., C.B., will preside. Wednesday, April 2nd, at 8 p.m.: Seventeenth ordinary meeting. "The Dwellings of the Poor of Great Cities," by Mr. Elijah Hoole.

THE ENGINEER.

MARCH 28, 1884.

THE CONDITION OF OUR NAVY.

ANY discussion on our system of national defence and our fleet in the House of Commons is hampered by the fact that very few members possess the necessary technical knowledge to enable them to master the questions at issue, and speak with weight and confidence. On the other hand, these matters are discussed technically with a good deal of plain speaking, and occasionally very ably, at Institutions whose proceedings do not attract sufficient attention to produce much effect. What we need is to have opinions which command respect because they come from men who have mastered the subject, spoken in a voice that is loud enough to be heard throughout the kingdom. Perhaps there is nothing more likely to attain this end than a Parliamentary Committee, before which the best authorities are summoned to give evidence. Such a Committee was asked for by Sir John Hay on the occasion of the discussion of the Naval Estimates on Thursday, March 20th, and, we regret to say, asked for in vain. Curiously enough, while the state of our fleet was severely censured by some of those who best understand the subject in the House on Thursday, the condition of our national defences was reviewed professionally in the Theatre of the United Service Institution on Friday. On that afternoon a most able paper was read by Sir Charles Nugent, and discussed by officers whose opinions are peculiarly weighty, inasmuch as some of them have held high official positions, and have been the actual official authorities on this subject. In the discussion the speakers were all on the same side, the only difference of opinion on the general question being that some went further than the lecturer in their condemnation of the feeble and imperfect means at present provided for the defence of England. This paper we notice elsewhere. In the House of Commons Sir John Hay began by condemning a return recently prepared in such terms as he said were calculated to lead to the belief that we have sixty-two efficient armour-clad ships, a belief which, we venture to think, argues a degree of credulity that would rarely be found in a member of Parliament. He then made good his objections in detail. The Defence clearly requires new boilers; the Hydra and Gorgon have been pronounced by Sir Thomas Brassey himself to be scarcely fit for coast service in the Channel. The Wyvern, Vixen, and Viper have only 3in. of iron, and have been actually condemned. The Black Prince and Resistance are out of repair, and the Warrior, Glatton, Prince Albert, Cyclops, Hecate, and Scorpion are inefficient in a less degree, the Warrior and Repulse being ships that ought to be struck off our list, in the same way that we are so ready to insist on the fact that the French ironclad wood-built ships of the same date should no longer be regarded as efficient. Sir John Hay, in fact, considered that, while England has but 38 serviceable armoured ships, of which 9 are on distant stations, France has 35 fit for service, as well as 14 building. Italy has two of the most powerful ships afloat, carrying 100-ton guns, and is building five more very powerful vessels, two with 19in. and three with 18in. armour. It has been a maxim in old days that England ought to have a fleet equal to that of any other two Powers in order to protect her commerce and colonies. Instead of this she has, of all sorts, 62 ships, against 64 of France and 19 of Italy, or, taking efficient ships only, England has 39, while France and Italy together have 46 or 47. He referred also to the fact that the condition of the hulls and boilers, which used to be shown clearly, is now passed over in silence, and is, he assumes, in an unsatisfactory state. Lord H. Lennox then spoke briefly and strongly on the bad condition of the Navy.

Sir Thomas Brassey, in reply, urged that more and more money is spent on Naval Estimates, and that the Government were satisfied that England would maintain her naval supremacy; that the French were building ships chiefly to replace their wood-built armoured vessels; and he pointed out that England had eighteen ironclads nearly ready for sea, including the Dreadnought, the Devastation, the Ajax, the Agamemnon, the Conqueror, and the Rupert. After short speeches from Mr. Jenkins and Mr. T. Bruce, Mr. Gorst spoke forcibly in support of the appointment of a Select Committee, and called attention to the speed with which French ships were supplied with powerful breech-loading guns and machine guns, as well as the fact that Russia, France, and Italy had cruisers with a speed of 17 knots, while France, Russia, and Germany would each have more torpedo boats than ourselves at the conclusion of the present year. Mr. W. H. Smith declared that he was prepared to go further than had been suggested in questioning the efficiency of ships, chiefly on account of the condition of their boilers, of which only one in twenty-eight had been attended to for the last four years. He hoped that the civil lord was prepared to justify the great responsibility he took in saying that our navy was in a state to maintain our naval supremacy, but if so, the Government ought to welcome the appointment of a Committee, because it would satisfy the public mind, which was now really alarmed. English mercantile ships had 80 per cent. of the carrying trade of the world, and it was most serious if we had no efficient means for its protection. Mr. Campbell Bannerman said, after speaking of discipline, that the steel boilers lasted twelve or fourteen years, though, to meet Mr. Smith's charge, they ought, on an average, only to need looking to after a very much longer period—in fact, not generally during the lifetime of a ship. He quoted words of the French Budget Committee on French Navy Estimates for 1884, to the effect that France could not compare with England in the number of her ironclads and cruisers. To satisfy all doubt, he stated that it was "the opinion of the Admiralty that we were not in so depressed a condition in this matter as some of those who had spoken would lead us to imagine."

The discussion in Committee being broken off, it may be well, at this stage, to point out the general character of the attack and defence of our policy in naval matters. The attack was definite. It dealt with paucity of ships, bad condition of boilers, deficiency in ships, cruisers, and torpedo boats, and delay in the supply of modern armaments of breech-loading guns and Nordenfelts. Under the strong conviction of matters being in a bad, nay, a dangerous condition, a Select Committee is pressed for, and all this is met simply by the refusal to appoint a Committee, coupled with as weak and unsatisfactory a defence as we could well imagine. In these cases we may naturally expect the accusers to act on partial impressions, and the Government to meet them with the facts and figures which they must possess and could give on unquestionable authority. Instead of this, the figures and facts appear in the accusers' statements, and the reply that is meant to meet all this and restore our confidence is that the Admiralty opine "that we are not in so depressed a condition as some would lead us to imagine." This is intended to satisfy us so fully that we are to see that a Select Committee is obviously unnecessary; yet this vague statement only amounts to saying that some part of what is alleged is not endorsed by the Admiralty. Are our ships sufficiently numerous and efficient? This is not said. Are our boilers in working order, seeing that only one in twenty-eight has been touched for four years? Well, we are reminded of the assumed fact that steel boilers last longer than iron, concerning which there is no trustworthy evidence of any kind. Is it true that we are deficient in swift ships and in torpedo boats? We are not informed whether these are the matters in which the Admiralty think our imagination may have been encouraged to run a little too far; so this may all be true, and this "depressed condition" may be a little too strongly stated only as concerns our guns. Up to this point, then, surely it may be admitted that it would be difficult to instance so feeble a defence, even were it not discredited by the refusal to grant a Select Committee. Can any sober-minded man doubt that our Navy urgently needs attention? In our judgment the question of relative numbers of fleets of ships can be variously stated, because the number of efficient ships in each fleet greatly depends on what date we choose to make our estimate. Speaking generally, there is no doubt that other fleets are rapidly approaching our own in strength. The ships that France is building are regarded as alarmingly formidable by sober men, and the fact that Germany and Italy have latterly constructed powerful navies makes the state of things more serious, although we hold that Russia's armour-clad fleet is weaker than is generally supposed. The feature, however, that we would specially press now, is the fact that the type of vessel adopted in foreign navies ought to influence us. Italy has two ships building—the Italia and Lepanto—with a speed far exceeding that of any armoured vessel we have, and with 100-ton breech-loading guns far surpassing in power any other piece extant, and capable of making short work of anything afloat except the very heaviest clad ships. Such vessels are capable of becoming a scourge to our commerce, and running a course, as we have before pointed out, that it would be very difficult to check, unless we build similar ships ourselves. It would be a serious step to construct gigantic vessels like those of Italy; but we should judge from Mr. Barnaby's observations on this question in his paper last year at the United Service Institution, that there would be little hesitation on the part of our professional if our political authorities saw their way to such a step. If this is not to be, however, we may fairly ask to be told of the manner in which such ships are to be dealt with in case of war. The attack of any European country hardly suggests itself to any Englishman. We only ask in what way are we to protect our trade from the attack of such ships, bearing in mind that England is said to have a stock of food only sufficient to last for six months at the most, occasionally for three months only, and that being an island our shipping trade is absolutely necessary to keep us from starvation.

THE LEA CONSERVATORS AND THE HERTFORD SEWAGE WORKS.

A VERY important and interesting case, relative to the pollution of a river by sewage, has just been decided in the Queen's Bench Division of the High Court of Justice. In this instance the Lea Conservancy Board brought an action against the Corporation of Hertford and the Rivers Purification Association, the object of the proceedings being to obtain an injunction restraining the defendants from causing or permitting any of the sewage from the town of Hertford to flow into the river Lea, and from causing or permitting any water containing any impure or foreign matter, whether in solution or not, to flow from the sewage works into the river. The plaintiffs also sought damages for the injury done by the pollution of the river, and by the deposit and accumulation of mud consequent on the presence of sewage. The case was tried before Mr. Justice Williams without a jury, the trial itself occupying thirteen days. Eminent counsel were engaged on either side, and among the witnesses were Dr. Odling, Dr. Meymott Tidy, Dr. Dupré, Professor Wanklyn, Professor Voelcker, Dr. Stevenson, Sir Joseph Bazalgette, and Mr. Chatterton. Some hundreds of samples of the effluent water from the Hertford Sewage Works were produced in court, and in order that he might more readily appreciate the evidence on the subject, the learned Judge took the trouble to pay a couple of visits to the scene of the alleged pollution.

The sewage of Hertford is treated by the Rivers Purification Association, according to the process which bears the name of Dr. Anderson. A mixture of sulphate of alumina and proto-sulphate of iron is introduced into the sewage, followed by a certain quantity of milk of lime. The sewage thus treated flows into settling tanks, where the impurities are thrown down, and whence the supernatant liquid flows off into the river. Thus the sewage is simply subjected to chemical precipitation, neither irrigation nor filtration being employed by way of supplement. The method thus resembles that which is proposed in the scheme now before the Local Government Board at the instance of the Lower Thames Valley Main Sewerage Board. Any defects in the results at Hertford may therefore be expected to repeat themselves at Mortlake; and, on the other hand, if the Hertford works are successful, there is a fair prospect for the Thames Valley scheme. When the process was introduced at Hertford the details of the operation were fixed by Mr. Melliss, who, in partnership with Mr. Mansergh, has devised the Mortlake plan. In prescribing the exact method at Hertford, Mr. Melliss consulted Professor Wanklyn; and it was claimed that the proportions established in the use of the chemicals were the very best possible. Dr. Tidy, in giving evidence for the Conservators disputed this, and asserted that a proper proportion of chemicals would be about twenty times as great as that employed in treating the Hertford sewage. Major Flower, the sanitary engineer to the Lea Conservancy, in the course of his evidence expressed a different opinion, his idea being that there was rather an excess of chemicals than a deficiency. The real effect of the chemical treatment was the subject of some very conflicting ideas. The sewage works were placed in the hands of the Rivers Purification Association in April, 1878. In the following August Mr. Keates, the consulting chemist to the Metropolitan Board of Works, having analysed a sample of the Hertford effluent at the request of the Lea Conservators, reported thereon, saying:—"The analysis shows the water to be but little less pure than the water of the Lea at the New River intake." Nevertheless, Mr. Keates found it needful to add that the river was in a bad state, and "evidently seriously polluted by sewage." The curious fact was that the tributary stream, called the Manifold Ditch, into which the sewage effluent first discharged itself, was "very foul, just in the state it would be if it received the Hertford sewage, and yet the effluent water coming down from Hertford was itself little less pure than drinking water." Mr. Keates confessed that this was "a very extraordinary state of things," and he acknowledged that in this instance there was a mystery which he could not fathom.

In case it should be said that the apparent contradiction between cause and effect, to which we have just referred, is peculiar to the Anderson process, we may fall back on an earlier experience at Hertford, when the sewage was being treated by the Phosphate Company. In December, 1873, Mr. Keates found the effluent produced by the phosphate process to be "remarkably pure for effluent water," and such as might, in his opinion, "be admitted into any running stream without producing such a degree of pollution as could be dangerous to health." The samples were "colourless, tasteless, and quite free from odour of any description, and were neither acid nor alkaline." In April, 1875, Major Flower reported that, having gone over the works, he found the effluent discharged by the Phosphate Company to be "free from pollution," and even standing a severer test than the company's chemist expected; but in the following month Major Flower stated in his report:—"The Manifold Ditch is in a foul state, and smells almost as badly as ever." By way of explanation he went on to say:—"This seems to indicate that the treatment by phosphate of alumina is merely temporary in its effects; the effluent from the company's works is certainly good, and free from any offence, and I find the works are well and carefully managed." In July, 1875, Mr. Keates made a further analysis of the effluent, and said:—"This appears to me to be a sample of ordinary pond water, or of the water of ditches running through meadows. I can find nothing in the water which would render it unfit to be allowed to pass into a river." Thus the phosphate process presented the same paradox as that which afterwards occurred under the Anderson patent. A rude explanation might be offered by suggesting that the effluent was of varying quality, and was always at its best when a sample was being taken. But we must presume that Major Flower knew what he was about, and we may also conclude that the company in either case were superior to any such miserable device as that of dodging the Conservators. But taking the facts as they present themselves, we have certainly a very discouraging state of things, if, indeed, the river suffered to the extent alleged. On the degree of pollution there is a direct conflict of evidence. The Judge had a very difficult task in deciding what to believe, and arrived at the conclusion that there was exaggeration on both sides. Apparently he considered that the exaggeration was greatest on the side of the Conservators. With regard to the quality of the river mud, which was said to be impregnated with sewage, Mr. Justice Williams declared himself satisfied that there had been "gross exaggeration" on the part of witnesses "who applied nothing more than a superficial observation to the matter, and who were too readily misled into attributing what was undoubtedly offensive to the influence of the Hertford sewage water, simply because Hertford sewage water there entered the river, and might account for everything." The learned Judge thus dismissed the question of the mud, and he dismissed in like manner the question of river pollution, his conclusion being that the effluent was doing no harm whatever. Judgment was given for the defendants with costs.

In its legal aspect the Hertford case may be easily misunderstood. But there can be no mistake as to the interpretation to be applied to the Judge's words, where he says—"I find that no real injury, pollution, or nuisance has been caused by the Corporation to the waters of the Lea." Yet it is difficult to pass by the whole mass of evidence which goes to show that a nuisance is somehow created by the effluent. The excellence of the effluent is admitted by Major Flower, but he contends for the impurity of the stream, and the Judge thus treats the point:—"I come, therefore, to the same conclusion as that really arrived at by Major Flower a long time ago, that his cause of complaint is in no way traceable to a defective or improper manner of working Anderson's process at Hertford, but to some supposed radical defects in every chemical purification process taken alone, and without being supplemented by some further process, either by irrigation over a large area of suitable land, or some equivalent." That secondary decomposition does take place in the case of a seemingly admirable effluent is a matter of common experience. Clear, colourless, and odourless water obtained from sewage by a chemical process, will, if kept for two or three days, emit a sewage odour. After another day or two the smell passes off, and the water may then be kept for any length of time without giving offence. The hundreds of samples produced before Mr. Justice Williams were inconclusive, seeing that they had most likely passed through the brief stage of secondary decomposition. But it may be asked whether such decomposition can make a stream offensive. Of itself it could scarcely do so; and yet it might develope a species of vegetation which would ultimately cause annoyance. Towards the close of his remarks the Judge made this observation:—"There appears to be some extremely subtle organic elements and some faint odours which cling to sewage effluents, which defy all treatment by any known practical process, whether chemical or otherwise, and which are not capable of being detected or traced by the chemist." To those parties who are particularly jubilant over the defeat of the Lea Conservancy Board, perhaps we may properly commend the remark which immediately follows the foregoing. Thus we find the Judge saying:—"It seems to me that no practical process, or combination of processes, has ever yet been brought into use by means of which sewage water can be rendered quite safe to be discharged into a river from which drinking water is to be drawn." In this case the Judge said, "It was not suggested that any drinking water was drawn from the Lea within any distance that could possibly be affected by the effluent, even if it at any time contained the germs of disease." Mr. Justice Williams would find Dr. Frankland at issue with him on this point. But it will be seen that the Hertford case stands apart from any instance of pollution in which the drinking supply is obviously concerned. Great emphasis will be laid on the first conclusion laid down in the judgment—that so long as the Corporation of Hertford thoroughly and efficiently subject the Hertford sewage to the best practical process of purification, they are not liable to an action for discharging the effluent into the river at the authorised places. In estimating the value of this declaration, it is necessary to bear in mind a statement made by the Judge in his opening remarks. He there says:—"The rights and obligations of the parties to this action in relation to each other are to a large extent regulated by local statutes. One effect of these statutes is greatly to narrow and control some of the questions determinable between the parties in an action at law." The case is therefore somewhat of a special nature. As for the physical facts, it may be questioned whether the tribunal was the best that could have been devised for their elucidation. Supposing it was held to be proved that the Hertford works were making the river offensive, the issue need not have been a serious one. A few acres of land disposed as a filter would have deprived the effluent of its power to do harm, supposing it to have any.

SIR CHARLES NUGENT ON IMPERIAL DEFENCE.

Side by side with the power of our fleet, which was discussed in the House on March 20th, comes the question of our national defence, as discussed on March 21st, in the United Service Institution by Sir Charles Nugent, who, as an engineer officer, naturally dealt with the elements which form the complement to our sea-going fleet, that is our system of defence of coast and harbours. Sir C. Nugent observed, indeed, that the Capital and Royal Arsenal lay in a prominent and insufficiently protected position, but he confined himself to the question of coast defence proper, which was a large enough subject in itself. He noticed that we have every reason for saying that the matter has again and again been spoken of as serious, yet it continues to be regarded with apathy. It is of vital interest, it is easily understood, and information has been supplied of a startling character; yet the public appear so satisfied, either that there is no cause for alarm or else that it is not their business, that nothing is done; and thus while all the nations on the Continent stand armed to the teeth, watching each other with the vigilance of camps, we drift on in the security of a fool's paradise. Four years since a Royal Commission inquired into this subject. This Admiral Colomb ironically terms a great public instructor, by which authentic facts are collected and knowledge is increased. Yet Sir Charles observes that even this low function can hardly be said to be fulfilled in this instance, for he has never met with anyone who has even read the report. He then went on to the features of the question itself, leaving to our sea-going fleet the duties of acting in masses upon the enemy, protecting our lines of commercial communication, and defending our territories beyond the seas. It is necessary to secure our coast by defences on the vulnerable points and by fortified harbours in which vessels can collect. Portsmouth, Plymouth, Portland, Pembroke, Cork, Dover, Sheerness, and Chatham have had a good deal done to them, but even they are still jeopardised by distinct omissions on the ground of economy in the operations proposed for their defence. Leaving these, however, he came to places of wealth and commerce which naturally invite attack, and the loss of which would entail suffering and confusion and danger, or even ruin in some cases. These, omitting London, are Liverpool, the Humber, the Clyde, Southampton, the Forth, the Tyne, the Tees, Bristol, Cardiff, Swansea, Dublin, Belfast, Sunderland, Folkestone, Newhaven, Dover, and Dundee. Of these Southampton is inaccessible, Bristol and Cardiff are very difficult of access, Liverpool, the Forth, and Tyne have some defences, but the others are at present grossly neglected. There are also many secondary ports which ought to be defended in a less perfect way, and there are stretches of coast where an enemy might land which ought to be seriously considered and provided for by the selection of a good position to oppose an invader landing by operations which should actually be rehearsed so as to be performed without peril in time of need. The lecturer then dwelt on the question of utilisation of railroads, showing that times and distances would be too short to enable us to obtain any great advantage from our railways. In our present condition the destruction of the old Martello towers was to be regretted, for they might have been modified and screened with earth and long range guns mounted on them. Steamships are much better calculated to effect concentration of force on the one hand than railways on the other. At a well-chosen moment we might learn to our cost that we had not provided against the sudden landing of an enemy. The great Napoleon asked only for six days' command of the Channel, saying that he would be in London on the fifth. What would he have thought necessary in these days of steamers, and especially what would he have deducted for the assistance of a Channel Tunnel? Sir Charles Nugent observed that we have life insured to the extent of 435 millions, and marine insurances amounting to 450 millions. What, he asked, would these be worth if any enemy landed? Whatever would be the value of London fire insurances in such a case? He divided the opposers of national defence into three main classes:—(1) The fearless; (2) the peace-at-any-price party; (3) economists. The fearless fear nothing because they know nothing; the remedy for them is education. The peace-at-any-price party should certainly not object to secure peace at the price of efficient precautions against invasion. Why is it that France is so very eager to see the Channel Tunnel completed? As a matter of commerce, it ought to be less important to them than to us. Why is it that they have recently spent 5½ millions on eight harbours opposite our coast? Why is it, in the face of suggestions for general disarmament, that the French fleet has been increased by 130 ships? Economists ought not to oppose our spending money on forts, which is the cheapest investment in the way of defence. Our fleet has 92,000 miles of communication to guard, and a traffic in which 19,311 vessels are engaged continually. It has to carry stores and reinforcements abroad, and with this our coast-line of 3800 miles, with thirty or forty vulnerable points, has to be guarded. It is most important, then, to facilitate the operations of our fleet by a complete system of defence of our coasts and harbours.

Our defence should embrace shore batteries and submarine mines, supplemented by gun and torpedo boats for harbours of primary importance, and occasionally coast defence vessels. In secondary harbours the same means might be employed to a less extent. In connection with these, artillery, engineers, infantry, and seamen would be required. Volunteers, properly organised, might meet the demands of the first three classes, but as a special demand would be made on our reserve of seamen in time of war, it is suggested that a sea militia might be organised from our fishing population, who might be engaged with their boats to perform the duties that would suddenly be needed. In addition to all this passive defence, we need well-chosen "strategic harbours," where our fleet may shelter and refit. Our south coast is well provided with such places. Portsmouth, Plymouth, and Portland would now serve and with little expense; Falmouth also. Milford Haven and Holyhead might easily be made secure on the west, but on the east, between Dover and the Forth, we are in great need. Harwich is strongly fortified, but its harbour is not sufficiently good. Yarmouth Roads are shoaling, St. Nicholas-gateway and Cockle-gateway are only partly practicable; the Humber is not safe in bad easterly weather, the Tyne is impracticable for large draught vessels, and some spot, such as Filey, should be adopted. The Germans may teach us a lesson. They have lately spent enormous sums of money on Wilhelmshafen and Kief. The former now has more wharfage facility for war purposes than all our dockyards put together. Dover undoubtedly is most important, and it is well that its harbour is now being completed. It secures the right flank of our eastern front, and it would be easy to second what nature has already prepared on the left end of this coast line by defending Long Hope Sound and its extensive anchorage between Scotland and the Orkneys, as well as Thurso and Wick. The west coast does not need much; Milford Haven and the Severn are defended, and a good deal is done at Liverpool. The Clyde and Holyhead still need attention. Ireland has an excellent harbour in Cork, but Waterford and Kinsale and Belfast should be specially defended, as well as Dublin, Lough Swilley, Lough Foyle, Bantry Bay, and the Shannon.

