STEAM ENGINES AT THE ROYAL AGRICULTURAL SOCIETY'S NEWCASTLE SHOW.

No. I.

The Journal of the Royal Agricultural Society's Show, which has just been issued, contains elaborate reports on the performance of the competitive steam engines tried at the Newcastle-on-Tyne Show last July. These reports are three in number. The first is by Mr. Herbert Little, as senior steward of implements; the second is by Mr. Daniel Pidgeon, Associate Mem. Inst. C.E., as reporting judge; and the third is by Sir F. Bramwell and Mr. W. Anderson, as consulting engineers to the Society. The first of these deals briefly with all the implements tested, steam engines, weighing machines, potato planters and raisers, and cream separators. It is well written and satisfactory, but it calls for no special treatment. The second deals very fully with the construction of the engines tested. It describes the engines, and the whole process of testing. Mr. Pidgeon commences with a brief *résumé* of the progress made in the construction of steam machinery since the Cardiff trials of 1872. He refers to Mr. Anderson's arguments in favour of the Society instituting another competition, and after explaining that the Council of the Society at last determined to hold a competition, and announced their determination in November, 1886, he goes on to say:—"It is a matter of great regret that the determination in question was found displeasing to a number of the chief agricultural engine makers in the country. These gentlemen met in the following month, and, after consultation, agreed to abstain from competing at Newcastle, chiefly on the ground that 'a great deal more time should have been given between the announcement of such prizes and the date of the trials.' After duly considering the objections raised to their proposals by this important body of engine makers, the Society determined to go forward with the trials, and events have proved that their judgment was correct. It is now known that two at least of the best engines competing at Newcastle, and these by different makers, were not commenced three months before the trials took place, while not only did both these 'improvised' engines beat all previous performances of portable engines, but one of them about equalled in economy of fuel anything hitherto accomplished by the most economical condensing compound engines in existence. It is scarcely invidious, under the circumstances, to say that the plea of 'want of time' conveys an impression either of unwillingness or of unreadiness to enter upon a contest which has not only been won, but well won, without other preparation than that afforded by past experience, and an already acquired knowledge of the theory of steam."

We have already fully criticised the action of the principal makers in this matter. We believe several firms signed the now celebrated letter with reluctance; and we have reason to know that more than one firm have since regretted that they did not compete. We may repeat here what we have already said, namely, that the issue of the circular-letter was a blunder. There was no pressure brought to bear. There was nothing done to compel or induce firms to send engines for trial. The proper and dignified course would have been simply not to compete, without giving any reason for not competing. Instead of this, the signatories to the circular-letter condemned themselves out of their own mouths, asserting in effect that they really did not know how to build an engine worth trying, and that it would take them two years to find out how it was to be done. We need scarcely say that such an assertion was received with smiles of incredulity by those who know the skill, talent, and industry of the very firms who thus gratuitously libelled themselves and each other. No one believes that the true reason for not competing was fully stated. As we have said, the thing was a blunder from beginning to end, and it is not likely to be repeated.

Mr. Pidgeon deals at some length with the reasons why the compound engine is more economical than the simple engine. He shows that "a pound of pure carbon is capable of liberating, by its perfect combustion, 14,500 (British) heat units, equivalent to (14,500 × 772 =) 11,194,000 foot-pounds of work; or, if burned in one hour, equal to 5·6-horse power. In other words, if it were possible perfectly to utilise all the heat-energy contained in a pound of carbon, only one-sixth of that pound would be required for the production of mechanical energy equal to one horse-power for one hour. But the best coal is not all carbon, and is usually rated as yielding ten millions of foot-pounds of work per pound of coal consumed; while, again, coal burnt in a steam boiler is not all utilised—more than a fourth of it being lost, even in the best boilers, so that the amount of work which a pound of coal is capable of doing in the furnace of a boiler becomes reduced to 7½ million foot-pounds; roughly equalling, if the coal were burnt in an hour, four horse-power, or a quarter of a pound of coal per horse-power per hour."

He then goes on to deal with the sources of waste—the reasons why we do not get more than about one-seventh of a proper return; and he explains the superior efficiency of the compound engine in the following words:—"Some device is wanted capable of diminishing the range of temperature in the cylinder. The compound engine is such a device. Steam at the boiler pressure is first led into a small cylinder, whence, after a moderate expansion, it exhausts into a large cylinder, to be finally rejected into the air. At the presumed working pressure of 100 lb., therefore, and with a cut-off at half stroke, steam, entering the small cylinder at 328 deg., would leave it, in accordance with Marriotte's law, at a pressure of 50 lb., and a corresponding temperature of 280 deg.—the total drop of temperature in the high-pressure cylinder, where, as will presently appear, the losses due to cooling are greatest, being only 48 deg. Similarly, steam entering the large cylinder at 50 lb. pressure, and 280 deg. temperature, is rejected into the air at a pressure of 15 lb., and a temperature of 212 deg., representing a drop of 68 deg. The total range of temperature is, indeed, the same in both these instances, viz., 116 deg., but the cylinders of the compound engine have each a mean temperature much nearer that of the steam employed in them than is the case with the cylinder of the simple engine. It is obvious from these considerations that a further advantage might be expected from leading the steam through a succession of cylinders for the purpose of minimising the fall of temperature in each. A step has already been taken in this direction by the construction of triple-cylinder compound engines, and it is probable that a still larger number of cylinders might be advantageously used in large steam engines."

This is simply the old, well-worn heat-trap theory. We regret that Mr. Pidgeon has adopted it, and has missed the true reason why the compound engine is more economical than the simple engine. If it could be shown that the initial condensation was really less in the compound than the simple engine, all would be well; but this has never yet been proved. If the theory were true, then the initial condensation in triple-expansion engines would be very small. As a matter of fact, it is known to be enormous. Why, has yet to be satisfactorily explained; but the fact remains the same. The true reason why the compound engine is economical is not that condensation and re-evaporation do not take place, but that the steam resulting from re-evaporation is in the simple engine nearly all wasted into the condenser without doing any work, while in the compound engine it is not only made to work, but to work expansively. Let us take, for example, a simple engine using 24 lb. of water per horse per hour. One-fourth of this, or 6 lb., will be condensed during the time the admission port is open. As expansion goes on, and the pressure falls, about 1 lb. will be re-evaporated, a little more or a little less, according to the working conditions. The remainder will be re-evaporated as soon as the exhaust port opens, and will go straight to the condenser. Each pound of the 5 lb. wasted was made into steam twice, once in the boiler, once in the cylinder. In the compound engine the condensation may easily amount to 25 per cent. in the high-pressure cylinder. Water will be re-evaporated during the exhaust stroke of the high-pressure piston and the steam stroke of the low-pressure piston, and it will then do work on the latter, and in the end there may be no steam which has not done work discharged into the condenser. It is well known that the low-pressure cylinder of properly designed triple expansion engines works perfectly dry, the steam issuing from the indicator cocks without a trace of moisture. We do not wish it to be understood that we blame Mr. Pidgeon; he has accepted what was at one time the popular view of the matter, and error dies hard.

Mr. Pidgeon draws an interesting comparison between the relative economical efficiency of the compound and simple portable engine, taking the engines which went to the brake as examples. He shows that the Paxman compound beat the Paxman simple engine by 28·9 per cent.; the Foden compound beat the Foden simple by 29·7 per cent.; while the McLaren compound beat the McLaren simple by 18·6 per cent. Concerning his description of the trials and of the engines, it must be enough to say that he has written lucidly and to the point. Nothing, indeed, can be better in its way. As, however, we ourselves fully described the trials and the engines at the time, we must pass on to the third report by the consulting engineers.

This constitutes, we hold, one of the most valuable treatises on the steam engine ever written. Its value lies essentially in the fact that it is an analysis of the performance of actual steam engines, that it deals with a vast mass of practical data, and that it applies theory to the elucidation of the information acquired. It would of course be quite out of the question to follow Sir F. Bramwell and Mr. Anderson in minute detail. That would be simply to reproduce their report. We must content ourselves therefore with indicating the line taken, and saying something of the facts, and of the deductions drawn from the facts.

The authors begin by explaining that "the object of our work is to exhibit and consider some of the leading facts connected with economy in fuel and in water, pointing out the relations between the results actually obtained, and the results theoretically obtainable; distinguishing between those cases where there is some room for practical improvement, and those other cases where, until new metals or materials are met with competent to stand the needed temperatures that must prevail in a theoretically perfect engine, the engineer must be content with the production of work still far removed from ideal perfection." They begin by considering the duty of the boiler. The report is written so that it may be understood by persons of small engineering knowledge, and goes therefore into explanations of what are familiar matters to most of our readers. But we may say here, by way of parenthesis, that this method of treatment renders the report simply invaluable to the student. As an example, we may take the following passages concerning the performance of the boiler of Mr. Foden's simple traction engine:—"During the trial run, which lasted 263½ minutes, 138¼ lb. of coal were consumed, and a total of 1413 lb. of water at 63 deg. were supplied to the engine. The condensed exhaust steam raised the temperature of this water from 63 deg. to an average of 83·6 deg., or 20·6 deg. We may assume that the exhaust steam in the heater was about 1 lb. per square inch above the atmospheric pressure, and under such circumstances the total heat above the freezing-point per 1 lb. weight of steam condensed would be 1147·2 units. The steam was condensed at 83·6 deg., or 51·6 deg. above the freezing point; hence the number of units imparted to the water supplied per 1 lb. weight of steam condensed would be 1147·2 − 51·6 = 1095·6 deg. units. The temperature of the 1413 lb. of fresh water supplied rose 20·6 deg., which represented the absorption of 29,107·8 units, and therefore dividing by 1095·6 units, we get 26·57 lb. of steam condensed in heating the feed-water, and consequently the total quantity pumped into the boiler was 1413 lb. + 26·57 lb. = 1439·57 lb."

The report then goes on to explain that in comparing the performances of boilers it is essential to reduce them to a common standard:—"In the case under consideration, the water was pumped in at 83·6 deg., or 128·4 deg. below 212 deg.; hence 128·4 units of heat have to be added to 966·6, making 1095 units in all, and the quantity of water which would have been evaporated, had it been supplied at 212 deg., would be increased in the proportion of 1095 to 966·6, that is $\frac{1439{\cdot}57\text{ lb.} \times 1095}{966{\cdot}6} = 1630{\cdot}8\text{ lb.}$ Dividing this quantity by the 138·25 lb. of coal used, we have, omitting for the moment the jacket question, the evaporative power of the boiler represented by 11·79 lb. of water from and at 212 deg. per 1 lb. of coal. With respect to the jacket question, the indicated horse-power developed was 13·88, consequently the units of heat converted into work per minute were $= \frac{13{\cdot}88\text{-H.P.} \times 33{,}000\text{ foot-pounds}}{772^{J}}$ = 593·3 units. The steam in the boiler and jackets was at 120 lb. pressure per square inch, and therefore at 350 deg. temperature above zero Fah., and the number of units of heat per 1 lb. of steam condensed at the same temperature would be 870·9. The run lasted 263½ minutes, hence the total quantity of steam condensed in the jackets was $= \frac{593{\cdot}3\text{ units} \times 263{\cdot}5\text{ minutes}}{870{\cdot}9\text{ units}} = 179{\cdot}5\text{ lb.}$ But this quantity must also be reduced to the standard temperature and pressure; and since it requires only 870·9 units to convert water at 350 deg. into steam at 120 lb. pressure, while it needs 966·6 units to evaporate from and at 212 deg., it follows that 179·5 lb. must be reduced in the ratio of 870·9 to 966·6, which makes it 161·7 lb. The utmost that the boiler evaporated therefore was 1630·8 lb. + 161·7 lb., or 1792·5 lb. from and at 212 deg. by the combustion of 138·25 lb. of coal, being at the rate of 12·96 lb. of water to 1 lb. of coal."

Here it is necessary to explain that it was unfortunately impossible to measure directly the water formed in the jackets, because these jackets drained directly back into the boilers. Mr. Anderson therefore has adopted his well-known theory that the condensation in a jacket is, as a rule, approximately the same as that which would otherwise take place in the cylinder as a result of the conversion of a portion of the heat of the steam into water. There is no physical connection between the two things. The law is purely empirical, and based on a certain number of observations of various engines. It is quite possible that it is fairly correct under the given conditions, but it would not be right to assume that it is right under all conditions. In the same way the curve of an indicator diagram usually approximates very closely to a hyperbola, which is simply a coincidence, and not in any way proof that saturated steam doing work in a cylinder is expanding strictly in accordance with Marriotte's law. This circumstance introduces a certain amount of uncertainty, but there can be little doubt but that the boiler in question evaporated practically 13 lb. of water per pound of coal from and at 212 deg. This is a splendid performance. Let us see what the boiler was like.

An elaborate table of particulars of the boilers is given in the report. Turning to it we find the following:—

General description of boiler	Locomotive.
Area of grate at trial	2·63 sq. ft.
Width of bar...	⅜in.
Width of air space	¼in.
Area of air spaces	·77 sq. ft.
Height of fire-box crown above bars	30¾in.
Length from out to out of tube plates	72in.
Number of tubes...	76
Material...	Steel.
Outside diameter of tubes...	1⅝in.
Inside diameter of tubes	1½in.
Heating surface of fire-box	20·45 sq. ft.
Heating surface of tubes	188·5 sq. ft.
Heating surface of smoke-box	2·6 sq. ft.
Heating surface, total	211·5 sq. ft.
Area of chimney	·49 sq. ft.
Area of blast nozzle	3·7 sq. in.
Calorimeter or area through tubes	134 sq. in.
Ratio of grate area to calorimeter	2·828 to 1.
Ratio of calorimeter to air spaces in grate ...	1·207

The last three figures in the table we have calculated ourselves, for, curiously enough, the report only gives the ratios for the normal grate which was not used during the trial, being partly bricked up. It will be seen that the total heating surface amounted to no less than 80·4 square feet per foot of grate, an enormous proportion. The coal consumed per hour was 31·48 lb. It was burned at the rate of very nearly 12 lb. per square foot of grate per hour, which is very low. The total water evaporated per hour was approximately 363 lb., so that the rate of evaporation was only 1·72 lb. per square foot of heating surface per hour, which is extremely low. The firing was so admirably managed that the quantity of air admitted to the grate only exceeded that theoretically necessary by 9·1 per cent. The water consumed per horse-power per hour amounted to 26·1 lb., and the total heating surface per indicated horse-power was not less than 15·23 square feet. None of these latter figures are given in the report. They are so instructive that we are somewhat surprised they have not been recorded. They show that judged by ordinary standards the boiler was enormously large for its work. It has as much heating surface, indeed, as is usually allowed in a ploughing engine competent to indicate 60-H.P. In a succeeding impression we shall deal with other boilers on the same basis. It would unduly extend this article to attempt to do so now.

At the last meeting of the Chemical Society, a "Note on the Atomic Weight of Gold" was read by T. E. Thorpe, F.R.S., and A. P. Laurie. In a former paper—"Trans.," 1887, 565—the authors give as their final result of twenty-five determinations of the atomic weight of gold the number 196·85, which differs by 0·21 from the value determined by Krüss. Krüss has sought to show, however, that this difference is probably due to the presence of free gold in the bromoaurate of potassium employed by the authors—*Berichte*, 1887, 2365. The authors reply that they were unable to detect any free gold in the salt used by them, and that they therefore altogether dissent from Krüss's conclusion that the lower value of 196·64 is to be preferred.

THE DRAINAGE OF FENS AND LOW LANDS BY STEAM POWER.

By W. H. Wheeler, M. Inst. C.E.

No. XIV.

[Concluded.]

To compensate the district of Rhinland for the loss of the large area of polders taken from it by the drainage of Lake Haarlem, and to effect the maintenance of the water in the Ringvart or surrounding canal at a uniform level, pumping stations were erected at Halfweg, half-way between Haarlem and Amsterdam, to lift the water into the Y, when it rose above the height at which it would flow away by gravitation; at Spaarndam, near Amsterdam, to lift it into the Spaarn; and at Katwig, to lift into the North Sea. A pumping station was also erected at Gouda, to regulate the water in the Gouda Canal and to discharge the flood water into the Issel. The following table gives the principal dimensions and particulars of the engines and wheels:—

	Halfweg.	Katwijk.	Spaarndam.	Gouda.
Date of erection	1852	1880	1845	1857
Number of wheels	6	6	10	6
Dia. of wheels in feet ..	21·64	29·50	17·05	26·00
Width in feet	6·56	8·00	—	5·75
Total width	39·36	48·00	68·42	34·50
Number of scoops	24	—	—	12
Internal diameter, feet ..	11·84	—	—	—
Dia. of circle to which scoops are tangents in ft.	5·70	10·50	—	11·16
Number of revs. per min...	4½	4½	8	4
Velocity of periphery in feet per second.. ..	5·00	6·17	—	5·44
Weight of each wheel in tons	15	43	—	—
Average dip of wheels in ft.	4·60	5·66	—	4·16
Lift in feet	1·64 to 2·62	0 to 7·00	—	4·0 to 6·0
Total discharge in tons per minute	1037	2000	1889	1053
Description of engine..	Single cylinder hor. condensing	Two compound hori. condensing.	2-cylinder horizontal condensing	horizontal condensing
W.H.P.	123	370	280	240
Ratio of speed of engine to wheel	13·5 to 6·00	36 to 4	3 to 1	4 to 1
Ratio of W.H.P. to I.H.P. per cent. ..	—	33 to 70, mean 50	—	81·97
Days of 24 hours working 1 year	50, average 3 years, 1853-56	60	—	—
Pressure of steam in lbs. per square inch ..	45	80	—	65
Cylinder dia. in feet	3·36	2·00 and 3 00	3·02	3·00
Length of stroke	8·00	4·25	5·16	5·25
Number of boilers	3	8	4	3
Size of boilers in feet .	28·0 × 5·50	32·66 × 7·31	37·72 × 5·40	—
Coal used in lbs. per W.H.P. per hour ..	5·50	7·71	11·00	—
Cost of machinery in £ ..	4845	14,200	—	—
Do. per W.H.P.	39·39	23·66	—	—
Do. buildings in £	7896	15,100	—	—
Per W.H.P.	64·20	25·16	—	—
Do. total do.	103·59	48·82	—	—

At Halfweg the six scoop wheels are ranged in two sets of three each on either side of the engine-house. The wheels have a combined width of 39·36ft. Each set of these wheels is fixed on a cast iron axle, but is so arranged that the couplings can be disconnected and only part of the wheels worked when the lift is high. The framing for each of the wheels consists of three heavy rings of cast iron, with spokes connecting the rings to a heavy iron nave. These rings are cast in two segments and bolted together, and to them are attached cast iron start posts, and on these twenty-four flat wooden scoops are attached. The consumption of coals has been found to vary very considerably as the lift is altered, owing to the large proportional absorption of power at the low lifts required simply to move the machines, the following being given as the result of trials:—

Lift in feet.	Consumption of coals per horse-power per hour in water lifted in lbs.
0·45	50·0
0·66 to 1·00	14·20
1·00 to 1·33	11·00
1·33 to 1·66	8·80
2·00 to 2·28	5·50

The discharge of these wheels varies from 154 tons per revolution when the water is low in the canal, to 230 tons when it is at its highest. These wheels ran 3623 hours during the emptying of Lake Haarlem, the average lift being 20in. The average power exerted in water lifted was 92-horse power, and consumption of coal at the rate of 9 lb. per horse-power per hour. The total quantity of water raised was 202,765,406 tons. The time the engines ran for the three years after the lake was dried—May 1st, 1853, to July 1st, 1856—was 3675 hours, equal to an average of fifty-one days a year.

Katwig.—The combined machinery at Katwig is the largest instalment of pumping machinery erected in Holland or England. The arrangement and construction of the wheels is similar to that at Halfweg. The wheels are capable of lifting 2000 tons per minute to a height of 4ft., or 1200 tons to a height of 7ft. On the discharge side the floor of the raceway immediately in front of the wheel is made movable and hinged at the outer end, so that it rises and falls automatically according to the height of the water, and so makes a movable breast and prevents the back current on to the wheel when it is working. The height to which the wheels have to lift the water varies daily with the tidal condition of the sea from a few inches to seven feet. The variation on the inside is small, never varying more than about 18in. The average time of working is about sixty days of twenty-four hours in the year.