As to forces, our regular army numbers in all 189,252, of which 67,000 are in England, 27,000 in Ireland, 61,641 are in India, and 22,000 are in other foreign stations, leaving over 11,000 not accounted for by Sir Charles. The Militia numbers 143,000, the Yeomanry 14,000, and the Volunteers 248,000; in all, 584,252, exclusive of reserves and pensioners. A local Indian army would give us our 62,000 men for general service; but most of them would be required abroad in war. Sir Charles then details 90,000 men for ports and arsenals, and 18,000 for commercial ports, leaving 78,000 regulars and 80,000 militia for a field army and 100,000 volunteers for a coast army; and for this our army must be increased by 62,000 men. If this is refused us, we must endeavour to get 80,000 additional Militia—that is, 72,000 Infantry and 8000 Yeomanry. This might give us eight army corps in the field, without encroaching on the Volunteers' coast army. This might constitute a sufficiently formidable force to deter a continental Power from risking an attempt upon England. If this scheme is insufficient, what resource is left except conscription, which in Germany amounts to 1 man in 15? Our only hope, indeed, of holding our own lies in the integrity of Greater Britain—that is, the union of Great Britain and her colonies—a question to be dealt with after that of England itself. The cost of the system of defensive measures above proposed would be £2,500,000, perhaps; but were it greater, it is necessary, and should be done. The points to be taken up, then, as detailed by Sir C. Nugent, are as follows:—(1) The defence of commercial ports; (2) the formation of harbours of refuge; (3) Militia strengthened; (4) coast defence fleet completed; (5) sea fencible or volunteer organisation instituted for ports; (6) registration of fishermen and boats; (7) ports for naval observation formed. England, Sir Charles pointed out, has the enormous advantages of an island position in a climate suited to develope the energies of her people, with coal and iron, and the trade which time has developed, with its water highways, forming the best possible line of communication if only a secure base of operation be established. Sir Charles then instanced facts showing how the necessity of guarding and fortifying our coast had made itself felt from early historical times. The second portion of the question, dealing with colonial defence, forms the subject of a paper to be read by him next Friday.

We may mention for the information of general readers, that Sir Charles Nugent, as well as Sir Lintorn Simmons, the chairman, and Colonel Inglis, who was present, have all been employed in the Royal Engineer departments connected with home defence. Admiral Colomb, Admiral Boys, and General Smyth, the Commandant of Woolwich, and other officers who took part in the discussion, have also been officially connected with the question. That such an audience should manifest such warmth of opinion in the same direction was noteworthy. We do not now refer to the fact that the need must be strongly felt by individuals because Engineer, Artillery, and Naval officers are not given to agree in this way in the discussions at the United Service Institution, but rather to the fact that so strong a consensus of opinion on the part of officers holding official positions argues that the judgment of the War-office authorities is clear and pronounced on this subject.

THE IRON TRADE ARBITRATION.

The Arbitration Court to be held by Dr. R. S. Watson, to decide the rate of wages for the ironworkers of the North of England for the second quarter of the present year, will possibly rouse greater interest than any that has been held for years. The employers claim a reduction that would bring wages down lower than they have been in the history of the Arbitration Board; and this, and the fact that the trade is worse than it has been for four years—judging by the number of the idle furnaces and works—will give to the decision of the arbitrator an importance that did not attach to his last award. It is believed that about one-half of the puddling furnaces in the North-east of England are now idle, and some of those that are in operation have been of late compelled to work irregularly, so that it is evident that there is deep depression in the trade. Moreover, the prospects are very gloomy just now—the demand for shipbuilding iron has fallen off very seriously during the whole of the present year, whilst for the vessels that have been ordered there is now a keener competition between iron made by the old puddling process and the soft steel that is on the Clyde so largely preferred. It is under these circumstances that the arbitration is to take place, and as in Scotland the wages and workmen in the rolling mills are to be brought down without resort to arbitration, it is evident that if the latter method does not give the employers financial relief, there will be an outcry against the method when its results are contrasted with those that attend the ordinary laws of supply and demand in the labour market. Hence, the interest with which the results of the arbitration now to be conducted will be watched by those interested in industrial matters.

RAILWAY ACCIDENT AT STEPNEY.

On Saturday last, as the 2.8 p.m. London and Tilbury train from Fenchurch-street for Southend was standing at Stepney Station, it was run into by a train bound for North Woolwich, belonging to the Great Eastern Railway Company. Some twenty or thirty passengers, it is stated, were more or less injured, though none, it is believed, very seriously. The Southend train should certainly have been safe; but the signalman at Stepney seems to have forgotten its existence, and to have taken off the signals for the Great Eastern train. Stepney Station is approached by one of the sharpest curves on the line, and the driver of the last-named train was taken entirely by surprise by finding another train standing at the station only twenty or thirty yards distant. In an emergency of this kind there could be no circumstance more fortunate for the passengers in both trains than that the approaching train was fitted with the Westinghouse brake, the quick action of which is exactly suited for such occasions; and although it was, of course, impossible to bring the train to a stand, yet the effect of the collision was very greatly mitigated by its prompt application by the driver. As showing the beneficial effect of a brake, even when the train cannot be stopped, it is interesting to notice that the passengers in the Great Eastern train were at first ignorant of what had happened; while all the injured belonged to the Southend train. The carriages being all firmly braced together by the brake, there was a complete absence of the jerks and reboundings which form such a dangerous feature in even slight collisions when a train is not fitted with a continuous brake.

THE BUILDING EXHIBITION.

The fifth annual "Building Trades Exhibition" is now open to the public in the Agricultural Hall, Islington, and will remain open until the 5th of April. It is certified by the Board of Trade as an international exhibition, although we do not observe the names of any foreign exhibitors. The certificate is, however, obtained for the protection of inventors who wish to exhibit inventions not at the time protected by letters patent. The whole of the ground floor of the Hall is well filled, as well as part of the gallery and the arcade. It is to be noted that the things exhibited are yearly more relevant to the purposes of the Exhibition, and large quantities of the requirements of house building, finishing, and equipments are shown. This includes collections of materials required by builders, including stones, natural and artificial, bricks, woods, joinery, turnery articles in the rough and finished, and machinery for their preparation. House, office, and public building fittings and ironmongery, including some very fine specimens of ornamental wrought iron work, are shown in large quantity, while sanitary fittings occupy a larger space than hitherto, although this has always been a leading feature. Some good work in furniture and decorative joinery is exhibited, and altogether the collection is one of much interest to builders and building owners and occupiers. There is not any notable novelty to be found, but the improvement which is yearly being made in builders' requirements and house fittings and decorations is well illustrated in a hundred ways.

SOUTH STAFFORDSHIRE TRADERS AND THE RAILWAY COMPANIES.

The prospects of the release of the South Staffordshire industries from the iron grasp of the railway companies are becoming brighter. The South Staffordshire Freighters' Protection Association is losing no time and sparing no effort. Last Friday an influential deputation had an interview with the directors of the London and North-Western and the Great Western Railway Companies. They laid the case of the manufacturers before them in the same way as a short time previously it was laid before the Midland Railway Company. The directors recognised the importance of the interests represented, and negotiations were begun of a nature to warrant the belief that satisfactory and general concessions will in the end be arranged. We understand that in pursuance of these negotiations the Association is likely shortly to convene a large meeting, embracing representatives from all the trades of the district. That such a gathering would still further justify the efforts of the Association we do not doubt. The views which Birmingham would then express may be gathered from the remarks of the chairman at the recent annual meeting of the Birmingham Chamber of Commerce:—"Orders from countries like China and Japan, where our quotations were at one time certain to meet with business, are now given to France or Belgium. If the railway companies do not afford the aid necessary to face this competition, manufacturers, who employ so largely the labour of the country, must look to the Government to make up any lack of foresight on their part."

BASIC STEEL SHIPS.

From the notices that have been published of the authorisation by Lloyd's agents on the Tyne, of the use of basic steel in shipbuilding, the inference has been somewhat hastily drawn that the steel trade of Scotland will be adversely affected. No doubt the makers of this steel will compete, and probably with success, against those of Scotland for orders given out by North of England shipbuilders; but, on the other hand, the erection of works for producing basic steel in Scotland has been proceeding for a considerable time. These works are quite near the Clyde, so that they will have a good chance of obtaining from the Clyde builders such orders as they may be prepared to give. At the same time the Siemens steel works in Scotland has earned a reputation which it will not be easy to shake.

LITERATURE.

The Practical Dictionary of Mechanics: A Description of Tools, Instruments, Machines, Processes, and Engineering; History of Inventions; General Technological Vocabulary, and Digest of Mechanical Appliances in Science and the Arts. By Edward H. Knight. Vol. IV.—supplementary volume. London: Cassell and Co., 1884. 960 pp.

It was probably intended that the title of this dictionary should be "the dictionary of practical mechanics," as it is a description of machinery, tools, and implements in more or less general use, and is thus distinguished from the three previous volumes, which contained a great deal of what might be called patent specification mechanics, many of the things illustrated and described being confined in their history to the paper stage. This was pointed out when these volumes appeared, and we are glad to find that the fault has not been repeated in this supplementary volume.

The new one contains a good deal which was not in common use when the first three were published—as, for instance, dynamo-electric machines and electrical apparatus; but also a good deal which was omitted. It is exceedingly well and profusely illustrated, the whole of the "get up" being of that fine finish which is now so well known a product of the higher class American printing establishments. The short descriptions are generally well done, and this has often been difficult. Throughout the greater part of this volume, and whenever necessary, the descriptions are supplemented by references to those technical journals in which full descriptions may be found. This is a most valuable feature, and gives the dictionary an importance it would not otherwise have. Thus everything has been done to make this volume really useful, and we may safely recommend it as necessary to every library. There is one remark which must be made with reference to the classification adopted, namely, that it is not the best, and has led to the separation of numerous apparatus of the same class, but of different applications. For instance, under "steam-plough anchor" at one end of the book we find Worby's self-moving disc anchor for steam ploughing, commonly known as Fowler's, and under "anchor" we find another form of the same thing used by the makers of roundabout steam-ploughing tackle, which, by-the-bye, is what Worby originally made it for. Again, we find horse ploughs given at different and widely separated places under the unlooked-for names of "black land plough," "breaker," "brush plough," "combination plough," "combination cotton plow," "cotton sweep," and others. The same remark applies to locomotives, and many other things.

The material for this volume was found in an advanced state of preparation after the regretted death of Mr. Knight last year, and had he lived to finish his work this error in classification would, no doubt, have been avoided. It is rather a serious blunder, inasmuch as a reader never knows when he has completed his reference, or when to conclude that the thing he wants is not in the book, because he cannot be certain that he has remembered all the possible names by which to seek it. In another edition this may be remedied. Although the engravings and plates illustrate chiefly American engines and machines, a large number of English machines are given as type of the things referred to. Altogether, the fourth volume is distinctly an improvement on the first three.

PRIVATE BILLS IN PARLIAMENT.

A Select Committee of the House of Lords which met on Tuesday had before them the Liskeard and Caradon Railway Bill. This Bill is promoted by a company already in existence, and is for the purpose of extending the authorised line to Launceston, where a junction is to be formed with the narrow gauge North Cornwall line, which in its turn joins the South-Western at Lidford. The railway, according to the promoters' case, is intended to serve purely local purposes, and will accommodate a district rich in mineral, cattle, and agricultural produce generally, but which up to the present time has been entirely without railway service. At present cattle from this district destined for the South-Western have either to pass by a circuitous railway route or must be driven, each course involving considerable inconvenience to the dealer. Mr. Jenkins, C.E., and Mr. Galbraith, C.E., both engineers of great experience in the district, stated that in their opinion the line was laid out in the best possible manner for the benefit of the district. Mr. Jenkins stated in cross-examination that the company had not yet applied to the Board of Trade for leave to run passenger trains over its line, there being certain difficulties in the shape of curves and gradients which would first have to be remedied. He had not the slightest doubt, however, that these alterations would be carried out, and that it would then obtain from the Board of Trade the necessary powers. On behalf of the Great-Western Railway Company—whose *locus standi*, though challenged, had been allowed—Mr. Pope, Q.C., contended that this line was intended not to serve local interests, but in reality to extend the narrow-gauge system further southwards. This meant the introduction of competition. He contended that when a company such as the Great-Western was required to face competition it should be upon equal terms, and should not be, as in the present case, with a company whose object was to enhance its selling price when it should be taken over by one of the larger companies. At the conclusion of Mr. Pope's address the Committee passed the preamble of the Bill.

In the House of Commons on Monday the Select Committee on group 5 met to consider the two remaining Bills on their list—the Hull, Barnsley, and West Riding Junction Railway and Dock Bill, and the Scarborough and Whitby Railway Bill. The Trustees of Heple, &c., Inclosure Act, having been settled with by the promoters of the first-named Bill, and the North-Eastern Railway Company having withdrawn its petitions against both Bills, the schemes were left unopposed, and were accordingly referred to the Chairman of Ways and Means. The Committee had thus the singularly good fortune to dispose of a formidable looking list in two sittings, each of something less than a quarter of an hour in duration. The powers contained in the Hull and Barnsley Bill are of an insignificant character, consisting mainly of deviations, works, and abandonments of authorised railways. The Scarborough and Whitby Bill enables the company to make a branch railway to Whitby Harbour, and to enter into arrangements with the North-Eastern and Whitby and Redcar and Middlesbrough Union Railway Companies. The capital proposed to be raised under the Bill is large, the company asking for power to issue £180,000 in shares, and to borrow a sum not exceeding one-third of that amount.

Group 7.—The first Bill in this group was that of the Great Northern Railway Company; but with the aid of the Court of Referees and of friendly negotiation, the company had succeeded in disposing of all the opposition with which its Bill had been threatened. The Committee therefore proceeded with the Dore and Chinley Railway Bill, which involves a scheme of no little importance, as affording a Midland route between Manchester and Sheffield, and a possible alternative line from London to Manchester. The Bill incorporates a company for the purpose of constructing a railway, somewhat over twenty miles in length, from Dore station, on the Midland line, near Sheffield, to Chinley, situate on the Midland Company's Manchester main line. The estimated cost of this connection is little short of a million, to cover which the company takes power to issue £1,050,000 in shares, and to borrow £350,000 in addition for the purposes of equipment, station accommodation, &c. According to the promoters' case, the traffic, or, at all events, the passenger traffic, from Manchester to Sheffield is at present entirely in the hands of the Manchester, Sheffield, and Lincolnshire Company, whose line is only 41 miles in length, as against 74 miles, the distance traversed by traffic between these places passing over the Midland Company's railway. By this new line, the Midland Company would have at their disposal a route but one mile longer than their competitors. The scheme is warmly supported by the Midland Company, who has come to an arrangement with the promoters by which the line is to be worked by the large company on 50 per cent. terms, the Midland guaranteeing also 3 per cent. on the Dore and Chinley Company, who will also receive whatever profits may be realised above this figure. Mr. Noble, the manager of the Midland, in giving evidence in support of the scheme, spoke of the great disadvantage to his company and to the public resulting from the practical monopoly of Manchester and Sheffield traffic enjoyed by the Manchester, Sheffield, and Lincolnshire Company, and he stated, that as a matter of fact, the traffic carried by his company between the places mentioned was *nil*. In reply to a question as to whether this railway would not furnish an alternative route from London to Manchester, Mr. Noble said that it undoubtedly would, though, for obvious reasons, it would not be used for passenger traffic, except in the case of a breakdown on the main line. Evidence was given by Mr. Parry, C.E.—the engineer to the scheme—and Mr. Baker—Fowler and Baker—with regard to the engineering details. Both gentlemen were cross-examined at considerable length as to the injury which this line was alleged to inflict upon the residential estate of a Mr. Hall, the suggestion of the petitioner being that the promoters should proceed through his land by cut and cover or tunnel for a distance of 200 yards, instead of by a cutting with an embankment, as was proposed by the Bill. The witnesses agreed that to do what was desired by Mr. Hall would be to incur an additional expenditure of about £20,000, as well as the inconvenience of emerging from a tunnel within a short distance of a junction. Moreover, they represented that their scheme for an embankment would not interfere with Mr. Hall's view in any greater degree than would be the case if a tunnel were constructed. Having heard the evidence of Mr. Underdown, the general manager of the Manchester, Sheffield, and Lincolnshire Railway Company, in opposition to the scheme, and the addresses of counsel, the Committee decided that a provision should be inserted in the Bill, sanctioning the Midland guarantee, and for this purpose they adjourned. The Chairman stated that it was the intention of the Committee to make proper provision for the protection of Mr. Hall.

Group 9.—Admiral Egerton's Committee proceeded with the consideration of the scheme of the Manchester, Sheffield, and Lincolnshire Railway Company for an extension of the system from Chester to Connah's Quay. Mr. Robertson, M.P., gave evidence in favour of the Bill. He stated that he had been engineer to the Great Western and North-Western Railway Companies in the North Wales District, and had been engaged in mining since 1842. He was concerned in the promotion of the Wrexham, Mold, and Connah Quay schemes, and the works of that company were now in course of construction. He considered that the extension proposed by the Bill would be of the greatest possible advantage to the company. He did not contemplate any difficulty to navigation as the result of the construction of their bridge across the river Dee. This view was confirmed by Admiral Bedford, and several nautical witnesses. Sir Edward Watkin, the chairman of the Manchester, Sheffield, and Lincolnshire Company, condemned the system under which the North Wales traffic was in the hands of two companies. Mr. Abernethy, C.E., also supported the scheme.

Group 10.—The Committee on this group met on Friday to hear evidence upon the Henley-in-Arden and Great Western Junction Railway Bill, a scheme for reviving the powers conferred upon the promoters by an Act of 1873. The Great Western withdrew their opposition to the Bill, and that company having been the only opponents, the Bill was sent to the Committee on Unopposed Bills. This was the last case in the group.

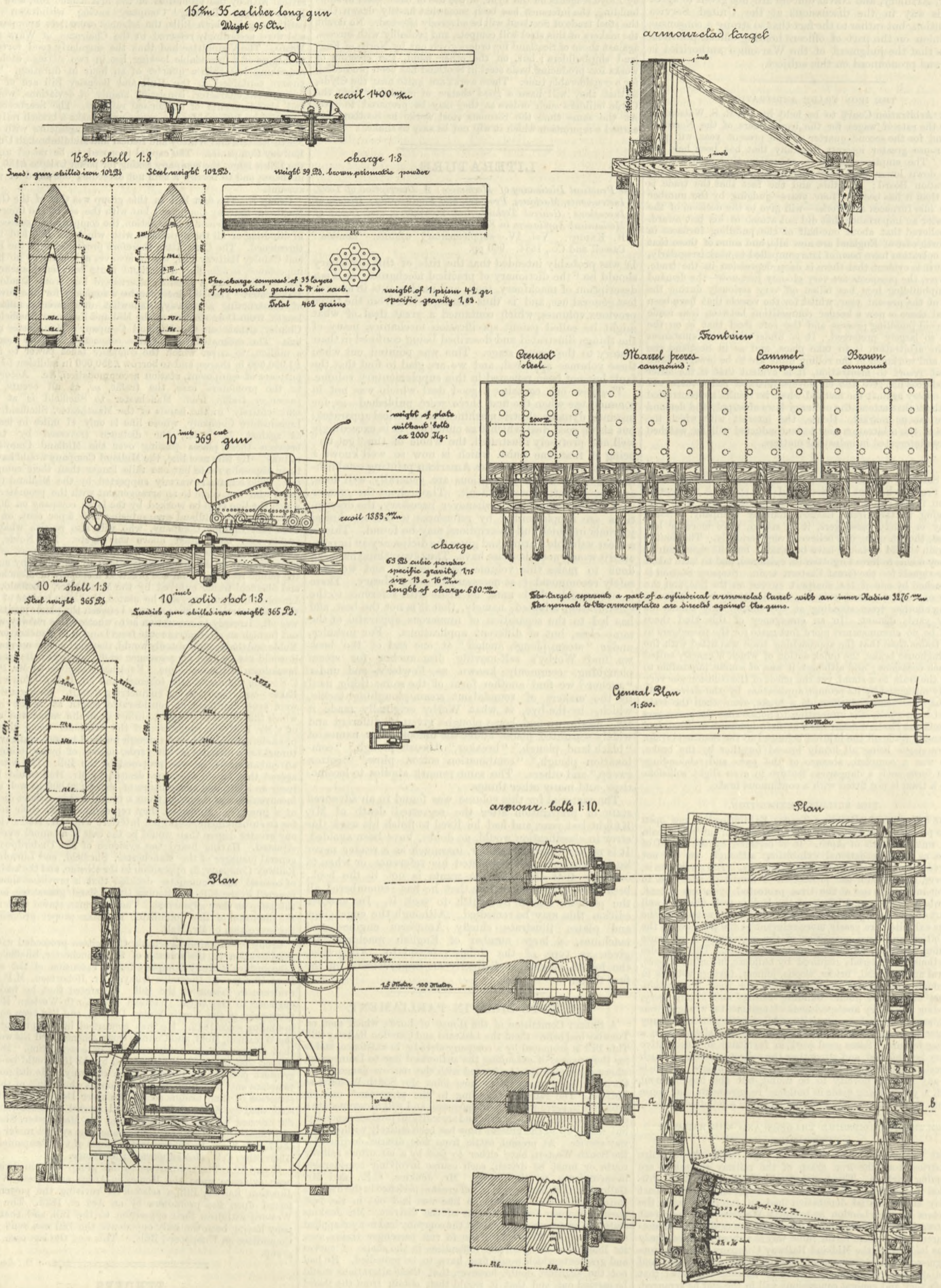
TENDERS.

SUPPLY OF PIPES FOR KENILWORTH.

	£	s.	d.
Chilvers Coton Foundry Company, Nuneaton	1562	0	0
Cockrane and Co., near Dudley	1376	11	10
Clay Cross Company, near Chesterfield	1295	0	0
The Stanton Ironworks Company, near Nottingham.	1289	0	0
C. E. Firmstone Bros., Stourbridge	1265	0	0
J. and S. Roberts, West Bromwich—accepted	1248	0	0

ARMOUR-PLATE TRIALS AT COPENHAGEN.

(For description see page 275.)

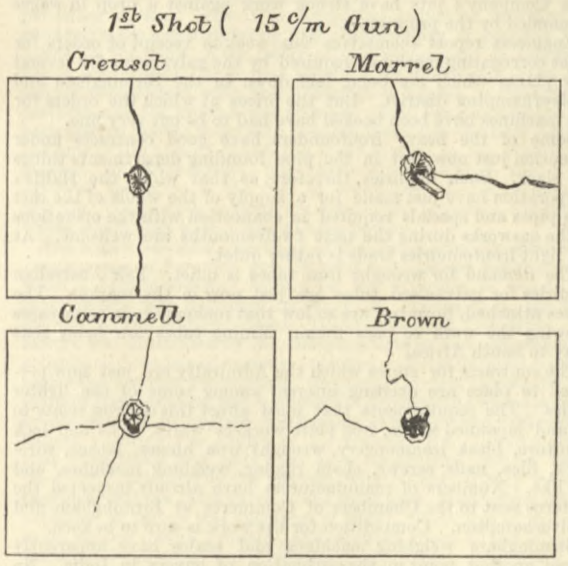


ARMOUR-PLATE TRIALS AT COPENHAGEN.

A SERIES of important armour-plate trials was carried out on the island of Amager, near Copenhagen, on the 20th and 21st inst., in the presence of the King of Denmark, the Minister of Marine, and a numerous party of officers and representatives of the various firms interested.

The trials were conducted in a most successful manner by chief-constructor Nielsen and Captain Jessen, of the Royal Danish Navy. The target consisted of four separate sections, each of which represented a part of a cylindrical armour-clad turret, with an inside radius of 3276 mm. (10ft. 9in.). The 225 mm. (nearly 9in.) thick armour plates were placed upon an oak backing of the same thickness, and fastened to the framing of the turret by means of armour bolts, which were screwed into the plates. The number of the bolts was twelve in the Brown and the Cammell plate, eleven in the Marrel plate, and sixteen in the Creusot plate. The inner skin consisted of two 8 mm. ($\frac{5}{16}$in.) plates, of which the right half—seen from the front —was screwed together, and the left half rivetted together. The skin was supported by two vertical 8½in. × $\frac{7}{16}$in. riders, of which one was rivetted and the other screwed on the front side of the skin, between double 3in. × 3in. × $\frac{6}{16}$in. angle irons. The distance between the two riders was 2ft.

Each target was placed so that the line of fire was normal to the middle of the curve, and the targets were further built independent of each other upon a platform of 1in. iron plates, which were bolted to a solid foundation of timber. Each target was supported from behind by two 1in. iron plates, which were rivetted to the skin and the platform, forming a frame on the edges of every armour-plate. Each target was covered by 1in. iron plates. The armour-plates were 1500 mm. (5ft.) high and 2000 mm. (6ft. 6½in.) broad, measured along the chord on the outer side of the plate. The mean thickness of each plate was found by measurement to be as follows:—The Creusot plate, 228·7 mm.; the Marrel plate, 228·1 mm.; the Cammell plate, 233·7 mm.; the Brown plate, 229·7 mm.



In order to be able to perforate a target covered with a wrought iron armour-plate of 225 mm. or 235 mm. thickness, and of the same construction and dimensions as the present, the energy required per centimetre of circumference of projectile must at least be as follows:—

	Thickness of plate.	
(1) By Krupp's formula:—	225 mm.	235 mm.
With the 10in. muzzle-loading gun	14·33 mt. ...	15·15 mt.
With the 15 cm. breech-loading gun	10·18 mt. ...	10·75 mt.
(2) By Gâvre formula:—		
With both guns	13·86 mt. ...	14·64 mt.

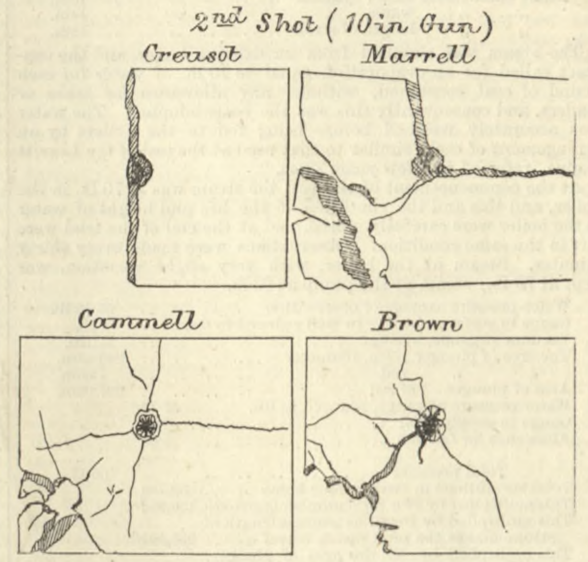
The 10in. muzzle-loading guns of 18 tons, and the 15 cm. breech-loading gun of 35 calibre length, were selected for firing against the targets. The two guns were mounted close by each other on a platform, at a distance of 100 m. from the targets. Both guns used battering projectiles of steel from Krupp, and of Swedish chilled iron. The following table gives some particulars as to the firing with these guns:—

	10in. M.L. gun.	15cm. B.L. gun. (5·9in.)
Weight of gun	18,450 kg. ...	4750 kg.
Calibre...	10in. = 25·4 cm. ...	14·91 cm.
Battering charge	31·5 kg. cub. P. ...	19·5 kg. br. pris.
Battering projectile of steel and chilled iron	182·5 kg. (402·3 lb.) ...	10 k. (shell)
Muzzle velocity c (measured on the 16th February, 1884)	434·7 m. ...	538·0 m.
Striking velocity V 100 m. ...	430 m. (1410·8 ft.) ...	531 m. (1742·2 ft.)
Pressure on bottom of chamber	2390 atmos. (15·7 tons) ...	2090 atmos. (13·7 tons)
P = weight of projectile / Q section of projectile ...	0·3662 ...	0·2921
Total energy, $\frac{pv^2}{2g.100}$ (on impact)	1720·7 mt. (5551 ft. tons) ...	732·8 mt. (2364 ft. tons)
Energy per centimetre of circumference, $\frac{pv^2}{2g.2r\pi.1000}$ (on impact)	21·79 mt. ...	15·65 mt.

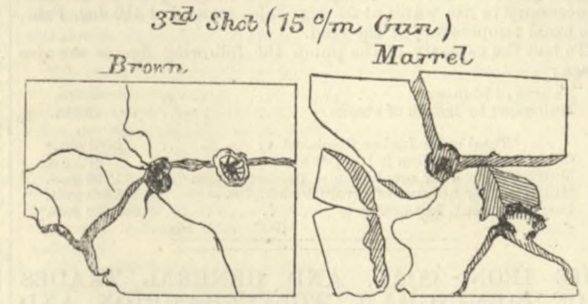
When the resistance against penetration of the target armoured with a 225 mm. wrought iron plate is calculated by the Gâvre formula, the 15 cm. breech-loading gun will only have a surplus of energy of 13 per cent., while at the same time the 10in. muzzle-loading gun has a surplus of 57·2 per cent.; by the Krupp formula both guns have about the same surplus of energy. On our English system the 10in. gun has about 52·3 per cent., and the Krupp gun about 37·8 per cent. surplus energy.

The first day's trials were opened with a 15 cm. Krupp's steel shell against the centre of the Marrel plate. The head of the shell remained embedded in the plate. The shell broke up, leaving a long point projecting from the face of the plate. Two wide cracks opened in the plate, the first extending upwards from the shot-hole to the upper edge, and the second from the shot-hole horizontally to right edge of plate. Both cracks extended throughout the entire thickness of the plate. In the second round a similar shell was fired at the Cammell plate, striking the same in the centre and causing four surface cracks in the steel face of the plate. The cracks extended vertically and horizontally to the sides of the plate. The shell was broken up and the penetration of the point was very inconsiderable. In the third round Messrs. Brown and Co.'s plate was next tested in a similar manner, the shell striking the same in the centre and creating a zigzag crack extending from points of impact to the left side of the plate. In this case the penetration of the shell was considerably greater than in the case of the Cammell plate. The shell was broken up, the head remaining embedded.

The final round of this series was fired at the Creusot plate. The shell struck the plate in the centre and cracked the same completely through vertically. The rear portion of the shell was broken up, but the head penetrated the plate to a considerable depth.



The next series of trials was commenced by a 10in. Krupp steel shell being fired from the 10in. Armstrong gun against the lower portion of the left side of the Creusot plate. This portion of the plate was broken into eight or ten large and small pieces and carried some distance to the rear, so that only the right-hand portion which had previously been detached from the other by the 15 cm. shell remained in position. A Krupp steel shell was fired from the same gun at the lower left-hand portion of the Marrel plate. The shell completely penetrated the plate and remained whole. The left side of the plate was much smashed up, and the cracks created by the first shot were greatly widened. In the seventh round the lower left-side



portion of Messrs. Cammell and Co.'s plate was subjected to the same test. The shell perforated the plate and broke up. The corner of the plate struck was partly shattered, but very few cracks were formed. In the eighth round the shot, the same as the above, unfortunately struck Messrs. Brown's plate considerably lower than was intended, and the portion struck was therefore carried away. Several new cracks appeared, and a large opening combined the two points of impact. The shell appears to have remained unbroken.

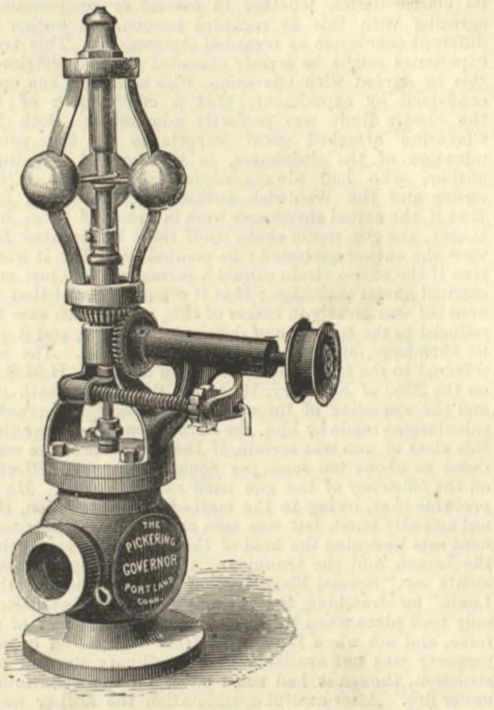
This brought the first day's proceedings to a close. On the following morning, 21st March, the trials were resumed, the projectiles used on this occasion being solid chilled iron shot of Swedish manufacture. As the Cammell plate had shown the greatest amount of resistance to penetration, it was decided to fire a solid shot from the 10in. gun at it; but the result showed that neither the small size of the plate nor the construction of the backing was suitable for so heavy a test. As it was, the plate was hurled some distance to the rear, together with the frame, backing, timbers, &c.; but although several pieces were knocked off the plate by the concussion, the main body of the same remained intact, as the shot had not penetrated. This test, though proving the very superior quality and toughness of the plate, was considered too severe for the remaining plates which were capable of offering any further resistance, viz., Marrel and Brown; and it was therefore decided to use only the small calibre (15 cm.) against them.

In the tenth round the shot struck the plate between the point of impact of the first steel shell and the right-hand side, and penetrated to a considerable depth, though not so deep as the Krupp steel projectile, and split the upper portion of the plate horizontally. The old cracks were considerably enlarged; but it was generally acknowledged that the 15 cm. gun was too light a piece to be successfully employed against plates of this thickness. The eleventh and last round of the trials was fired with the same type of projectile, viz., 15 cm. chilled iron shot against the right-hand lower portion of the Marrel plate, penetrated the same to a considerable depth, and knocked off a large piece of the plate, at the same time laying bare some of the iron in the rear. With this the trials were concluded.

The following may be quoted as the points demonstrated by these trials, viz.:—(1) That the guns employed were not suitable for the occasion, the 10in. being too heavy and the 15 cm. too light. (2) That the dimensions of the plates were too small for so severe a test. (3) That the Krupp steel shells were of a remarkably good quality. Not knowing the reason for the selection of the particular guns used, it is impossible to criticise it from a Danish point of view. To us in England the results would have been more instructive if the two guns' projectiles had had either equal total energies or equal perforations.

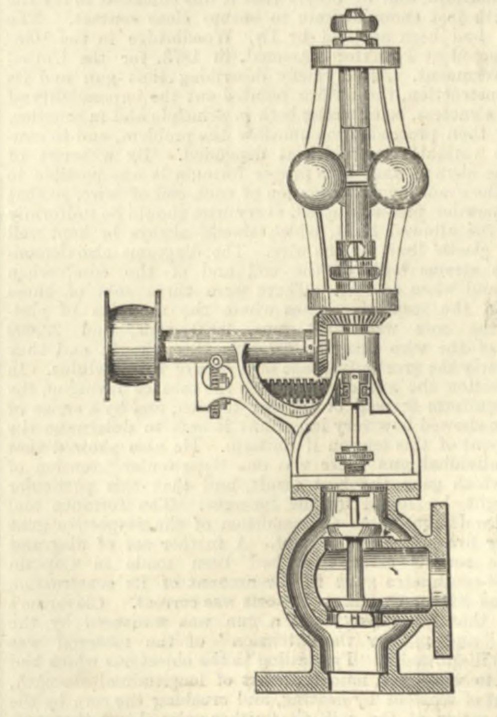
PICKERING'S PATENT GOVERNOR.

THE object of this invention, being introduced by Messrs. Ransome and Marshall, Scotland-road, Liverpool, is to obtain the requisite centrifugal force and stiffness without the use of a spiral spring, and consists in the adaptation of a flat spring or number of flat springs placed together in such a manner as to secure the ends and middle portion, and at the same time to keep these parts at all times parallel with the centre of motion. The bands of steel used for this purpose are about 20 w.g. in the 4in. size, and consequently, being so thin and elastic, they are not at all liable to break, neither are they liable to "set" or lose their elasticity. A peculiar curve is obtained by this arrangement



called a double cyma, by the use of which two or more strips firmly secured together will work freely without tendency to buckle or interfere with each other's action.

As may be seen by the engraving, the ends of the springs are secured to flanges, the lower of which resting on steel washers, and having a collar to prevent its rising, is capable of only a rotary motion, while the upper one, being at liberty to move lengthways as well as to rotate, receives its rotary motion from the lower one through the springs, and communicates any lateral motion due to the varying centrifugal force immediately to the balanced valve to which the governor is firmly secured by the bracket. The valves are of the equilibrium type. There being no joints or pins, the governor is both durable and trustworthy,



and is very much in favour for use on electric light engines One of these governors was supplied by Messrs. Ransome and Marshall, Liverpool, on the engine illustrated recently in THE ENGINEER, which was manufactured by Messrs. Garrett and Sons, Leiston. On all the recent governors there is a spiral spring brake which enables the engine to be run at varying speeds, and is very useful when attaching to old engines, as the governor can often be adjusted by means of this without altering the size of existing governor pulley on engine. The speed at which it should be run is stamped upon each governor. The governor is in considerable use, being employed by Messrs. Garrett and Sons, of Leiston; Messrs. Siemens Bros., Messrs. J. and H. Gwynne, and others.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending March 22nd, 1884:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 11,989; mercantile marine, Indian section, and other collections, 2938. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 5 p.m., Museum, 1379; mercantile marine, Indian section, and other collections, 163. Total, 16,469. Average of corresponding week in former years, 15,077. Total from the opening of the Museum, 20,859,363.

THE INSTITUTION OF CIVIL ENGINEERS.

WIRE-GUN CONSTRUCTION.

AT the ordinary meeting on Tuesday, the 18th of March, Sir J. W. Bazalgette, C.B., President, in the chair, a paper on the above subject was read by Mr. Jas. A. Longridge, M. Inst. C.E.

Before entering on the specific subject of the paper, the author referred to a number of documents received by the Institution from the Ordnance Department, U.S.A. These were mostly translations from the works of Virgile, Rosset, and Clavarino, and related entirely to the hoop-construction of guns. The conclusions and formulæ arrived at by these authorities completely bore out those of the author's paper of 1860, and the fundamental formulas agreed with those derived by Lamé, Hart, and Rankine. The formulæ, however, required modification in certain circumstances, when account was taken of the action of lateral forces, whether of tension or of compression. In guns constructed on the author's principle, there was no strain on the core or coil in the direction of the axis of the gun, so that only the radial compression-force had to be considered; it was shown that in no case was this very important, and that its effect vanished when the modulus of elasticity of the material of the gun was the same throughout. Virgile came to the conclusion that no part of the gun should be strained beyond its elastic limits, whether in tension or compression. Whilst agreeing with this as regarded tension, the author came to a different conclusion as regarded compression. This from his own experience might be largely exceeded without detriment, and in this he agreed with Clavarino, who expressed the opinion, fully confirmed by experiment, that a compression of three times the elastic limit was perfectly admissible. Both Virgile and Clavarino attached great importance to the proper determination of the shrinkages, in this respect agreeing with the author, who had always contended that Sir William Armstrong and the Woolwich authorities were wrong in assuming that if the actual shrinkages were in excess of those indicated by theory, the gun would shake itself right by repeated firing. This view the author contested; he pointed out that it would only be true if the excess strain caused a permanent set just equal to the original excess shrinkage; that it often happened that the permanent set was greatly in excess of this, and in such case the gun was reduced to the condition of deficient shrinkage, and it might be of no shrinkage, and would then inevitably fail. The author next referred to the failure of a 6·3in. gun on board H.M.S. "Daring" on the 22nd of February, 1883, resulting in the death of two men and the wounding of three others during target-practice. From calculations made by him, the author concluded that the failure of this class of gun was certain, if the powder pressure was not kept down to about ten tons per square inch, the effect of which on the efficiency of the gun need not be stated. He thought it probable that, owing to the method of construction, this gun did not actually burst, but was torn asunder by the successive permanent sets loosening the hold of the hoops upon each other between the breech and the trunnion. After referring to Rosset's experiments on "Special Elasticity," or the extension of the "Elastic Limit" by stretching, the author pointed out that inasmuch as this only took place when the stretching was the effect of mechanical force, and not when it resulted from contraction in cooling, this property was not available in the ordinary method of gun construction, though it had some effect on the behaviour of a gun under fire. After careful consideration the author was forced to the conclusion that the construction of a perfect hooped gun was beset with enormous practical difficulties, and that the present armament of the country was unreliable.

Turning to wire guns, the author remarked that there was a good deal of misconception on the subject. It was not that a material in the form of wire was much stronger than the same material in mass, and that the method of coiling it on was expeditious and convenient. This was true; but the essential feature of wire gun construction consisted in the facility it afforded of bringing the body of the gun into the proper state of varied initial tension, in order that, when the powder-pressure acted, every portion of the coil might be equally strained to a predetermined tension. Thus the important question was to determine the proper tension with which to lay on the wire. It was maintained by some that the tension should be uniform, and by others that it was to lay the wire on with just enough strain to ensure close contact. The latter plan had been adopted by Dr. Woodbridge in the 10in. gun constructed at Frankford Arsenal, in 1873, for the United States Government. After briefly describing that gun and its mode of construction, the author pointed out the impossibility of its proving a success, being wrong both in principle and in practice. The author then proceeded to enunciate the problem, and to enumerate the variables on which it depended. By a series of diagrams he showed that by a proper formula it was possible to determine the exact laying-on tension of each coil of wire, so that when the powder pressure acted, every wire should be uniformly strained to the allowed limit, which should always be kept well within the elastic limit of the wire. The diagrams also demonstrated the strains both of the coil and of the core, when under fire and when at rest. There were three sets of these diagrams, in the respective cases where the modulus of elasticity of the core was 4500 tons, 9000 tons, and 22,000 tons, that of the wire being 22,000 tons throughout; and they showed clearly the great advantage of a core of low modulus. In the next section the author dealt with the case of laying-on the wire with uniform instead of varying tension, and by a series of diagrams he showed how very important it was to determine the proper amount of this tension if uniform. He also showed that for each individual gun there was one "particular" tension of laying-on which gave the best result, and that this particular tension might be found by the formulæ. The formulæ and diagrams also demonstrated the condition of the respective guns when under fire and when at rest. A further set of diagrams showed the serious error that had been made in Captain Schultz's 34-centimetre guns if the account of its construction in the United States Ordnance Reports was correct. Clavarino's hypothesis, that the strength of a gun was measured by the "extension" and not by the "tension" of the material was shown to be ill-grounded. Proceeding to the objections which had been made to wire-guns, namely, want of longitudinal strength, derangement of tensions by heating, and crushing the core by the compressive action of the coil, the author pointed out that such objections had no validity, provided the gun was constructed properly.

The next section of the paper was devoted to a brief examination of the practice of "chambering." This was maintained to be only a device for reducing the initial pressure of the powder gases to such an extent that it would not overcome the inherent weakness of the guns of the present day. A comparison was made of two 13in. guns, one with a large chamber, the other unchambered, and it was shown that whilst the two guns were equally strained by the explosion, the chambered gun, with 500 lb. of powder, imparted about 19,000 foot-tons of energy to the projectile; the unchambered gun, with 413 lb., gave nearly 30,000 foot-tons. Some remarks were then made upon slow-burning powder, and it was maintained that it was a retrograde step as regarded ballistic effect, and was only called for by the weakness of the gun. The principal inferences drawn from the investigations on which the paper had been founded were three—first, the paramount importance of a proper formula for the laying-on tension of the wire; second, the advantage of a core of material of a low modulus of elasticity, such as cast iron; third, the advantage of a thin core. In an appendix were given the principal formulæ for the construction and the calculation of the strength of these guns, and a few examples of their application.

TRIAL OF A DEANE DIRECT-ACTING COMPOUND STEAM PUMP.

A COPY has been sent us of the report of a committee appointed by the Public Water Board of the City of Lynn, Massachusetts, to test the pumping engine manufactured by the Deane Steam Pump Company, Holyoke, Mass., and newly erected at their waterworks. From this report we take the following figures. The contractors were notified that the committee would test the pump by a 24-hour trial on the same conditions as a previous trial of the Leavitt pump, and being satisfied that the capacity was fully up to the guaranteed capacity, the test was only for the guaranteed duty. The pump is of the kind now being introduced into this country by the Pulsometer Engineering Company, London, to which a gold medal has been awarded at the Calcutta Exhibition. It is a horizontal duplex compound condensing engine and pump of the following dimensions:—

Diameter of H.-P. cylinder	16in.
" L.-P. "	30in.
" water piston or plunger	17½in.
" " rod	3in.
Actual length of stroke	1·99ft.
The air pump is the independent pattern	
Deane patent with steam cylinder	10in.
" " water "	14in.
" " length of stroke	18in.

The steam was supplied from an existing boiler, and the contract called for an evaporation equal to 10 lb. of water for each pound of coal consumed, without any allowance for ashes or cinders, and consequently this was the basis adopted. The water was accurately weighed before being fed to the boilers by an arrangement of casks similar to that used at the test of the Leavitt engine, referred to a few years since.

At the commencement of the test the steam was at 70 lb. in the boiler, and this and the condition of the fire and height of water in the boiler were carefully noted, and at the end of the trial were left in the same condition. Observations were made every thirty minutes. Steam at the boiler, with very slight variation, was kept at 70 lb.; steam at the pump at 63 lb.

Water-pressure average of observation		57·13 lb.
Gauge to surface of water in well reduced to lbs. ..		8 lb.
Vacuum at gauge, average		27·1in.
The area of plunger 17½in. diameter = ...		240·53in.
" " rod " = ...		7·06in.
Area of plunger—½ of rod = ...		237·00in.
Water-pressure at gauge, reduced to lbs. ..	57·13	
Gauge to supply level	8·00	
Allowance for friction	1·00	
Total pressure		66·13
Total revolutions in twenty-four hours	32,738	
This multiplied by 4 for total number of strokes	130,952	
This multiplied by 1·99ft. as average length of stroke makes the total piston travel	260,594ft.	
This multiplied by 237, the area of plunger, and by 66·13, the total water-pressure, gives the work done	4,084,240,197 foot lb.	
Water in each tank full fed to boiler	493 lb.	
Number of tanks full used	134	
Total water fed to boiler	66,062 lb.	
Less condensed water from steam pipe* ..	727 lb.	
Total water used for pumping engine		65,335
Which at the evaporation of 10 lb. of water for 1 lb. of coal, gives		6,533·5 lb.
as the amount of coal consumed.		

$$\frac{4,084,240,197}{6,533 \cdot 5} \times 100 = 62,512,285 \text{ foot-pounds for 100 lb. coal.}$$

which is the duty developed by the engine during the test, an excess of over 4 per cent. of that guaranteed by the contractor. The boiler evaporated 9 lb. of water per pound of coal. The quality of the coal was below the average, which accounts for the low evaporation and the arrangement for weighing the water made it necessary to use water at 51 deg. Fah., instead of 110 deg. Fah., the usual temperature of the feed.