Gouda.—The six wheels are all ranged in two sets on one axle. When the station was first erected the wheels had flat scoops, and were driven by a high-pressure condensing horizontal engine, having an effective power of 111 W.H.P., made by the Atlas Company at Amsterdam. The wheels were each 5·75ft. wide and 24·27ft. in diameter. The consumption of coals with this machinery was at the rate of about 6 lb. per W.H.P. per hour. The cost was £7863 for buildings and £10,666 for machinery, equal to about £70·84 for the former and £96 for the latter, or a total of £166·84 per horse-power of water lifted. In 1872 these wheels were changed for wheel pumps—*Pompraden*—having a width of 5·25ft. and diameter 25·84ft. The drum was 19·41ft in diameter. These wheels made from 3·63 to 4·30 revolutions a minute. The number of buckets was originally six, this number being subsequently increased to twelve. At one time buckets were tried, having a curved form with the concavity towards the inner water, and others with the concavity towards the outer water. There was not found in working to be much difference in the result between the two systems, but, if anything, the latter gave the best results. The loss by slipping and imperfect filling of the pump wheels was found to amount to as much as 22 per cent. of the theoretical discharge. These pump wheels were last year altered to wheels having flat scoops, and new engines of the horizontal condensing type have been put up by Friedrichs Wilhelm Hutte, of Mulheim. These engines have a stroke of 5·25ft.; cylinder, diameter, 3·00ft.; I.H.P., 147 each. Steam is used at a pressure of 60 lb., and is cut off at half the stroke. The engines make 16 revolutions per minute to 4 of the wheel. With four wheels at work the discharge is 152·8 tons, lifted to a height of 6ft., equal to 240 W.H.P. The indicated horse-power of the two engines being 294, this gives an efficiency of 81·97 per cent. The scoops are tangents to a circle having a diameter of 11·16ft. The outer diameter of the wheel is 26ft.; the inner diameter and length of scoops, 4·23ft. The scoops are twelve in number, made of wood, the framing of the wheel being iron. With the scoop fully immersed, the discharge at each wheel is 43·88 tons per revolution, or 175·52 tons per minute, and for the six wheels 1053·12 tons. With an immersion of 3ft. the discharge is reduced to 33·22 tons per revolution. The two engines use at the rate of half a ton of coal per hour, which, with an effective power of 240 W.H.P., is equal to 4·67 lb. per hour.

Zuidplas Polder, near Moderieht, Holland.—This is a very low polder, the peat having been used largely for fuel. The lift from the surface of the water to the mean level of the river Issel, into which the water is discharged, is about 22ft. The area of the polder is 11,050 acres, of which 682 acres are occupied by the Ringdyke, leaving 10,368 acres. At the beginning of the present century windmills driving scoop-wheels were erected to keep down the level of the water. In 1825 the Dutch Government determined to thoroughly drain the Lake. For this purpose it was divided into two parts, the lower level being separated from the upper by a surrounding canal or Ringvart, into which the water from the lowest part was lifted, and from which it was raised with the drainage of the rest of the polder into a collecting basin, which discharged into the river Issel by sluices. The lower level was drained by fifteen windmills, eight driving Archimedean screws, and seven scoop-wheels. For the lift from the upper level there were fifteen windmills, ten of which drove screws and five wheels. There were also erected in 1838 two steam engines driving screws. The windmills were in operation until 1873, the annual cost of maintaining them being at the rate of £60 each. The Archimedean screws, erected in 1838, were 5·83ft. in diameter, the axle being 1·70ft., and the blades 0·12ft. thick. The axle was laid at an inclination of 30 deg. The screws made 47 revolutions a minute and the engines 19·86. The engines were direct double action, with cylinders 1·66ft. diameter, and having 7ft. stroke. The spur wheel fixed on the crank shaft, geared into a bevel wheel on the axle of the screws. With a lift of 6·16ft., the discharge was 1·17 tons per revolution, equal to 57·46 tons per minute. The horse-power of the engine in water lifted was 24 W.H.P. The consumption of coals was at the rate of 21·34 lb. per W.H.P. per hour. There are now two pairs of pumping stations, each having installations consisting of scoop wheels and centrifugal pumps. The scoop-wheels at present in use are the largest in diameter in use in Holland, one being for the lower lift and the other for raising the water from the Ringvart to the collecting basin. The wheels are 32·80ft. in diameter and 4ft. wide. The lift is 11·80ft. for the lower, and 8·20ft. for the upper wheel. They have thirty-two curved iron scoops, the curve being concave to the internal water, and make 4½ revolutions a minute. The velocity at the periphery is 7·22ft. per second; the weight of one wheel with its axle is 21 tons. The author has seen these wheels at work, his impression being that their performance is not satisfactory, the scoops not entering or leaving quietly, or with the best effect, the water being too much dashed about. The wheels are not provided with shuttles to regulate the supply of water to the scoops. These wheels work in an uncovered masonry raceway outside the engine-house, and are driven by single-cylinder condensing horizontal engines. The wheels discharge 110·5 tons per minute to a height of 11·75ft.; the horse-power of the engines in water lifted is eighty-nine, and the consumption of coals at the rate of 7 lb. per W.H.P. per hour. The two steam engines and wheels cost £5000, or at the rate of £28·03 per W.H.P. The centrifugal pumps were erected in 1876, by Messrs. Gwynne and Co., London. They are of the direct-acting type, having horizontal spindles, and are fixed in pairs in the two engine houses, one for the lower and the other for the upper levels. The suction and delivery-pipes are 3ft. in diameter, and the latter is carried by a bend below the lowest water-level in the basin into which they discharge. Each station has two pumps driven by separate non-compound direct-acting engines, fitted with variable expansion gear, and having steam-jacketted cylinders, 24in. diameter, with 20in. stroke; the engine and pump making 100 strokes per minute at the full lift of 13ft. A separate air-pump is provided for charging the pumps at starting. Each pump is capable of raising 71 tons per minute. The diameter of the pump disc is 6ft., and the width 3ft. Steam is supplied by four Lancashire boilers, with 24 Galloway tubes 25ft. long by 6·5ft. wide at the lower station and three boilers at the upper. The working pressure of steam is 75 lb. The lift varies from 5ft. to 13ft. These machines give off in water lifted from 40 to 50 per cent. of the indicated power, the average being 40. The consumption of coal is at the rate of 7·67 lb. per W.H.P. per hour. The four centrifugal pumps, with the engines and boilers, cost £11,833. Taking the power in water lifted as 62·64, this is at the rate of £47·22 per W.H.P. The pumps work under some disadvantage as compared with the wheels, the work of the latter being more regular and constant, while that of the pumps frequently varies both with regard to the lift and time of working. At a trial of one of these pumps made in 1877, the consumption of coal was found to be at the rate of 5·95 lb.—2·7. kilog. —per horse-power of water lifted. The average lift was 12·73ft., the number of revolutions 105; discharge 87·17 tons per minute.

Waterland.—This polder is situated near Amsterdam, and contains 25,000 acres. There are three pumping stations, provided with engines driving scoop-wheels. The Buiksluit station has two curved scoops, with the concave side of the curve towards the internal water. The curve is struck to a large radius, and, although this form is advantageous in entering the water, is not well adapted for parting with it. The wheels are 20·66ft. in diameter by 3·70ft. wide, and have sixteen curved iron scoops. The wheel makes 5½ revolutions a minute to sixty of the engine, the speed at the periphery being 5·66ft. per second. The dip is about 4ft., and the lift from 2·60ft. to 4·25ft., the mean being 3·60; each wheel can discharge 105 tons a minute. The wheels are driven by two single-cylinder condensing horizontal engines of 30 actual horse-power. The cylinders are 1·37ft. in diameter, with 2·16ft. stroke. Steam is generated in two double-flued Lancashire boiler, each 6·87ft. by 28ft. long, having twelve Galloway tubes. The safety valve is weighted to blow off at 90 lb. The machinery was erected by the Prins Van Orange Company, in 1875. The wheels work on an average 120 days, of fifteen hours, in the year.

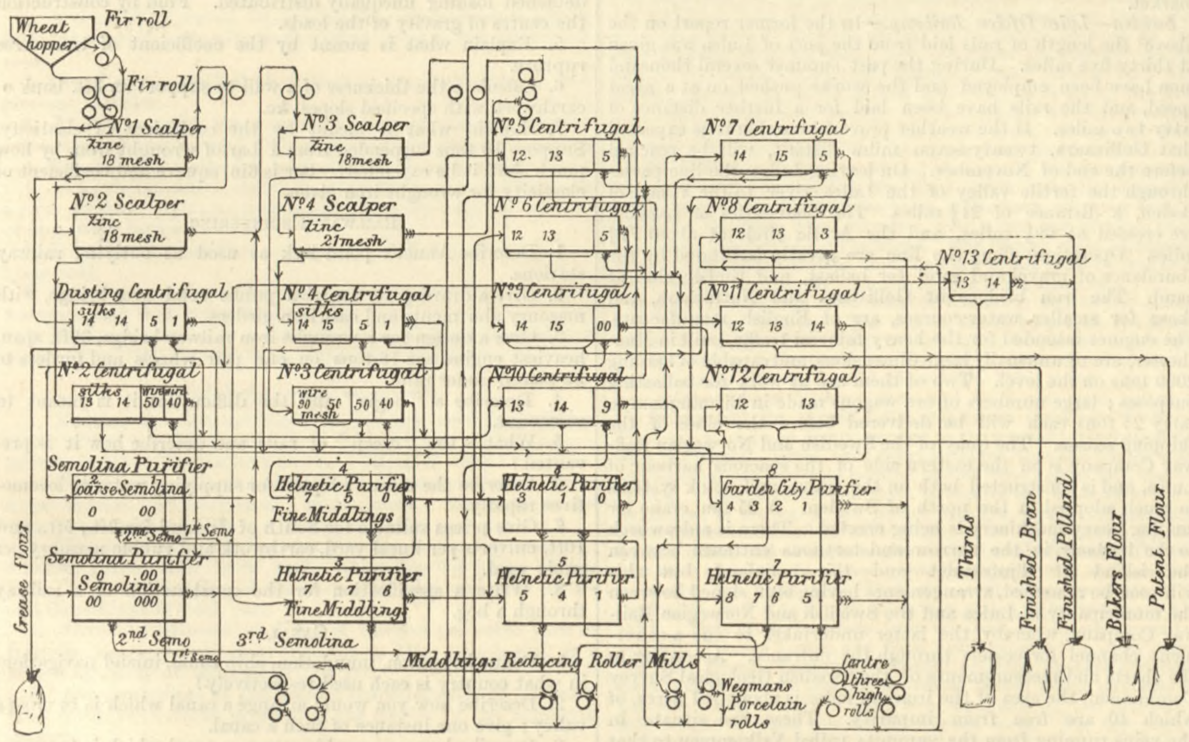
MODERN MILLING.—ITS BIRTH AND DEVELOPMENT.

By Gilbert Little.

III.—TRIBUTARY DEVELOPMENT.

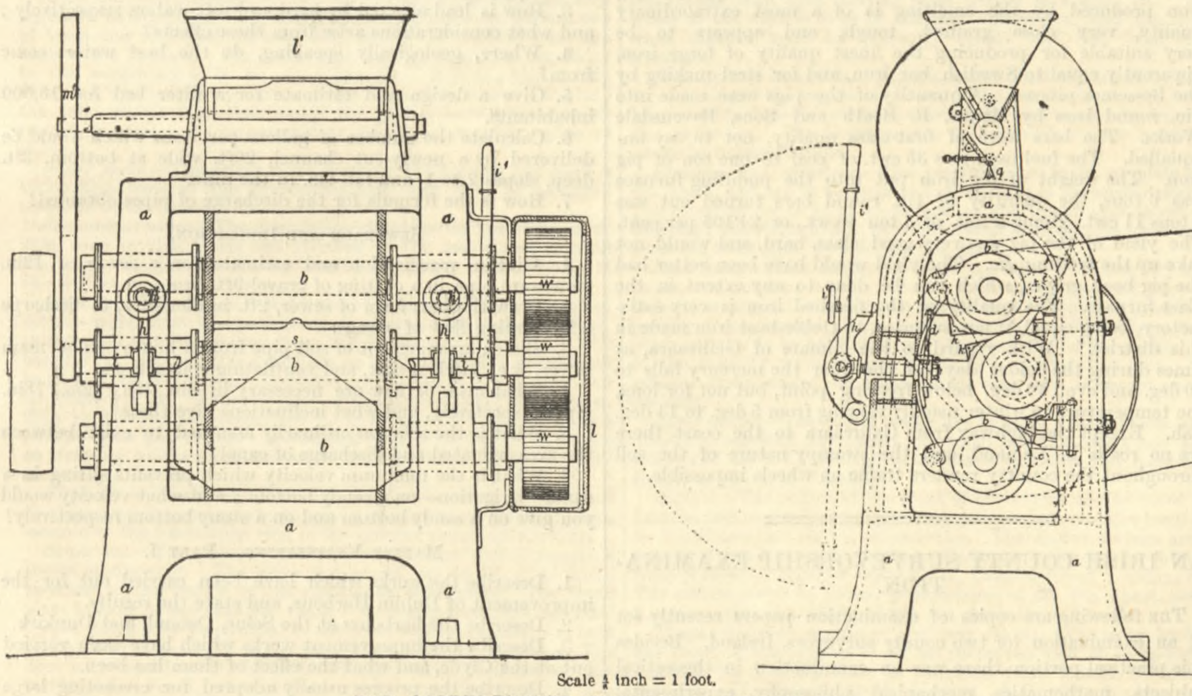
It is a remarkable fact that the origin of some of the most important branches of engineering is obscure. Dates are at best only approximate, and their sources are like some of our largest rivers, which are the exuberant oozings of some marsh, of which it is impossible to say when the reedy slime ends and when begins the river. The beginning of modern British milling engineering is, however, a marked exception, as it almost instantly shaped itself into a stately stream. As described in our last article, the City Mill, Manchester, was the fountain-head of complete roller milling; there the source of the gradual reduction system is at once clear and defined, but as some rivers at their source are insignificant little streams without force or body, and in their course are fed by tributaries which give to them all the serviceable qualities they possess, in like manner the roller system of milling has gathered all that is best in it.

In the march of improvement in general engineering posthumous fame has in some prominent instances been very much a matter of luck, while many of the most original minds of their day drew a blank. It is difficult to see how it could be otherwise, as it is those who display sagacity and practical wisdom in putting in motion what their brains or the brains of others conceive, who must rise to the surface of success, while the mere originator must not be disappointed if he commercially does not float. The recent history of improvement and change in milling could furnish not a few instances in support of this point. It is true that the roller system has been focussed in the name of some half-dozen persons, and their family denominator has been made a synonym for modern milling; but a writer surely fails in the first essential if his work takes any colour from the "I did it" feeling of the inner circle, which has prevented one or two men from seeing that at best they were only visible fractions, and not as they suppose, integers in the rapid working out of the great change. The illusion or aberration that allows men, otherwise clear-sighted, to drop into this state of feeling rarely provokes among their compeers any harsher emotion than one of smiling pity. All the roller systems, as now in operation, are carried out on the same broad lines, and differ only in the smallest details; and modern milling may be said to have been reduced to an exact science. It is impossible to mention here a fraction of the names of the men who have contributed to this result, and richly deserve to be designated tributary streams; neither can we turn aside to refer to the few men of admitted milling genius, whose technical and business individuality or have been absorbed in the names of one or other of the few individuals, who have so naively embodied everything in modern milling under their family surname. We can only refer to the recognised systems, and the first that suggests itself, as a chief tributary stream, is that known under the name of Mr. Harrison Carter. Mr. John Mooney, who placed the order for the first "Carter" roller plant, in sending the "flow-sheet," which we reproduce, refers to what he calls "the glorious ignorance of milling engineers and millers in those days." "Those days," our readers will notice, were of the year 1880, and this fact, more than any other, brings out the suddenness and completeness of the change from the millstone to the roller system. His first plant was started on what is now called the "short" system, as there were only four "breaks;" while six or seven is the number now usually adopted. While it is shorter in the "break" process than the first "Simon" mill, it is longer and more elaborate in the "reducing" part. This part had, however, been attended to by Mr. Simon in a number of mills he had erected subsequent to his little experimenting plant at Manchester, and prior to the erection of his first "Carter" plant. The "Carter" system has been among the most successful, and taking the number of mills equipped as the indication of popularity, it ranks next to the "Simon," though it is only fair to Messrs. Thomas Robinson and Sons, Rochdale, to mention that while they were late in entering the field, they have secured a very large share of the more recent orders, and are now next o the first in the race. The recent correspondence in The Engineer on "Automatic Milling" brought out the fact that from his advent among the experts Mr. Harrison Carter persistently endeavoured to impress on the millers the advantages of self-regulating—or, as he termed it, controllable—mills. The author is aware that there have not been wanting attempts to make this detail rank as the all-in-all of milling, while the fact is, many of the old-fashioned and combination mills were automatic, and the adding of a few elevators more or less and some additional conveyors is not "the immortality conferring" attainment of improved milling. Referring to the "flow sheet," it will be seen that this mill is automatic, the material not being subjected to any manual labour from the time the wheat enters the first set of rolls till it is sacked off in the finished state as flour, thirds, pollard, and bran. It will be seen that



FIRST FLOW SHEET OF MR. HARRISON CARTER'S SYSTEM.

the clean wheat is spouted to two sets of "fir" break rolls, and in the usual way is subjected to four different "breaks" and four different "scalpings." The outsiftings of the four scalpers is then collected in a conveyor and sent to the dusting centrifugals, where the flour made in the break process is dusted out, and the semolina and middlings pass over the tail of the centrifugals to be sized, the semolina being sent to the gravity purifiers and the fine middlings to the Helvetic purifiers. The semolina is again sized by an air current in the gravity or aspirating purifiers. As described in connection with Mr. Thomas Muir's patent system of extracting the germs, the semolinas are composed of the best part of the kernel, but are also largely made up of the most deleterious parts, in the form of fibrous, shreddy portions of the husk, as rasped off in ribbon-like strips by the grooves of the break rolls. In practice it was found impossible to separate the large white semolina from the fibrous particles by the ordinary system of dressing, as the pieces were of about equal size, and the method of sizing by gravity was resorted to with success. The machine employed for this purpose was invented as far back as 1790, and exactly similar machines were used to sift the materials in the earliest days of the pottery industry. Quite a bevy of patents have been taken out within the last six years for methods of sifting and sizing grain and ground minerals by means of exhaust draughts and circulating air currents; but we find that all such appliances have been anticipated by the "artificers in art" in the pottery districts, and more, as we have recently seen the drawings of an old flint grinder in which the air current passed through both the pneumatic sifter and centrifugal pulveriser, the fan exhausting at the tail end of the pneumatic separator, and blowing in at the hopper of the grinder; and thus a continually circulating air current was kept in both machines. In modern milling the air current is utilised to grade the semolina. An exhaust trunk is coupled up to the division chambers, and the air suction divides the particles, the heavy semolina falling into the first division, the branny semolina into the second, and the fibrous semolina into the back spouts—see illustration of Parr's machine on page 480 of The Engineer, December 17th, 1886. The fine middlings, it will be seen, are treated on the "Helvetic" sieve purifiers. All the best middlings purifiers at that time were of foreign design and manufacture. In fact, the same may be said of nearly all the other machines used in the roller system. Nothing could be more simple than a good middlings purifier. It is simply an ordinary shaking dickey sieve, covered with silk, with an exhaust fan drawing a current of air through it, and carrying off the light browny parts from the pure parts which pass through the silk. Machines of this simple description were largely imported from Germany and America, and sold at £140 to £200 each, and we are not divulging any secrets of the trade in stating that machines of superior construction could have been made by British agricultural engineers, and sold at a good profit for £60 to £70. They are doing it now when there is little demand for milling machinery. The purified semolina and middlings were reduced on the Turner and Carter patent three-high roller mills. This little middlings mill was one of the first of the modern milling machines of English manufacture put on the market, and it is still one of the best. Its success has been quite unique, and its record of durability we believe unsurpassed. As it was the parent of all the English roller mills, and has only been improved in a few details, it will be interesting if we give illustrations here.



Scale ½ inch = 1 foot.

THE CARTER-TURNER THREE-HIGH ROLLER MILL.

In this mill the rolls are three in number, *b b b*, made of chilled iron. The spindles are of steel, and run in bearings, having a length of about four times their diameter, of phosphor bronze, with a very efficient self-acting lubricating arrangement, by means of which the oil is kept flowing continuously from end to end of the bearings, but without means of escape. The centre roll bearings are fixed to the frame. Those of the upper and lower rolls, it will be seen, have projecting arms *c c*, by one of which they are hinged to the frame, and by the other are coupled to the connecting bow springs *d*. Each of these springs is grasped at its centre by a clip *e*, the stem of which passes through and is supported in the frame, terminating in an excentric ring *f* formed in the short bent levers *h* on the outside of the frame, and by means of these levers and the adjusting screws h^1, which they carry at their upper ends, the relative positions of the rolls to each other are regulated with mathematical correctness. The pressure is applied by the hand lever i^1 acting on the excentric axis *i*, and if this handle is lowered the rolls are brought into contact with a pressure due to a multiplication by nearly 100 of the force applied, and by raising the handle the rolls are again thrown apart. The gear wheels *w w w* have a relative speed of 5 to 4 to the rolls, and run in an oil-tight case. The success of this has been marvellous, as only three sets of gears have been renewed after eight years' working, and it is not surprising that all the other milling engineers have adopted this plan.

It may be added that all the theorising about three-high roller mills not being suitable for "break" machines has in practice been found wide of the predictions of the four-roller mill advocates. From the outset Mr. Simon was a consistent advocate of the three-high mill for both "breaks" and "reductions," and the past seven years' experience has fully justified his faith and utterly demolished the theories of the four-roll mill makers. Their contention was that the middle roll, having to perform double work—so they asserted—of the top and bottom rolls, it would wear out doubly fast. Experience, however, that unerring guide, has clearly demonstrated that the flutes of the upper and bottom rolls, actually wear out as fast again as the flutes of the middle one, and a large extra expense of four-roll mills may be looked on as unremunerative capital. As Mr. Simon maintained—and on this point he almost stood alone—the upper and bottom rolls being the fast running, or working, in theory they should, and in practice they have worn out sooner than the slow-going or middle roll; and it is an indisputable fact, strange as it may seem, that the middle roll lasts about two sets of top and bottom rolls.