To test the capacity of the pump the following figures are also given:—

As area of plunger = ...	237in.
Multiplied by length of stroke = ...	23·9in.
Total cubic inches displaced	5664·3in.
Cubic inches to gallon 231 = per stroke	24·5 gals.
Multiplied by 4 for revolution = per revolution ..	98 gals.
Multiplied by number of revolutions 32,738 = ..	3,198,324 gals.
Less 4 per cent. lost action = ...	3,060,392 gals.

* This pipe, owing to the arrangement of the building and the machinery already in it, was over 80ft. long, and of an area but two-thirds that proper to supply the engine.

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

(*From our own Correspondent.*)

BUYING is this week restricted. The quarterly meetings are held on the 9th and 10th of next month in Wolverhampton and Birmingham respectively, and purchasers prefer wherever possible to delay new business until those gatherings have passed over. That there will be any radical change in prices is not generally anticipated. There were, however, buyers on 'Change in Birmingham this—Thursday—afternoon who ventured the opinion that marked bars will be declared down 10s., making them £7 per ton, with £7 12s. 6d. as the Earl of Dudley's price. This view was not, however, generally favoured.

Nevertheless, in the face of the reductions in wages which the ironmasters and the colliery proprietors are hoping to secure shortly, it cannot but be that some concession in prices will have to be made. It is this knowledge that this afternoon mainly influenced consumers in postponing fresh operations. The end of the quarter too tends to limit business on export account.

Marked bar firms are irregularly employed, and prospects of an early improvement cannot be considered bright.

Bars for shoeing purposes, rolled by the best firms, were named this afternoon at £7 10s., and fullered shoe bars at £8. Ordinary shoeing bars are £7 2s. 6d., and common can be had at £6 10s.; best turning bars are £7 10s., and best plating bars £8. Best angle bars are also £8, and best rivet iron is £9.

Second quality angle iron, of from 1½in. to 4½in., was quoted to-day £6 17s. 6d. to £7 7s. 6d., yet common sorts were priced at as low as £6 5s. to £6 10s. Even this lowest price leaves plenty of room for the North of England makers to get in their angles, since they are prepared to accept £5 15s. easy.

Tee iron was abundant at £7, while superior sorts of from ⅞in. to 2¼in. were quoted at £8 to £8 10s. per ton.

A fact illustrative of the decline in prices which has marked the quarter now expiring is to be gathered from the contract books of some manufacturers who use horseshoe bars. These show that the prices at Christmas, 1883, differed only an average of 2s. 6d. upon Christmas, 1882, yet that the difference between the prices now current and those of the last-mentioned date is 5s.

Excellent cable iron stands nominally at £8 to £9 per ton, but the price cannot be easily obtained, especially in face of the competition from South Wales and elsewhere. One firm of chain cable and anchor manufacturers assure me this week that they can buy Welsh iron, to wit, "big siders"—bars—at £5 9s. per ton delivered into this district, whereas local ironmasters would require, perhaps, £6 5s. Staffordshire bars can, of course, be bought at £6, but not, I am told, "big siders" for cable and anchor making.

Iron to be worked into girders for constructive purposes is also coming into this district from Wales, as likewise from the Cleveland district.

There were not many new orders for galvanising sheets placed this afternoon. The proposals which have been considered by the sheet makers for limiting the output are understood to have been to close the mills either for one week in four or two weeks in four. Some makers offered to go as far as the latter proposal, but opinion was divided, and no definite agreement has been come to. Meanwhile the curtailment by voluntary effort goes on, and here and there firms are to be found whose sheet mills have been running only three weeks out of the last seven, the proprietors preferring this course to working at a loss. Export sheets, of 20 b.g., were quoted £7; galvanising sheets, of 24 b.g., £7 10s.; and 27 b.g., £8 10s.

Germany, Russia, Italy, Canada, the United States, the Australias, India, the Brazils, and some other parts of South America are all taking thin sheets in encouraging quantities, and, with home orders added, makers keep quite busy. From £10 to £11 is asked for 20 b.g., and from £13 to £13 10s. for 24 b.g. Soft steel sheets of 24 g. are £13, but iron charcoal sheets run up from £15 10s. to £20 per ton, according to gauge and repute of maker. Tin-plate makers are fairly brisk.

Plates for the manufacture of tanks with angle pieces are to be had at £7 5s. to £7, but for using up without angles £7 10s. to £8 is demanded.

The inquiry for pigs did not yesterday in Wolverhampton, or to-day in Birmingham, show that briskness which sometimes precedes the quarterly meetings. This may be taken as a certain indication that buyers do not anticipate any rise in prices. As to competition from outside districts in pigs, it has to be remarked that Northamptonshire and Derbyshire send in the most iron. Thus local firms have to keep down their rates, especially for part-mine and cinder, the former being now about 42s. 6d., and the latter as low as 35s., but 37s. 6d. is mostly paid. The lowest rate for Northamptonshire is 37s. at works, and Derbyshire 38s. Good North of England foundry pigs are quoted at 50s. delivered. Staffordshire all-mine is 60s.; hot blast and cold blast 20s. more. When the manufacture of basic steel begins in this district, the output of cinder pigs will increase. Hematites are slow of sale, but vendors do their best to keep up prices. Tredegar hematites are quoted firm this week at 58s. 6d. delivered.

The colliers are already beginning to show signs of resistance to the masters' proposal to bring down wages. At a meeting of the men, held at Netherton on Tuesday night, it was resolved:—"(1) That we object to a wages board based upon less than 3s. 8d. minimum in wages; and (2) That we do not submit to a reduction in the present rate of wages." The North Staffordshire colliers also seem determined, if possible, to postpone the inevitable. The men at Clough Hall and the New North Staffordshire Coal and Iron Company's pits have struck work against a drop in wages demanded by the proprietors.

Engineers report themselves this week in receipt of orders for sheet corrugating machines required by the galvanisers for several new plants which are being laid down in the Birmingham and Wolverhampton district. But the prices at which the orders for the machines have been booked have had to be cut very fine.

Some of the heavy ironfounders have good contracts under execution just now, but in the pipe founding departments things are slack. Such inquiries, therefore, as that which the Halifax Corporation have just made for a supply of the whole of the cast iron pipes and specials required in connection with the operations of the gasworks during the next twelvemonths are welcome. At the light ironfoundries trade is rather quiet.

The demand for wrought iron tubes is quiet. Fair Australian inquiries for galvanised tubes are just now in the market. The prices attached, however, are so low that makers are in some cases allowing the work to pass them. Mining tubes are being sent away to South Africa.

The contracts for stores which the Admiralty are just now prepared to place are exciting interest among some of the lighter trades. The requirements that most affect this district relate to tin and japanned wares, iron plate workers' wares, locks and lock furniture, black ironmongery, wrought iron hinges, lathes, wire-work, files, nails, screws, chain rigging, weighing machines, and the like. Numbers of manufacturers have already inspected the patterns sent to the Chambers of Commerce at Birmingham and Wolverhampton. Competition for the work is sure to be keen.

Birmingham weighing machines and scales have apparently scored another point in the estimation of buyers in India. No fewer than three gold and two silver medals with first-class certificates have been awarded to Messrs. W. and T. Avery, scale and weighing machine makers, for the goods exhibited by them at the Calcutta Exhibition.

The strike of spike makers which occurred last week at the Phœnix Works, Handsworth, of Messrs. Warden and Sons, has been amicably settled. The terms arrived at are that the men shall work at a 10 per cent. reduction until the completion of a current piece of work, and that afterwards the customary rate shall be paid.

Satisfaction is expressed at the progress of the Birmingham Compressed Air Power Bill before the various committees of the House of Commons. The Bill has now been amended so that half the profits above 10 per cent. go to the consumers; the Birmingham Corporation is empowered to purchase at the end of twenty-one years. The company is absolved from any liability in case of accident, and a clause has been inserted giving protection to the London and North-Western Railway Company.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The condition of the iron trade in this district continues depressed, and both buyers and sellers appear to be uncertain what course to take with regard to the future. Prices are already so low that makers have little or no margin for any further concessions; whilst consumers are evidently of the opinion that the lowest point has not yet been reached, and they buy only from hand to mouth. As regards pig iron, there is no material giving way; but there is very little business offering, except that here and there buyers would give out orders at under current rates. These, however, are only few in number, and as makers are not prepared to accept the prices offered, the actual transactions are very limited in extent. In the finished iron trade there is a continued downward tendency, as most of the local manufacturers are getting very short of orders, and outside brands are coming in at such low prices that they are compelled to make some concessions to secure business. Altogether the prospects of the iron trade are certainly discouraging. The first quarter of the year is closing with very little business coming forward to replace expiring contracts; and so far as some of the large iron-using branches of industry are concerned, actual requirements are unquestionably on the decrease.

There was a fairly good attendance at the Manchester iron market on Tuesday, but little or no disposition to buy. For pig iron, however, local and district makers held out for late rates, Lancashire being quoted at 44s. 6d.; Lincolnshire, at 44s. to 44s. 6d.; and North Derbyshire, at 45s. 6d. to 46s. 6d., less 2½ for forge and foundry qualities delivered equal to Manchester. Outside brands, such as Scotch and Middlesbrough, were also without material change; for good north-country foundry brands, 45s. net cash was about the price at which dealers would sell for prompt delivery equal to Manchester, but there was little or nothing doing to really test values, and in Scotch iron, merchants continue to offer at 3d. to 6d. per ton under makers' prices.

Hematites still meet with only a very slow sale, and 56s. less 2½ remains nominally about the average price for good foundry brands delivered into the Manchester district.

In the finished iron trade business is extremely quiet, which, to some extent, is due to the usual suspension of buying pending the quarterly meetings. Where business is done it is only at very low figures, and the average prices for delivery into the Manchester district are about £5 17s. 6d. for good Lancashire and North Staffordshire bars, with lower qualities of local brands to be bought at £5 15s. and Cleveland bars at £5 12s. 6d., or even a little less in some cases; ordinary qualities of sheets £7 10s., and the better qualities £7 15s.; hoops, £6 5s. to £6 7s. 6d.; and common North-country plates and angles, £5 10s. to £5 12s. 6d. per ton.

Engineers generally throughout this district are still kept moderately employed, and in some special branches they are busy; but in ordinary classes of work orders are running out more rapidly than they are being replaced, and where there are any orders going out they are only secured at very low prices.

The decreasing activity in engineering is reflected in the condition of the brassfoundry branches of trade; inquiries for all classes of fittings for engineers, boiler-makers, and marine work are reported to be falling off, and to get orders extremely low figures have to be quoted.

Amongst the special branches of engineering in which activity is maintained I may mention that Sir Joseph Whitworth and Co., of Manchester, are being kept fully employed in their steel works, and they have just completed several exceptionally large forgings made out of their fluid pressed steel. One of these is a solid forging which is to form the tube or barrel for a 63-ton gun. The length of this forging is 34ft. 7in., and the greatest diameter 29in.; in the rough it weighed about 31 tons, and finished for boring 28 tons. Amongst other gun material, Messrs. Whitworth are making hoops for 100 and 110-ton guns, and some of these, after they have been rough turned, weigh as much as 13 tons. The other large forgings just completed include a couple of marine crank shafts. One, a three-throw crank shaft, is for one of the new British war ships: the length of this shaft is 28ft. 5in., the outside diameter 17in., with a hole through of 8in. diameter, and the cranks have a throw of 24in., or equal to a stroke of 4ft. The weight of the crank in the rough was about 19 tons, and finished it weighs about 12¼ tons. The second forging is a spare single-throw crank for the City of Rome. This has been built up in five pieces and shrunk together; the length of the shaft is 13ft., the diameter of the shaft 25in., and of the collar 45in.; through the body of the shaft there is a hole of 14in. diameter, and through the pin a hole of 8in. diameter. The crank has a 36in. throw and weighs 21 tons.

Messrs. Whitworth are also very busy in the tool department, where they have orders in hand for a number of the Indian State Railways for all kinds of tools for locomotive repairing shops and general railway plant requirements.

The strike in the Warrington wire drawing trade, to which I referred last week, continues, and shows no sign of settlement. So far, not much inconvenience has been experienced by the stoppage of works, as makers held heavy stocks, out of which they have been able to supply their orders. In the event of the men persisting in their refusal to accept the reduction in wages, the employers are contemplating the practicability of training fresh hands to the work on the basis of the wages paid in Germany. For a considerable time past German manufacturers have been serious competitors with the Warrington houses in the Colonial markets, and the much lower prices at which German makers have been able to deliver their wire goods in Australia and New Zealand has practically almost closed the above market to the Warrington makers. It is, therefore, felt absolutely imperative that a considerable reduction in the cost of production should be effected, and the Warrington makers are determined to reduce the rate of wages which they have hitherto been paying.

The winter sessional meetings of the Manchester Association of Employers and Foremen were brought to a close on Saturday last, when a very interesting lecture on the explosion of boilers and other vessels was delivered by Mr. E. B. Martin, C.E., the chief engineer to the Midland Steam Boiler Inspection Company. The lecture was illustrated by Mr. Martin's unique and comprehensive collection of models of various exploded boilers, grouped together under the heads of locomotives, furnaces, Cornish, Lancashire, and plain cylinder boilers, and a number of experiments were also made by Mr. Martin to explain the various causes of the explosion of boilers. During the course of his remarks Mr. Martin observed that when steam was only used as a condensing medium boilers frequently collapsed by the vacuum within them if they were not provided with an inlet valve. The most usual cause given for the explosion of boilers was shortness of water, which was supposed to cause sudden undue pressure, and another more or less supposed cause of explosions was electricity. Sir Wm. Armstrong had thought that this electricity was formed from the act of evaporation, and he sent details of an observed case at Seghill to Professor Faraday, who, however, properly explained it as the result of the friction of globules of water carried at a great velocity by the steam and rubbed against a wooden jet, and as an illustration of some of the fallacies entertained with regard to boiler explosions Mr. Martin showed by experiments that electricity, one of the supposed causes, could only be produced by carefully prepared special apparatus, and that therefore it was a mistake to attribute explosions to this cause.

In the coal trade a moderately steady tone is maintained, but pits, as a rule, are not kept running more than three and a-half to four days a week, and even with this limited output stocks accumulate under load, and have to be pressed on the market at low prices. Quoted rates are without change, but for quantities sellers are in many cases open to offers, and the tendency of prices is in a downward direction. At the pit mouth the best coal averages 9s. to 9s. 6d.; seconds, 7s. to 7s. 6d.; common house fire coals, 6s.; steam and forge coal, 5s. 6d. to 6s.; burgy, 4s. 6d. to 5s.; best slack, 4s. to 4s. 3d.; and ordinary qualities, 3s. 3d. to 3s. 6d. per ton.

For shipment there has been a fine business doing at low prices. Good ordinary Lancashire steam coal delivered at the high level, Liverpool, or the Garston Docks, averaging 7s. 3d. to 7s. 6d. per ton.

The demand for coke has been decreasing of late, but prices are without material change, best cokes being quoted at 10s. up to 12s., and common qualities at about 8s. per ton at the ovens.

Barrow.—I cannot hear of any further change having occurred in the position of the hematite pig iron market of this district during the past week. To all appearances the market is quieter now than it has been for some months past, and at present there are few signs of any improvement taking place. I hear makers all over the district complaining of a want of confidence on the part of consumers, who are very backward in placing out orders, limiting them to present requirements. Little business is reported to have been booked by makers on home account, and the orders to hand from foreign and American consumers are considerably restricted. The weight of metal now warehoused at makers is considerable, and as the deliveries do not represent anything like the output, stocks are rapidly increasing. Prices are unchanged, and No. 1 samples of Bessemer qualities are quoted at 47s. per ton net at works, prompt delivery; No. 2 at 46s., and No. 3 at 45s.; while inferior samples are changing hands slowly at 44s. 6d. per ton. The steel trade does not improve, but all-round makers are restricting the output. Orders from all quarters are restricted, and the deliveries by rail and sea are limited. Rails are in the market at from £4 10s. to £5 per ton net at works. Shipbuilders are but indifferently employed, and few good engines are being made, I notice that; and few orders have come to local makers. Boilermakers and engineers are quiet. Iron ore is in moderate request at low prices, orders having been booked as low as 8s. 6d. per ton net at mines. The weight of ore banked at mines is considerable, and some time must elapse before it is worked off. Coal and coke easier. Shipping dull.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

A CURIOUS instance of how wages agitations at inopportune times operate against both capital and labour has been brought to my knowledge. At the time when Mr. Pickard was pushing his demand for 15 per cent., the Kiveton Park Company was unable, owing to its men having given notice, to sign a contract for 10,000 tons per week—totally new business—and the contract went into the North. For the last three months the Kiveton Park miners have not worked more than from one and a-half to two days per week on an average; and so great has been the suffering that the Council of the Sheffield, Rotherham, and District Miners' Association have contributed £100 to their relief. This allowed 7s. per head per man and 1s. 6d. to each lad. The men were very grateful for the help; but had the majority of them been wise last November they might now have had double the employment, and had no difficulty in finding the food their families required.

The annual meeting of the shareholders in Messrs. Charles Cammell and Co., Limited, last Wednesday, was appropriately made the occasion by Mr. George Wilson, the chairman and managing director, for a retrospect of the affairs of the company. The company was twenty years old that day. In 1864 they commenced as the owners of the Cyclops and Grimethorpe Works, which they had very considerably extended, and had added to them by the purchase of what were the "Howard" and "Agenolia" works. They acquired the Penistone establishment in 1866, and the Oaks Collieries in 1873, and now they had the Derwent Works at Workington, so that at present they were the possessors of five different establishments—each of them large works—to say nothing of the mines they were developing in Cumberland. An important factor in the policy they had pursued was that the works were all entire and complete within themselves. In 1864 they made scarcely a thousand tons of steel per week; they now made as much as a thousand tons per day. During the twenty years the total profits earned by the company had amounted to upwards of £1,700,000, of which fully £340,000 had been paid in interest, and the remainder, £1,360,000, had been mainly distributed in dividends. During the twenty years they had had experience of every condition of trade, good, bad, and indifferent—the bad, he was sorry to say, prevailing. They had been constantly passing through a transition state of the steel trade, the like of which had never been seen since the metal came into use. They had, however, kept themselves in the front by adopting every improvement, and their property to-day was in a more valuable, efficient, and sound condition than at any previous stage of its existence. They were now, he must fairly claim, the largest producers of steel in the world, and all they required was an abundant and speedy demand at moderate prices to show what the property was capable of doing for them. Mr. Wilson, referring to the bold experiment of transferring the manufacture of steel rails to the coast, said that seven months had sufficed to take down the plant at Dronfield and re-erect it at Workington. The mills at Dronfield were capable of rolling from 3000 to 4000 tons of rails per week; but he had stood on more than one occasion near the saw at Workington—the saw which cut off the rails as they came from the mill—and for an hour together he had witnessed a rail weighing a quarter of a ton leaving the saw every fifteen seconds without interruption. This was at the rate of 60 tons an hour, and was equivalent to a turn-out, by continuous work, of upwards of 8000 tons of rails per week. Of course that might be said to be a *tour de force*, as they said in France, but it showed what the machinery was capable of doing if only human nature could endure the toil, and cast iron withstand the effects of the accumulating heat produced by such a stream of hot metal.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade continues in a steady and hopeful condition. A large amount of business has been done during the last few days, but the tone of the market held at Middlesbrough on Tuesday last was somewhat quieter. Consumers offered 37s. 1½d. per ton for No. 3 g.m.b., but neither makers nor merchants would accept less than 37s. 3d. Most of the makers, indeed, quoted 37s. 6d., and would not entertain business under that figure. Forge iron is now 35s. 9d. to 36s. per ton, and only odd lots can be had at the lower price. The statistical returns for the month are anxiously looked for, and when known will, without doubt, have great influence upon the market. It is thought that stocks will be found to have undergone a substantial reduction.

The stock of Cleveland pig iron in Messrs. Connal and Co.'s store at Middlesbrough amounted on Monday last to 60,737 tons, indicating a reduction of 40 tons during the week. Their stock at Glasgow has increased by 421 tons.

Shipments of pig iron from the Tees have been above the average this month. The quantity sent away up to Monday night was 63,404 tons, as compared with 52,287 tons in the corresponding period of last month. Of this quantity 20,123 tons went to Germany, whereas only 8659 tons were sent to that country in February.

The finished iron trade remains in a stagnant condition. The demand does not improve, and prices are no better. Manufacturers prefer to close their works rather than accept lower rates with the certainty of working at a loss. Ship plates are £5 2s. 6d. to £5 5s. per ton on trucks at makers' works; angles, £4 15s. to £4 17s. 6d.; and common bars, £5 to £5 2s. 6d., all cash 10th, less 2½ per cent. Puddled bars are £3 5s. to £3 10s. per ton net at makers' works.

The accountant to the North of England Board of Arbitration issued, on Saturday last, his certificate for the two months ending February 29th. It appears that the average net selling price of finished iron was £5 13s. 7d. per ton, being a reduction of 4s. 4d. per ton when compared with the two months ending December 31st. The total reduction for the whole of last year was 10s. 7d. per ton. There has also been a great falling off in the quantity of manufactured iron made. During the two months ending February 29th, the quantity was only 90,616, as against 109,220 tons for the two months ending December 31st, and 117,365 tons for the two months ending October 31st.

Messrs. T. and W. Toward, engineers, boiler makers, and shipbuilders, of Newcastle-on-Tyne, have filed their petition. Their liabilities are £5910 12s. 1d., and their assets are estimated at £3383 6s. 9d. The firm made an offer to pay 15s. in the pound, by six instalments of 2s. 6d. each over thirty-three months, but this was refused by the creditors.

Lloyds' Register Committee has been making some experiments with basic steel, made by the North-Eastern Steel Company, at Middlesbrough. The steel was rolled into plates and angles, and subjected to hot and cold tests, tensile and temper tests, and proved in every way satisfactory. Messrs. Lloyds will, therefore, allow basic steel to be used for ships built under their surveyor's inspection, subject to the usual conditions.

The engine building firms situated on the banks of the Tyne are about to reduce the wages of their employés. The skilled workmen at Messrs. G. R. Stephenson and Co.'s, at Newcastle, have already agreed to submit to a reduction of 2s. per week, and the hammermen and labourers to a reduction of 1s. per week.

The employers in the finished iron trade have prepared their case in support of their demand for a 10 per cent. reduction in ironworkers' wages, and a copy thereof has been sent to Mr. R. S. Watson, the selected arbitrator, and another to Mr. Iron, the operative secretary. They show that the sliding scale would have given about 5 per cent. reduction for the period under consideration, and they estimate the disadvantage they suffer by the non-existence of any scale owing to the action of the operatives as equivalent to another 5 per cent. They are also able to point to the more or less complete stoppage of many of the works as an additional reason for demanding relief in the shape of lower wages. The current belief is that at least 5 per cent. reduction will be awarded, which would bring wages to the same level as in the autumn of 1879.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market was very quiet in the past week, with little business doing in warrants, the fluctuations of which have been inconsiderable. Makers' iron is steady, with scarcely any alteration in prices that could be noted. The production of pig iron at present is believed to be, on the whole, not much larger than the consumption and exports. There are ninety-three furnaces in blast, as compared with ninety-four in the preceding week and 111 in the corresponding week of 1883. The quantity of iron in the warrant stores still shows an increase, the addition during the past week being about 420 tons.