Our flow sheet shows the sequence of operations in the first Carter plant, and it may be also said to explain the *modus operandi* of the most recent, as the Carter firm advertise that their gradual reduction method has only been altered in a few trifling details since the erection of the one we illustrate.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

Argentine Republic—Trade in 1886.—The United States consul at Buenos Ayres reports:—The general trade of the Argentine Republic during 1886 has not been profitable or satisfactory. The violent fluctuations of gold have rendered it impossible for importing houses to be sure what they are doing with regard to their time sales. Transactions promising a fair return ended in loss. The tendency to over trading continued to an extent which must still further demoralise the financial status of the country. A foreign trade which year after year continues to show an increasing balance of trade against the country, a very large proportion of the imports not being for reproductive industries, must tell upon its financial condition, and bring on commercial depression, if not convulsion. Great Britain has regained the first place in the total trade of the Argentine Republic, especially in imports—near 40 per cent. The vitality of British trade is seen by the imports having quadrupled since 1876 and trebled since 1886. The significance of this will be understood when it is considered that the entire trade of the Argentine Republic has only doubled within the last ten years, and has had no such development with any other country. Nearly all the business done by Great Britain in the River Plate is carried on through English agents or houses of manufacturers having their establishments here, and who, with the facilities afforded by their banks and steamship lines, must continue to have a monopoly of the import trade. Of British imports, coal, coke, iron manufactures, machinery, and railway materials constitute fully two-fifths. The immigration from Europe, especially from Italy, in great part agriculturists, goes on increasing every year. The Government make a great mistake with regard to their public land, by not dividing it into small parcels for the benefit and within the reach of those of small means. Instead of this the national lands are put up to auction at a given base of so much per league, and thus are out of the reach of immigrants. A large portion of the public domain has, through this system, passed into the hands of speculators, prices ranging from 2½d. per acre in Paraguay to an average of 18s. in Buenos Ayres, where there is also an extreme range of prices according to distance from the city. The work of railway construction has been prosecuted with more than usual activity. The Central Northern road has been completed 168 miles beyond Tucuman, and most of the work made ready for laying the rails as far as Salta. Sixty-two miles of road have been completed, between Metan and Rosario de Frontera. The works of the Chilcas and Rio Pasagè are in progress, and the whole line will be pushed during the present year, also the branch from Dean Fures to Chilceto, a distance of 258 miles. All the necessary works of the branches of the Northern Central to Santiago del Estere and Chumbicha have been opened for public service. The road from Buenos Ayres to Rosario has been running regularly, reducing the time between the two places by seven hours; and is now being extended—and will soon be completed—to Sunehales, a distance of twenty-eight miles. A line, projected in the interest of the Buenos Ayres and Pacific Railway is being constructed from here to Mercedes, in San Luis, there to join the preceding line, which is being pushed on to Orellanos, a distance of 220 miles, and will in a few months be completed. From Mendoza northwards the last link in the Andrea line is being constructed. Various other lines have been projected, and for some of them concessions have been obtained. Among these is a line to Bahia Blanca, directly across the Andes by a new pass to Chili; and another from Buenos Ayres to Chili across the Andes by a southern pass. Of the Argentine railways, 51½ per cent. belong to private companies, 30 per cent. to the nation, and 18½ per cent. to the provincial Governments. The British Consul at Buenos Ayres reports :—"The battle of the gauges is being fought here. The railways of 5ft. 6in. gauge form the greater part, and are 3196 miles long. The narrow gauge railways of 3ft. 3½in., forming a general network of narrow gauge lines throughout the Republic, will, when complete, be the next in importance; their length will be 2870 miles. The railways in the province of Entrê Rios are of 4ft. 3½in. gauge and 895 miles long, but, being cut off by the river Parana, cannot be connected with the other provinces." First-class coal has been discovered at two different places, one about 120 and the other about 150 miles south of San Rafael, in the province of Mendoza. It is announced that on the estate of St. Igarzabal, near Paganso, in the province of Rioja, and only nineteen miles from the Colorados station on the Chilceto and Dean Fures Railway, coal is both abundant and rich. The Government is engaged in building ports at several important points. The Argentine Congress has made provision for the erection of extensive docks and port works in front of the city of Buenos Ayres, and appropriated £2,060,000 for the purpose. The necessary surveys have been completed, and approved by the Government, and a contract for the work entered into with Senor E. Madero. The importance of this port to the commerce of Buenos Ayres cannot be over-estimated.[1] The deepening of the Riachuelo Canal to the south of the city has been persistently carried on during the last year, and that port will continue to be a complementary harbour to the city of Buenos Ayres. With that view the Government has contracted with both the Southern and Western Railways for the erection of extensive moles and warehouses on the Riachuelo, to be under Government control. There has been constructed a very extensive mole at Bahia Blanea by the Southern Railway, also one at Alalaya, and others are being constructed at Conception del Uruguay, Corrientes, Gualeguachu, Rozario, Santa Fé, and Zorate, at the cost to the Government of over £125,000. The construction of these ports will greatly assist the river commerce of the Republic, which is every year assuming larger proportions.

Russia—Fiscal policy.—The mercantile body attending the fair of Nijni Novgorod presented to the Minister of Finance on his recent visit a memorial pointing out the requirements of industry and trade, urgently demanding immediate attention and satisfaction. The first part is devoted to the question of the parasitical foreign industry established within the western borders, which affects the development of national industrial efforts very unfavourably, and is encouraged by the incongruity of the railway tariffs. The second most important question occupying the attention of the Russian industrial world is that of markets for disposal of their produce, such as those of Central Asia, the distant East, Persia, &c. The Russian mercantile body ask for the adoption of all possible measures for the protection of Russian trade in these markets against foreign competition. In view of the impending revision of the Russian customs tariff, a request is made that the tariff should be revised with the active co-operation of persons interested in it and intimately acquainted with the question of Russian production; and that these persons should not be accidentally selected, but true exponents of the opinions of Russian producers. Attention is drawn to the inequality of the incidence of taxation on various commercial and industrial establishments. The question of factory inspection is dwelt on, and the imperfections of the new law and the shortcomings of those enforcing it pointed out. To all these demands the Minister, speaking as Minister of Finance and as the bearer of a message from the Emperor, has given the clearest and most favourable replies, excluding the possibility of any doubts. With regard to the complaints of the semi-foreign and parasitical industry established in the western provinces, the Minister said that "the Government have decided upon the adoption of measures for placing upon an equality the competition between the Loda and the central manufacturing districts of the empire, and will not confine themselves to what has been done in this direction. He also observed that the decision of the council of the Empire in July last, subjecting the railway tariffs to Government control, will enable the Crown gradually to introduce a tariff system fully meeting the requirements of the country. As regards the participation of manufacturers in the general revision of the Customs tariff; he was convinced that by this means alone a satisfactory Customs tariff could be elaborated. The *Moscow Gazette* says that the memorial omitted all mention of the revision of the trade conventions and treaties of commerce between Russia and foreign countries. The greater part of these have lost all practical import, having been concluded under economic conditions different to those now existing in Russia; they are, on the one hand, an impediment to the development of our foreign trade, and on the other, a prolific source of abuses. Those concluded during the predominance of free trade doctrines are unprofitable to the country, undermine its commercial marine, and so impede the development of the export trade. Thus our treaty with Great Britain in 1858, while placing on the same footing in Russian harbours the shipping of both countries, empowers the British Government to refuse Russian vessels the same privilege.

Russia—Trade in 1887.—During the first six months of 1887 Russian exports increased £6,097,000, or 39½ per cent., over the corresponding period of 1886, while imports decreased £1,899,454, or 14½ per cent. These figures show a revival in the Russian export trade, which, with the import trade, had steadily declined since 1884. The railway returns for the first five months of the year show considerable animation among the native industries. The total receipts of all Russian railways show an increase over a similar period in 1886 of £1,024,554, or 14 per cent., not attributable to accidental or temporary causes, such as the opening of new lines, the quantity opened during the last twelve months being 146 miles. The increased returns are due to a steady increase of traffic, there having been carried 2,603,174 tons more of merchandise and 592,000 more passengers—increases of 18 and 5 per cent. The lines principally affected by this increase are those running to the Baltic and Black Sea ports. The increase on the Dunabourg-Riga, Dunabourg-Vitebsk, and Orel-Vitebsk was from 31 to 50 per cent.; and in the Lozow-Sevastopol line 64 per cent., mainly due to the increased export of flax, hemp, and maize. Russian trade with Persia has made considerable strides in the last ten years, having risen from a value of £636,364 in 1875 to over £1,181,820 in 1885. This increase would have been far larger if the means of communication had been easier and less expensive, in which case Russian goods might have competed with those of Great Britain, who could place her merchandise in the Persian market at smaller cost. In spite of this drawback, the export of Russian goods to Persia has increased during the last ten years nearly 100 per cent., because English goods though cheap are mostly inferior to Russian in quality, and this has caused the latter to steadily gain favour. Up to the present there are but two ways of transporting Russian goods to Persia, either by Batoum and the Trans-Caucasian Railway to Baku, or down the Volga to Astrakhan, and then by sea to Baku, from whence the goods are conveyed over the frontier. The Volga is available only in the summer, and then is but an uncertain mode of transit, owing to the constant silting of sand and changes in the river channel, which render impossible any large amount of traffic. The route by Batoum is preferable, though the distance of Batoum from the interior and the expenses of trans-shipment there are disadvantageous. Very large reductions in the cost of transport must be made before the route to Persia can be largely utilised. An alternative route has been suggested by constructing a railway along the shores of the Caspian Sea, connecting the various manufacturing centres in the interior of Russia with the ports on the Caspian, a line from Tsaritzin or its neighbourhood to Baku. Should the Persian Government ever carry out the projected railway from the Caspian to the Persian Gulf, it would, in connection with the preceding proposed railway, give Russia direct access in a southerly direction to the Indian Ocean; and, in connection with the Trans-Caspian Railway, to the heart of Central Asia. The importance of such a direct and relatively cheap mode of transit cannot be exaggerated. The advocates of this scheme consider that the certain opposition to it of the Trans-Caspian Railway might be averted by opening that line to foreign merchandise, by means of which it could recoup itself for any loss sustained by the establishment of a cheaper and more direct line between the centres of Russian industry and the Persian market.

Sweden—Lulea Ofolen Railway.—In the former report on the above[2] the length of rails laid from the port of Lulea was given at thirty-five miles. During the past summer several thousand men have been employed and the works pushed on at a great speed, and the rails have been laid for a further distance of sixty-two miles. If the weather prove favourable it is expected that Gellivaara, twenty-seven miles distant, will be reached before the end of November. On leaving Lulea the line passes through the fertile valley of the Lulea river to the village of Boden, a distance of 21¾ miles. The boundaries of Lapland are crossed at 69½ miles, and the Arctic circle at about 77¾ miles. Operations along the line are greatly facilitated by the abundance of gravel and sand for ballast, and timber, close at hand. The iron bridges at Gellivaara and Nattavaara, and those for smaller water-courses, are of English manufacture. The engines intended for the heavy mineral traffic, built in Manchester, are of unusually large dimensions, and capable of hauling 2000 tons on the level. Two of them are at work for ballasting purposes; large numbers of ore wagons made in Birmingham to carry 24 tons each will be delivered before the close of the shipping season. The quay of the Swedish and Norwegian Railway Company is on the eastern side of the spacious harbour of Lulea, and is constructed both on the frame and spink systems so much adopted in the north of Sweden. A 25-ton crane for landing heavy machinery is being erected. There is a drawback to the harbour, in the narrow and tortuous entrance between the island of Tjufsundet and the mainland, but this will soon be remedied, arrangements having been signed between the municipality of Lulea and the Swedish and Norwegian Railway Company, whereby the latter undertakes to cut a convenient channel for vessels through the entrance. According to the charts and measurements of the Swedish Geological Survey Commission, the area of the iron ore lodes is about 161 acres, of which 40 are free from impurity. These are situate in the veins running from the summits called Valkommen to that of Kungsryggan, and on the heights of Koskullskulle and Kapten's Hojden The latter lodes are about fifteen acres in extent, and will be the first mines opened up by the railway. Most of the Gellivaara ores lie near the surface, and will only require quarrying. In parts of Kunsryggan and Valkommen there are massive boulders of metallic ore rising many feet above the earth. The Gellivaara ores have been analysed by Messrs. Johnson, Matthey, and Co., and at M. Fried. Krupp's works. The percentage of metallic ore in the former analysis was 70, in the latter 69·9. Several tons of the metal were sent to England, and smelted by the Chatterley Iron Company, Tunstall, Staffordshire, who report:—"The yield of metallic iron from the ore averages 70·55 per cent. Messrs. Pease's Bowden Close Durham coke was used in the smelting, one ton of which is required to produce one ton of pig iron. About 8·65 per cent. of limestone was used as a flux, and the ore melted most freely. The pig iron produced by the smelting is of a most extraordinary quality, very close grained, tough, and appears to be very suitable for producing the finest quality of forge iron, apparently equal to Swedish bar iron, and for steel making by the Bessemer process. A quantity of the pigs were made into 1in. round bars by Messrs. R. Heath and Sons, Ravensdale Works. The bars were of first-class quality, not to say unequalled. The fuel used was 35 cwt. of coal to one ton of pig iron. The weight of pig iron put into the puddling furnace was 6 tons, the quantity of 1in. round bars turned out was 4 tons 11 cwt., giving a loss of 1 ton 9 cwt., or 24·166 per cent. The yield of the pig was very good class, hard, and would not take up the fettling, &c. The yield would have been better had the pig been greyer, which can be done to any extent in the blast furnace. The quality of the finished iron is very satisfactory, being equal, if not superior, to treble-heat iron made in this district." With regard to the climate of Gellivaara, at times during the colder days of the year the mercury falls to 30 deg. and even 40 deg. below freezing point, but not for long, the temperature in winter usually varying from 5 deg. to 14 deg. Fah. Except the highway from Gallivaara to the coast there are no roads in Lapland, and the swampy nature of the soil throughout the country renders traffic on wheels impossible.

AN IRISH COUNTY SURVEYORSHIP EXAMINATION.

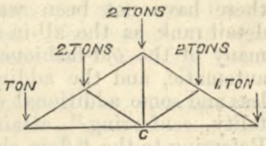
THE following are copies of examination papers recently set at an examination for two county surveyors, Ireland. Besides this practical portion there was an examination in theoretical subjects, mathematics, mechanical philosophy, experimental physics and geology; there were twelve candidates, the successful competitors were Mr. E. A. Hacket, M.E., and Mr. Singleton Goodwin, Assoc. M. Inst. C.E.

PROPERTIES OF MATERIALS—MATERIALS.

1. What timber would you use for the following purposes:—Piles in sand, piles in fresh water, piles for salt water, seats in a church, church roof, floors; where are these grown and what are their market forms?
2. To what timber does the following description apply, where is grown and what are its uses: no visible medullary rasp, sapwood yellowish or brownish white, with pores inclined to red, grain twisted and porous?
3. What gives dolomite its durable qualities—where are to be found its representatives in England?
4. What is the least weight which placed on a pillar 6in. diameter and length 3ft. would crush it when made of the following kinds of stone: greenstone, limestone, sandstone?
5. Write a specification for rails; traffic quick passenger and heavy goods.
6. What is the effect of temperature on cast iron?

PROPERTIES OF MATERIALS—STRAINS.

1. Find the strain on the members of the accompanying roof truss when loaded as shown in sketch. What effect would it have on strains for a load of 2 tons to be suspended at C?



2. Show that in an ordinary flanged girder with continuous web, show that the flanges of the girder are helped by the web as if ⅙ of the web were placed in the flanges.
3. Give Gordon's rule for the strength of pillars. What is the safe load on a wrought iron pillar circular in section, 6in. diameter and 15ft. long?
4. Find by construction the bending moment of a girder with detached loading unequally distributed. Find by construction the centre of gravity of the loads.
5. Explain what is meant by the coefficient of transverse rupture.
6. Calculate the thickness of a wall to support an 8ft. bank o earthwork with specified slopes, &c.
7. Explain what is meant by the coefficient of elasticity. Suppose 10 tons suspended from a bar of wrought iron, by how much shall it be extended? Bar is 6in. square and coefficient of elasticity for wrought iron given.

RAILWAY ENGINEERING.

1. Describe Annet's point lock as used at outlying railway stations.
2. Give a drawing for an Irish public road over bridge, with masonry abutments and cast iron girders.
3. Give a design for a wrought iron railway bridge, 30ft. span, heaviest engine has 16 tons on one pair wheels and girders to be placed under rails.
4. Describe a "bogie" and the difficulties it is meant to surmount.
5. What is the "creep" of rails, and describe how it is prevented?
6. Describe the means adopted for supplying water to locomotives rapidly.
7. Give prices suitable for South of Ireland for 3ft., 5ft., and 10ft. culverts per lineal yard, earthwork and rubble masonry per cubic yard.
8. Write a specification for the construction of a railway through a bog.

CANALS.

1. Define irrigation, inundation, ship canal, inland navigation; in what country is each used respectively?
2. Describe how you would arrange a canal which is to cross a valley; give one instance of such a canal.
3. Describe how you would arrange a canal which is to cross a watershed, and give one instance of such a canal.
4. Give a dimensional sketch of a dock gate for tail bay, rise of water 8ft., width lock 12ft.
5. Describe one kind of river with movable sluice, and give an instance of its use.
6. What is the cause of the deterioration of the Suez Canal, and what means have been proposed for its improvement?
7. Describe one means, other than a lock, of getting up a height.
8. What is the meaning of canalising a river; give one instance.

HYDRAULIC ENGINEERING WATERWORKS.

1. What is the mean annual rainfall in Ireland?
2. What are the points of consideration regarding the available supply of water from a drainage area?
3. How is lead affected by hard and soft waters respectively; and what considerations arise from these effects?
4. Where, geologically speaking, do the best waters come from?
5. Give a design and estimate for a filter bed for 10,000 inhabitants.
6. Calculate the number of gallons per hour which would be delivered by a newly-cut channel, 20ft. wide at bottom, 3ft. deep, slopes 2 to 1, and fall 6in. in the mile.
7. How is the formula for the discharge of pipes obtained?

SEWERAGE AND IRRIGATION.

1. Give a specification and estimate for a sewer of 12in. stoneware pipe in a cutting of gravel 9ft. deep.
2. Draw the best form of sewer, 2ft. in diameter, to discharge a fluctuating flow of sewage.
3. Sketch arrangement of soil pipe from a house; show main sewer, w.c., kitchen sink, and ventilating connections.
4. What rates of flow are necessary in 6in., 9in., 12in., 18in. pipes respectively, and what inclinations give these?
5. What is the relation ordinarily assumed to exist between the area irrigated and discharge of canal?
6. What is the minimum velocity which prevents silting in a canal—irrigation—on a sandy bottom; and what velocity would you give on a sandy bottom and on a stony bottom respectively?

MARINE ENGINEERING.—PART I.

1. Describe the works which have been carried out for the improvement of Dublin Harbour, and state the results.
2. Describe the harbours at the Seine, Ostend, and Dunkirk.
3. Describe the improvement works which have been carried out at the Clyde, and what the effect of them has been.
4. Describe the process usually adopted for creosoting large balks of timber.
5. Describe succinctly the manufacture of Portland cement.
6. Compare the effects of longitudinal groynes and transverse dykes on a river estuary.
7. Give a cross-section of a reclamation bank, rise of tide 4ft., centre line of bank at low water, foreshore slopes 1 in 40, moderate exposure. Give an estimate of cost, materials supposed to be ¼ mile average distance, and length of bank ½ mile.

PART II.

1. Describe, with regard to cost and convenience for traffic, wet dock, basin, quay wall. If called on to report on a place where suitable sites for each existed, state fully which you would select and give reasons.
2. Write a specification for concrete, describe the process for preparing each constituent.
3. Is there any reliable formula for the thickness of retaining walls. Calculate the thickness of a retaining wall 18ft. high, and specify slope and weights of materials used.
4. Give a description of Wicklow Harbour, and give the method of putting in concrete used there.
5. Give a design for a quay wall. To be founded 16ft. below

[1] Sketch of harbour accompanies report.

[2] ENGINEER, vol. lxxiii., pages 3 and 4.

present bottom of harbour, which depth is to be got by dredging. High water, 18ft. above bottom of harbour; rise of spring tide, 12ft. Estimate its cost for a length of 1000ft., and describe the means you would adopt for getting in the foundations.

COUNTY WORK—ROADS.

1. State what information, plans, &c., are necessary when going to make a road between two towns across a bog. The upland is gently undulating, and there is a river to cross.
2. Give a cross section of road where in upland.
3. Give a cross section of road where in bog.
4. Give an estimate per perch for question No. 2.
5. Give an estimate per perch for question No. 3.
6. Make a drawing of a bridge over the river; there is a good gravel foundation at the bed of the river. The ordinary water is 3ft. above the bottom; flood water 7ft. above bottom, and the adjacent bog 9ft. above the bottom.
7. Give a specification to maintain a road (1) through a bog, (2) through upland.

RIVERS.

1. A river is improved by longitudinal embankments alone. State what shall ordinarily be the effect on river bed after some years.
2. Describe one method of making a longitudinal bank, and give one instance.
3. What is usually the course of a river in flat ground, the soil being soft and loamy? Where shall be the deepest channel?
4. Describe one method of protecting a soft river bank.
5. Is a tide an improvement or otherwise to the navigation of a river estuary? Give an instance and describe fully the method of improving estuary.
6. Describe one method commonly used for draining low-lying land.
7. Describe how you would drain a few acres of land alongside a stream, and with a gentle slope.
8. Give one method of computing the discharge of drainage pipes. Does the material of the pipe affect the flow?

COUNTY WORK.—ARCHITECTURE.

1. Mention the different kinds of masonry used in building construction, and illustrate them by sketches. What means have been taken for the prevention of damp in walls?
2. What is the seasoning of timber? What is its use? Write a specification for a carpenter. For a joiner. The work to be done in an ordinary villa.
3. Give a working drawing of a fireplace in the top storey of a house, in an outer brick wall. Show flooring joists, ceiling joists, &c., and junction of chimney with roof, and give names and dimensions of each part.
4. Give an estimate in detail of the cost per cubic yard of concrete, masonry, and excavation for an 18in. rubble wall in a trench 3ft. deep on concrete 3ft. by 2ft.
5. Give particulars of the leading characteristics of architecture, from the Norman invasion to the middle of the sixteenth century.
6. A $1\frac{1}{2}$ brick wall, 40ft. high and 12ft. long, shows signs of coming forward; a timber shore is put against it 30ft. long, the bottom end of shore is 3ft. from face of wall. Show what is the maximum horizontal pressure liable to come against strut, and total maximum thrust and size of strut.
7. Give a working drawing of a doorway for a country mansion. The door is 4ft. by 8ft., the upper panels are glazed, lower panel moulded on outside, and bead butt on inside. Show trimmings, &c.

LONDON AND SOUTH-WESTERN RAILWAY LOCOMOTIVE.

(*Continued from page* 385.)

Regulator.—In the inside of the dome is to be placed a cast iron regulator in two parts, with flanged joints, to have two valves, one of brass and the other of cast iron, and to be worked from the back of the fire-box. The steam pipe leading from the regulator to the smoke-box is to be of copper, No. 7 B.W.G., $4\frac{1}{2}$in. inside diameter, and is to have a brass flange brazed on where it fits into the tube plate; the other end of the pipe to have a brass collar brazed on, and is to be secured to the stand regulator pipe as shown.

Water space.—The water space between the fire-box and shell is to be $2\frac{1}{2}$in. wide at the foundation ring, and is to be enlarged upwards to the dimensions shown on drawing.

Foundation ring.—The foundation ring is to be Yorkshire iron, $2\frac{1}{2}$in. wide by $2\frac{1}{2}$in. deep, and rivetted to the inside and outside fire-boxes with $\frac{7}{8}$in rivets, snap-headed 2in. pitch, the side being of the section shown on drawing.

Ashpan.—The ashpan is to be placed below the fire-box casing, with movable doors and perforated dampers at the back and front, so arranged as to be worked from the back of the fire-box. The handles for working the doors are to be placed at a convenient height on the foot-plate. The sides are to be of $\frac{1}{4}$in. plates, and the bottom of $\frac{3}{8}$in. plates, of good Staffordshire iron; angle irons, $2\frac{1}{2}$in. by $2\frac{1}{2}$in. by $\frac{3}{8}$in. thick, are to be rivetted to the sides and bottom with $\frac{5}{8}$in. rivets. The ashpan is to be of the form shown on drawing, and is to be secured to the lugs forged on the foundation ring as shown.

Fire-bars and carriers.—The fire-bars are to be of cast iron, of the form and dimensions shown, and the carriers of wrought iron, secured to the foundation ring in the manner shown on drawing.

Smoke-box.—The smoke-box is to be of the form and dimensions shown on drawing. The sides and crown are to be $\frac{5}{16}$in. thick, rivetted to the flange of the smoke-box tube plate. The front plate is to be in one, and $\frac{3}{8}$in. thick. An angle iron $2\frac{1}{2}$in. by $2\frac{1}{2}$in. by $\frac{1}{2}$in. thick is to be rivetted to the front and side plates. A hole for the door is to be cut in the front plate 3ft. 10in. diameter. The door is to be of best Staffordshire iron $\frac{3}{8}$in. thick, protected on the inside with a shield, placed $1\frac{1}{2}$in. from door, and is to bed on to a wrought iron ring which is to be rivetted to the outside of the front plate. Great care must be taken that the door and the wrought iron ring are properly faced, so that when the door is closed a perfectly air-tight joint is made. The cross bar is to be made to lift out of malleable cast iron sockets, which are to be rivetted to the inside of the sides of the smoke-box. Two handles and a gripping screw are to be provided, also a handle for opening the door. All the plates are to be clean and smooth and well ground over. All rivets are to be $\frac{5}{8}$in. diameter, $2\frac{1}{2}$in. pitch, and are to be countersunk and filed off flush. The outside handles are to be finished bright. All lamp iron brackets are to be fixed as shown.

Blast pipe—To be fitted with Adams' patent vortex pipe.—An arrangement for drawing off the ashes from the smoke-box is to be provided.

Chimney.—The barrel of the chimney is to be of good smooth best best Staffordshire iron $\frac{1}{4}$in. thick, to have a butt joint, and is to be rivetted together with countersunk rivets down the back, having a hoop of half-round iron at the top; the bottom is to be of best Yorkshire iron $\frac{3}{8}$in. thick, perfectly free from hammer marks, and accurately fitted to the smoke-box. The height of the top of the chimney from rails is to be 13ft. $2\frac{3}{4}$in.

Frames.—The frames are to be of the form and dimensions shown on drawing, each frame being rolled in one piece—or if welded, the joint is to be not less than 2ft. 6in. behind the centre of the driving axle. The frame plates are to be planed over the entire surface, both inside and outside, and finished $1\frac{1}{8}$in. thick. The plates are to be of good tough fibrous Yorkshire iron of frame-plate quality of approved make, and to bear the brand of the maker in a legible manner. All the plates are to be perfectly level and straight throughout, and marked from one template. All holes are to be drilled and rimered out to the exact sizes given, and each bolt and rivet must be turned to gauge, and fitted into its place a good driving fit. When the frames and cylinders, &c., are bolted together, and before the boiler, wheels, and axles are put in their places, the accuracy of all work must be tested by diagonal, transverse, and longitudinal measurement. The frames are to be placed at a distance of 3ft. $11\frac{1}{2}$in. apart, and are to be stayed at the leading end, in front of the driving wheels, and in front of the fire-box by flanged plates as shown, also at trailing end with a cast steel transverse stay, and a cast iron foot-plate. The flanged stay plates are to be planed to the exact length required, and are to be double rivetted to the frames, the rivets being placed zig-zag. At the leading end a wrought iron plate $1\frac{3}{8}$in. thick is to be rivetted to the bottom of the cross flanged plates with rivets $\frac{7}{8}$in. diameter, placed zig-zag; this plate must be perfectly square with the frames, and be planed on the top surface where it takes the cast iron bogie pin, and also on the bottom surface where it beds on to the cast iron cross slide of the bogie. The cast iron bogie pin is to be accurately turned, and is to be firmly secured to the bottom plate with six bolts $1\frac{1}{8}$in. diameter countersunk heads, turned, and fitted into their places a good driving fit. The driving wheels are to be placed 1ft. 5in. in front of the fire-box. The driving and trailing axle-box guides with their wedges are to be of Vickers, Sons, and Co.'s cast steel, the top and sides are to be in one piece, to be free from honeycomb and all other defects, the flanges are to be planed all over and fitted to template. They are to be fastened to the frame with bolts 1in. diameter, turned and driven tight in the holes. The horn stays are each to consist of two bolts, $1\frac{3}{8}$in. diameter, with a cast iron distance piece accurately fitted between the horns. The frames must be finished with a good smooth surface, and the horn plates must be free from cross-winding and square with the engine in all directions.

Bogie.—The bogie is to be made of the form and to the dimensions shown on drawing. The wheels are to be placed 7ft. apart, centre to centre. The frame plates are to be planed inside and outside, and are to be of the same quality as those specified for the main frames, $1\frac{1}{4}$in. thick, and placed 2ft. $7\frac{1}{4}$in. apart. The axle-box guides to be of Vickers, Sons, and Co.'s cast steel, bolted to the frames with $\frac{7}{8}$in. turned bolts, and driven tight into the holes. The frames are to be firmly secured to the wrought iron box girder with $\frac{7}{8}$in. rivets. Great care must be taken that the frames when put together are perfectly parallel and at right angles with the box girder. Flanged plates $\frac{3}{4}$in. thick to receive the cross slide are to be secured to the top of the girder with $\frac{7}{8}$in. rivets. These plates when planed and fixed in their places must be perfectly parallel to each other, and at right angles with the side frames. The cast iron cross slide is to be planed on its bedding surface and bored out to receive the bogie pin. Each side controlling spring is to be laminated, and is to consist of sixteen plates, $2\frac{1}{2}$in. wide and $\frac{3}{16}$in. thick. They are to be made from the best spring steel manufactured by Thomas Turton and Sons, Cammell and Co., John Brown and Co., Brown, Bayley, and Dixon, or John Spencer and Sons. Each spring must be thoroughly tested before being put into its place by being weighted with two tons, and on the removal of this weight it must resume its original form. The top plate of each spring must bear the brand of the maker of the steel and the date. The plates are to be properly fitted and tempered, and are to be prevented from shifting side or endways by nibs stamped upon them. The buckles are to be sound forgings, and are to fit the springs accurately, and are to be well secured to them. Through the centre of the casting forming the bogie pin, a wrought iron pin 3in. in diameter is to pass, fitted at the bottom end with a countersunk head and washer, and at the top with a nut and cottar; the hole in the bottom plate of the box girder is to be elongated to allow for the lateral motion of the cross slide. Each spring cradle is to be made of two Yorkshire iron plates 6in. deep, $1\frac{1}{8}$in. thick, with cast iron distance pieces rivetted between them at each end; these cast iron pieces are to be provided with means of lubrication, and are to be shaped to rest on the saddles formed on the top of the axle-boxes. The springs are to be coupled to the beams by hooks as shown; the pins through the hooks are to be of steel, and the eyes of the hooks are to be case-hardened. The brackets holding the springs are to be of Yorkshire iron, and are to be bolted to the frames with $1\frac{1}{8}$in. turned bolts driven in a tight fit. The whole of the work is to be of the best description, and the bogie when finished must be perfectly square and free from cross windings.

Footsteps and handrails.—Footsteps and handrails are to be fixed on each side of the engine as shown. The handrails are to be of $1\frac{1}{2}$in. outside diameter on both sides of the engine and in front of the smoke-box. The footsteps are to be roughed; the handrails are to be finished bright.

Platform and splashers.—The platforms are to be of plate iron $\frac{3}{8}$in. thick, and are to be secured to the frame as shown on drawing. The splashers are to be of plate iron to the dimensions shown on drawing; the rivets are to be countersunk flush outside; the angle irons are to be $1\frac{1}{2}$in. by $1\frac{1}{2}$in. by $\frac{1}{4}$in. thick.

Sand boxes.—Each engine is to be provided with two dry sand boxes, one cast iron box in front of each driving wheel; they are to be so arranged that the valves can be worked together by suitable gearing from the foot plate; the valves are to be circular. Sand pipes are also to be fixed as shown, the sand to be led within 2in. of the rails by wrought iron pipes $1\frac{1}{2}$in. inside diameter. The general arrangement of sand boxes and gear is shown on the drawing.

Buffer plates.—The buffer plates are to be of wrought iron, same quality as specified for frames, 8ft. long, 1ft. $7\frac{3}{8}$in. deep, and $1\frac{1}{4}$in. thick, and are to be rivetted to the stays on inside and outside of frames as shown on drawing.

Buffers.—The buffers at the front of the engine are to be of the London and South-Western Railway pattern, of wrought iron, and to the dimensions shown on drawing. The buffer springs are to consist of two No. 3 india-rubber cylinders, which are to be obtained from Messrs. G. Spencer and Co., 77, Cannon-street, London, E.C. The buffers are to be placed at a distance of 5ft. 9in. apart, centre to centre, and at a height of 3ft. 5in. from the rail level.

Draghooks, screw couplings, and side chains.—The drag hook at the front of the engine is to be furnished with an india-rubber cylinder No. 6, which is to be obtained from Messrs. G. Spencer and Co., 77, Cannon-street, London, E.C. The hooks, screw couplings, and side chains are to be made of best iron chain cable quality, and to drawing.

Wheels.—The wheels are to be of wrought iron, and of the best description and workmanship. The driving and trailing wheels are to be 6ft. 7in. diameter, the bogie wheels 3ft. 4in. diameter over the tread of the tires. Great care must be taken that the bosses and the junction of the ring and arms are all perfectly sound; the top or outer part of the spoke must be forged solid with the rims and not welded; the ends of the spokes must be welded together at the boss before the washers are welded on. The driving and trailing wheels must be bored and turned, and have keyways cut strictly to template, so that they shall be exactly alike; and each wheel must be put on the axle by hydraulic pressure of not less than 100 tons. The rims must be correctly turned to gauge to receive the tires, and the whole wheel trimmed up, so that the surfaces and lines are all fair and true. The skeleton is to be turned to a diameter of 6ft. 1in., the rims are to be $4\frac{7}{8}$in. broad, $1\frac{3}{4}$in. thick at centre; to have twenty-two spokes $1\frac{1}{2}$in. thick at the boss and 4in. wide, and at the rim $1\frac{1}{4}$in. thick and $3\frac{1}{2}$in. wide. The bosses are to be bored out parallel to a diameter of $8\frac{1}{2}$in., and are to be 1ft. 5in. diameter. The cranks for the coupling rods are to be forged solid with the bosses 12in. centres, and bored out to fit the coupling rod-pins, and are to be connected with the rim by three arms forged in one piece. The crank pin holes are to be quartered. The bogie wheels, for which the method of manufacture is to be the same as before specified, must be turned and bored strictly to template, so that they shall be exactly alike, and each wheel must be put on the axle without keys by hydraulic pressure of not less than 50 tons. The rims are to be $4\frac{3}{8}$in. wide, $1\frac{3}{4}$in. thick at the centre, to have ten spokes $1\frac{1}{2}$in. thick at the boss, and $3\frac{1}{2}$in. wide, at the rim $1\frac{1}{4}$in. thick, 3in. wide. The bosses are to be bored out parallel to a diameter of 7in., and are to be $13\frac{3}{4}$in. diameter. The whole of the wheel are to be in all respects as shown. The balance weights in the driving and trailing wheels are to be forged solid with the spokes.

Tires.—All the tires are to be 3in. thick and of best crucible cast steel, manufactured by Vickers, Sons, and Co., Krupp, or Cammell and Co., and are to be stamped with the name of the maker. The tires are to be secured to the wheels in the manner shown with a square lip and tap bolts $1\frac{1}{8}$in. diameter and 11 threads per inch. Each tire is to be bored out to template before being shrunk on the wheels, and is to be accurately turned, so that the diameters and thickness of the tires of each class shall be exactly similar. Each tire is to be guaranteed to stand without fracture the test of being pressed cold into an oval shape by hydraulic power to the extent of 2in. compression for each foot of external diameter.

Axles.—All the axles are to be of the best crucible cast steel, manufactured by Vickers, Sons, and Co., Krupp, or Cammell and Co., and are to be stamped with the name of the maker. All the axles are to be the dimensions shown on drawing. The bearings of the driving and trailing axles are to be 9in. long, $7\frac{1}{2}$in. diameter. The bearings of the bogie axles are to be 10in. long and $5\frac{1}{2}$in. diameter: all the turned parts of each class of axle are to be made to gauges and duplicates of each other.

Axle boxes.—All the axle boxes are to be of best gun-metal, and to have bearing surfaces of white metal, the mixture to be as specified. The keeps are to be of cast iron. All the axle boxes are to have lubricating pads as shown. The axle box of each class must be made to gauges and duplicates. There is to be only one groove in the crown of the axle boxes, with the lubricating holes leading into it.

Springs.—The springs are to be made of the best Swedish spring steel, manufactured by Thomas Turton and Sons, Cammell and Co., John Brown and Co., Brown, Bayley, and Dixon, or John Spencer and Sons. Each spring must be thoroughly tested before being put into its place by being weighted with 6 tons, and on the removal of this weight each spring must resume its original form. Each driving and trailing spring is to be 4ft. centre to centre of eyes when loaded, and is to consist of 11 plates $\frac{1}{2}$in. thick and 5in. wide, the bogie axle-box spring is to be 4ft. centre to centre of eyes, and is to consist of 13 plates $\frac{1}{2}$in. thick and 5in. wide. The top plate of each spring must bear the brand of the maker of the steel and the date. The plates are to be properly fitted and tempered, and are to be prevented from shifting side or end ways by nibs stamped upon them. The buckles are to be sound forgings, and are to fit the springs accurately, and are to be well secured to them. The shank on the bogie spring buckle is to be forged solid with the plate which is to be shut up at the crown of the buckle. The driving and trailing springs are to have adjustable hangers at each end as shown. The bogie springs to have adjustment at the buckle. All the springs are to be so adjusted that when the engine is road-worthy the height from rail-level to the centre of the buffers shall be 3ft. 5in.

Compensating lever and carriers.—Each lever is to be placed between the driving and trailing wheels, and is to be connected by a cross-shaft as shown; each carrier is to be secured to the frames with 1in. diameter studs as shown. The compensating lever is to be fitted at the centre with a phosphor-bronze bush, accurately fitted and pressed into its place by hydraulic power.

Cylinders.—The cylinders are to be 18in. diameter when finished, with a stroke of 24in. They are to be made of best, close-grained, hard, and strong cold-blast cast iron; they must be as hard as they can be made, to allow of their being properly fitted and finished, and must be perfectly free from honey-comb or any other defect of material or workmanship; they must be truly bored out, the ends being bell-mouthed. All the joints, covers, and surfaces are to be planed or turned, and scraped to a true surface so that a perfect joint can be obtained. All studs are to be tightly screwed. The cylinders are to be made with loose covers at both ends, provision being made on the back cover for carrying the slide bars. The cylinders are to be set in a horizontal line, placed at a distance apart of 6ft. $1\frac{1}{2}$in. from centre to centre, with steam-chest on side as shown on drawing. The steam ports are to be 14in. long and $1\frac{3}{8}$in. wide. The exhaust port is to be 14in. long and 3in. wide. The holes in the frames and flanges of the cylinders are to be carefully rimered. When the cylinders are correctly set to their places they are to be firmly secured to the frames by turned bolts $1\frac{1}{4}$in. diameter, driven home a tight fit.

Piston and piston-rods.—The pistons are to be made of good tough cast iron of the form and dimensions shown, and are to be fitted accurately to the cone of the rods, and secured thereon by gun-metal nuts formed with collars, and taper steel pins through the nut. The piston head is to be an easy fit in the cylinder; the packing rings are to be two in number, of cast iron $\frac{3}{4}$in. wide, $\frac{1}{2}$in. thick, and turned all over. The rings are to be turned larger than the diameter of the cylinders, then to be cut and sprung in to fit the bore in the cylinders; they are to be prevented from turning round in the pistons by dowel pins fixed in the piston. When finished the whole must be an easy and accurate fit, so that the finished rod and piston can be moved readily backwards and forwards in the cylinder. The piston-rods are to be $3\frac{1}{2}$in. diameter, and are to be made of the very best cast steel by the makers before specified; they are to be truly fitted to the heads, and are to be tapered where they enter the crosshead, and to which they are to be secured by cottars of mild Swedish steel.