Business was done in the warrant market on Friday, at from 42s. 5d. to 42s. 6d., and 42s. 5½d. cash; and 42s. 7d. to 42s. 7½d. one month. On Monday the quotations were 42s. 5½d. to 42s. 6½d. cash, and 42s. 7d. to 42s. 7½d. one month. There was a fair business on Tuesday at 42s. 7d. cash. On Wednesday business was done at 42s. 4½d. to 42s. 5½d. cash. To-day—Thursday—transactions took place at 42s. 5d. to 42s. 5½d. cash, and 42s. 6½d. to 42s. 7d. one month.

The quotations of makers' iron are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 53s.; No. 3, 51s.; Coltness, 58s. 6d. and 51s.; Langloan, 54s. 6d. and 51s. 3d.; Summerlee, 52s. 6d. and 48s. 6d.; Calder, 53s. 6d. and 47s. 9d.; Carnbroe, 52s., and 48s. 6d.; Clyde, 48s. and 45s. 6d.; Monkland, 44s. 3d. and 41s. 6d.; Quarter, 43s. 9d. and 41s. 3d.; Govan, at Broomielaw, 44s. 3d. and 41s. 6d.; Shotts, at Leith, 53s. 6d. and 52s.; Carron, at Grangemouth, 48s. 6d. (specially selected, 54s.) and 47s. 6d.; Kinneil, at Bo'ness, 46s. and 45s. 6d.; Glengarnock, at Ardrossan, 52s. and 46s.; Eglinton, 46s. 3d. and 43s.; Dalmellington, 49s. and 45s. 6d,

The manufactured iron goods shipped from Glasgow in the past week embraced £36,297 worth of machinery, £4540 sewing machines, £5800 steel manufactures, and £26,300 various kinds of iron goods. The engineering trades are now becoming slack, not merely in the marine but in the general department. In some shops the employers are resorting to short time, in preference to discharging workmen; and it is feared that, except in a few special departments, such as bridge and locomotive building, we are entering upon a particularly dull season.

At a meeting of the workmen and others connected with the Clyde Tube Works, Coatbridge, the other night, Mr. James Stewart, one of the partners, said that they were this year in the iron trade back to the depression of 1880, and the outlook was even blacker than then. They—Clyde Tube Works—themselves, he said, were as yet little affected, but it was idle to conceal the fact that there was no prospect of this continuing. Steam engineering and other branches of the trade were suffering great depression.

The demand for hematite iron is steady, and prices are without change.

The coal trade, which has been very quiet for several weeks, now begins to show a little improvement. Up to this date the shipments of Scotch coals are about 35,000 tons less than they were at the same time last year; but merchants state that they are now receiving fair orders in connection with both the Continental and Quebec trades. There is no change in prices either for shipment or home consumption.

A conference of miners' delegates was held in Glasgow a few days ago, at which it was reported that in many districts the men are restricting the output of coals, with the object of rendering the fuel scarce and dear, and thus helping indirectly to higher wages. It was resolved that a central board be appointed to extend the short time movement. The miners of the Motherwell district have agreed to form a local union to work on the short "darg," and that the men do not earn more than 3s. a day.

In the course of March there have been a good many launches on the Clyde, but it is very difficult to obtain new contracts. Some of the yards are so slack that short time is being adopted, and in one or two cases further reductions of wages have been intimated.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE ironmaking men of this quarter are looking forward with some degree of anxiety to quarter day, to see what will then be the chances of the year's trade. So far there is not much lifting of the cloud. Things are as low as they can well be, and only what ironmasters describe as a bread-and-cheese trade is being done.

I expect daily to have intimation of one of the new blast furnaces at Cyfarthfa being put into action. The proprietors of the works have been compelled to buy pig ever since the dismemberment of the furnaces, and this naturally they wish to end. The bar trade of Cyfarthfa is moderately active at present, and I have no doubt but that the company will get a share of the steel rail trade when it is ready.

The exports of manufactured iron last week included 700 tons to Warheng, 1310 tons to Ibrail, 650 tons to Rouen, and 704 tons to Savona.

The management of the Castle Steel and Ironworks, Milford Haven, have been obliged to pay off a number of men consequent upon the poorness of trade.

American advices as to the state of the tin-plate trade have had rather a depressing effect here. Fortunately books are fairly supplied, and at tolerably good prices. Makers are disposed to keep prices intact, and the tendency is more to reduce make than figures.

The Barry Dock question is understood to be halting pending communications expected from the Marquis of Bute. Opinions differ widely at Cardiff respecting the feasibility of the overtures made for the purchase of the docks. If purchased a syndicate would, of course, be formed to work the docks, and perhaps for a time the management would remain in a great measure as it is now. When Mr. W. T. Lewis took all into his hands the changes made were remarkably few—a fair proof that the officials had become well grounded and efficient. Possibly the same course would be pursued.

I am glad to hear that Mr. Davey has started a second furnace at Briton Ferry. It has been a gratifying event.

The condition of things in the colliery districts remains very much as it was, and as it has been for the last month. House coal does not recover its tone, and small remains a drug; but as for steam coal, the run for it is as marked as ever. It is evident that a large portion of trade which was once enjoyed by the northern coalowners has come in this direction. The differences between masters and men in the North led to the diversion of traffic to Wales, and now that the qualities of Welsh steam coal have been tested, it will be a difficult matter to re-change the course.

Mr. Harry Martin, late of the Mountain Ash districts, is entering upon new duties in connection with Dowlais collieries. New sinkings are in course of being made.

A meeting of one section of the Plymouth colliers was held this week, to protest against the system of fines in vogue, ranging from 1s. to 20s. It was maintained that colliers could not at all times avoid rubbish being sent up in the trams; yet for acts out of their power to prevent, fines were levied. At the close of the meeting the protest was signed, and forwarded to the management.

The contrast between the two ports of Cardiff and Newport is very marked at present, the one enjoying great prosperity, while some considerable degree of dulness pervades at the other. The shipments were—Cardiff, 138,849 tons; coastwise, 13,469 tone. Newport, 37,988 tons; coastwise, 17,978 tons.

Pitwood is coming in freely; prices steady. Iron ore is a drug.

IN the construction of agricultural implements in the United States, they are gradually acquiring knowledge by the slow process of finding out by experiment for themselves what they might get from many an ancient book or catalogue in a few minutes. But that is not their way. One man has just patented a bad form of the old and well-known Norwegian harrow. What a lot of things some of the Americans of this class could invent immediately after they returned to the States if they visited one of the Royal Agricultural Society's shows?

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 numbers of the Specification.*

Applications for Letters Patent.

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

18th March, 1884.

5029. GALVANOMETERS, J. Blyth, Glasgow.
5030. GEAR for BICYCLES, T. Taylor, C. Buckley, and F. Boyling, Coventry.
5031. MEAT CARVING, &c., FORKS, R. W. Eadie, jun., Birmingham.
5032. AUTOMATIC HYDRO-PNEUMATIC PUMP, J. Glosier, Manchester.
5033. FURNACES, W. P. Thomson.—(*C. McMillan, U.S.*)
5034. BRAKES, R. W. Vining, Liverpool.
5035. SIGNAL LAMPS, R. W. Vining, Liverpool.
5036. LETTER RACKS, F. Iles, Birmingham.
5037. DYNAMO-ELECTRIC MACHINE, H. Cushman, Lower Broughton, and J. P. Hall, Oldham.
5038. COLOURING MATTERS, J. H. Johnson.—(*H. Caro, Germany.*)
5039. MEASURING STOP-COCKS, J. Anderson, Glasgow.
5040. STRAINING WIRE, J. C. Wynn, Birmingham.
5041. RAILWAY SIGNALLING APPARATUS, C. E. Spagnoletti, London, and S. Griffith and J. Rose, Reading.
5042. CORKING MACHINES, J. B. Powell, Bristol.
5043. BOTTLES and STOPPERS, F. A. Bird, Birmingham, and J. B. Fenby, Sutton Coldfield.
5644. GLUEING SURFACES of MATERIALS, A. S. Coghill and J. A. C. Ruthven, Dublin.
5045. CUTTING INDEXES of BOOKS, &c., A. S. Coghill and J. A. C. Ruthven, Dublin.
5046. SWEEPING MACHINES, J. Barrow, Miles Platting.
5047. SMALL-ARMS, G. Wilkins, Birmingham.
5048. VELOCIPEDES, E. F. Harper, Birmingham.
5049. CHIMNEY COWL, E. W. Harcourt, Oxford.
5050. TONGUES for BUCKLES, F. R. Upcott, Cullompton.
5051. TRICYCLE, T. McIsack, East Greenwich.
5052. AUTOMATIC TELEGRAPHS, H. J. Allison.—(*J. Absterdam, New York, U.S.*)
5053. SIGHT FEED LUBRICATORS, A. Baird, Glasgow.
5054. CHAIN CIRCULAR SAW, H. J. Sidley, Kanturk.
5055. SCYTHES, G. V. Frankish, Sheffield.
5056. POLISHING MATERIAL, H. Brewer, jun., Manchester, and W. A. Brewer, Crumsall.
5057. WOODEN BLOCK FLOORING, A. E. Geary, Manchester.
5058. ARMOUR-PLATES, J. D. Ellis, Sheffield.
5059. CRANK DRIVING GEAR, J. Monteith, Lanark.
5060. ENGRAVING CYLINDERS, F. Bosshardt.—(*H. Carliez, France.*)
5061. ELASTIC PAD for WET STAMPS, J. E. Walsh.—(*A. Callwaert, Brussels.*)
5062. SPINNING, &c., FIBRES, T. S. Tetley, T. Pickles, and A. Cockroft, near Halifax.
5063. LOCKING, &c., DOORS of RAILWAY CARRIAGES, W. J. Muller.—(*W. H. Campbell, Vladivostock, and A. Strother, St. Petersburg.*)
5064. FIREPROOF FLOORS and CEILINGS, W. J. Tickelpenny, Fulham.
5065. HARNESS, A. Vickery, Brixton.
5066. BOATS, &c., R. Harding and J. R. Lecky, Ireland.
5067. THRASHING MACHINES, P. Pierce, Wexford.
5068. ARTIFICIAL EYES, F. Schutze.—(*H. Hamecher, Berlin.*)
5069. SECONDARY ELECTRIC BATTERIES, R. Kennedy and W. Fairweather, Glasgow.
5070. BLEACHING, R. Kennedy and W. Fairweather, Glasgow.
5071. OXIDISING SULPHITES, &c., R. Kennedy and W. Fairweather, Glasgow.
5072. EYE BRACKETS for HOLDING STAIR RODS, &c., W. S. Rosenthal, London.
5073. SCOURING, &c., LEATHER, W. L. Jackson, Chapel Allerton.
5074. DEVICES to be USED in SMOKING CIGARS, &c., J. C. Mewburn.—(*F. Gretsch, Paris.*)
5075. FLOORS and CEILINGS, H. J. Haddan.—(*F. L. Perrière, Paris.*)
5076. APPARATUS for CARRYING MONEY, &c., H. H. Hayden, New York, U.S.
5077. MAKING INFUSIONS of COFFEE, &c., O. Arndt, Germany.
5078. BALL BEARINGS for BICYCLES, &c., W. R. Lake.—(*J. C. Garrood, Boston, U.S.*)
5079. PORTABLE RAILWAYS, J. A. Mays, London.
5080. IMITATION STAINED GLASS, W. Cunliffe, London.
5081. FEED APPARATUS for ROLLER MILLS, &c., J. Chaplin, Ipswich.
5082. CRUSHING STONE, &c., W. R. Lake.—(*T. A. Blake, New Haven, U.S.*)
5083. VELOCIPEDES, W. R. Lake.—(*D. Crowley, U.S.*)
5084. COP-WINDING MACHINES, J. H. Johnson.—(*E. E. Plantrou, jun., France.*)
5085. TRICYCLES, &c., S. Haynes, Stansted.
5086. EYE PROTECTORS, W. R. Lake.—(*D. Genese, U.S.*)
5087. BREECH-LOADING GUNS, W. Gardner, London.
5088. TEA-POTS, T. E. Powell, London.
5089. CONTINUOUS MALT KILN, A. J. Boult.—(*H. A. Kolndorfer, Vienna.*)
5090. FRICTION CLUTCH OPENINGS, M. Lohmann and M. Stolterfoht, Prussia.
5091. AUTOMATIC REGULATING BRAKE GEAR, W. Greig, Dartford.
5092. MAGAZINE GUNS, A. H. Russell and L. A. Bartlett, United States.
5093. BRAKES, W. Cross, Forth Banks.
5094. TUBE SCRAPER and BRUSH, W. H. Gales, London.
5095. MOTORS, L. Mégy, Paris.
5096. TREATING LIQUIDS, F. S. Barff, London.

19th March, 1884.

5097. COMPRESSING ENSILAGE, J. T. Moore, Crewe.
5098. GOLD-PLATED and POLISHED ZINC SHEETS, &c., A. E. Heckford, Birmingham.
5099. GUIDE WIRES for RING SPINNING, T. Dean, Burnley.
5100. HAIR PINS, W. L. B. Hinde, Birmingham.
5101. EXTENDING the RANGE of SHOT GUNS, J. W. Johns, Whitehouse.
5102. LETTER and REFERENCE FILE, A. Blackwood, Manchester.
5103. REELING or WINDING YARNS, &c., J. Dyson, Farnworth, and J. H. Stott, Rochdale.
5104. WHEAT-WASHING MACHINES, J. Cooke, Newark-on-Trent.
5105. PICKERS for LOOMS, C. Moseley and B. Blundstone, Manchester.
5106. FLUSHING WATER-CLOSETS, &c., T. Caink, Worcestershire.
5107. SHARPENING SAW BLADES, E. Mossberg, Sweden.
5108. SUN BLINDS, B. Boothroyd and J. Doherty, Southport.
5109. FLAME ACTION in STEAM BOILERS, W. Wright, Scotland.
5110. DRESSING SILK, &c., J. B. Kershaw, Yorkshire.
5111. TAPS, J. Tyrer, Formby, near Liverpool.
5112. DRUMS or PULLEYS, R. Woodhouse and S. Mitchell, Yorkshire.
5113. MILL for ROLLING IRON and STEEL, W. J. C. Gill, Lancashire.
5114. PREVENTING the CARRIAGE GEAR of SPINNING MULES from UNGEARING, T. H. Rushton and E. Fairhurst, Lancashire.
5115. TAKING-UP MOTION for LOOMS, W. Lord and G. Spofforth, Yorkshire.
5116. BICYCLE BRAKE, C. A. Goslett, Derbyshire.
5117. PREVENTING the BURSTING of INDIA-RUBBER BAGS, W. Garside and H. Stockton, Lancashire.
5118. PROTECTING SHIPS' BOTTOMS, H. T. Stinchcombe, Bristol.
5119. SOFTENING, &c., WATER, W. Wyatt, Shropshire.
5120. DOUBLE-DRIVING BALANCE GEAR for VELOCIPEDES, H. J. Brookes and J. Morris, Staffordshire.
5121. ARRESTING LOCOMOTIVES and CARS, M. F. Bonzano, Philadelphia, U.S.
5122. SKINNING ANIMALS, R. Greome, Sheffield.
5123. PIN FRAME WARPS, &c., for WINDING YARNS, R. Whitehead, Swinton, near Manchester.
5124. FELTING, &c., HATS, H. Polak and H. Lowe, Cheshire.
5125. COUPLING for PIPES, J. J. Lacey, California, U.S.
5126. CLEANING FLUES, L. Mills, Gravesend.
5127. ASSORTING GREEN LEAF in the MANUFACTURE of TEA, J. Dick, Glasgow.
5128. MIDDLINGS PURIFIERS, R. Howarth, Lancashire.
5129. GRINDING, &c., the SURFACES of ROLLERS, T. W. B. Mumford, Wanstead, and R. Moodie, West Ham.
5130. CHROMIC COMPOUNDS, S. G. Thomas, London.
5131. STEAM BOILERS, T. Craddock, London.
5132. CAGES for BIRDS, &c., A. Lawrie, Birmingham.
5133. MUSIC STAND, C. Spratt and A. C. Churchman, London.
5134. ENGRAVING by PHOTOGRAPHY, L. de Roux, Begles, near Bordeaux.
5135. SPINNING TOPS, W. H. Hall, West Brighton.
5136. BOOTS, &c., J. Borrett, London.
5137. ABSENTEE'S RETURN, &c., INDICATOR, W. H. Cooper, London.
5138. ELECTRO-MOTORS, &c., O. March, London.
5139. PREPARING FRUIT for PRESERVING, E. Pink, jun., London.
5140. SEPARATING STALKS, &c., from FRUIT, E. Pink, jun., Southwark.
5141. JAMS, E. Pink, jun., London.
5142. TREATING RESIDUAL LIQUORS of the AMMONIA SODA PROCESS, W. Weldon, Burstow.
5143. DECORATING ENAMELLED IRON, G. J. Rhodes, Wolverhampton.
5144. PRODUCING PICTURES on ENAMELLED IRON, G. J. Rhodes, Wolverhampton.
5145. PRODUCING PICTURES on ENAMELLED IRON, G. J. Rhodes, Wolverhampton.
5146. LETHEBY PHOTOMETERS, D. W. Sugg, London.
5147. COUPLING for PIPES, D. T. Powell, London.
5148. EXPANSION JOINT for WATER PIPES, H. W. Allan, Glasgow.
5149. PROTECTING TELEGRAPHIC, &c., CONDUCTORS, A. R. Bennett, Glasgow.
5150. CENTRIFUGAL MACHINES, W. Fairweather.—(*W. Angele, Berlin.*)
5151. GLASS ROOFING, J. Sewell, Yorkshire.
5152. CANDLE MOULDING MACHINES, J. Claret, London.
5153. DYEING INDIA-RUBBER COATED FABRICS, W. S. Mackie, Manchester.
5154. RESIN SOAP, J. Imray.—(*H. J. E. Hennebuttee, France.*)
5155. MACHINES for SEPARATING LIGHT and HEAVY SUBSTANCES, W. R. Lake.—(*H. Seck, Dresden.*)
5156. EXTINGUISHING FIRE, A. J. Boult.—(*T. Andre, Paris.*)
5157. ELECTRIC JEWELLERY and ORNAMENTS, A. M. Clark.—(*G. Trouvé, Paris.*)
5158. ENGINES to be WORKED by STEAM, &c., J. J. Miller and G. J. Tupp, London.—*January 25th*, 1884.
5159. DIFFERENTIAL GEAR APPLICABLE to TRICYCLES, J. J. Miller, London.
5160. FINISHING LACE, &c., L. Lindley, Nottingham.
5161. VACUUM PRODUCERS, &c., S. Robertson, London.
5162. HOLDERS for STAIR, &c., RODS, M. Merichonski, London.
5163. SLEEPING BERTHS for DORMITORIES, &c., J. Johnson, Limehouse.
5164. TESTING the PRESENCE of MOISTURE in LINEN, W. B. Woodbury, London.

20th March, 1884.

5165. CARRIAGES employed in TWIST LACE MACHINES, R. B. Gamble, Nottingham.
5166. FACILITATING the DISSOLUTION of METALLIC LEAD, A. W. Anderson, London.
5167. VIOLIN CASES, G. A. Chanot, Manchester.
5168. FILED FABRICS, H. Lee, Bolton.
5169. ROTARY WEB PRINTING MACHINES, G. A. Wilson, Liverpool.
5170. PORTABLE STAND for SUSPENDING MINERS' SAFETY LAMPS, A. Howat, Hulme.
5171. CUTTING TOBACCO, W. Adie and G. R. Adams, Dundee.
5172. SUPPLYING PURE WARM AIR into PRIVATE HOUSES, &c., J. Watson, Torquay.
5173. ROTARY PUMPS, R. G. Morton, Errol.
5174. PRODUCING CONTINUAL MOTIVE POWER, G. Hollinshed, Sale, Cheshire.
5175. DISINFECTING LITTER, &c., J. Brown, Savile Town, Dewsbury.
5176. MAKING RAILWAY RUGS, &c., A. T. Miller, Rock Ferry.
5177. CHAFF-CUTTERS, J. Wilder, Reading.
5178. COMBINATION JACKET-WRAP, M. Jackson, London.
5179. APPARATUS for LOADING and UNLOADING GRAIN, W. Cooper and J. Holdsworth, Hull.
5180. PENDANT LOCKETS, J. G. Rollason, Birmingham.
5181. STEAM LUBRICATORS, &c., H. Wilson, Stockton-on-Tees.
5182. BICHROMATE of SODA, C. S. Gorman, Irvine.
5183. DISPENSING with the NECESSITY of TURNING OVER the LEAVES of MUSIC, J. T. Key, Sheffield.
5184. OPENING and CLOSING WINDOW SASHES, C. H. Wood, Sheffield.
5185. KNIFE CLEANERS, G. Pickett, London.
5186. SKETCHING, M. E. Rowlandson, Heavitree.
5187. LIGHTING of LAMPS, W. Brierley.—(*R. Richter, Prussia.*)
5188. RIVETTING WROUGHT IRON PULLEYS, A. Crossley, Cleckheaton.
5189. CROW or BRIG for SUPPORTING KETTLES, &c., R. Rowbotham, Manchester.
5190. TRAMWAY, &c., ENGINES, D. G. Morrison, Kilmarnock.
5191. ARTIFICIAL LEATHER, W. Travis, London.
5192. RED PIGMENTS, &c., J. C. Martin, Richmond.
5193. AUTOMATIC DIAL WEIGHING MACHINES, L. A. Groth.—(*C. Liekien, Germany.*)
5194. BRICKS for BUILDING PURPOSES, H. Hart, Ballymacarron.
5195. CUTTING VEGETABLE SUBSTANCES, B. Samuelson, Banbury, and R. E. Raker, Burnham.
5196. ELEVATING PUMPS, J. Berly.—(*E. Fesquet, Paris.*)
5197. RECEIVING STREET MUD or DUST, W. B. Powell, London.
5198. GAS-HOLDERS, H. J. Haddan.—(*A. Meizel and G. J. S. Couffinhal, France.*)
5199. ROTARY CUTTERS, H. J. Haddan.—(*H. Gruau, France.*)
5200. SECONDARY PILES or BATTERIES, P. Nolet.—(*M. and J. B. Gloesener, Belgium.*)
5201. THRASHING MACHINES, J. R. Jefferies, Ipswich.
5202. LIFE-SAVING WAISTCOAT, E. G. Brewer.—(*J. B. Berna, Belgium.*)
5203. RAILWAY COUPLINGS, J. Cowan, Glasgow.
5204. MUSICAL PEGS, F. St. Aubin, London.
5205. BUILDING CONCRETE, J. M. Tall, London.
5206. ECONOMISING FUEL, T. C. Horsfield, Nottingham, and F. Prince, Brighton.
5207. WATERPROOF GARMENTS, B. Birnbaum, London.
5208. CONNECTING INCANDESCENCE LAMPS to their HOLDERS, A. Duffin, Belfast.
5209. GAS FIRE, C. C. Wilson, Leeds.
5210. BUFFERS, C. Roberts, Wakefield.
5211. WALLS with LOUVRE OPENINGS, J. C. Bothams, Wiltshire.
5212. STOVES, &c., S. and J. Belham, London.
5213. HYDRAULIC LIFTS, G. Hutchinson, Newcastle-upon-Tyne.
5214. DISTRIBUTION of ELECTRIC ENERGY, J. S. Beeman, London.
5215. CARPETS, &c., G. W. Oldland, Kidderminster.
5216. TRAVERSE NET, A. C. Travell, Nottingham.
5217. GATHERING TWITCH, D. Prime, Clavering.
5218. DENTAL PLATES, H. H. Lake.—(*F. W. Seabury, Providence, U.S.*)
5219. SILO, F. W. Turner, London.
5220. METALLIC CASKS, C. T. Lewis, London.
5221. SEWING NEEDLES, E. Edwards.—(*E. Krat, Germany.*)
5222. CHIMNEY TOPS, J. C. Bothams, Wiltshire.
5223. NON-CONDUCTING MATERIAL, H. Bolze, Germany.
5224. AERATING FLOWER-POT, E. H. Clark, Starcross.
5225. MARINE ENGINE GOVERNORS, A. M. Clark.—(*A. Fuller and A. H. Bell, New York, U.S.*)

21st March, 1884.