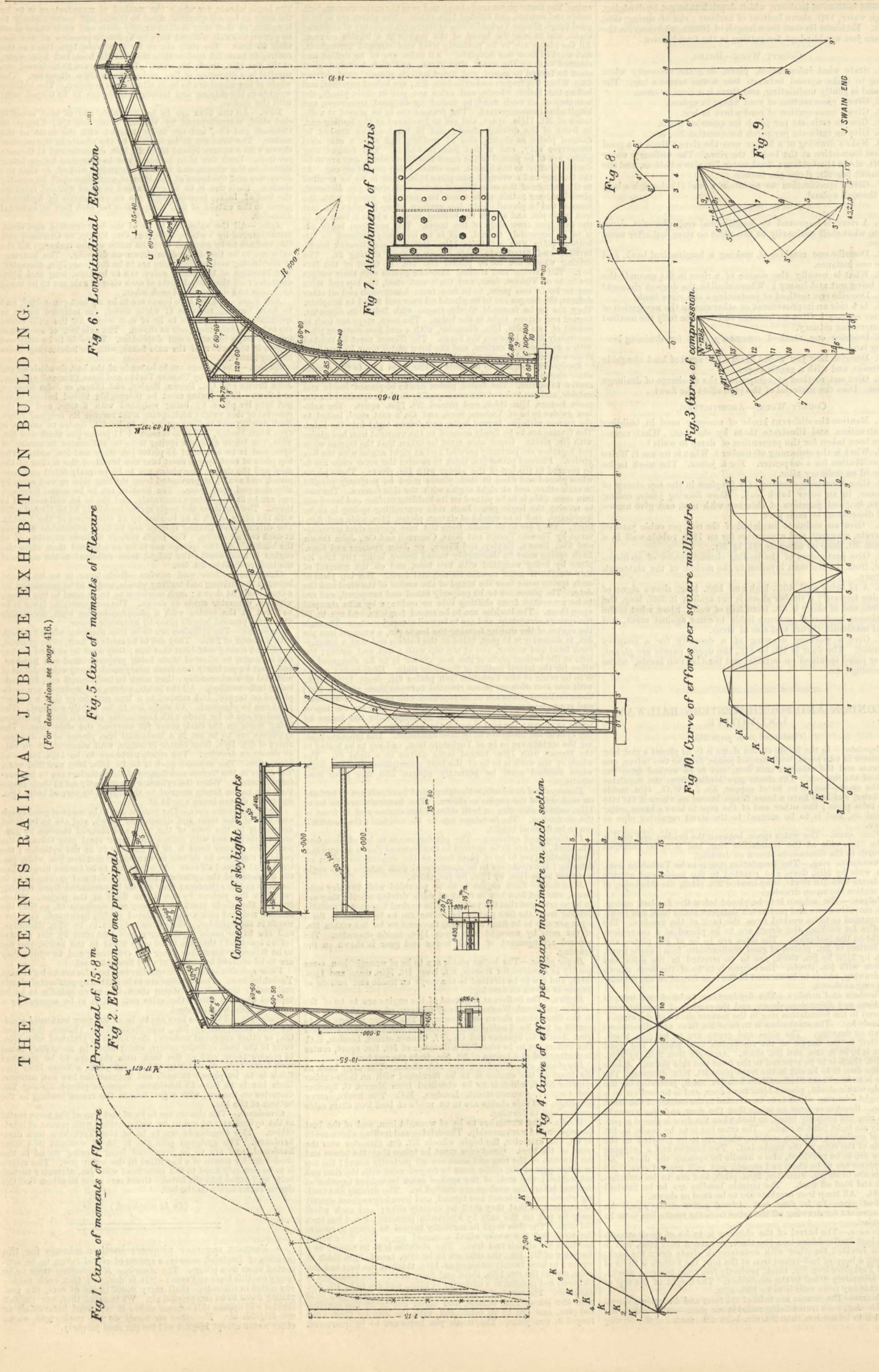
Valve spindles.—The valve spindles and buckles are to be of best Yorkshire iron. The spindles are to be guided by gun-metal glands and bushes through the steam chest, the valve spindle is to be tapered where it enters the valve rod, and is to be secured by a cottar of mild Swedish steel.

Slide bars.—The slide bars are to be of the very best mild crucible cast steel, 6in. by 3in., manufactured by Vickers, Sons, and Co., or other approved makers; they are to be attached with $1\frac{1}{4}$in. bolts to the back cylinder covers, which must be accurately fitted to receive them, and at the back ends they are to be attached with bolts $1\frac{1}{4}$in. diameter to the motion plate, a brass liner $\frac{1}{4}$in. thick is to be placed at each end between the bar and carriers. Each bar is to have 15 lubricating recesses placed zig-zag 2in. diameter on the top, with a $\frac{3}{8}$in. hole in the recess leading to the bottom of the bar.

Crossheads.—The sleeves are to be of cast iron of the same metal as the cylinders, and are to be well provided with means of lubrication. The crossheads are to be of best Yorkshire iron case-hardened. The gudgeon pins are to be of wrought iron case-hardened, and are to be prevented from turning round in the cross-head by means of a key fitted in the outer jaw. The sleeve is to be securely fixed to the cross-head with $\frac{7}{8}$in. diameter turned bolts well fitted into the holes. Great care must be taken that the sleeve works freely on the bar.

(*To be continued.*)

A FRENCH engineer proposes another scheme for the invasion of England, namely, a system of postal tubes, to be supported upon iron pillars. The *American Manufacturer* tries to be funny on this topic and says:—"It is designed that each tube—one metre in diameter—shall carry small trains of cars, the propelling force to be compressed air. We imagine that our English cousins will oppose this scheme unless it is agreed beforehand to use English air. No other air would do the work right, as no other water except English will temper steel properly."

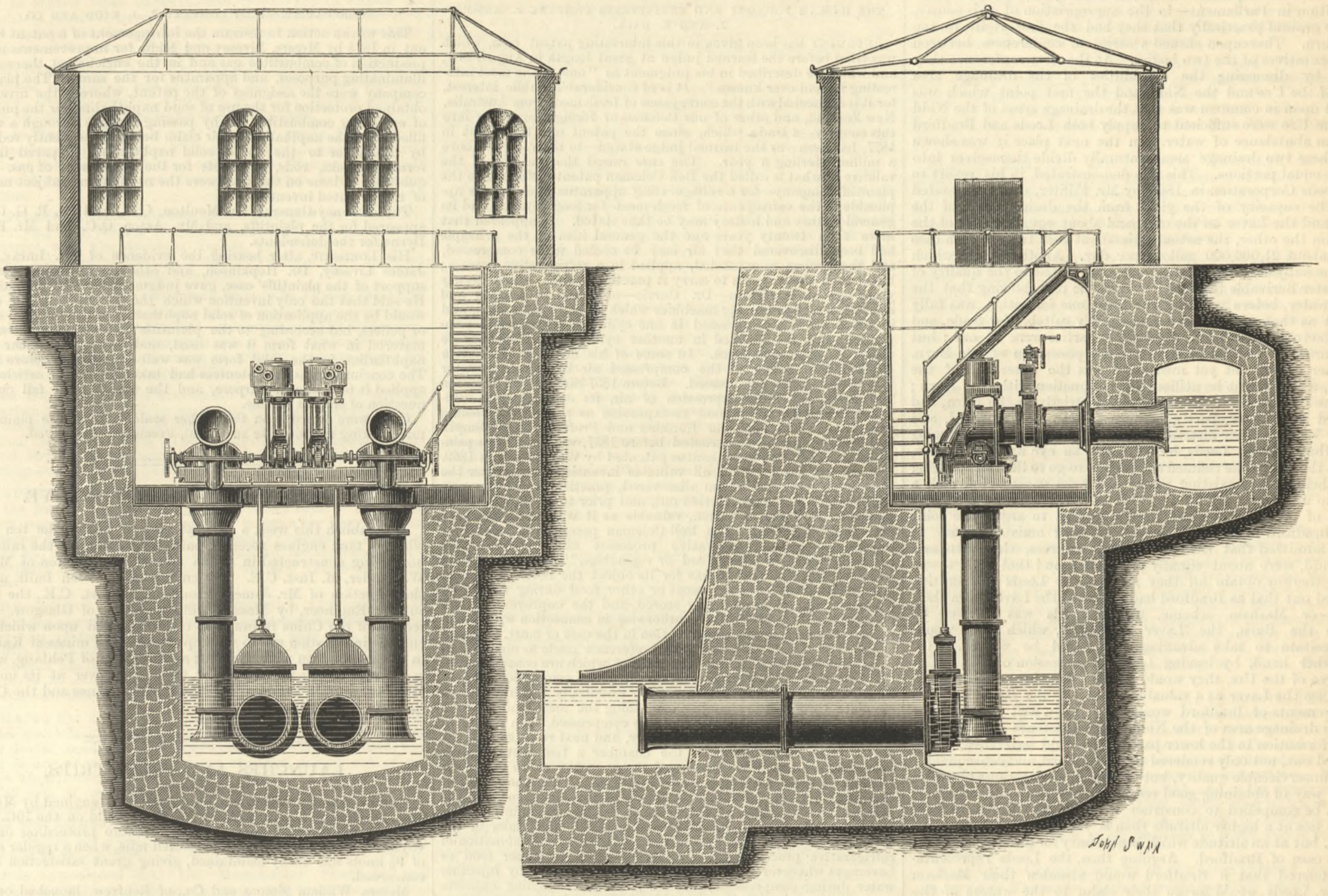


THE VINCENNES RAILWAY JUBILEE EXHIBITION BUILDING.

(For description see page 416.)

PUMPING ENGINES, WHAMPOA DOCKS.

MESSRS. W. H. ALLEN AND CO., LONDON, ENGINEERS.



PUMPING ENGINES, WHAMPOA DOCKS.

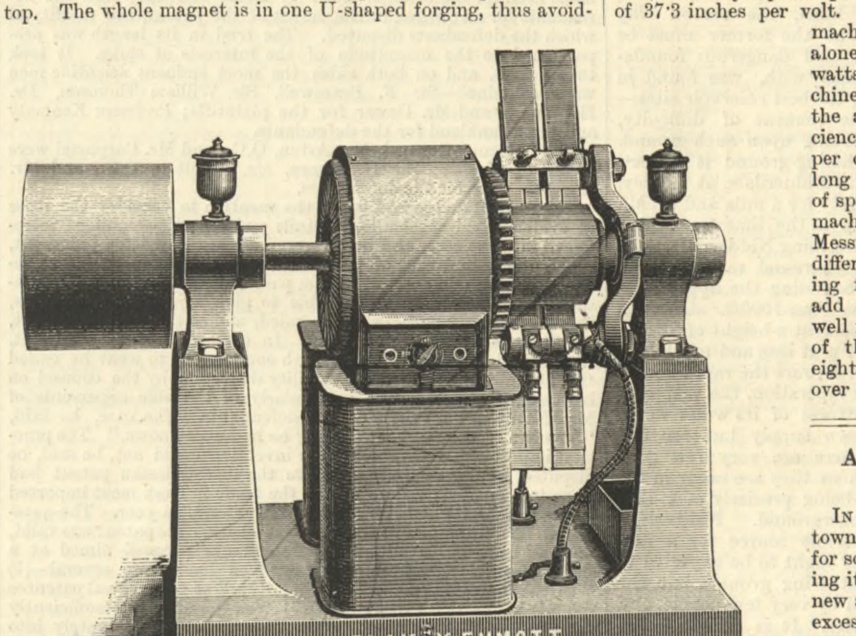
We illustrate above a fine set of centrifugal pumping machinery, manufactured by Messrs. W. H. Allen and Co., of York-street Works, Lambeth, for the Whampoa Docks, Hong Kong, to the order of Mr. Gillies, the engineer there. These pumping engines are constructed with pipes 36in. internal diameter, and are capable of delivering 160 tons of water per minute. The engines are of the vertical form, with 22in. cylinders, and are arranged to run at 180 revolutions per minute. They are designed so that either engine may work either pump. The arrangement of these large pumps is exceedingly compact, and admits of the engines being entirely under control. The dock for which these pumps are made is one of the largest in the East. The company is not only able to do its own repairs, but has a large shipbuilding industry of its own, the whole of the workshops being fitted up with all the latest improvements, showing the great strides that have been made in this locality of late years.

THE SHIP CANAL COMMENCED.

The actual work of constructing the Manchester Ship Canal was commenced a week ago in a strangely modest and unassuming manner, considering the magnitude and importance of the undertaking. Instead of having an elaborate ceremony with a public personage as the leading figure, as is customary in such cases, the directors went quietly up the Mersey to Eastham, on the Cheshire shore, and each cut a sod. Nothing could be more unpretentious than that method of inaugurating what is likely to prove a revolutionary enterprise, commercially speaking; but it must be observed that Eastham is not the most convenient or most accessible spot for an elaborate public ceremony, and this may have influenced the directors in dispensing with formalities. An ordinary navvy's spade being handed to Lord Egerton, the chairman of the company, his lordship cut the first sod, amid ringing cheers from the assembled spectators. Following him, Sir J. C. Lee, deputy chairman, Mr. Alderman Bailey, Mr. Henry Boddington, Mr. J. K. Bythell, Mr. W. J. Crossley, Mr. C. J. Galloway, the Mayor of Stockport (Mr. J. Leigh), and the Mayor of Oldham (Mr. S. R. Platt), each cut a sod, they being directors. Mr Leader Williams, C.E., chief engineer to the company, next filled a wheelbarrow with earth and tipped it near by, thus really beginning the work of excavation, and subsequently Mr. Boulton, of Ashton-under-Lyne, cut a sod on behalf of himself and other shareholders. Later on the directors examined the plant which the contractor, Mr. Walker, has collected, which, at Eastham and Ellesmere Port, embraces fifteen locomotives, numerous steam navvies, or excavators of the latest and most improved type, massive cranes, and a vast quantity of timber and steel rails. It is expected that rapid progress will be made with this, the lower part of the canal, notwithstanding the advent of wintry weather, and the upper part will be proceeded with. A sufficient number of trucks have been provided by the Ashbury Railway Carriage Company, which has contracted to supply 100 wagons each week up to next May. Already within a week a good deal has been done. The steam excavators have been put in position, railways are being laid down for carrying away the excavated matter, and smiths' and joiners' workshops and store sheds have been erected. Naturally, the prospect of work has drawn many hundreds of unemployed men to the scene of operations; but as only one section of the canal is at present being proceeded with, only a small number of men has been taken on yet. Only some three or four hundred are so far employed, but there is a good prospect for genuine and capable workmen, for this section alone will probably require at least two thousand men, and when the whole work is in progress the number of men employed will be between twenty and thirty thousand.

THE "BLAKEY-EMMOTT" DYNAMO.

We illustrate below a new pattern dynamo, made by Messrs. Blakey, Emmott, and Co., of the Northern Telegraph Works, Halifax. It is of the single magnet type, with the poles at the top. The whole magnet is in one U-shaped forging, thus avoiding in the magnetic circuit both the resistance of joints and the use of cast iron. The armature is of the modified Gramme type, and is built up of thin insulated discs of annealed iron, the whole being securely mounted on a gun-metal spider, which is keyed to the shaft, thus ensuring positive mechanical driving. The armature is wound with only one layer of wire. The commutator consists of forty sections of specially hard-drawn copper, insulated with mica. There are two brushes on each side, each separately adjustable, and fitted with hold-off catches. The shaft is of steel, the bearings are of gun-metal and are of ample length. Sight-feed lubricators are used, by means of which the quantity of oil delivered can be readily seen and adjusted. The pulley is wide, thus favouring steady driving. The whole machine is put together on a strong cast iron base, which makes a very rigid foundation. The machine under notice, which is compound wound for constant potential, is intended for an output of 60 ampères and 100 volts; the speed being 1100 revolutions per minute. The cross-sectional area of the magnet bars is 30 square inches. The total cross-sectional area of actual iron in the armature is 20 square inches. The total excitation of the field magnets at full load is 12,130 ampère turns. The total strength of the useful field is 378 lines—English measure. The density in the magnet cores is 12·6 lines per square inch, and in armature core 18·9 lines per square inch. The length of wire on the armature is 360ft., which is at the rate of 43·2 inches per volt, or at a periphral speed of 3000ft. per minute, at the rate of 37·3 inches per volt. The total weight of copper in the machine is 95 lb., and in the armature alone, 13 lb. This gives an output of 63 watts per lb. of copper in the whole machine, and 461 watts per lb. of copper in the armature only. The electrical efficiency at full load is said to be over 92 per cent. The machine keeps cool after long runs, and there is a total absence of sparking at the brushes. This type of machine is now being constructed by Messrs. Blakey, Emmott, and Co., in different sizes, intended for outputs varying from 10 to 1000 lamps. We may add that the machines are mechanically well finished, and the electrical efficiency of the larger machines is still higher, an eighteen unit machine, giving, it is said, over 95 per cent. electrical efficiency.



SINGLE FORGING DYNAMO.

A COMPLICATED WATER SUPPLY CASE.

In common with almost every large town in the kingdom, Bradford has been for some time past much exercised respecting its water supply, and the necessity for new and ampler sources. To this need the excessive drought of a few months ago gave powerful emphasis, and the Corporation have been striving energetically and with laudable zeal, on behalf of the population, to meet the demand. A scheme being eventually formulated, the next step was to prepare a Bill to be submitted to Parliament, and to this the Council were looking forward when they discovered that a very potent factor which had been overlooked would have to be reckoned with. From the sister town, Leeds, came a *caveat emptor* which caused them to halt, and which subsequently led to a complete change in their programme. For a time there was a deadlock, followed by a contest between the two towns, and numerous conferences. This contest, however, was thoroughly and sincerely friendly throughout, and the manner in which it was conducted to the conclusion now attained was in the highest sense creditable to the two boroughs. The principle of "give-and-take" regulated the proceedings, and apparently all parties are now satisfied; but the result means the loss of at least a year, and the circumstances were so unusual and so complicated that they are well worth describing.

After weighing the merits of a number of proposals for increasing their water supply, the Corporation of Bradford decided to apply to Parliament for authority to take water from the river Burn, a tributary of the Ure, at Masham. But when the Leeds Corporation ascertained what Bradford was contemplating, they put in an objection—which, of course, meant subsequent opposition in Parliament—to the appropriation of this source, on the ground practically that they had the first right to tap the Burn. Thereupon ensued a series of conferences between representatives of the two bodies. At the first conference they began by discussing the capabilities of the drainage area both of the Ure and the Nidd, and the first point which was agreed upon in common was that the drainage areas of the Nidd and the Ure were sufficient to supply both Leeds and Bradford with an abundance of water. In the next place it was shown that these two drainage areas naturally divide themselves into nearly equal portions. This was demonstrated in his report to the Leeds Corporation in 1866 by Mr. Filliter, who then stated that the capacity of the yield from the drainage area of the Burn and the Laver on the one hand about equalled that of the Nidd on the other, the actual estimate at that time in each case being about 21,000,000 gallons per day. Another point which was the subject of mutual agreement related to the quality of the water derivable from each source, the test showing that the Nidd water, before reaching the limestone formation, was fully as soft as that of the Burn, and equally suitable for trade and manufacturing purposes. So far the parties were at one; but then arose a friendly rivalry for the possession of the Burn. Another source not yet mentioned was the watershed of the Laver, which might be utilised in conjunction with the Burn; but the Bradford scheme was confined strictly to the Burn, and ignored the Laver, partly because it was not required, and partly because other districts had already arranged for drawing from that source. Leeds, however, had an eye upon the Laver, and at the same time claimed a first right to go to the Burn, urging that their already existing works had been constructed with a view to ultimately taking that course. Having thus advanced a sort of prescriptive right, they proceeded to argue the point with Bradford in, as has been said, the most amiable spirit. It being admitted that the two available sources, the Burn and the Nidd, were about equally productive, and that both towns could thereby obtain all they needed, the Leeds Corporation pointed out that as Bradford had excluded the Laver from their Burn—or Masham—scheme, unless Leeds was allowed to utilise the Burn, the Laver watershed, which they would not hesitate to take advantage of, would be wasted. On the other hand, by leaving Leeds in possession of the drainage area of the Ure, they would be able, for the reason stated, to utilise the Laver as a valuable adjunct to the Burn, and the requirements of Bradford would be equally well provided for by the drainage area of the Nidd. The existence of the limestone formation in the lower part of the Nidd watershed, it was pointed out, not only rendered the water hard, and consequently of an unserviceable quality, but prevented such serious obstacles in the way of obtaining good reservoir sites that the engineers would be compelled to construct works in the millstone grit, which lies at a higher altitude than is necessary in the case of Leeds, but at an altitude which is necessary for gravitation works in the case of Bradford. Arguing thus, the Leeds representatives offered that if Bradford would abandon their Masham scheme, Leeds would forego their claim to the waters of the Nidd. The suggestion appears to have come with surprise to the Bradford representatives, inasmuch as the Nidd drainage area had been regarded most particularly as a prospective source of supply for Leeds, and the possibility of drawing from its store had been entirely ignored by Bradford out of consideration for Leeds. From this it naturally followed that further consideration would be necessary on the part of Bradford, and on its being pointed out that that would delay the Parliamentary proceedings contemplated by Bradford, Leeds very generously offered to furnish at cost price, if required, a supply of water to such portions of the Bradford area as the Leeds service could reach. In suspicious quarters purely selfish motives were attributed to Leeds, underlying their apparent frendliness and magnanimity. It was said, for example, that as the Nidd is nearer to Leeds than the Burn, the reason why Leeds wished to force Bradford to take the former must be that limestone, the most treacherous and dangerous foundation that engineers could have to deal with, was found in the valley of the Burn, and underlying the best reservoir sites—therefore Leeds wished to avoid the element of difficulty, and the great expense involved in working upon such ground. The character here ascribed to the gathering ground is correct. At a spot named Goyden Pot Hole, in Nidderdale, at Limley, the Nidd disappears underground entirely for a mile and a half, so large and numerous are the fissures in the limestone. Mr. Paterson, in a report two years ago, describing Nidderdale, said:—"It has a magnificent stretch of catchground mostly on the millstone grit. Its moorland ridges bounding the upper Nidd are very elevated, being nowhere less than 1000ft. above sea level, and culminating in Great Whernside at a height of 2245ft. Though dotted by enormous patches of peat bog, and much of it devoid of that steepness of slope which favours the rapid flow of rainfall, with a minimum of loss by evaporation, the vast area of this watershed and the general softness of its water would commend it for the purposes of town supply but for two insuperable objections; first, that there are very few good reservoir sites; and second, that such as they are occur in the mountain limestone, one of the best being precisely over that very part of the Nidd flowing underground. Nidderdale, therefore, must be rejected as a possible source for a new Bradford supply." Such facts as these ought to be expected to influence Leeds in the choice of a gathering ground, but the suspicions thrown out were entertained by very few people, and those the least responsible in the matter. It is true that the Bradford Corporation, if they eventually adopt the Nidd, would, as the case now appears, have to go to the higher ground for their reservoir sites, and at greater outlay, but that is not yet conclusively established; and a further examination by engineers, which has been decided upon, may put a different aspect on the matter. At all events, the Bradford people are satisfied with the present position of the controversy, more especially as they can now take another year for consideration and examination—sure of water from Leeds in the meanwhile, if needed—and if they can in the end reconcile themselves to the Nidd source, they will be spared opposition, and, of course, heavy expense, from Leeds, when they go for parliamentary powers. Some formal steps are necessary to ratify the mutual arrangement proposed, but the compromise is virtually settled, and while it shows wisdom on both sides, the whole matter furnishes a unique instance of what may be done even in such a prolific cause of contention as the appropriation of a new source of water supply.

HEATING GAS.—Some one who is anxious to rid the London atmosphere of its smoke, by using cheap heating gas, says that there is plenty of room in the streets for all the pipes besides the space that is wasted for ordinary traffic.

LEGAL INTELLIGENCE.

QUEEN'S BENCH DIVISION.

Before Mr. JUSTICE STEPHEN.

THE HASLAM FOUNDRY AND ENGINEERING COMPANY *v.* MESSRS. J. AND E. HALL.

JUDGMENT has been given in this interesting patent case, which was tried before the learned judge at great length in August last, and which he described in his judgment as "one of the most interesting he had ever known." It is of considerable public interest, for it is connected with the conveyance of fresh meat from Australia, New Zealand, and other of our Colonies or foreign countries into this country—a trade which, since the patent was taken out in 1877, has risen—as the learned judge stated—to the value of above a million sterling a year. The case raised the question of the validity of what is called the Bell-Coleman patent—assigned to the plaintiff company—for a refrigerating apparatus and process applicable to the conveyance of fresh meat for long voyages, and its general nature and history may be thus stated. It appeared that more than twenty years ago the general idea of the principle had been discovered that air may be cooled while compressed, and then, when re-expanded, applied in a refrigerative process; but it took many years to carry it practically out. About twenty years ago an American—Dr. Gorrie—exhibited in London and elsewhere cold-producing machines which he had constructed, and in which air was compressed in one cylinder, cooled while compressed, and re-expanded in another cylinder in a manner to utilise its expansive force. In some of his machines Dr. Gorrie effected the cooling of the compressed air by injecting water into it while being compressed. Before 1857 Sir William Thomson had suggested the compression of air, its cooling while compressed, and its subsequent re-expansion as a means of cooling apartments; and Professor Rankine and Professor Piazzi Smyth had such apparatus constructed before 1857, while the same principles were adopted in apparatus patented by Windhausen in 1869. But, as has happened in all valuable inventions, long after the idea or principle had been discovered, practical difficulties prevented its being really carried out, and prior to the Bell-Coleman patent in 1877 the invention, valuable as it was, had not proved practically successful. The Bell-Coleman patent (1877) was "for improvements in refrigerative processes and apparatus for preserving meat or other food or vegetables," and the invention was described thus:—"It has for its object the better and more economical preservation of meat or other food during transit by sea or on land, or while being stored, and the improvements are also applicable in breweries or otherwise in connection with beverages. In carrying out the invention in the case of meat, the meat is placed in a chamber which is by preference made as air-tight as is conveniently possible, and the walls of which are constructed in the best known manner for diminishing the conduction of heat through them. The invention consists essentially in causing air to circulate through the chamber containing the meat and through improved apparatus, in which last it is compressed, then cooled in its compressed state by means of water, and next re-expanded, the object being to maintain in the chamber a temperature never exceeding 30 deg. Fahrenheit, and never so low as to cause the freezing of the meat, which would injure it." Then the specification gave a more detailed description of the apparatus and the process, which would to the general reader be unintelligible. "What we believe to be novel and original, and claim in the invention secured to us by the patent, is (1) the combination of refrigerative processes for preserving meat or other food or beverages wherever compressed air is cooled, first, by injecting water during compression; secondly, by intermingling opposite currents of water with the air; thirdly, by passing it through considerable lengths of piping traversing the chambers containing the substances to be preserved, and having a temperature never below the freezing point, all substantially for the purpose described. (2) The arranging or combining together of steam engine, air compressing, and air expansion apparatus in an improved manner described." Then came the third and most important part of the claim:—"The application of the pipes provided for the passage of the compressed air to the expansion cylinders and traversing the chamber in which the meat or other food is, or beverages are, subjected to the refrigerant preservative action as described." The question now raised in this action was whether this patent is valid as against a certain apparatus and process used by the defendants. The Bell-Coleman patent had been assigned to the plaintiff company, who used it by fitting up the process on ships used for the colonial trade in meat, and they sued the defendants for an alleged infringement of the patent, the validity of which the defendants disputed. The trial in its length was proportioned to the magnitude of the interests at stake. It took twelve days, and on both sides the most eminent scientific men were examined—Sir F. Bramwell, Sir William Thomson, Dr. Hopkinson, and Mr. Dewar for the plaintiffs; Professor Kennedy and Mr. Frankland for the defendants.

The Attorney-General, Mr. Aston, Q.C., and Mr. Carpmael were for the plaintiffs; Sir H. James, Mr. Moulton, Q.C., and Mr. Bousfield were for the defendants.

The learned Judge had taken the vacation to consider the mass of evidence and mechanical details and scientific opinions introduced into the case, and he now read a lengthy written judgment, substantially in favour of the plaintiffs on the main questions involved, though on account of one part of the claim in the specification as it stands he was unable to give a judgment for them, though that may perhaps be amended, and so the final judgment, it will be seen, is not yet given. In commencing his judgment, the learned Judge paid a very high compliment to what he called "the extraordinary skill and ability displayed by the counsel on both sides," and he spoke particularly of the able arguments of Mr. Moulton on behalf of the defendants. The case, he said, "was one of the most interesting he had ever known." The practical importance and value of the invention could not, he said, be disputed, as it appeared that since the Bell-Coleman patent had come into operation, the value of the trade in fresh meat imported from our colonies had risen to a million sterling a year. The question to be determined in the case was whether the patent was valid, and had been infringed by the defendants' process, aimed at a similar result. That question resolved itself into several—(1) Was the invention new and useful? (2) Was the original patentee the "true and first inventor?" (3) Was the invention sufficiently described? The learned Judge then entered elaborately into these questions, arriving at a conclusion in favour of the plaintiffs upon the former questions. No doubt, he said, some refrigerating process was known before this patent in 1877; but in this as in so many inventions there were practical difficulties in carrying it out, and prior to this patent the invention had not been rendered practically effective; and this process had rendered possible the vast extension of the trade which had since taken place, amounting to a value of above a million sterling in the course of the year. There could therefore be no doubt as to the utility of the invention; and he also came to the conclusion that the patentee was the true and first inventor of the process he had patented, for the application of the principle involved. He further came to the conclusion that the defendants' process was substantially the same as that patented in the plaintiffs' patent, with only colourable differences; and thus he came to a conclusion in favour of the plaintiffs on all the main questions involved. But then, coming to the last question—which is always one of great nicety—whether or not the specification of the particular apparatus patented is sufficiently precise and defined, he was of opinion that as to one part of it, it was not so, and that therefore, while this remained, he could not give judgment for the plaintiffs. But if that in any way could be got rid of, then such judgment would be given.

Mr. ASTON, on the part of the plaintiffs, at once applied to "disclaim" that part under the late Act.

Mr. BOUSFIELD, for the defendants, opposed the application.

The learned JUDGE said the question was one of importance, and he should like to have it argued out, and so he would appoint a day for the purpose.

Before Mr. JUSTICE KEKEWICH.

ALBO-CARBON LIGHT COMPANY *v.* J. KIDD AND CO.

This was an action to restrain the infringement of a patent taken out in 1878 by Messrs. Livesey and Kidd for improvements in the production of combustible gas and in the enrichment thereof for illuminating purposes, and apparatus for the same. The plaintiff company were the assignees of the patent, whereby the inventors obtained protection for the use of solid naphthaline for the purpose of enriching combustible gas by passing the gas through a vessel filled with the napthaline, their claim being subsequently reduced by disclaimer to the use of solid naphthaline prepared in the forms of sticks, rods, or pellets for the enrichment of gas. The questions at issue on this trial were the novelty and subject matter of the patented invention.

The Attorney-General, Mr. Moulton, Q.C., and Mr. R. G. Glenn appeared for the plaintiffs, and Mr. Aston, Q.C., and Mr. E. W. Byrne for the defendants.

His LORDSHIP, after hearing the evidence of Mr. Imray, Mr. James Livesey, Dr. Hopkinson, and others who were called in support of the plaintiffs' case, gave judgment for the defendants. He said that the only invention which the patentees could claim would be the application of solid naphthaline in the form of sticks or pellets, but according to the plaintiffs' own evidence it was immaterial in what form it was used, and it was also clear that naphthaline in the solid form was well known long before 1878. The conclusion was the patentees had taken a known article and applied it to a known purpose, and the action must fail on the question of subject matter.

Costs were awarded on the higher scale, but, on the plaintiffs' undertaking to prosecute an appeal, execution was stayed.

TEN-WHEELED TANK LOCOMOTIVE.

WE publish this week a general view of one of the ten ten-wheeled tank engines recently built for service on the railways now being constructed in China under the direction of Mr. C. W. Kinder, M. Inst. C.E. The engines have been built, under the direction of Mr. James Cleminson, M. Inst. C.E., the Consulting Engineer, by Messrs. Dübs and Co., of Glasgow. The section of the China railways in operation, and upon which the engines in question are to work, place the coal mines at Kaiping in communication with the coast and the port of Pehtang, which is situated on the north bank of the Peiho River at its mouth. We shall publish further details of these engines and the China railways in later issues.

LAUNCHES AND TRIAL TRIPS.

THE s.s. Viceroy, which has been built and engined by Messrs. Wm. Doxford and Sons, sailed from Sunderland on the 10th inst. with a cargo of 2000 tons of coke. Before proceeding on her voyage she was taken over the measured mile, when a regular speed of $9\frac{1}{2}$ knots was easily maintained, giving great satisfaction to all concerned.

Messrs. William Simons and Co., of Renfrew, launched on the 14th inst. another of their patent hopper dredgers with its machinery on board complete. The vessel, which is named the St. George, has a hopper capacity of 300 tons, and is constructed with "Brown's improved form of bow and bucket ladder," an arrangement which adds considerably to the strength of the vessel, and by which it is enabled to dredge through banks and shoals to 30ft. depth of water. The propelling and dredging engines are compound surface-condensing, and steam is supplied by a steel boiler constructed for 90 lb. working pressure. The St. George will leave in a few days for the south coast of England.

The Royal Mail steamer Benguela, of the British and African Steam Navigation Company, had a very successful trial trip from the Mersey on Tuesday. The Benguela has for the past few months been in the hands of the well-known engineers and shipbuilders, Messrs. Fawcett, Preston, and Co., who have thoroughly overhauled both the engines and the hull, and supplied new boilers, as well as converted the engines into triple expansions of the most recent three-crank type. The reversing is effected by direct steam reversing engines of Messrs. Fawcett's special make. The steamer left the Mersey on Tuesday morning, under the command of Captain William Jolley, and having also on board, in addition to Messrs. Fawcett and Preston's representative, the following gentlemen:—D. H. Holman, Board of Trade surveyor; A. C. Stuart, Government engineer for West Africa; Captains Griffiths and J. F. Brown, Mr. James Robinson, Mr. J. Steele, marine superintendent to the British and African Company; Mr. J. Blackburne, superintendent engineer to the African Company; Mr. John Harrison, and a number of gentlemen from the office of Messrs. Elder, Dempster, and Co., the agents for the steamer. The trial was conducted by Messrs. Fawcett, Preston, and Co., under the supervision of Mr. J. J. Wilkie, the superintendent engineer for the owners of the vessel. The trial lasted about seven hours, and from first to last was of a most satisfactory nature. The engines, which are constructed to the specification of Mr. J. J. Wilkie, worked with remarkable smoothness, and even when they were going at the highest speed there was an almost entire absence of vibration in any part of the steamer, whilst the engines themselves were perfectly free from any heating. No attempt was made to unduly push the vessel, but she comfortably travelled at a steady pace of about $12\frac{1}{2}$ knots per hour. The cylinders are respectively 21in., $34\frac{1}{4}$in., and $55\frac{3}{4}$in. in diameter, and 3ft. stroke. Steam of 160 lb. pressure is supplied from two large boilers, 13ft. 6in. in diameter. The average vacuum was $27\frac{3}{4}$in., and the speed 70 revolutions. From the result of the trial it is confidently anticipated that a saving in coal consumption of from 20 to 25 per cent. will be effected by the conversion.

Messrs. Craig, Taylor and Co. have launched a screw passenger steamer for Messrs. Segovia Cuadra, of Seville, built for Messrs. Stephenson, Clarke, and Co. Her dimensions are: 240ft. by 32ft. by 18ft., with long full poop and T.G.F. She is handsomely fitted for both first and second-class passengers, and has the electric light fitted throughout in the passenger accommodation, and also for discharging cargo. Her engines are of the triple expansion system; cylinders, $18\frac{1}{2}$in., 29in., and 48in.; stroke, 36in.; pressure of steam, 160 lb. Built by Messrs. Westgarth, English, and Co., Middlesbrough. She is fitted with steam steering gear by Davis and Co., London, the windlass by Emmerson, Walker and Co., and three steam winches and large steam crane by Roger and Co. The vessel was gracefully christened Sorre-del-Oro by Mrs. Candlish, of Edinburgh. In consequence of the breakdown of the sheer legs at Middlesbrough she is compelled to go to Hartlepool to ship her engines. The vessel has been built to the highest class, Bureau Veritas, and has been superintended by Mr. Cuthbert Potts, of Sunderland.

NATURAL GAS.—Findlay, a town in Ohio, owes much to natural gas. The *American Manufacturer* says:—"The following new manufactories have located there since the discovery of gas: Six glass factories, three rolling mills, one nail and wire mill, one edge tool factory, one lantern factory, one churn factory, one foundry, one ironworks, one brass works, one chain factory, one handle factory, one aluminus metal factory."

RAILWAY MATTERS.

In this column of our last impression a projected railway between Dijon and Charleroi was mentioned as reducing the distances between Antwerp and Marseilles to 224 miles. This should read by 224 miles.

It is stated that experiments conducted in Japan on the relative merits of German and English rails have resulted in a verdict against the German article on all accounts, but especially ou account of their want of enduring power.

The Argyleshire New Railway, the proposed line from Ardrishaig to Furnace, and along Loch Eck, from near Dunoon to Strachur, has, the *Railway News* says, now been marked off, with a view to commencing operations on an early date.

It is stated that a survey is being made for a proposed railway from Bourn to Melton Mowbray, in connection with the Great Northern and Eastern and Midland Railway. The new line would be a direct route from the Midlands to the Eastern Counties.

A telegram from Chicago states that the great American carrying firm, Messrs. Wells, Fargo, and Co., have completed a contract with the Atchison, Topeka, and Santa Fé Railroad covering the express business on the 8000 miles of lines operated on or controlled by the Santa Fé system.

Judging by railway revenue, things in Queensland are improving. The revenue returns for the September quarter show a total revenue proper of £937,445, an increase of £110,227 as compared with the corresponding quarter last year. Railway receipts amounted to £162,918, an increase of £29,000; postage shows an increase of £29,000; telegraph, £1000.

The *Glasgow Herald* understands that in next session of Parliament a Bill will be promoted for the construction of a new circular underground railway for Glasgow and suburbs, starting from St. Enoch-square. The line throughout is entirely underground, and will be connected with the Caledonian Railway system at Bridge-street and the North British at West George-street.

Under the heading "Co-operation between Railroads and the Navy," the *Springfield Union* (U.S.) says:—"As soon as we get over the rush we are going to invent a big navy gun that will throw deadly car stoves into the enemy's vessels. Two grand results will be accomplished. The enemy will be annihilated in a particularly melancholy manner, and we shall get rid of the car stoves."

The decision of the West Bromwich Corporation to prohibit the carriage of goods over the tramways has drawn forth a vigorous protest from the public. They urge that the vast majority of the people of West Bromwich who are dependent upon the trade of the district for their living believe that goods traffic can cause no substantial injury to any one, and will be of the greatest advantage to the town and the trade of the district.

During the first quarter of this year not a single passenger was killed in a railway accident in India, though ten met their deaths through their own misconduct or want of caution, viz., from falling when getting in or out of trains, falling out of carriages when trains were in motion, &c., and eleven injured through similar acts of carelessness or want of caution. In accidents proper, forty-seven passengers received injuries, thirty-seven of whom were injured by collisions, eight through trains or parts of trains leaving the rails, and two owing to accidents caused by obstructions on the lines.

It is announced that the Manchester, Sheffield, and Lincolnshire Railway Company have in view the construction of a new branch railway across the Dearne Valley from their line at Stairfoot, near Barnsley, to the Houghton Main Colliery, Darfield. The route of the proposed new line has already been surveyed by Mr. Coles, and Sir A. Douglas is the engineer in charge of the work. The new line will be of considerable importance, inasmuch as it will open out a portion of the South Yorkshire coalfield which has not as yet been worked, and which has at present no railway communication. A Bill authorising the extension will be promoted in the next session of Parliament.

On the New York, Newhaven, and Hartford Railway it appears that there are no less than 518 level crossings in Connecticut alone. The company is, however, beginning to see the necessity and desirability of removing some of them. The American *Engineering News* says the extent to which economy, as well a safety, has been sacrificed by many of the railroad grade crossings in use is curiously illustrated by the alleged fact—which we believe is substantially correct—that the lowering the grade on the Indianapolis, Decatur, and Springfield road for some distance, in order to cross the Chicago and Indiana coal road below the latter's grade, is proving so valuable an improvement for the Indianapolis, Decatur, and Springfield Company that their engines will haul four more cars over the road than they could before this, the steepest grade on the road, was cut down. There are not many such extreme cases as this, but there are very many where one or two cars could be added to the train if the crossing stops were eliminated.

It is fully expected that the Birmingham cable tramway between Colmore-row and Hockley will be opened for traffic before Christmas. The members of the Watch Committee of the Town Council were shown over the works on Monday. The company were first conducted to the boiler house, a roomy building in which are set a series of six boilers, of Messrs. W. and J. Galloway and Sons' 1875 pattern, about 25ft. long by 6ft. diameter, fitted with interchangeable tubes. It is expected that, with 80 lb. pressure to the square inch, three, if not two, of the boilers will furnish sufficient power to drive both the Birmingham and the Handsworth cables, if the latter is carried out. Adjourning to the engine-room, the visitors found themselves in front of two fine engines, each of 250-horse power, and having fly-wheels of about 15ft. in diameter, and with a face of 2ft. in breadth. Between these engines is an arrangement of powerful cog-wheels, which transmit the power from the engine shaft to the pulleys round which the cable passes. The engine cylinders have each a diameter of 24½in., and the stroke is 48in.

Writing of the Halifax high-level railway, the *Leeds Mercury* says:—The people of Halifax have cause to be gratified at the present position of the scheme for a high-level railway. Only those resident in the town, or intimately connected with it by business, will be able to fully realise the advantages which will follow from the construction of the proposed line. Halifax is emphatically a "town in a hole" so far as relates to the older portion of the municipality; but its modern development has gone on apace, so that the surrounding hill-sides present unique features, from the extent to which building operations have been conducted on almost inaccessible sites. Some such scheme as the high-level railway was therefore felt to be necessary for the relief alike of "man and beast," for at present cartage from the existing stations proves alike difficult and costly. That the need was strongly felt is shown by the fact that the high-level railway is to be constructed, although the scheme of connecting lines with the North, once associated with it, had been abandoned. The contracts for the work have been let to the firm of Messrs. Baker and Son, of Bradford, who at the latter town have for some time been engaged upon important works for the Midland Railway Company. It is arranged that the ceremony of "cutting the first sod" of the high-level railway shall take place next month, near Christmas probably; but already the contractors are engaged in laying down plant, with the intention of proceeding with the preliminary operations for the making of a tunnel at Holmfield. The joint engineers for the new railway are Mr. Samuel Uttley, of Halifax, and Messrs. John Fraser and Sons, of Leeds.

NOTES AND MEMORANDA.

There are nearly ten thousand steamers of various sizes on the waters of the world, with an aggregate burden of over ten millions of tons.

The deaths registered during the week ending November 12th in 28 great towns of England and Wales correspond to an annual rate of 20·0 per 1000 of their aggregate population, which is estimated at 9,244,099 persons in the middle of this year. The six healthiest places were Brighton, Norwich, Sunderland, Hull, Nottingham, and Portsmouth.