5226. PACKING for PISTON RODS, &c., J. S. D. Shanks, near Belfast.
5227. OILING and DAMPING YARN, S. Laing, Hawick.
5228. SALMON FISHING, R. Macartney, Antrim.
5229. METALLIC BOXES, W. H. and B. Jones, Wolverhampton.
5230. RAILS and CHAIRS, W. Wright, Airdrie.
5231. BLEACHING LINEN, &c., J. H. Riley and J. Downham, Bury, and J. Apsley, Rochdale.
5232. COMPRESSED FUEL, W. Adgie, Leeds.
5233. LOWERING BOATS, &c., H., W., and J. Robinson, Hull.
5234. SCREEN for CORN DRESSING MACHINES, L. J. Barrell, Langham.
5235. WARP LACE MACHINES, H. Hill, Nottingham.
5236. WARP LACE MACHINES, H. Hill, Nottingham.
5237. PROTECTING BRICKS from DAMP, &c., H. Walley, Manchester, and T. Gare, Stockport.
5238. BICYCLES and TRICYCLES, P. Skeldon, Wolverhampton.
5239. AERATED LIQUIDS PUMP, A. M. Davis and H. D. Forges, London.
5240. BOATS' ROWLOCKS, J. Hallman, West Hartlepool.
5241. SCISSORS, &c., C. Ibbotson and F. Kenning, Sheffield.
5242. FABRIC USED in CONSTRUCTING BOATS, &c., C J. Fox, Birkenhead.
5243. MAKING BOOTS, &c., B. Bloomer, Stourbridge.
5244. STOPPERING BOTTLES, G. C. and A. G. Thompson, Sheffield.
5245. ALLOYS of CHROMIUM, T. Slater, London.
5246. LOCK FURNITURE, J. Whitehead, Holbeck.
5247. SCREW STUDS, P. A. Martin, Birmingham.
5248. WATERPROOF CLOTHING, A. C. Henderson.—(*A. B. Boyer, Paris.*)
5249. CARTRIDGES, J. Andrews, London.—*26th February*, 1884.
5250. ROLLING AXLES, J. H. Bickley, Dover, U.S.
5251. MOLINEUX CHECK ACTION in PIANOFORTES, J. and A. Hines, London.
5252. SELF-EMPTYING TIPPING BOXES, J. W. F. Bryan, Glasgow.
5253. DOMESTIC FIRE-GRATES, T. Fraser, Aberdeen.
5254. VELOCIPEDES, T. Young, Smethwick.
5255. COPING TILE, W. Tuffee, Gravesend.
5256. SILOS, W. Ellis, Chagford.
5257. DIRECT-ACTING MOTOR, L. Richards, Dowlais.
5258. PROPELLING SHIPS, J. Howell.—(*T. Logan, Winfield, U.S.*)
5259. STUDS, &c., S. Betts, London.
5260. STARCHING FABRICS, E. Capitaine.—(*Drumm und Co., Germany.*)
5261. FASTENINGS for NECKTIES, &c., G. M Braggiotti, London.
5262. WASHING ORES, &c., T. Vosper, London.
5263. CORKSCREWS, H. J. Haddan.—(*Heimendal and Theller, Germany.*)
5264. VARYING SPEED GEAR MECHANISM, J. Roots, London.
5265. CHIMNEY TOP, D. Walker, London.
5266. EVAPORATING SYRUPS, &c., F. W. Nash.—(*C. H. Boon, West Indies.*)
5267. FURNACES, R. H. Hepburn, London.
5268. COTTON GINNING MACHINERY, C. T. Burgess, Brentwood.
5269. ANTISEPTIC PREPARATIONS, J. Walker, Leeds.
5270. STEAM ENGINE REVERSING VALVES, T. H. Owen and S. W. Allen, Cardiff.
5271. STEERING GEAR, J. Petrie, London.
5272. SPINNING YARN, H. H. Lake.—(*C. A. Coggeshall, Providence, U.S.*)
5273. COMBINED FLEXIBLE SOLE, SPRING, AND HEEL STRENGTHENER for BOOTS and SHOES, W. Gifford, Walthamstow.
5274. WARP LACE MACHINES, H. Hill, Nottingham.

22nd March, 1884.

5275. FEATHERWEIGHT SKETCHING APPARATUS, A. D. Chapman, London.
5276. ADMITTING AIR to FURNACES, &c., J. Moulson, Balsall Heath.
5277. HYGIENIC APPARATUS, T. H. Dale, Birmingham.
5278. TREATING WOOL, W. H. Marling, King Stanley.
5279. NON-SLIPPING SOLES for BOOTS and SHOES, H. Markus, Fleetwood.
5280. FINISHING WATERPROOF FABRICS, P. and L. Frankenstein and R. P. Wicks, Newton Heath.
5281. WASTE WATER PREVENTER, J. Friend, Exeter.
5282. COMBINED TRACTION ENGINE, P. J. Parmiter, near Salisbury.
5283. TOBACCO PIPES, D. T. Lee, London.
5284. GOVERNING the SPEED of PUMPS, J. Churm, near Stoke-upon-Trent.
5285. SPRING WHEELS, H. S. Stewart, London.
5286. STEEL PENS, J. A. Drew, Wareham.
5287. PRODUCING ELECTRIC CURRENTS, N. B. Dennys, London, and J. C. Cuff, Singapore.
5288. PREVENTING CORROSION of METAL TUBES, E. H. Waldenström and W. Sumner, Manchester.
5289. SHUTTLE PEGS, D. Bailey and B. Berry, Halifax.
5290. CLEANING LAND, &c., J. and E. Gledhill, Lindley.
5291. LAST for BOOTS and SHOES, W. Barker, Halifax.
5292. WINDING SPOOLS, T. Helyear, Bridport.
5293. MINERS' DIALS for SURVEYING, A. G. Thornton, Manchester.
5294. MUSICAL INSTRUMENT, A. E. Edwards, London.
5295. MEAT CHOPPING MACHINES, J. W. Russell and J. Stronach, Aberdeen.
5296. PRESSING GREEN FODDER, J. T. Moore, Crewe.
5297. WINDLASSES, R. S. Abercromby, Glasgow.
5298. PEN and PENCIL CASES, W. Vale, Birmingham.
5299. COOLING LIQUIDS, H. Stephens, Leeds.
5300. WEAVING LOOMS, T. Richmond, F. Baynes, and H. Livesey, Blackburn.
5301. LOOM JACK JOINTS, J. W. Taylor and D. Harrop, Huddersfield.
5302. ROTARY GAS ENGINES, T. H. and W. A. Johns, London.
5303. GAS ENGINES, T. H. and W. A. Johns, London.
5304. ELECTRODES, T. Rowan, London.
5305. MATTRESS MAKING, C. C. Bacon, London.
5306. DRAWING FINE IRON and STEEL WIRE, T. Shaw, Brighouse.
5307. REPAIRING SLIVER or CARD CANS, J. Baxendale, Bolton.
5308. FIRE-ARMS, M. Kaufmann, London.
5309. COMBINED HOLDER and GALLERY for INCANDESCENT ELECTRIC LAMPS, W. Harvie, Glasgow.
5310. TESTING ELECTRICAL CABLES, J. L. Clark.—(*H. C. Mance, Kurrachee, India.*)
5311. KEEPING INK and other ROLLERS in their PLACES, H. Noble, London.
5312. RAILWAY CHAIRS, T. E. Craven and J. Webster, Leeds.
5313. SAFETY RING, R. Uhlich.—(*C. P. Grout, New York, U.S.*)
5314. PROTECTION of FLEXIBLE TUBING, R. Uhlich.—(*C. P. Grout, New York, U.S.*)
5315. ELECTROMETER, H. R. Cassell, London.
5316. TUCKER for SEWING MACHINES, J. Barrett, Knightsbridge, London.
5317. TREATMENT of VEGETABLE, &c., FIBRES, A. W. L. Reddie.—(*MM. Dillies et Compagnie, Roubaix, France.*)
5318. BINDING SCAFFOLDING, &c., H. Pataky.—(*L. Muth, Berlin.*)
5319. ELASTIC SETS of TEETH, H. Pataky.—(*I. Beutelrock, Munich, Bavaria.*)
5320. MODIFYING SOUND, R. Plant and E. Perry, Birmingham.
5321. BELLS, B. R. Jackson, Birmingham.
5322. CUTTING, &c., SCREW-NUTS, W. Fairweather.—(*G. Skrzivan, Berlin.*)
5323. DOMESTIC FIRE-PLACES, R. Steadman and W. E. Edwards, London.
5324. MAKING-UP PACKAGES of LARD, G. H. Middleton, Birmingham.
5325. RAISING HEAVY BODIES, D. W. Sargent, London.
5326. DIE-STOCKS and TAPS, B. Wesselmann, Hamburg.
5327. REGULATING the SUPPLY of WATER, J. Sibbald and W. Kinnes, Dundee.
5328. PREPARATION of NEW SOLUBLE NEUTRAL SALTS of CERIUM, J. B. Mackey, London.
5329. SPRINGS, J. A. Turner, West Gorton.
5330. OVERHEAD SEWING MACHINES, C. D. Abel.—(*B Rudolph, Berlin.*)
5331. ENGRAVING from PATTERN, J. Imray.—(*J Schweizer, Switzerland.*)
5332. STUDS, &c., S. Betts, London.
5333. EXTRACTING ALUMINIUM from its NATURAL SILICATES, L. Lossier, Geneva.
5334. LEGGINGS, W. R. Lake.—(*J. A. King, Chicago.*)
5335. DYNAMO-ELECTRICAL MACHINES, Sir W. Thomson, Glasgow, and S. Z. de Ferranti, London.
5336. HEATING STOVES, H. Hardy, London.
5337. SECONDARY BATTERIES, S. Kalischer, Berlin.
5338. LATHE CARRIERS, A. W. Harrison, London.
5339. FILTER, A. M. Clark.—(*C. E. Chamberland, Paris.*)

24th March, 1884.

5340. METERS for MEASURING LIQUIDS, W. P. Thompson.—(*P. Samain, Paris.*)
5341. SET PANS or BOILERS, D. Hawmshaw, Halifax.
5342. FASTENINGS for GLOVES, &c., F. R. Baker, Birmingham.
5343. STEAM TUBULAR BOILERS, W. Wright, Airdrie.
5344. METAL WEARING SURFACES for INDIA-RUBBER OVER-SHOES, W. R. Lake.—(*F. Richardson, U.S.*)
5345. ALLOYING MANGANESE IRON, C. Billington and J. Newton, Longport.
5346. BISCUIT BOXES, J. Hall, Sheffield.
5347. HUMANE FISH GAFF and NET COMBINED, W. Burgess, Malvern Wells.
5348. DREDGERS, F. J. Candy, Highfield, Fen Ditton.
5349. ADAMANTINE ROLLER VARNISH, J. L. Tomkys, Haslingden.
5350. STOCKINGS, C. Neyret and E. Wunderly, Paris.
5351. PORTABLE ELECTRIC BELLS, W. E. Irish, Sunderland.
5352. ATTACHING the HANDLES of TABLE CUTLERY, &c., C. F. Barnes and T. N. Batt, Sheffield.
5353. PHOTOGRAPHIC EXCHANGE BOXES, H. Kayser, Berlin.
5354. BOOT LAST, A. Savage, London.
5355. VOLTAIC BATTERIES, R. H. Courtenay, London.
5356. BRAKES, J. Carver, Nottingham.
5357. PURIFYING LIGHTING GAS, H. Springmann.—(*Dr. Hipp and Dr. Grüneberg, Germany.*)
5358. ROASTING COFFEE, &c., H. Springmann.—(*A. van Gülpen, Emmerich-on-the-Rhine.*)
5359. BELT or STRAP FASTENERS, J. W. Cann, Surrey.
5360. PAPER-MAKING MACHINES, W. Leishman, Hemel Hempstead.
5361. MOSS LITTER PREPARING MACHINE, J. Haye, Etzhorn.
5362. TELEPHONE SUPPORT, G. W. Errington, Newcastle-on-Tyne, and F. Caws, Sunderland.
5363. VELOCIPEDES, C. Lee, Tottenham.
5364. COMPRESSED AIR MOTORS, A. H. Alldridge, Birmingham.
3565. GAS MOTOR ENGINES, J. Magee, Belfast.
5366. PERAMBULATORS, &c., W. H. Dunkley, Birmingham.
5367. WEAVING LOOMS, E. J. B. Jacquot, France.
5368. TOOLS, G. A. Spratt, London.
5369. DIVIDING CIRCLES, H. J. Haddan.—(*F. A. Mora, France.*)
5370. GUN LOCKS, H. J. Haddan.—(*M. R. de Belleval, France.*)
5371. TOY GUN, W. Britain, London.
5372. SORTING, &c., GREEN MALT, F. Wirth.—(*G. Stein, Germany.*)
5373. POSTAL BALANCE, W. G. Hiscock, London.
5374. SELF-PROPELLING SUBMARINE BOATS, J. H. Blakesley, London.
5375. COINING PRESSES, J. M. Napier, London.
5376. STEAM TRAMWAY ENGINES, W. P. Green and J. Walker, Leeds.
5377. CYLINDER PAPER MACHINE, G. H. Mehner, Saxony.
5378. BRINGING DOWN COAL, G. A. and W. H. Crow, Newcastle-upon-Tyne.
5379. COUPLINGS, &c., for RAILWAY VEHICLES, W. R. Lake.—(*C. E. Mark, Flint, U S.*)
5380. SPINNING MACHINES, W. R. Lake.—(*R. Paton and A. Heel, Germany.*)
5381. STEAM BOILERS, S. B. Ballian, Paris.
5382. EXPLOSIVE COMPOUNDS, H. E. Newton.—(*A. Nobel, Paris.*)
5383. EVAPORATING, &c., LIQUIDS, H. E. Newton.—(*A. Nobel, Paris.*)

ABSTRACTS OF SPECIFICATIONS.

Prepared by ourselves expressly for THE ENGINEER *at the office of Her Majesty's Commissioners of Patents.*

2104. COLOURING MATTERS, *F. Wirth, Frankfort.—25th April*, 1883.—(*A communication from Messrs. Dittler and Co., trading under the firm of Farbwerk Griesheim-am-Main, Griesheim.*) 6*d*.

The inventor claims, First, the preparation of sulpho-amido-naphthalic acids from disulpho and trisulpho reduction; Secondly, the production of yellow or colouring matters by the combination of a "diazo" compound obtained from the sulpho-naphthalene with phenol and soda, or with α naphthol, β naphthol, α naphthol-mononsulphonic acid, β naphthol-mononsulponic β acid, or β naphthol-disulphonic acid and soda.

3109. CONSTRUCTION OF PAVEMENTS AND ROADWAYS, &c., *E. G. Banner, London.—22nd June*, 1883. 10*d*.

Relates to a pavement kerb composed of a series of blocks constructed of concrete arranged end to end, with a passage or passages therethrough, suitable to accommodate telegraph and other wires, gas pipes and the like, and provided at intervals with removable parts or covers affording access to the said passage or passages.

3474. SAFETY VALVES, *J. H. Johnson, London.—13th July*, 1883.—(*A communication from Messieurs Lethuillier and Pinel, Rouen.*) 6*d*.

Consists of a safety valve so constructed or arranged that when the valve disc or valve proper opens, the escaping steam passes between the edges of the said valve proper and the sides of a chamber surrounding the said valve proper, and thereby move the said valve proper away from its seat to an extent proportionate to the positive increase of pressure within the boiler.

3578 SYNCHRONISING AND TIME SIGNALLING MECHANISM FOR CLOCKS, *W. S. Harrison, London.—20th July*, 1883. 8*d*.

This relates to an arrangement of clockwork mechanism which can be readily and detachably affixed to any clock to be synchronised.

3693. BOTTLE STOPPERS, *M. Gill, Huddersfield.—28th July*, 1883.—(*Not proceeded with.*) 2*d*.

Relates to the arrangement of a plug or stopper composed of wood, glass, or other suitable material, which is provided with a rubber washer.

3695. APPARATUS FOR CHECKING THE RECEIPT OF MONEY FROM PERSONS RIDING IN PUBLIC VEHICLES, &c., *D. Dossett, Leyton.—28th July*, 1883.—(*Void.*) 2*d*.

Relates to the construction of an apparatus in which are contained a continuous roll of consecutive numbered tickets.

3745. COMBINED POT OR VESSEL FOR TEA AND COFFEE &c., *H. de M. Wellborne, London.—31st July*, 1883.—(*Not proceeded with.*) 2*d*.

The pot or vessel is divided longitudinally into two parts by a division reaching from the handle to the ends of the spout, thus forming two distinct chambers in the pot or vessel itself, and two separate conduits in the spout, by means of which the liquids are separately poured out. At the mouth end of the spout is a small tap, which opens or shuts either of the two divisions in the spout.

3755. TRICYCLES, *J. and T. Webb, Coventry.—31st July, 1883.—(Void.)* 2*d.*

Relates to the employment of a spring motor, so that the tricycle may be self-propelling.

3756. CUTTING OUT AND MAKING SHOES AND BOOTS, *E. Edwards, London.—31st July, 1883.—(A communication from P. D. Fréchingle, Paris.)—(Not proceeded with.)* 2*d.*

The object is a novel method of cutting out and making shoes and boots, in such manner that the sole, the heel, and the back stiffening piece are all formed of a single piece of leather.

3759. TRAWLING SHAFTS, *J. Faulkner, Yarmouth.—1st August, 1883.—(Not proceeded with.)* 2*d.*

Relates to the construction of the trawling shaft for fishing.

3762. GUN CARRIAGES AND GUN STOCKS, *D. Walker and W. S. Simpson, London.—1st August, 1883.—(Not proceeded with.)* 2*d.*

The main features are an upper or sliding carriage, to which is attached the gun; also the application of a spring or springs to cushion the recoil and to produce a return recoil of the gun, together with the novelties of mechanical applications involved in these arrangements.

3767. CONSTRUCTION OF SHEAR LEGS FOR FACILITATING THEIR ERECTION, *J. and E. Gledhill, Huddersfield.—1st August, 1883.—(Not proceeded with.)* 2*d.*

Relates to a means for raising and lowering the shear legs with ease.

3769. PREPARATION OF A FOOD FOR INFANTS, *W. E. Davies, Sherborne.—1st August, 1883.—(Provisional protection not allowed.)* 2*d.*

Consists of a mixture of milk, cream, sugar of milk, and chloride of sodium—common salt.

3774. AUTOMATIC STOPPER FOR BOTTLES, &c., CONTAINING AERATED WATERS OR LIQUIDS, *W. Samson, Dundee.—1st August, 1883.—(Not proceeded with.)* 2*d.*

Relates to the construction of inside stoppers.

3780. MANUFACTURE OF SHOES FOR HORSES, &c., *R. Wood, Manchester.—2nd August, 1883.—(Not proceeded with.)* 2*d.*

The shoe is formed with a groove, into which is fitted a pad of india-rubber or other suitable material.

3782. TRANSMITTERS FOR TELEPHONES, *T. M. Morriss, London.—2nd August, 1883.* 6*d.*

The hollow box of the transmitter is made of carbon, in two parts, the portions being insulated from each other. The conducting wires are attached one to each part of the box, which is partly filled with granulated coke.

3783. APPLIANCE FOR HOISTING APPARATUS APPLICABLE TO LOW-LEVEL BRIDGES, *J. P. Bayly, London.—2nd August, 1883.—(Not proceeded with.)* 2*d.*

Relates to the arrangement of apparatus for raising the arch or span by means of weights, hydraulic or steam power.

3784. RAILWAY LOCOMOTIVE EXHAUST APPARATUS, *J. Armstrong, New Swindon.—2nd August, 1883.—(Not proceeded with.)* 2*d.*

The inventor places in any convenient position on a locomotive, by preference near the cylinders and forming a partial jacket, a reservoir connected with the exhaust ports, so that when an exhaust port is open to the cylinders the steam flows into the reservoir, and there expands until the steam pressure in the blast pipe falls low enough to allow its escape to the atmosphere.

3786. FOG SIGNALS FOR THE RAILS OF RAILWAYS, *E. Ludlow, Birmingham.—2nd August, 1883.—(Not proceeded with.)* 2*d.*

Refers to the lead or other soft metal clips by which fog signals are secured to the rails of railways.

3788. CHIMNEY-TOPS OR COWLS, *A. J. Boult, London.—2nd August, 1883.—(A communication from J. Wüstner, Annery, France.)—(Not proceeded with.)* 2*d.*

Relates to improvements in chimney-tops or cowls which serve to prevent the smoke passing through a chimney being driven back by the wind.

3789. APPARATUS FOR WASHING CLOTHES, &c., *E. Edwards, London.—2nd August, 1883.—(A communication from E. and J. Paape, Angleur, Belgium.)—(Not proceeded with.)* 2*d.*

Relates to an apparatus for washing and cleaning linen, &c., by means of steam from boiling water, together with soap or other detergent.

3804. CONSTRUCTION OF FURNACES AND FIREPLACES FOR CONSUMING SMOKE AND ECONOMISING FUEL, &c., *W. J. Williamson, London.—3rd August, 1883.—(Not proceeded with.)* 2*d.*

Certain arrangements of perforated bricks and air passages are introduced into the bridges and flues beyond the grate bars, whereby combustion is promoted and smoke consumed when applied to steam boilers, without the disadvantages resulting from cold air coming in contact with the heated surfaces of the boiler.

3805. OVENS AND DOORS OF SAME OF COOKING RANGES, *J. B. Petter, Yeovil.—3rd August, 1883.—(Not proceeded with.)* 2*d.*

The oven doors consist of a frame carrying the latch, hinges, and other parts, and are panelled with one or more sheets of gauze wire or perforated metal or mineral substance, either (if one or more than one be used) laid close together or apart with air spaces between each, thus affording free escape for vapours, effluvia, and steam from the said ovens.

3810. APPARATUS FOR COOLING OR HEATING LIQUIDS, *B. H. Remmers, Glasgow.—4th August, 1883.—(Not proceeded with.)* 2*d.*

The apparatus is so constructed that the liquids to be cooled or heated circulate through a series of narrow channels in a direction contrary to that of a stream of cooling or heating liquid, which is kept separate from the liquid under treatment by thin conducting plates or partitions.

3812. FOLDING BOXES OR CASES, *S. Cropper, London.—4th August, 1883.* 6*d.*

The sides and ends of the box are hinged together, and are provided with grooves, dowels, projections or recesses to receive the top and bottom which are formed to slide into position, or have parts to fit the dowels, projections, or recesses.

3813. CRUTCHES, HEELS OF BOOTS, &c., *H. J. Haddan, London.—4th August, 1883.—(A communication from G. N. Thurzo, Vienna.)—(Not proceeded with.)* 2*d.*

The object is to afford greater freedom and facility of motion to persons using artificial means of support and locomotion.

3814. DETACHING GEAR FOR SHIPS' BOATS, &c., *W. Mills, High Southwick.—4th August, 1883.—(Not proceeded with.)* 2*d.*

Consists of a lipped pocket, enclosing a weighted hook, the pocket being formed upon the end of a rod or bolt which it is proposed to secure to the keel of the boat.

3815. SUPPORTS FOR TELEPHONE WIRES, *J. C. Mewburn, London.—4th August, 1883.—(A communication from O. N. André, Neuilly, France.)—(Not proceeded with.)* 2*d.*

This relates to a method of insulating and supporting the wires so that the "sonorous vibrations" shall be absorbed.

3816. POLES FOR LAWN TENNIS NETS, *S. C. Davidson, Belfast.—4th August, 1883.* 6*d.*

To prevent the poles being pulled inwards by the stretched rope, a spike is driven into the ground, and to it the base of the pole is fastened. A winding device for tightening the net is described.

3819. MANUFACTURE OF UMBRELLAS, &c., *M. Hyam, London.—4th August, 1883.—(Not proceeded with.)* 2*d.*

Relates to the arrangement of the ribs and stretchers in such manner that they or any of them can be removed quickly, and without taking the umbrella entirely to pieces.

3820. TREATMENT OF LIQUORS PRODUCED IN THE AMMONIA-SODA PROCESS, AND OBTAINING HYDROCHLORIC ACID THEREFROM, *L. Mond, Northwich.—4th August, 1883.* 4*d.*

The inventor claims, First, treating the liquor remaining, after fully carbonating the soda in the ammonia-soda process, by concentrating it by evaporation, separating the crystals of sodium chloride which form, and treating the residue with sulphuric acid, in place of liberating the ammonia with lime, whereby sulphate of ammonia and hydrochloric acid are formed in place of ammonia and calcium chloride, as heretofore; Secondly, obtaining hydrochloric acid from the said liquor, by evaporating the surplus water, separating the sodium chloride as it salts out, and adding sulphuric acid to the concentrated liquor, or to the ammonium chloride obtained therefrom by crystallisation, or by complete evaporation.

3821. GAS GENERATING FURNACES, *L. Mond, Northwich.—4th August, 1883.* 6*d.*

The generator is preferably rectangular, two opposite sides being perpendicular and solid to the bottom, while the other two are perpendicular for some distance below the top and then slope towards each other, and are supported on dead plates, below which are the clinkering holes. Air is admitted through slits extending along one or more sides of the generator and above the clinkering holes.

3822. TREATMENT OF DRAWINGS OR DESIGNS PRINTED UPON PAPER, &c., TO IMITATE STAINED, GROUND, CUT, OR EMBOSSED GLASS, &c., *G. Rydill, London.—4th August, 1883.* 6*d.*

This relates to the treatment of designs on paper, with oils, fats, wax, or gum to render the same translucent, and then placing them between two sheets of glass. It further relates to printing designs with asbestos or other fireproof paints or colouring matter.

3823. SPRING MATTRESSES, SHIPS' BERTHS, &c., *A. Lawrie, Birmingham.—4th August, 1883.* 6*d.*

This relates to the construction of wire network, especially applicable for use in spring mattresses, ships' berths, and seatings of sofas, chairs, and other articles for sitting or reclining upon.

3824. APPARATUS FOR THE TREATMENT OF VAT WASTE, *H. Kenyon, Altrincham.—4th August, 1883.—(Not proceeded with.)* 2*d.*

Relates to improvements in the general construction of apparatus.

3825. VELOCIPEDES, *H. J. Lawson, Coventry.—4th August, 1883.* 6*d.*

This relates to a friction cone clutch worked by a handle in combination with a method of driving direct on the axis of tricycles.

3826. TREATMENT OF BREWERS' YEAST, *J. S. Lord, Newark-on-Trent.—4th August, 1883.* 2*d.*

The object is to preserve brewers' yeast, rendering it light, dry, and easily portable for exportation, and capable of keeping for months. The yeast, as taken from the brewers' fermentation, is pressed, and then mixed with a saturated solution of carbonate of lime.

3827. ELECTRIC LAMPS OR LIGHTING APPARATUS, *W. R. Lake, London.—4th August, 1883.—(A communication from La Société F. Girard et Cie., Paris.)—(Not proceeded with.)* 2*d.*

This relates to an arc lamp, the upper carbon of which descends, by gravity, between two rollers whose movements are controlled by an electro-magnet.

3828. CALCULATING MACHINES, *W. R. Lake, London.—4th August, 1883.—(A communication from K. Duschanek, Freiburg.)* 10*d.*

Relates to the general arrangement of the mechanism in these machines.

3829. PROCESS OF TANNING, *W. Clark, London.—4th August, 1883.—(A communication from G. Dalla Zonca, Venice.)* 4*d.*

Relates to a process of tanning hides and skins with vegetable substances only.

3830. HOISTS FOR RAISING AND LOWERING WEIGHTS, *T. and W. Brown, Bolton.—6th August, 1883.* 6*d.*

Consists in apparatus for arresting or stopping the "cage" when the rope or other equivalents break when used in connection with round iron or wire guide rods, together with the means for releasing the "cage," so as to descend gently or otherwise to a more convenient part of the "shaft" for repairs. Also in improved guides to reduce the friction to a minimum, at the same time prolonging the life of the guide rods.

3831. MANUFACTURE OF BEER, DISTILLED LIQUORS, SYRUPS, OR EXTRACTS, *W. Clark, London.—7th August, 1883.—(A communication from A. E. and W. E. Feroe, Tivoli, and J. S. Bancroft, New York.)* 4*d.*

Relates to the employment of corn-meal in the making of beer, syrups, and distilled liquors.

3833. BICYCLES, AND CERTAIN APPLIANCES CONNECTED THEREWITH, &c., *A. C. Henderson, London.—7th August, 1883.—(A communication from G. Rothgiesser, Bielfeld, Prussia.)* 6*d.*

This relates, First, to the saddles; Secondly, to an adjustable step for mounting bicycles; Thirdly, to saddle bags, pocket, or cases; Fourthly, to the manner of suspending the lamp; Fifthly, to the oil cans; Sixthly, to the addition to bicycles of a gradient measure; Seventhly, to a spanner.

3834. CORES FOR CASTING STEEL AND OTHER METALS, *H. A. Gadsden, London.—7th August, 1883.—(A communication from J. A. Herrick, New York.)—(Not proceeded with.)* 4*d.*

Relates to the employment of a silica mixture in ventilated cores.

3835. APPARATUS FOR COUNTERACTING THE THRUST OF SCREW PROPELLER AND OTHER SHAFTS, *G. A. Teulon, London.—7th August, 1883.* 6*d.*

This consists in causing a pressure of steam, gas, air, or other elastic fluid, which pressure is regulated so as to increase and decrease as the speed of the screw varies, to act upon a disc or piston fixed to the shaft, and revolving in a closed chamber.

3836. APPARATUS FOR STOPPING, NIPPING, OR HOLDING CABLES OR ROPES, *T. C. Guillaume, Cologne.—7th August, 1883.* 4*d.*

A fixed frame having a curved grooved surface is placed over a similarly grooved pulley, both surfaces being formed according to the archimedian spiral. The rope passes through the channel formed by the opposite grooves, and by turning the pulley the motion of the rope can be checked.

3838. BOATS, CHIEFLY FOR RACING PURPOSES, AND OARS THEREFOR, *A. J. Boult, London.—7th August, 1883.—(A communication from M. F. Davis, Portland, U.S.)—(Not proceeded with.)* 4*d.*

Relates to the general construction of the boat, and also to the peculiar construction of the oar.

3839. COMPOUNDS FOR ELECTRIC WIRE INSULATORS, PIPES, &c., *W. P. Thompson, Liverpool.—7th August, 1883.—(A communication from J. F. Martin, Chicago, Ill., U.S.)* 4*d.*

Asphaltum, liquidised by heat, has added to it 40 to 60 per cent. of fine marble dust. After thorough mixing the hot liquid is run into moulds of the desired form.

3840. TAPS OR COCKS, *S. Defries, London.—7th August, 1883.* 6*d.*

The cock is composed of a shank having a closed butt and a branch connection carrying a cock, the main object being to enable it to be disconnected from one cask and inserted in another.

3841. WATCH KEYS AND HOLDING TOOLS, *J. S. Birch, New York.—7th August, 1883.* 6*d.*

Relates to a watch key having jaws that open and close by sliding out and in the end of the case, the end of the said case and the backs of the jaws bearing thereon having curves by which the turning of the key in winding the watch binds said jaws more tightly on the watch post.

3842. APPARATUS FOR CIRCUIT CLOSERS AND CONNECTIONS FOR ELECTRIC ALARMS, *H. W. Ferris, Merton, Surrey.—7th August, 1883.* 6*d.*

A series of upper and under plates are attached to an india-rubber mat or rug, in such a manner that when the mat is trodden on they complete the circuit of an alarm bell.

3845. BREECH-LOADING SMALL-ARMS, *T. Woodward, Aston.—7th August, 1883.—(Not proceeded with.)* 2*d.*

Relates to improvements in the lock mechanism of small-arms.

3846. MEANS AND APPARATUS TO BE EMPLOYED IN THE TRANSMISSION OF THE ELECTRIC CURRENT TO ELECTRIC LAMPS OR VESSELS, &c., *A. L. Fyfe and L. Goldberg, London.—7th August, 1883.* 8*d.*

The conductors are carried on wheels, and are connected, one end of each, to the insulated axes, to which the generators are also connected by adjustable contact pieces.

3847. ELECTRIC SIGNALLING AND FIRE-EXTINGUISHING APPARATUS, *W. R. Lake, London.—7th August, 1883.—(A communication from S. Ziembinski, Cracow, M. Szwambaum and H. Stypulkowski, Warsaw.)—(Not proceeded with.)* 4*d.*

This relates to an apparatus for automatically signalling a fire and turning on a water valve, either when the temperature has reached a predetermined point or should it rise at an abnormally rapid rate.

3848. FIREPLACES AND FIRE-BACKS, *W. Clark, London.—7th August, 1883.—(A communication from J. H. Burnam, Fayetteville, U.S.)* 6*d.*

Consists of a fireplace or frame enclosed in a chimney in a partition wall between two adjoining rooms on the same floor, the opening in the fireplace extending through it and into the adjoining room, and a metallic heat-conducting fire-back inserted into said opening in the fireplace or frame and provided with a grate, so that a fire made in the grate in one room will heat it and also the adjoining room on the same floor.

3849. DIFFERENTIAL PULLEY BLOCKS, *W. T. Eades, Birmingham.—8th August, 1883.* 6*d.*

Refers principally to "Weston's differential blocks" and consists essentially in the manner of making or forming the arms carrying the chain confining or guiding tubes for preventing the twisting of chains. The said arms, which are produced from wrought iron, are each formed in one piece, and together constitute the sides of the frame, both of the top and bottom blocks, the frames being usually made from malleable cast iron.

3850. MACHINERY FOR SIFTING, SEPARATING, OR PURIFYING FLOUR, &c., *J. H. Johnson, London.—8th August, 1883.—(A communication from H. Cabanes, Bordeaux.)* 6*d.*

The apparatus combines the functions of a separator and purifier with those of a sifter, and it consists of a frame actuated by a cam shaft and springs, and moving vertically and horizontally in a case. To this frame another frame or series of frames or sieves covered with cloth or gauze is attached, and receives the materials from a hopper. Fans are arranged to deliver a current of air in a horizontal direction both above and below the sieves.

3851. CONSTRUCTION OF GAS LANTERNS FOR LIGHTING STREETS, &c., *J. H. Johnson, London.—8th August, 1883.—(A communication from R. Kraussé, Germany.)* 8*d.*

This consists in admitting warm air in the quantity required by arranging the cross section of apertures of tubes in the proper proportion. The lantern is tightly locked, and a cap or cover prevents the entrance of wind.

3852. VENETIAN BLINDS, *G. Dreghorn, Inverness.—8th August, 1883.—(Not proceeded with.)* 2*d.*

This consists in replacing the tapes by links and bands of metal.

3853. AUTOMATIC SAFETY CAR SIGNALS, *W. H. Rushforth, New Jersey, U.S.—8th August, 1883.* 6*d.*

The object is to protect standing trains from collision from the rear, and it consists in connecting a danger signal with a system of pneumatic brakes operated from the engine or upon the breaking of a coupling, so that when the brakes are applied the signal will be exposed.

3854. LOOMS FOR WEAVING, *R. H. Brandon, Paris.—8th August, 1883.—(A communication from G. Crompton, Worcester, U.S.)* 10*d.*

This relates to improvements in the shed forming mechanism, and in the combination therewith of shuttle-box operating mechanism, and also in the method of weaving in open shed looms. The jacks are formed of bars, with three series of teeth, two on one edge and one on the other. Two partial gears are arranged to intermittently engage teeth at opposite edges, and a pattern surface places the teeth in gear with one or the other of the partial gears. Vibrators actuated by one series of teeth are connected so as to move the pattern chain or surface.

3855. PROCESS OF AND APPARATUS FOR DISTILLING PEAT AND OBTAINING BYE-PRODUCTS THEREFROM, *F. C. Glaser, Berlin.—8th August, 1883.—(Not proceeded with.)* 4*d.*

The peat is treated in a furnace or oven consisting of a series of vertical shafts having at bottom a stepped grating. The walls of the shafts have about half-way up rows of channels which can be put into communication with an exhaust to draw off the carbonic oxide gas there formed. In the upper part of the shaft is an opening connected to a pipe for leading the gases generated to a cooler or scrubber of special construction. Larger flues in the upper parts of the partition walls carry off the heated air.

3856. PRODUCTION OF SODA CRYSTALS IN THE MANUFACTURE OF SODA BY THE AMMONIA PROCESS, *C. D. Abel, London.—8th August, 1883.—(A communication from La Société Anonyme des Produits Chimiques de Sud-Ouest, Paris.)* 4*d.*

A mixture of water and bicarbonate of soda is raised to boiling point, whereby the bicarbonate is transformed into sesqui-carbonate. A certain quantity of hot water is then added and violent ebullition produced, accompanied by stirring, whereby about 80 per cent. of the excess of carbonic acid will be driven off, and a solution of carbonate of soda mixed with a slight proportion of bicarbonate will be produced. This is brought to a gravity of from 30 deg. to 40 deg. Beaumé, and is then allowed to cool in deep crystallising vessels. The carbonic acid gas separated is drawn off by a pump, and utilised in the manufacture of soda by the ammonia process.

3857. SILO AND PRESS IN CONNECTION THEREWITH, *S. H. Stocks, Cleckheaton.—8th August, 1883.* 6*d.*

The object is to construct a silo so that the contents can be easily pressed by hand and that such silo shall be portable, and it consists of a wooden chamber with a cover fitting over ties or rods and capable of being tightened by screws and springs.

3859. BREECH-LOADING SMALL-ARMS, *W. M. Scott, Birmingham.—8th August, 1883.* 6*d.*

This relates to the arrangement for cocking the hammers of drop-down guns when the breech ends of the barrels are raised from the break off; and also to means for tightening or adjusting the fore end on the body of the gun to compensate for wear of the bearing parts of the joint and loop.

3860. MACHINE FOR TRIMMING THE EDGES OF CARDS FOR COMBING FIBROUS MATERIALS, *H. H. Lake, London.—8th August, 1883.—(A communication from F. G. Beaumont, France.)* 8*d.*

The characteristic feature of this invention is an arrangement for guiding the strips or bands of cards for combing fibrous materials, so as to enable a band saw or endless blade to be used for trimming their edges.

3861. MACHINERY FOR WASHING AND DRYING TEXTILE MATERIALS IN DYE WORKS, &c., *W. E. Gedge, London.—8th August, 1883.—(A communication from J. Chavanne, E. Bruyas, and J. P. Balm, France.)* 6*d.*

This relates to an apparatus for both washing and drying, and which is constructed on the principle of a centrifugal hydro-extractor, and it consists in an arrangement for enabling water to be supplied to the machine while at work, and also in constructing the basket so as to permit a stick furnished with hanks to be placed therein, and held immovable during the action of the machine.

3862. CONSTRUCTION OF SHIPS AND VESSELS, *C. P. Schaeffer, London.—8th August, 1883.—(A communication from O. Holtermann, France.)—(Not proceeded with.)* 10*d.*

The object is to construct vessels so as to travel at a great speed, and it consists in making the immersed portion of the hull in the form of an "ordinary spinning spindle" or a form approximating that of the solid generated by the revolution of a segment of a circle about its chord.

3863. CRANES, HOISTS, &c., *F. Service, Newport, Monmouth.—8th August, 1883.—(Not proceeded with.)* 4*d.*

In one arrangement columns are fixed to a boat or to a truck and the cranes secured to a loose collar with brackets so as to allow them to turn, and also slide on the columns by means of a rope coiled on a drum. The winding rope passes down through the column to the winding drum.

3864. TUNNELS AND SUBWAYS, &c., *G. Edwards, Hanwood, Salop.—9th August, 1883.* 6*d.*

This relates to means for constructing tunnels under water, and it consists in the use of a working chamber in which tubes are formed, and which chamber can be moved backwards and forwards as required.

3865. SPEAKING TUBES FOR VEHICLES, &c., *F. W. Redfern and R. Wilkinson, Derby.—9th August, 1883.* 6*d.*

This relates to the use of a telescopic tube arranged so that when the tube is shut a whistle will be blown.

3867. BARRING ENGINES OR ENGINES FOR TURNING LARGE ENGINES, *W. Hargreaves and W. Inglis, Bolton.—9th August, 1883.* 8*d.*

The object is to cause the barring engine to be automatically disconnected from the large engine when the latter attains speed greater than that of the barring engine, and it consists in arranging a pinion driven by the barring engine and gearing with a toothed flywheel on the large engine shaft, so that when such pinion ceases to drive the fly-wheel it will, by the action of the fly-wheel, be moved out of gear therewith, and for which purpose the pinion is supported on a shaft in a pivotted frame.

3868. SCREW PROPELLERS, *L. Barstow, York.—9th August, 1883.—(Not proceeded with.)* 2*d.*

The blades are formed with one or more openings in their width near the boss, so that a portion of the water pressed upon by the blade will escape through such openings and greatly diminish the resistance. The after edges of the metal on each side of the holes are formed with a driving face to propel the water through the openings.

3871. NOBLE' COMBING MACHINES, *H. Priestmann, F. K. Adcock, J. Brown, and J. Copley, Bradford.—9th August, 1883.* 6*d.*

The object of the invention is to stop the rotation of the comb as soon as a small lap gathers around the drawing-off roller. The rubber working in contact with the drawing-off rollers is used to wipe off the moisture therefrom given off by the wool, the rubber being hinged and forced by a spring against one of the rollers. A series of levers are in connection with the rubber and also with the usual stop-rod, so that when a "lap" is forming round the drawing-off roller the thickness thereof above the surface of the roller will raise the rubber in such a manner that the lever will release the stop-rod and stop the machine.

3874. BREECH-LOADING SMALL-ARMS, *T. Horsley, York, and C. Pryse, Birmingham.—9th August, 1883.* 6*d.*

Drop down guns are constructed so that when the breech ends of the barrels are raised the stand sides of the main springs raise the hammers to full cock, in which position they are retained by the ordinary sear and bent mechanism until released by pressure on the triggers. On shutting down the barrels the main springs are depressed so as not to impede the descent of the hammers.

3876. MANUFACTURE OF GUNPOWDER, *O. Bowen, London.—9th August, 1883.—(Not proceeded with.)* 2*d.*

This consists of a mixture of 18 to 21 per cent. of carbonised powdered lignite, 4 per cent. sulphur, and 74 to 77 per cent. nitre, about 1 per cent. of water being added during mixing.

3878. CRANK SHAFTS FOR STEAMSHIPS, *J. Russell, Cardiff.—9th August, 1883.* 8*d.*

The object is to prevent breakage or undue straining of crank shafts, and it consists in making one end of the crank pin, not in a piece with the corresponding crank arm, but separate therefrom, and passing it through a brass bush made in sections of a tapering form and which fits a hole in the crank arm end. The sections are adjustable.

3883. CONSTRUCTION OF INCANDESCENT LAMPS, &c., *T. T. Smith, London.—10th August, 1883.* 10*d.*

Contact is made by a pair of metallic plates fitted within a tubular extension of the lamp, and connected with the filament, and a pair of insulated metal tongues, mounted within a socket on the lamp support. The tongues are distended by a spring, and make contact when the lamp is partly rotated in the socket. A movable support has a tripod base, and means to adapt it for suspension against a flat surface. The invention further relates to a switch coupling for rapidly bringing the leads within a flexible cord into electric connection with a pair of fixed spring terminals, and to a switch.

3884. MANUFACTURE OF PRECIPITATED PHOSPHATE OF LIME, AND RECOVERY OF SULPHUR FROM ALKALI WASTE, *W. Weldon, Surrey.—10th August, 1883.—(A communication from E. Lombard, Marseilles.)* 4*d.*

The inventor claims, First, employing solution of calcium sulphydrate as the reagent by which to precipitate dicalcic phosphate from solution of phosphate of lime in hydrochloric acid; and, Secondly, in combining said method of obtaining dicalcic phosphate with the recovery of sulphur from alkali waste by using that body as the raw material from which the solution of calcium sulphydrate used to precipitate dicalcic phosphate from a solution of phosphate of lime in hydrochloric acid is prepared.

3886. STORAGE OR SECONDARY BATTERIES, *A. J. Jarman, London.—10th August, 1883.* 6*d.*

In forming the battery two cylindrical lead plates are used, one being shaped so as to coat the inside of a stoneware cell, the other occupying a central position in the cell. Between the cylinders is packed a quantity of amorphous lead, constructed by pouring red hot lead into a solution of alcohol and water; this is maintained in position and in contact with the lead cylinders by packing the annular spaces with, preferably, glass wool or beads. Sulphuric acid and water is used as the exciting fluid.

3893. DUMPING BOATS OR SCOWS, *H. E. Newton, London.—11th August, 1883.—(A communication from the Barney Dumping Boat Company, Incorporated, New Jersey, U.S.)* 6*d.*

This relates to dumping boats, in which two floats or pontoons are hinged at their upper and outer longitudinal edges to platforms or deck pontoons, and consists in means for holding the floats together to receive the load; also in means for controlling or retarding their opening, and, further, in means for holding them in their open position while being towed through the water.

3894. STEAM AND OTHER PISTONS, *A. MacLaine, Belfast.—11th August*, 1883. 6*d*.

This relates to improvements on patents No. 408 and No. 2802, both in the year 1883, in which a double expansion movement is imparted to metallic packing rings of pistons, and it consists in the use of gunlock or other similar short springs inside the packing rings, so as to aid the coil springs in expanding the packing rings circumferentially.