At page 388 of our last impression are some figures given by Mr. Desmond G. Fitzgerald, showing the minimum quantity of different materials that theoretically could give an electrical horse-power hour of work in primary batteries, or the electro-chemical equivalent for the horse-power hour. To the figures may be added that for lead, namely, 6·38lb. ÷ E.

In London last week 2634 births and 1564 deaths, or one every 6·4 minutes, were registered. Allowance being made for increase of population, the births were 184 and the deaths 110 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 21·5 in each of the two preceding weeks, declined last week to 19·4.

In their report on the water supplied to London by the several companies during October, Mr. William Crookes, F.R.S., Dr. William Odling, and Dr. C. Meymott Tidy say:—The water supply to the metropolis has been characterised, for several months past, by the smallness of the nearly always inconsiderable proportion of organic matter which it contains. Thus, during the months of July, August, and September, the mean proportion of organic carbon present in the Thames-derived supplies was ·136 part in 100,000 parts of the water, corresponding to appreciably less than one-quarter of a grain of organic matter per gallon, or to less than $\frac{1}{3000}$th part of 1 per cent. Thus the maximum proportion of organic carbon in any one sample was ·151 part in 100,000 parts of the water, while the mean proportion present in the Thames-derived supplies, *i.e.*, ·137 part in 100,000 parts of the water, was identical with the mean for the previous three months.

In the Geological Section of the recent British Association meeting a paper was read on "The Organic Origin of the Chert in the Carboniferous Limestone Series of Ireland, and its Similarity to that in the corresponding Strata in North Wales and Yorkshire," by Dr. George Jennings Hinde. The author's object was to show that this rock, which has hitherto been usually regarded as an inorganic deposit of silica direct from the sea-water, is in reality made up of the microscopic detached spicules of siliceous sponges. These sponges lived in successive generations over certain areas, and, after the death of the sponges themselves, the minute spicules forming their skeletons fell apart and were strewn over the bottom of the carboniferous seas in countless numbers, so that by their accumulations beds of solid rock with a total thickness of from 150ft. to 350ft. have been formed. Sponges were thus more important as rock-formers in the carboniferous than at any subsequent geological epoch.

At a recent meeting of the Berlin Physical Society, Dr. Robert von Helmholtz showed and explained before the Society the experiments on vapour currents, of which he has recently given an account in "Weidemann's Annalen." In his earlier experiments on the formation of mist he arrived at the same results that had been obtained by Aitken, namely, that the condensation of supersaturated aqueous vapour, as it forms a mist, takes place only at some nucleus which is provided ordinarily by the particles of dust in the air. His observations on vapour currents have, however, now shown that other conditions have an influence on the condensation. When a platinum wire heated red hot by an electric current is brought near a current of vapour, the colour of the latter changes owing to an increased condensation. A similar result was obtained when the following agents were employed instead of the red-hot platinum wire, viz., the gases evolved from a hydrogen flame; the gases which rise from a glowing wire gauze; a metallic point from which electricity is making its exit; an electric spark; the vapours which rise from sulphuric acid; sal-ammoniac when formed in the current of vapour by the interaction of hydrochloric acid gas and ammonia. In all these last-named cases, where the condensation is facilitated, it is impossible to speak of any "nuclear" action.

When Professor Henry showed the remarkable distance at which electric inductive action could be indicated by the effect of one coil upon another situated in different parts of a house, and the inductive effect of a lightning discharge, the *Electrical World* says, "he little dreamed that the same principle would some day be employed for the purpose of maintaining communication with a rapidly moving train. Yet such is the case and the demonstration which we recently witnessed ourselves once again, and describe in another column, can leave no doubt that the system has been reduced to a practical basis. The operator on board the train was 'rushed,' perhaps harder than one in any stationary telegraph office, and the remarkably few repetitions required demonstrated fully the volume and clearness of the sound received in the telephone, both at the terminal station and on the car. With success demonstrated, the question will naturally be asked whether the system will find extensive application. We believe that, in the matter of its introduction, it will follow very much the course of the speaking telephone. When first brought out the mere possibility of its function was doubted. When finally demonstrated as an actual fact, it was looked upon much as a toy which might be used for certain purposes. After that, with very little delay, came the education of the public to the conveniences it afforded, making it the unparalleled success which it is to-day. So, we believe, it will be with the train telegraph."

Messrs. R. Heaton and Sons, of the Mint, Birmingham, will within the course of the present month despatch the first instalment of their magnificent Chinese order, received six months ago, for coining presses, previously announced in The Engineer. As the whole weight of the machinery will approach 1000 tons, the remainder of the contract will not be completed for another twelve months. The Chinese have ordered no fewer than ninety of the patent noiseless automatic presses for the new Mint, and there is a strong probability that the order is but the precursor of a number of others of equal magnitude. The first consignment, to be sent this month, will go to Canton, where the new Mint is to be erected, and the present shipment will consist of about twenty coining presses, with all accessories in the shape of boilers, furnaces for melting and annealing metal, machines for cutting the blanks and reproducing the dies, &c. When all the ninety presses are laid down the Chinese Mint will be capable of producing 2,700,000 silver and brass coins per day. Thus, working seven days a week, it would take nearly six months to strike one coin each for every Celestial in the Empire, while in two years' time only four coins a head would have been struck if the whole Mint were to work continuously. This will give an idea of the vastness of the work which the Chinese Government has begun in introducing a coinage currency, and goes far to argue the receipt of other successive valuable orders for machine plant. The presses are not very formidable pieces of machinery. Each machine will work in a space of about 8½ft. long, 7½ft. deep, and 5ft. wide. Each machine turns out from sixty to eighty coins per minute, a pressure of forty tons being brought to bear at each stroke. Messrs. Heaton send out four men to superintend the erection of the machinery, and to look after the Mint in its infancy, and these men will stay out for two years. Messrs. Heaton also supply the whole of the plans for the new building.

MISCELLANEA.

The Lancashire Patent Belting and Hose Company has been awarded the "First Order of Merit" for their Lancashire patent belts at the Adelaide International Exhibition.

Messrs. R. Waygood and Co. inform us that the fire which occurred at their works on Friday evening last only injured their carpenters' and pattern-makers' shops. The main portions of their factory, including their machine shops, lift-fitting shops, and general offices, are practically unhurt.

Telegrams received from Beaufort and Port Royal state that a syndicate of Northern and English capitalists has bought the interest of Mr. D. A. Appleton in the City of Port Royal and its vicinity, and will at once build half a mile of docks, and open direct railroad communication with Birmingham and Alabama.

Messrs. Bradley and Craven, Wakefield, have obtained three first medals at the Adelaide Exhibition; one for Craven's patent No. 1 brick-moulding and pressing machine; one for steam cylinder sanitary pipe-making machine; and one for steam-power ornamental brick-press; besides receiving the special merit certificates for each of these machines.

Messrs. Tangyes Limited have been awarded five first orders of merit at the Adelaide Exhibition for the following exhibits, viz.:—(1) 16-horse power winding engine and drums, and 4-horse power winding engines and drums; (2) steam pump, centrifugal pump, and direct-acting steam pump; (3) collection of three fans; (4) collection of lathes and iron-working tools; (5) general carpentery machine, sawing machine, saw bench, and band saws.

Last week the president and about eighty members of the Belgian Society of Engineers visited the Koekelberg Brewery, Brussels, which has been started by a company, with £60,000 capital, to brew Munich beers. An artesian well has been sunk, and plant of the newest description erected, with two Linde ice machines, driven by a 100-horse Hoyois engine and Prouhon tubular boiler. The establishment is electrically lighted throughout, and the success hitherto has been quite commensurate with the expectations formed.

The *Penang Gazette* of the 7th October gives an account of the establishment of an Engineers' Institute with headquarters at Penang. Engineers belonging to or connected with the Straits are, we understand, eligible for election as members. The Hon. W. E. Maxwell, C.M.G., Resident Councillor of Penang; the Hon. J. M. B. Vermont, M.L.C.; and the Hon. John Allan, M.L.C., have been elected honorary members of the Institute; and the committee consists of sixteen members, and the office bearers for the ensuing year are—President, Mr. F. M. McLarty; secretary, Mr. D. B. Paige; assistant-secretary, Mr. W. R. Park; and treasurer, Mr. M. Small.

An American paper says:—"At Ellsworth, Ellsworth County, Kansas, as a matter purely of speculation, some persons recently made up a fund to drill the earth to see what they could find. They were told by individuals learned in the geology of the region that the work would be fruitless, and advised not to waste the money, as there were no favourable indications. But the speculators went ahead with the drilling, and at the depth of 740ft they struck a bed of pure salt 160ft. thick, after which shale was encountered for 200ft., and then at a depth of 1100ft. a vein of natural gas was struck which promises to yield fuel in unknown quantities."

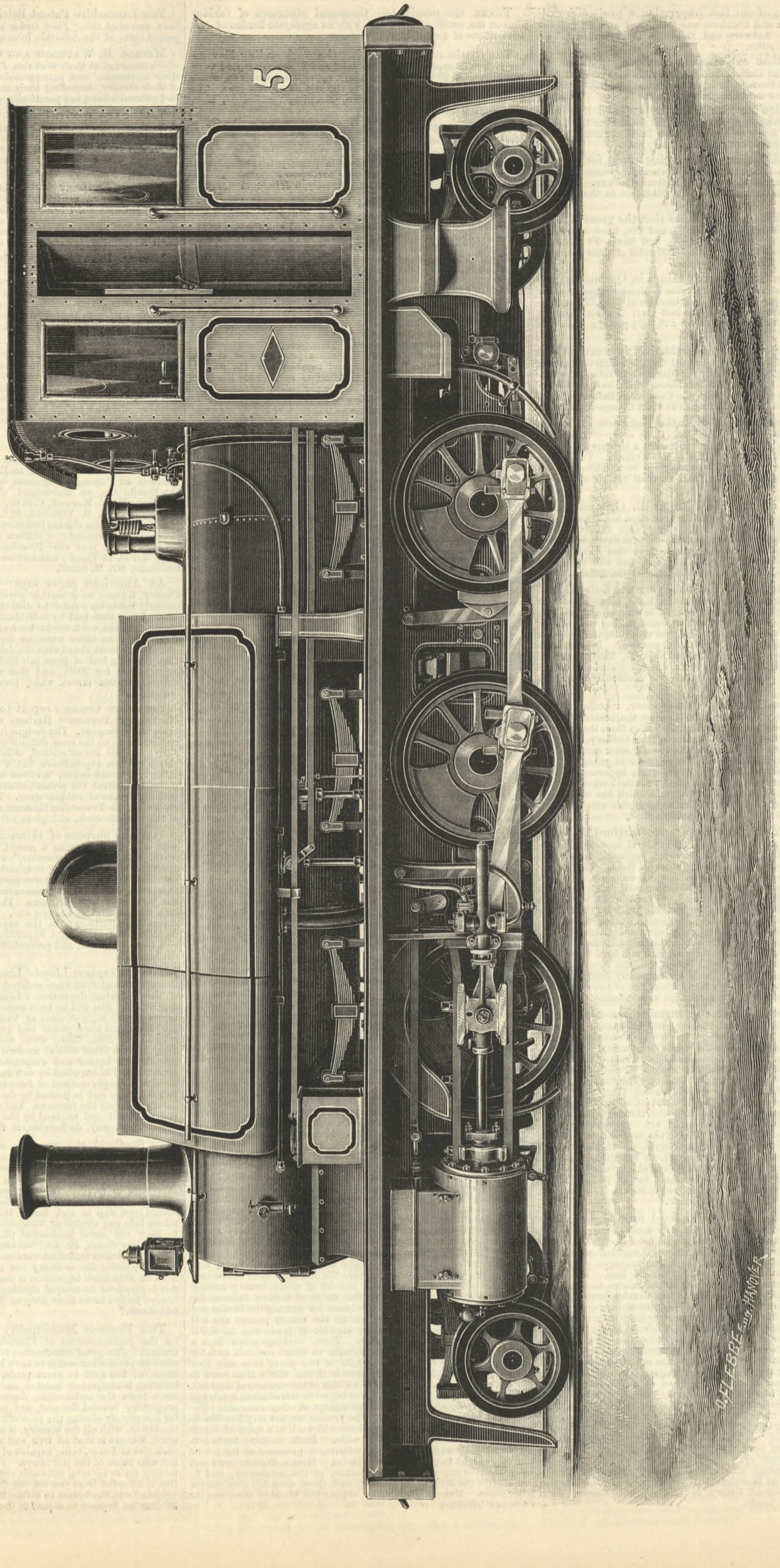
Sir John Coode's report to the Government upon the Mackay and Townsville Harbour works has been placed upon the table in Parliament. The designs for the Mackay Harbour are very costly, owing to the most difficult obstructions to the port. Alternative designs are submitted, either of which would involve over half a million expenditure, but a third design, which is unhesitatingly recommended, involves only £100,000 expense, and proposes to control the present channel by the construction of low-training banks of rubble stone. The *Colonies and India* says the report on the Townsville Harbour recommends a further extension of the present work, and gives exhaustive suggestions.

For the purpose of skimming molten cast iron, to prevent dirt from entering a mould, a German firm uses an automatic skimmer or "separator," which is placed upon the inlet aperture of the moulding-box, and consists of a rectangular box provided with some transverse partitions, dividing it into separate chambers, which are in communication by means of openings at the bottom of the partitions. The molten metal, being poured into the separator at one end, is caused to pass through the several compartments in the apparatus before it can enter the moulding-box, the light impurities being in this way caused to rise to the surface, and prevented from entering the mould with the metal.

The Rotterdam Lloyds' Line of mail steamers between Rotterdam and Java have ordered a new steamer for their service of the following dimensions: Length 320ft., breadth 36ft. 9in., depth 27ft. She will be built entirely of steel and to the requirements of the highest class of Veritas rules. The engines are of 1500 indicated horse-power and quadruple expansion type, having cylinders of 23in., 33in., 43in., and 63in.; length of stroke 42in. They will be fitted with all modern improvements, including Weir's patent feed heater and evaporator. Steam of 200 lb. working pressure will be supplied by two double-ended boilers worked by a novel and simple method of forced draught; the air is supplied by two 6ft. fans and is heated by the waste products of combustion before entering the furnaces. The vessel will be named Bromo, and is being built and engined by the Royal Shipbuilding and Engineering Company, de Schelde, of Flushing, Holland.

In Scotland the riparian owners will not allow even the weaker washings to run into the river, but we believe that manufacturers on this side have never been so circumstanced as to have been obliged to comply with such regulations, and therefore they have in most cases been unmindful of the interests of the public. The *Chemical Trades Journal* says:—"If Government should now step in and forbid the introduction of paper-making refuse into any stream or watercourse, we should of course expect to hear the usual hackneyed phrases of over-legislation, trade leaving our shores, &c. &c., but our legislators should bear in mind that the Scottish manufacturers have been made to put their houses in order, under the ordinary and existing laws of the realm, and if so be that fresh legislation is necessary, it seems to us that an Act is required to compel riparian owners and corporate administrative bodies to do their duty in the way that previous Acts have laid down."

The Brussels Municipality has put up a new theatre for the representation of Flemish plays on the site of the old arsenal. Fire-proof construction is adopted throughout, and every possible precaution seems to have been taken to prevent the outbreak of fire and to avert panic, except electric lighting. The building is completely isolated, and a substantial wall separates the stage from the auditorium, descending to the foundations and projecting beyond the roof, and an iron curtain will be provided for completely closing the proscenium opening. The wood-work of the latter, with all the scenery, is coated with asbestos paint. The great feature is that an iron and stone balcony corresponds with each tier of boxes, being capable of receiving not only its occupants but also those of the tier above. There are abundant outlets, with folding doors opening outwards and no fastenings, and communication is afforded from one balcony to the other, with permanent iron ladders from the lowest to within 6ft. of the street, as well as cage ladders for firemen to mount to the top of the structure.



TEN-WHEELED TANK LOCOMOTIVE.—CHINA RAILWAYS.

CONSTRUCTED BY MESSRS. DÜBS AND CO., GLASGOW.

(For description see page 410.)

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The Engineer, November 18th, 1887. PAGE

TO CORRESPONDENTS.

Registered Telegraphic Address "ENGINEER NEWSPAPER, LONDON."

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

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*** *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 can be taken of communications which do not comply with these instructions.*

Slow Coach.—*We are quite unable to decipher the minute writing which you have crowded on a post-card.*

Engineer.—*The shallow pan with large surface is the best for evaporation. A partial vacuum such as you propose to maintain will promote evaporation.*

Tubal.—*Upon what branch of mining engineering do you require information? Amongst the small books there is a good one on "Coal and Coal Mining," by W. W. Smyth, in Weales' Series.*

A. K. (Royal Thames Yacht Club).—*The difference in speed was probably due to the tide. The data are too incomplete to enable us to pronounce any opinion. As a fact, 2 lb. difference in pressure did not make a difference of a knot in speed.*

Tyro.—(1) *The fore ordinate is taken from the water line, as shown in your sketch, an allowance being subsequently made for the rake of the fore-foot.* (2) *It might or might not be a complete draught, according to the conditions laid down by those for whom it was made and by whom it was paid for.*

A. C.—*We have very little doubt but that your wheels will transmit twice the calculated power. The question is how long they will continue to do this. If you will give further particulars, we shall be happy to aid you. A pair of wheels bearing on two teeth may transmit with safety just as much power as a pair bearing on four teeth. It is all a question of pitch, thickness of tooth, width of tooth, &c.*

A. A.—*If the individual has no special "call" to be an engineer, he could not select a worse means of earning a livelihood. There is in the United States at present an excellent opening for electrical engineers. How long it may last we cannot say. For the rest, it is impossible to answer your questions save in general terms. If the young man has so little force of taste that it is a matter of indifference to him whether he becomes a civil or a mechanical engineer, then he ought to become neither.*

MASONTA.

(To the Editor of The Engineer.)

Sir,—Would any of your readers inform us of the exact nature of "Masonta," and the uses for which it is applied? Influx.

November 14th.

BEVIL WHEEL CUTTING.

(To the Editor of The Engineer.)

Sir,—I shall feel obliged if any of your readers can give me the address of a firm which undertakes to cut the teeth of small bevil wheels up to 12in. diameter mathematically correct, such wheels being required to run at a high speed without noise or back-lash. Engineer.

THE CONTRACTION OF CONCRETE.

(To the Editor of The Engineer.)

Sir,—To what extent does concrete made with Portland cement contract? I find the impression common that such concrete expands, and I know of hollow terra-cotta blocks being flushed up with it—6 to 1—to make solid work; yet repeated inspection shows a decided shrinking. Hence wall work built thus would only possess a cellular strength. Data as to blue lias concrete are easily found, but I am unable to trace how Portland cement concrete is said to behave. A. C. G.

BEARINGS FOR HIGH-SPEED ENGINES.

(To the Editor of The Engineer.)

Sir,—In answer to your correspondent, he cannot do better than use phosphor bronze and cylindrine oil, which has been used with excellent results on some of the most troublesome bearings. I think the manufacturer of this special class of oil is J. Etherington, King William-street, E.C. Whatever he does, by all means avoid using water, for in my experience I have found it the worst thing possible. It will not be noticed so much at first, but after a short time of use the machinery will suffer greatly. Marine Engineer.

November 9th.

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Remittance by Bill on London.—Austria, Buenos Ayres and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili, £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Sandwich Isles, £2 5s.

MEETINGS NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, November 22nd, at 8 p.m.: Ordinary meeting. Paper to be further discussed:—"Accidents in Mines," by Sir F. A. Abel, C.B., F.R.S., Hon. M. Inst. C.E.

Society of Arts.—Wednesday, November 23rd, at 8 p.m.: Ordinary meeting. "The Mercurial Air Pump," by Professor Sylvanus P. Thompson, D.Sc.; William Crookes, F.R.S., will preside.

Society of Telegraph Engineers and Electricians.—Thursday, November 24th, at the Institution of Civil Engineers, 25, Great George-street, Westminster, at 8 p.m. Papers to be read:—(1) "On some Instruments for the Measurement of Electro-motive Force and Electrical Power," by Dr. J. A. Fleming, M.A., Member, and C. H. Guningham. (2) "Portable Voltmeters for Measuring Alternating Potential Differences," by Professors W. E. Ayrton, F.R.S., V.P., and John Perry, F.R.S., Member.

DEATH.

On the 11th inst., Mr. George Preston White, C.E., of 13, Queen Anne's-gate, Westminster.

THE ENGINEER.

NOVEMBER 18, 1887.

THE HEXTHORPE COLLISION.