3895. LETTER-PRESS PRINTING MACHINES, *A. Godfrey, Lancaster.—11th August*, 1883. 6*d*.

This relates to "double-feed single cylinder letter-press machines," and also to platen machines, and the objects are, First, to enable the grippers of the former machines to be adjusted to different lengths of forme; Secondly, to enable the feed tables to be adjusted to suit the grippers; Thirdly, to improve the "lay" apparatus, so as to obtain a perfect register; Fourthly, to improve the "take-off," so as to suit the double feed; Fifthly, to adapt the improved "lay" apparatus to the feed table of a platen machine; Sixthly, to adapt a locking lever apparatus to a platen machine, as described in patent No. 1591, A.D. 1883; and, Seventhly, in adapting bearers and stops to such machine to preserve a uniformity of pressure over the "forme" and to prevent all "slur."

3896. DYEING COTTON FABRICS, *E. A. Gatty, Accrington.—11th August*, 1883. 2*d*.

The object is to dye fabrics chrome-yellow by precipitating oxide of lead thereon in the wet state with gaseous ammonia.

3898. APPARATUS FOR HEATING, HARDENING, AND TEMPERING STEEL WIRE USED IN THE MANUFACTURE OF CARDS, &c., *N. White, H. Hoyle, and F. W. Thomson, Halifax.—11th August*, 1883. 10*d*.

The wire is caused to pass under two bars of brass or copper heated by the passage of an electric current, and then through a hardening bath of oil or water. The tempered wire is ground and pointed by means of emery discs formed with steps, projections, and recesses.

3901. CONSTRUCTION OF ELECTRIC SWITCH OR APPARATUS FOR MAKING AND BREAKING CONTACTS, *J. Lea, London.—11th August*, 1883. 6*d*.

To prevent injury from sparking, the switch is so constructed as to break contact at a number of points simultaneously, the points where the breaks occur being easily adjusted or replaced.

3904. APPARATUS FOR CONTROLLING THE MOVEMENTS OF THE FEEDING BELLS OF BLAST FURNACES, *T. Wrightson, Stockton-on-Tees.—11th August*, 1883. 8*d*.

This relates to improvements on patent No. 1803, A.D., 1870, and it consists in the use of an hydraulic cylinder to control the feeding bell of a blast furnace, the piston of such cylinder being connected by its rod with the further arm of the lever from which the bell is suspended. The lever carries a counterweight to raise the bell and close the feed hopper when the lever is released from a catch rod, such movement being controlled by the hydraulic cylinder.

3910. MANUFACTURE OF INCANDESCENT ELECTRIC LAMPS, *A. Swan, Gateshead-on-Tyne.—13th August*, 1883. 6*d*.

The piece of glass or other insulating material usually employed for holding the conducting wires within the globe at the required distance apart is dispensed with. The wires, with the filament attached, are held in a pair of tweezers until sealed in the neck of the lamp.

3911. ACTIONS FOR PIANOFORTES, &c., *E. A. Brydges, Berlin.—13th August*, 1883.—(*A communication from A. Lexow, Berlin.*) 6*d*.

The object is to render the pressure of the releasing action imperceptible, and to secure a ready and precise releasing movement by employing an arm or releasing arrangement, which arm is provided with a suitable inclined surface, near or over which the fulcrum of the jack or hopper is arranged.

3912. APPARATUS FOR FEEDING THE ROLLERS AND PURIFIERS EMPLOYED IN THE MANUFACTURE OF FLOUR, *S. Leetham, York.—13th August*, 1883. 6*d*.

A hopper has a feed roller at bottom, and is divided near the centre by a hinged plate, the lower end of which is in close contact with the feed roller, so that the weight of the material must raise the plate before it can pass. A spring acts on the plate and regulates its pressure on the roller.

3915. INCANDESCENT ELECTRIC LAMPS, *G. F. Redfern, London.—13th August*, 1883.—(*A communication from A. Bernstein, Boston, U.S.*) 6*d*.

The filaments are made of tubes of paper or silk carbonised in the usual manner, and are attached to the conducting wires by large carbon sockets. The lamp fitting consists of a metallic socket. One wire is attached to the socket, the other passes through an insulated screw fitted in the centre of the socket, and terminates below the screw in a flat head.

3916. KILNS FOR BURNING LIME, BRICKS, CEMENT, &c., *W. Kemp, Miller's Dale, Derby.—13th August*, 1883. 6*d*.

This relates to an arrangement of a series of chambers to receive the lime or bricks, in combination with a furnace and a combustion chamber, from which the products of combustion are conducted by flues to the chambers containing the material to be burned.

3918. LOCKS FOR SECURING TRAVELLING AND OTHER BAGS, &c., *J. H. Ross, Dublin.—13th August*, 1883. 6*d*.

Projections or studs are attached to the lock bolt or other part, which is pressed down vertically to open the bag, and by acting upon levers cause the latter to be disengaged from catches on the other side of the frame of the bag.

3919. RESERVOIR PENHOLDERS, *J. D. Carter, London.—13th August*, 1883. 4*d*.

The object is to enable nibs of any length to be used with reservoir penholders; and it consists in making the tongue or capillary tube, which supplies ink to the nib, telescopic or otherwise adjustable to suit the particular nib employed.

3922. MANUFACTURE OF HYDROCHLORIC ACID FROM CHLORIDE OF AMMONIUM, &c., *L. Mond, near Northwich.—13th August*, 1883. 4*d*.

Chloride of ammonium is treated with an excess of sulphuric acid, so that when heated to, say, 250 deg. Cent. the whole of the hydrochloric acid is obtained from the chloride of ammonium without volatilising any ammonia. The residual product is an acid sulphate of ammonium, which is treated with ammonia or carbonate of ammonia in solution, or in the gaseous form, to convert it into neutral sulphate of ammonia, a valuable manure. The acid sulphate ammonia may also be mixed with insoluble or difficultly soluble phosphates to make a valuable manure.

3923. OBTAINING AMMONIA, TARRY MATTERS, AND COMBUSTIBLE GASES FROM COAL, &c., *L. Mond, Northwich.—13th August*, 1883. 4*d*.

This consists in converting the entire combustible matter in coal into gases at one operation by passing through such fuel air mixed with a large excess of steam or water, so as to maintain the mass at a dull red heat throughout, whereby an increased yield of ammonia is obtained.

3927. DISINTEGRATING, PULVERISING, AND GRINDING MACHINERY, *T. G. Bowick, Bedford.—13th August*, 1883. 6*d*.

This consists mainly in employing a current of air to regulate the fineness of the material produced by the disintegrating and pulverising process, and which can be varied in strength independently of the speed of the rotating blades or balls in the pulveriser.

3932. FIBRES FOR UPHOLSTERY, &c., *P. M. Justice, London.—14th August*, 1883.—(*A communication from J. G. Stephens, Brooklyn, U.S.*) 8*d*.

This relates to the production of curled fibres for upholstery purposes by coiling the same around a mandril to shape the curl or coil, and rubbing or ironing them at the same time to set or fix them in shape, the fibres being preferably heated while being rubbed.

3935. MANUFACTURE OR PREPARATION OF PAPER FOR COPYING PURPOSES, *W. P. Thompson, Liverpool.—14th August*, 1883.—(*A communication from M. W. Brown, Brooklyn, U.S.*) 4*d*.

This consists in treating paper to be used for copying purposes with a solution of chloride of magnesium, whereby it is kept permanently moist.

3941. ARTIFICIAL STONE OR STONE WARE, *H. J. Haddan, London.—14th August*, 1883.—(*A communication from J. Hemmerling, Germany.*) 2*d*.

A mixture of ground furnace slag, colouring matter, and soluble glass is prepared, and forms a powder to which soluble glass is added, and forms a paste which is run into moulds and backed with a mixture of cement and slag-sand, the whole being subjected to hydraulic pressure, and the blocks formed, dipped into soluble glass.

3943. SPORTING AND OTHER POCKET KNIVES, *T. Crookes, Sheffield.—14th August*, 1883.—(*Complete.*) 2*d*.

This consists in forming the ends of knives into cartridge extractors, and making a notch on the back of the blades so that the rim of any sized cartridge can be gripped and extracted from any central fire gun.

3948. MANUFACTURE OF PLIABLE PLATES AND SURFACES AS A SUBSTITUTE FOR GLASS FOR PHOTOGRAPHIC PURPOSES, &c., *J. J. Sachs, London.—14th August*, 1883.—(*A communication from Fickeissen and Becker, Germany.*) 4*d*.

Paper or a suitable fabric is stretched on a frame and its surface covered with fine varnish, and when dry the surface is made smooth by pumice stone or otherwise. It is then covered with a solution of gelatine isinglass. The emulsion for photographic or other use is then applied.

3953. BOOTS AND SHOES, *A. Bowman, Birmingham.—15th August*, 1883. 6*d*.

This consists in making an incision and doubling back the underlay of the upper leather of a boot or shoe so as to form an imitation welt, a separate top piece being inserted to form a continuation thereof.

3958. APPARATUS FOR FACILITATING COMMUNICATION AND THE TRANSPORT OF CASH OR OTHER ARTICLES BETWEEN DIFFERENT PARTS OF A SHOP, &c., *W. R. Lake, London.—15th August*, 1883.—(*A communication from G. R. Elliott, Boston, U.S.*)—(*Complete.*)—(*Void.*) 6*d*.

This relates to the arrangement of wires between the different points, wheeled carriers being arranged to travel thereon.

3961. TREATING CALCAREOUS AND DOLOMITE MARL AND FURNACES AND OVENS THEREFOR, *C. R. Cowens and W. J. Smith, Durham.—15th August*, 1883. 4*d*.

The marl is mixed with coal and charged into a fire-brick furnace or oven, which is divided into shelves or beds, the mixture being raked from bed to bed at stated intervals.

3971. PRODUCTION OF CERTAIN COLOURING MATTERS APPLICABLE TO DYEING AND PRINTING, *T. Holliday, Huddersfield.—16th August*, 1883. 4*d*.

This consists in the combination with fluorols or their sulpho acids of the diazo compounds of benzole, toluole, xylole, cinnole, naphthols, fluorols; the sulpho acids of these diazo compounds—diazo-amido-azo compounds of benzole, toluole, xylole. The process is similar to the one now in use for the manufacture of azo colours.

4003. TELEPHONIC APPARATUS, *G. H. Bassano, A. E. Slater, and F. T. Hollins, Derby.—17th August*, 1883. 6*d*.

A microphonic contact is used in place of the ordinary diaphragm in combination with a trumpet-mouthed case, or a plate of non-inductive material may have microphonic pencil contacts attached to it, and be actuated by an electro-magnet in such a manner as to form a transmitter, receiver, and relay.

4017. STOP VALVE, *J. A. and J. H. Hopkinson, Huddersfield.—18th August*, 1883. 6*d*.

This relates to improvements on patent No. 4586, A.D. 1881, the principal object being to facilitate the insertion of the sliding part or valve into its place between the valve seats and its withdrawal therefrom, and it consists in making the valve-box lid with a dome of sufficient size to receive the valve when opened.

4062. LAWN TENNIS MARKERS, *W. N. Hutchinson, Bideford.—20th August*, 1883. 6*d*.

A barrel is mounted on wheels and contains the marking fluid, and a tap at the bottom of the barrel is under the control of the driver of the machine, so that when opened a stream of fluid flows on to a small wheel travelling upon the ground to be marked out.

4207. PRODUCTION OF A NEW SOLID BASE BY REACTION OF ALDEHYDE AND HYDROCHLORATE OF ANILINE OR THEIR EQUIVALENTS, *J. Imray, London.—31st August*, 1883.—(*A communication from the Actien Gesellschaft für Anilin-Fabrikation, Berlin.*) 4*d*.

This consists in the production of bases by the action of aldehyde, paraldehyde, aldol, acetal, or crotonaldehyde upon the salts of aniline, toluidine, anisidine, or naphthylamine, and the conversion of these bases into the corresponding chinaldines.

4217. GASALIERS, &c., *T. Ford, Birmingham.—1st September*, 1883. 6*d*.

This relates to means for fixing globes or shades to gasaliers, gas brackets, and other gas lamps; and also to fixing perdifumes, smoke absorbers, reflectors, or other articles above the globes or shades; and it consists in applying a jointed arm to the bracket, such arm having a hook to clip the top of the globe, and carrying at its free end the perdifume, smoke absorber, reflector, or other article.

4408. TREATMENT OF HOPS AND APPARATUS THEREFOR, *G. F. Redfern, London.—14th September*, 1883.—(*A communication from F. Slama and F. Felix, Austria.*) 6*d*.

This consists in subjecting hops before boiling them with the wort to a tearing process, whereby their useful principles can be more thoroughly extracted; and further, to a machine for effecting the tearing of the hop cones.

4678. APPARATUS FOR ATTACHING BUTTONS TO TEXTILE FABRICS, &c., *J. T. Atwood, Boston, U.S.—2nd October*, 1883.—(*Complete.*) 4*d*.

This relates to a fastening device consisting of a bent wire forming a staple with arms of unequal length.

5363. TREATING CALCAREOUS PHOSPHORITES OR ORES FOR CONVERTING THE CARBONATE OF LIME CONTAINED IN THE SAME INTO PHOSPHATE OF LIME, *W. R. Lake, London.—13th November*, 1883.—(*A communication from J. Cox, Germany.*) 4*d*.

This consists in converting the carbonate of lime contained in calcareous phosphorites or ores into phosphate of lime soluble in water, or into assimilable bibasic phosphate of lime, or into tribasic phosphate of lime, or into a mixture of these substances, by means of phosphoric acid.

5453. HOUSING AND INSULATION OF ELECTRICAL WIRES BENEATH THE SURFACE OF THE GROUND, *H. J. Allison, London.—20th November*, 1883.—(*A communication from C. C. Gilman, Eldora, Io., U.S.*) 6*d*.

The underground conduit is built up of terra-cotta slabs rendered cellular by the process described in patent No. 4634, of 1881, and saturated with asphaltum. The wires are carried in grooved slabs of terra-cotta treated as above and supported on brackets erected within the conduit.

5534. ASH HOISTS, *J. D. Spreckels, San Francisco.—27th November*, 1883.—(*Complete.*) 6*d*.

This consists essentially of a chain of buckets suitably driven, and lifting the ashes from a receiver at bottom and discharging them into a chute or discharge pipe leading outside the ship or vessel, a cut-off slide being arranged to arrest and divert coals when thus hoisted.

5624. EXPLOSIVE COMPOUNDS AND PROCESSES FOR PREPARING THE SAME FOR USE, *S. R. Divine, New York.—4th December*, 1883.—(*Complete.*) 4*d*.

This consists essentially in the use of chlorate of potash or of perchlorate or permanganate of potash and the heavy oil of coal tar, combined in the proportions of about 7½ parts of the solid ingredient to about 1 part of the liquid ingredient.

5698. APPARATUS FOR PROVIDING HEAT AND GENERATING STEAM, *V. W. Blanchard, New York.—11th December*, 1883.—(*Complete.*) 6*d*.

The object of the First part of the invention is to mix heated air under pressure in regulated quantities with the products from the distillation of fuel, and to cause the said air and products to descend upon and in a bed of incandescent fuel, whereby complete combustion and intense heat is obtained and economy of fuel effected; and the object of the Second part is to construct a steam generator applicable to the improved furnace, and in which there is a constant circulation of water contained therein, in combination with a steam-air circulation, the generator and its several parts being so constructed that there will be no interference between the water circulation and the steam circulation.

5699. STEAM GENERATORS, *H. J. Allison, London.—11th December*, 1883.—(*A communication from J. E. Culver, Jersey, U.S.*)—(*Complete.*) 6*d*.

A cylindrical shell encloses a steam space and a water space, and is furnished with a feed pipe at bottom and a steam pipe at top. A multitubular structure is contained in the water space, and consists of two chambers connected by tubes. Water tubes cross the flue chambers and connect the water above them to the water beneath. A furnace of semi-elliptical shape in transverse section abuts against a secondary combustion chamber, so that its archway coincides with the upper semicircle of the entrance thereto.

5717. ELECTRIC LOW-WATER ALARMS FOR STEAM BOILERS, &c., *A. M. Clark, London.—12th December*, 1883.—(*A communication from T. McKenna and H. Carley, Long Branch, N.Y., U.S.*) 6*d*.

Mercury is employed to complete the circuit of an electric bell when the temperature becomes too high, the apparatus being attached to the boiler in such a manner that steam will reach the mercury-containing bulb when the water falls too low.

5773. REFRIGERATOR CARS, *C. C. Clay, Oakland, U.S.—18th December*, 1883.—(*Complete.*) 10*d*.

This relates to the construction of a machine which may be used for refrigerating air in railroad cars by means of the compression, cooling, and expansion of a volatile fluid; and which machine is also especially adapted for employing chloride of ethyl as the volatile fluid. The apparatus consists, First, in means for driving the gas compressing engine; and Secondly, in means for compressing the gas, cooling it, expanding it, and conducting the air into such proximity to it that the heat of the air is absorbed by the gas. The air is compressed and drives the engine to compress the volatile fluid, which fluid when compressed is cooled and expanded under a partial vacuum in a refrigerator.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

293,242. INSULATOR FOR ELECTRIC WIRES, *Albert W. Hale, Plainfield, N.J.—Filed May 17th*, 1883.

Claim.—(1) As a new article of manufacture, metallic insulators for electric wires, combining in a single piece a bearing for the wire and a means of attachment to the support, insulated and made insulating by a complete covering of glaze, substantially as and

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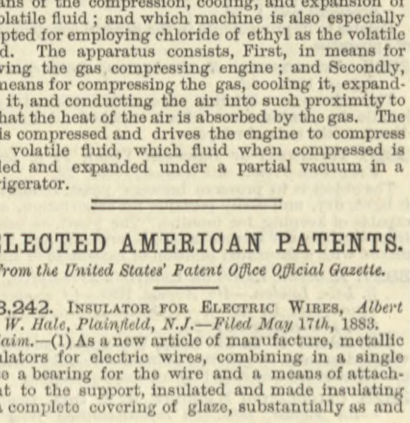

for the purposes set forth. (2) As a new article of manufacture, metallic insulators for electric wires, protected from atmospheric influences, and also insulated from both the wire and the support for such insulators by a complete covering of glaze.

293,434. INCANDESCENT ELECTRIC LAMP, *Thomas A. Edison, Menlo Park, N.J.—Filed August 7th*, 1882.

Claim.—(1) In an incandescing electric lamp, the device for holding an end of the carbon during the process of electro-plating, consisting of a flat piece of copper bent twice lengthwise upon itself, substantially

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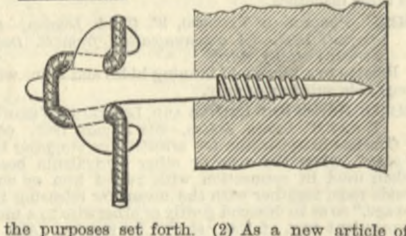

as set forth. (2) The leading-in wires of an incandescing electric lamp, having their inner extremities formed into or attached to flat metal strips, each bent twice lengthwise upon itself, substantially as and for the purpose set forth.

293,435. ELECTRICAL METER, *Thomas A. Edison, Menlo Park, N.J.—Filed August 14th*, 1882.

Claim.—(1) In an electrical meter, the combination

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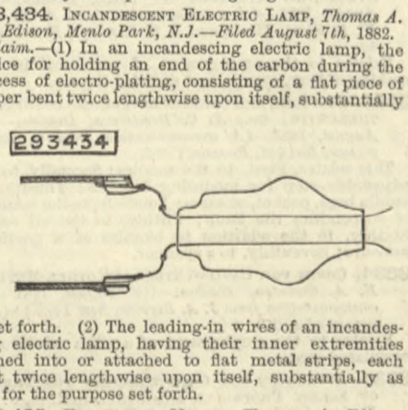
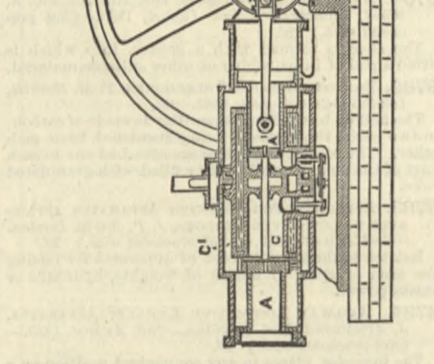


of the pivotted beam, oscillated by an electro-magnetic mechanism for moving the beam in both directions by electro-magnetic action, of a recording apparatus, and reciprocating dash-pot plungers attached to such beam, substantially as set forth. (2) In an electrical meter, the combination, with a pivotted beam, of electro-magnets for tipping such beam in opposite directions, a circuit controller moved by the beam, and a recording apparatus, substantially as set forth. (3) In an electrical meter, the combination, with a pivotted beam, of electro-magnets for tipping such beam in opposite directions, means for retarding the movement, and circuit controller moved by the beam, and a recording apparatus, substantially as set forth. (4) In an electrical meter, the combination, with a pivotted beam, the main electro-magnets, and the dash-pots, of the circuit controller operated by the beam, the recording apparatus and the electro-magnets for working such recording apparatus, substantially as set forth. (5) In an electrical meter, the circuit controller composed of a pivotted bar, mercury cups in which the circuit is made and broken, a mercury cup for constantly maintaining electrical connection with the moving bar, and a tube partly filled with liquid, for throwing the bar to the limits of its movements, substantially as set forth.

293,762. GAS MOTOR, *Hiram S. Maxim, Paris, France.—Filed March 9th*, 1883.

Claim.—(1) In a gas motor or engine operating by explosions of gas or gaseous mixtures, the combination of two working pistons, two exhaust pistons, valve mechanism, and igniting devices, all substantially as described, these parts being constructed for operating conjointly as a double-acting engine, as set forth. (2) In a gas motor or engine operating by explosions of gas or gaseous mixtures, the combination, with two sets of cylinders placed end to end, of two working and two exhaust pistons connected together and working in said cylinders, valve mechanisms connected with the cylinders, and igniting mechanism operating conjointly as a double-acting engine, as set forth. (3) In a double-acting gas engine, the combination, with two sets of cylinders and connected pistons working therein, of two sets of exhaust air inlet and gas inlet valves, and an igniting mechanism for exploding the charges in the cylinders alternately, as set forth. (4) The combination with cylinders C C^1 and connected pistons A A^1, of valve mechanism



or admitting charges of air and gas into the cylinders alternately, mechanism for igniting the charges, and mechanism for withdrawing the products of the combustion of the charges, these parts being constructed and arranged for conjointly operating as a double-acting engine. (5) The combination, with the shaft of a gas engine or motor, of a loose belt or fly-wheel, means for locking it to the shaft, and a starting device for imparting a rotary movement to the shaft, as and for the purpose set forth. (6) The combination, with the shaft of a gas engine or motor, of a winding drum, a cord, and a weight arranged for imparting a rotary movement to the shaft for starting the engine, as set forth. (7) The combination, with the shaft of a gas engine or motor, of a loose belt or fly-wheel, an adjustable friction clamp, a winding drum, a cord, and a weight, these parts being constructed to operate as a starting device for the engine, as set forth.

CONTENTS.

THE ENGINEER, March 28th, 1884.