The trial of Samuel Taylor and Robert Davies, the driver and fireman of the Manchester, Sheffield, and Lincoln train—which ran, at Hexthorpe, into a Midland train on the 16th of September—took place at York before Lord Chief Justic Coleridge, and terminated in a verdict of "Not guilty." No other verdict would have been consistent with the evidence and the ruling of the learned judge. It was not sufficient to secure a conviction to prove that the men had been negligent, it must be shown that they were criminally negligent, and of this there was no proof whatever. On the other hand it was made abundantly clear that the railway company had so arranged for the working of the traffic that nothing short of extraordinary vigilance could have prevented a collision from taking place. The coroner's jury returned a verdict of manslaughter against the prisoners; and it is fortunate that they did so, because this verdict was necessarily followed by legal proceedings which have fully brought to light the part played by the railway company. We have already very fully commented on the facts, in our impressions for September 23rd and 30th. It will not be out of place, however, to recall the circumstances to the minds of our readers. During Doncaster race week the traffic is very heavy, and the Manchester, Sheffield, and Lincolnshire Railway Company suspended the block system, and substituted for it a method of working with flags. These flags were intended to cut up the block sections into smaller intervals. On the day in question a Midland train was standing in the little station at Hexthorpe, and tickets were being collected, when the Manchester, Sheffield, and Lincoln train ran into it behind, with the result that the rear coaches were smashed up by the heavy engine, and many passengers were killed and wounded. It was said that the collision was due entirely to the negligence of Taylor and Davies, who, not keeping a proper look out, ran past two red flags. For this they have been put on their trial, and, as we have stated, acquitted, after a very brief consultation, by the jury.

Little that was not already elicited by the coroner's inquest and the Board of Trade inquiry came out at the trial. Indeed, the principal facts were well known from the first. It appears that the signalman at Hexthorpe cabin, about 1106 yards from the site of the collision, had a green flag hanging out of his window when the Manchester, Sheffield, and Lincolnshire train from Liverpool passed him at about 12.14 p.m. His distant signal was at danger. Taylor reduced the speed of his train at the distant signal, and drew up at ten or twelve miles an hour to the cabin. The train was quite under control; the signalman then lowered his home signal to permit the train to go on to the next section. Well into this section is an "advance signal," and at the foot of this was stationed a man with a red flag 390 yards from the cabin, whose duty it was to stop trains, provided a train was in Hexthorpe station. He could not see the platform because of a curve in the road, so a second flagman was placed on the curve at a point 506 yards from the platform, and in such a position that he could see both the platform and the first flagman. When the second man held his flag at danger the first man did the same. There can be no doubt that Taylor drove past both flagmen, and it was contended that neither he nor his fireman saw them, or that if they did see them they did not believe that the red flag overruled the advance signal. It will be seen that the arrangements here were extremely defective. We are not prepared to argue, as some of our non-technical contemporaries have done, that the line should have been worked during the race week as it is worked under normal conditions; on the contrary, it was quite legitimate to cut the ordinary sections up. But it could only be legitimate on the condition that most special pains were taken to render it certain that the new method of working should be clearly understood and carefully observed. Particular instructions should have been given by the foremen of the running sheds to the drivers, and the foremen should have satisfied themselves that the men understood their instructions. Instead of this, however, the men were handed a book of instructions, and no trouble whatever was taken to see that these instructions were read and understood. The argument used would probably be this: The men have the books; if they do not read them and they make a mistake they will be discharged from the company's service or fined. They will in some way be punished. This method of reasoning was wholly defective in that it took no thought for the public. We should scarcely consider that the police force of the metropolis did its duty if it contented itself with arresting and punishing burglars, leaving them to commit robberies unchecked. What is required is not the punishment of crime, but its prevention. To send an engine driver to prison could not be an adequate solace to a passenger whose leg was broken through the driver's negligence. It is beyond question that in this respect the railway company was greatly to blame. Furthermore, it seems that if the signalman had kept his advance semaphore at danger, or even at caution, there would have been no collision. Mr. Isaacs, assistant-inspector in the traffic department of the Manchester, Sheffield, and Lincolnshire Railway, was in the signal cabin at the time. He was cross-examined by Mr. E. T. Atkinson, and said that the red flag meant danger. He knew that Coates by holding out the red flag wanted the train to stop. He did not tell the signalman what he had seen. He allowed the signalman to work according to his instructions.—"Was it his instructions to let down the advance signal when Coates had a red flag out at the foot of it?"—Witness: "Yes."—"Where do you find it?"—Witness: "In Rule 41a." Several rules were then mentioned, but the rule witness wanted could not be found. "Do you say seriously it was the proper thing to let down the signal when Coates was close to it with a red flag?"—Witness: "It was done."—"Was it right, sir; answer candidly. Would you have done it yourself?"—Witness: "Yes; I should have had to do it to let the train pass." His lordship, interrupting, said: "The train was there. There was Coates showing a danger signal. Was it right at that moment to lower the advance signal?"—"The advance signal would have stopped the train if it had not been lowered."—"Was it a right thing to do to let the train come on?"—Witness did not answer. By Mr. E. T. Atkinson: "You had rather not answer it?"—Witness: "I had rather not answer it." It is not necessary, we think, to add anything more on this point.

It will be understood that the signal man, Coates, was 506 yards from the Hexthorpe platform; and it was proved that Taylor, if keeping a proper look-out, could have seen the Midland train 400 yards off. As the maximum speed of the train could not possibly have exceeded thirty miles an hour at this point, and was possibly considerably less, there would have been no trouble in stopping the train in time, if only it had been fitted with a proper brake. Instead of this it was fitted with an antiquated device, meritorious enough in the early days of continuous brakes, but now well known to be untrustworthy. For using this brake the company is seriously to blame. To it principally, if not altogether, the collision was due. To prove this it is only necessary to use the evidence given at the trial. We have said that there were two flag-men, one nearer Hexthorpe than the other. This man's name is Frost; he is a mineral guard, and well accustomed to the working of trains. He said he saw the train coming on towards him. "He did not feel alarmed, because he thought the driver had the train under control, and had acknowledged the signal. He thought the driver was not going at a speed which would prevent him from pulling up before he got to the Hexthorpe platform. The brake was put on when the tail-end of the train passed him"—that is, 506 yards from the Midland train. If the brake had acted properly the train would have been stopped in time. The driver's counsel argued that he was deceived by the brake and the signals; and it is worth notice that no attempt has been made to explain what he and his fireman were doing in coming up to a junction to take their attention off the road and the signals. That both should be engaged in attending to the fire, or the injectors, or anything else on the foot-plate at such a moment, requires a vigorous effort of the imagination.

The railway company is condemned out of the mouth of its own witness for retaining such a brake in use. Mr. Halmshaw, superintendent of the Liverpool district, was called, and said that the brake in question was what known as Smith's simple vacuum. After explaining the construction of the brake, he admitted that he had heard of several instances where the brake had been put out of order. In one case a man's coat had obstructed the working of the brake by getting underneath the lid of one of the valves. There was an indicator on the engine which showed whether the brake was acting or not. He had had one or two instances that came under his own observation where the vacuum brake was found to be faulty. He remembered the railway accident at Penistone, which formed the subject of a Board of Trade inquiry. He knew that the inspector then said that that accident was the second emphatic warning within the last six months for the necessity of automatic action. That accident took place two or three years ago, but the Manchester, Sheffield, and Lincolnshire Railway Company had since used the vacuum, and were using it at the present time. That brake was owned by Mr. Gresham, who was in court.—Mr. Gresham here rose and denied the ownership.—Mr. Gresham had, however, invented another automatic brake, which was superior to the vacuum, and was now being used on some of the principal trains of the company. By the automatic brake a train could be stopped by the guard when the engine was going at full speed. The second blow, which caused the more serious damage, would have been occasioned by the breaking of the vacuum brake pipe. "Had the carriages been fitted up with the automatic brake the second shock would not have happened, as the train would have remained stationary. He could not say that the carriages would not have been telescoped."

If Taylor and Davies had been found guilty of manslaughter, the railway company would have escaped censure. As the verdict stands, this, we are happy to say, cannot be the case. Whatever the *laches* of the company's servants, the verdict is essentially one of contributory negligence against the company. The entire system of working was bad, and it was carried out badly. The learned judge took in the essence of the case very clearly. He summed up to the effect that a person who voluntarily takes upon himself or has cast upon him a duty on the performance of which depends the lives of others, must bring to the discharge of that duty competent care, skill, and understanding; and if he fails to do so, and owing to such failure causes the death of another, that person is guilty of manslaughter. He further stated that before the prisoners could be convicted the jury must find that they had been guilty of culpable negligence, and that such negligence had caused the death of the deceased. He was of opinion that the company was seriously to blame for not adopting a different kind of brake after the warnings it had received, and that the suspension of the block system when special care was needed required explanation. If the jury thought the accident was due to a defective brake, they ought to acquit the prisoners. He also commented on the lowering of the starting signals, and the fact that the train was not provided with a cord of communication. The jury, after deliberating for half an hour, found the prisoners not guilty, considering the contributory negligence of the guards, the want of a cord communication, and the conflicting nature of the signals. The lesson taught the railway company has been a sharp one. May we hope that it will not have been taught in vain.

DOCK ACCOMMODATION FOR THE EAST.

Since we last wrote upon this subject but little seems to have been accomplished towards securing the construction of further facilities for docking ships to the eastward of Suez. According to advices received from Ceylon, the Lords of the Admiralty had made direct proposals to the Government of that Colony with the view of ensuring combined action towards the establishment of a dock at Colombo. These proposals we learn have been submitted to the Chamber of Commerce of the island, the members of which were unanimous in their approval of a scheme the carrying out of which must be essential to the completeness of Colombo as a port for shipping purposes. But while they were so unanimous, they appear, to judge by the reports published in the *Ceylon Observer*, to have singularly underrated the relative responsibilities of themselves and the Board of Admiralty. The latter has several alternatives open to it; the former may by an ill-judged want of liberality lose altogether the prospect of becoming possessed of a dock for very many years to come. The reply of the Chamber of Commerce, indeed, to the proposition of the Admiralty shows an utter want of appreciation of the position. It suggests, in effect, that the Imperial Government shall bear the whole cost of building the dock, while that of the Colony shall only be burdened with the expenditure necessary for the formation of a northern breakwater to render possible the entrance to it. It was pointed out, in the columns of the local journal above alluded to, that this northern breakwater is part of Sir John Coode's complete design for the harbour works of Colombo. According to that gentleman's view, such a breakwater is necessary if ever the anchorage ground in Colombo harbour is to be efficiently protected at all seasons of the year. The *quid pro quo* offered therefore by Ceylon to the Admiralty for the expenditure its people would thrust upon the latter is the execution of a work which, according to high engineering authority, must be done at their cost, whether a dock be provided or not.

We cannot but think the Colony, as represented by its Chamber of Commerce, is behaving after a very short-sighted fashion. We have remarked above that the Board of Admiralty has several alternatives to fall back upon in the event of its predilection for a dock at Colombo not receiving adequate support by the local interests of that place. Singapore has offered terms of inducement far beyond those to which the Ceylon Chamber of Commerce appears to have been willing to commit itself, and yet we learn that these have been considered to be inadequate by the home authorities. If Ceylon, however, should refuse to cap such terms, we may feel assured that, in comparison with the Straits Settlements, Colombo has but little chance of selection. But failing a determination as to either of these two Colonies, the Admiralty has yet another alternative. Trincomalee, on the east coast of Ceylon, has, almost ever since it was acquired by conquest, been the great naval port of the East. It is one of the finest harbours in the world, possesses a depth of water even exceeding the demands of the service, is already furnished with a complete dockyard establishment, and is, moreover, by past works of fortification, and by others at present in progress, fully capable of affording defence to any dock which might be constructed there. It is certain that a dock might be built and equipped at Trincomalee at far less cost than that which would have to be incurred for a similar work at Colombo; and yet the Ceylon Chamber of Commerce, while acknowledging how largely conducive to local interests the selection of Colombo would be, designs to throw upon the Imperial Government an outlay much larger than would have to be borne by it to construct a dock specially for naval purposes at Trincomalee, a port possessed, as we have pointed out, of many advantages unavailable at Colombo. We are as yet unaware of the opinion formed by the Lords of the Admiralty upon this reply to their overtures. We are quite uninformed, in fact, as to whether that reply has as yet been submitted to them; but we cannot but anticipate that it will be held to be most unsatisfactory in the financial sense in which we hold it to be certain the Admiralty approached the Colonial-office when submitting to it its proposals. There are many reasons for hoping, however, that the views expressed by the Colombo Chamber of Commerce will not be accepted, either by the Government of Ceylon or by the home authorities, as finally disposing of the question. We have in a former article named the many arguments that are in favour of the selection of Colombo as the site for a dock adequate to all mercantile and naval requirements, and we should much regret any hasty decision which failed to secure its selection.

But while we regard the subject from this point of view of localisation strongly in favour of Colombo, we do not forget that larger and more important interests are kept waiting while the negotiations we have referred to are left open. Time is an important element in the case. The deficiency of dock accommodation to the eastward of Suez is the subject of complaint from many quarters and by many interests—to none is such a factor more urgent than to our naval authorities. They are put to a vast expense, and to enormous inconvenience, by the absence of such accommodation. Singapore already possesses docks adequate to ordinary commercial requirements; but for the larger ships of our Navy there is no present provision between Suez and Hong Kong. The fact entails a heavy annual burden on the public purse; but, in the event of naval hostilities in the East, the consequences entailed by the deficiency named might be incalculably more serious. Public opinion demands therefore that no more delay should be permitted in the settlement of this matter than is absolutely necessary to the exercise of sound judgment in localisation of the means to remedy that deficiency. If a large Imperial question, of pressing need for settlement, is to be kept undetermined until colonists—whether in Ceylon or the Straits Settlements—become alive to their proper responsibilities and advantages, incalculable evil may result. As regards Ceylon, we are aware that other works of magnitude proposed have the prior sympathy of its Governor; but we deem that Sir Arthur Gordon will hardly fulfil his duty if he fails to urge the early and liberal acceptance of proposals which cannot be shelved much longer without injury both to the interests of the people, the Government, and those wider ones of an Imperial character which we have above indicated.

IRON AND STEEL IMPORTS.

In the discussions as to "free imports," the question of imported iron has often been introduced. Without touching on the general subject, it may be of interest to learn the fluctuations of late in the imports of iron and steel. Down to a recent period, these imports were divided into four classes—iron ore; bar iron, with the allied angle, bolt, and rod iron; "unenumerated;" and unwrought steel. Another class has of late been added—that of girders, beams, and pillars—previously included with the "unenumerated" goods. As to the first of these, iron ore, it is well known that there is a steady growth in the imports; and for the present year the total for the first ten months was 3,318,856 tons—the largest amount in any similar period, as far as we know. The bar, angle, bolt, and rod iron has decreased in the volume of importation of late. In the first ten months of 1885 the imports were 102,579 tons, but in the corresponding period of the present year they were 94,077 tons. The "unenumerated" iron and steel last year amounted to 2,936,001 cwt., and this was rather above that for the previous year. This year, with the girders, &c., added for the sake of accurate comparison, the quantity was 3,400,000 cwt., so that there is an increase of some moment. The girders, beams, and pillars, included in the last quantity, were, for the ten months, 49,370 tons, so that they are not so large in quantity as had been supposed. Finally, the imports of unwrought steel fluctuate more, but for the first ten months of the present year they were 11,124 tons, which is above the quantity for either of the two previous years. It will be seen that, apart from iron ore, the tonnage of the imports of iron and steel is not large this year it has been about 28,000 tons monthly, on the average, and the value about £280,000 monthly, so that the cost is rather heavy per ton imported. But this is only one side of the story: a considerable part of the importation is to allow of exportation afterwards—in other words, part of the imported iron only passes through this country. This year more than three-fourths of the bar, angle, bolt, and rod iron imported were exported afterwards, the unwrought steel imported was as largely sent out again, and more than a quarter of the unenumerated iron and steel imported was also afterwards sent out of the country. These re-exports are increasing: we sent out 58,000 tons of foreign bar, angle, rod, and bolt iron and steel in the first ten months of 1885, but this year, in the same time, the quantity was 73,000 tons. Similarly, the unwrought steel sent out rose from 6000 tons to 8000 tons in the ten months, and the unenumerated iron and steel from 788,000 cwt. to 1,000,000 cwt. It is clear, then, that the imports of iron and steel are maintained, but as there is a much larger quantity re-exported, the amount of foreign iron and steel left in the country for use is being reduced. Put into approximate figures, the account is thus. The imports, after deducting the re-exports, were, for the first ten months of 1885, about 150,000 tons, whilst in the first ten months of the present year it has been about 140,000 tons. The value has shown the same diminution, so that it would seem that there is only a portion of the imports remaining with us, and that in recent years that portion has known some diminution. This comparison takes into account, as we stated at the first, none of the ore brought in. Of that branch of the iron and steel imports of which so much has been made—the girders, beams, and pillars—we have only details for the present year; but this year, in the ten months, 49,370 tons were imported, and 4593 tons re-exported, so that it must be frankly admitted that the proportion retained, whether increasing or not, is larger than it should be. The fact that there is a heavy carriage on goods of such weight by rail, and that the sea carriage is less from Belgium and Germany to some of the towns near the coast, may have its influence on the tonnage of these goods, but the facts remain as above put.

ROADS IN THE COLONIES.

It seems to be apparent that, while nearly all of our Colonies are deeply intent on extending lines of railway within them, some of them at all events are, in the endeavour to find the means for such extension, neglecting to a very serious extent not only the methods of supplying deficiencies as to ordinary roads of communication, but are even disregarding the proper maintenance of those with which they have already supplied themselves. No course could be more full of danger to ultimate prosperity. The desire for railways is certainly natural. No one denies, or could deny, their vast importance in opening up districts which can by no other means be rendered available for settlement and cultivation. But after all, this importance, great though it be, must in all cases be held secondary to the perfecting of a network of close inter-communication in districts which are already fully occupied. That our colonists are now becoming alive to the danger of neglect of this principle is made apparent by the numerous complaints appearing in the many issues of our colonial press. Thus in those of Victoria we read that the general trade throughout the Colony is "languishing" on account of the bad state of the roads. The Ceylon journals write in even stronger terms of condemnation of a similar ill-policy adopted by its Government with views of an economy so false as to almost threaten by it utter ruin to the industries of several of the most important districts of the island. We read in the *Ceylon Observer* of many of the finest roads in the Colony having been so starved in the matter of upkeep that even light vehicles have been partially engulphed in the attempt to traverse them. If this be the case in the instance of transport of such a description the difficulties of heavier transport may well be conceived. So grave indeed has the question become in the Colony last dealt with, that its journals call for inquiry as to the responsibility attaching to such a state of things by a special commissioner altogether independent of it. The very foundations of the roads are stated to be disappearing in many places; while bridges and culverts along them are constantly failing. Ceylon has long held among our Colonies a pre-eminence as to the perfection of its roads; and to that fact has doubtless been largely due the exceptional success which has until recent years attended its planting enterprise. Railways may be extended to any degree, but they will fail of their object if the lines of roads feeding them are allowed to become impassable. To that condition those in Ceylon appear to have arrived, and we should say that the Secretary of State for the Colonies can scarcely continue longer to turn a deaf ear to the outcry to which the state of things existing is giving rise. As we have above written, Victoria echoes the complaint of Ceylon; while, though in a minor degree perhaps, other of our Colonies utter similar complaints. It must be an axiom that railways should follow roads. The former can never altogether accept the functions of the latter. Any Colony, therefore, which spends large sums on its railways, while it neglects the upkeep and development of ordinary roads, adopts a policy so suicidal that ere long the means must be wanting to make its railways pay for the cost of their maintenance and working.

"BOYCOTTING" AND RAILWAYS.

In a late issue we noticed the want of harmony prevailing among our South African settlers as to the routes to be adopted for continued extension of their railways. It does not appear from what we have, since we so wrote, read in the *Natal Advertiser*, that so far as that journal may be accepted as representing colonial opinion, our colonists in that part of our empire are willing to look at home for the causes of disunion. They throw the responsibility for it upon President Kruger's "persistent refusal to work in harmony with the other Governments of South Africa in regard to railways;" ignoring the fact which seems to be patent to those who study the subject by the light of the colonial press writing generally, that whatever may be the degree of force to be given to the complaint above stated, the difficulty has arisen mainly from the undue influence exercised by divergent local interests. But we notice this subject again mainly to call attention to the novel proposal the journal above named has made in order to force President Kruger to yield what he deems to be the interests of the Transvaal State to those of purely British Colonies. The proposal is that the Transvaal should be "boycotted" in order to prevent its alleged scheming propensity. We have heard only too much of late of the results to such a course in the case of individuals, and of its bad effect in such instances, to desire to see the system given the wider application suggested; but the idea is certainly a novel one in the history of railway development. It is as void of sense as would be a proposal that Middlesex should boycott Surrey because the desires of the inhabitants of the two counties might clash as to the direction some particular railway traversing both of them should follow.

LITERATURE.

The Economic Theory of the Location of Railways. By Arthur Mellen Wellington, M. Am. Soc. C.E. Revised and Enlarged Edition. New York: John Wiley and Son. London: E. and F. N. Spon. 1887.

This is a very interesting and instructive book, being an analysis of the conditions controlling the laying out of railways to effect the most judicious expenditure of capital. After introductory chapters on the "Inception of Railway Projects," and on the nature and causes connected with "location" which modify the volume of railway revenue, together with chapters on the probable volume and growth of traffic, and on "operating" expenses—including maintenance of way, fuel, repairs of engines and rolling-stock, train wages, &c.—the author deals in succession with the nature and relative importance of the minor details of alignment; the influence of distance on the receipts and working expenses; and the effect of curvature and of rise and fall of the line on the safety and efficiency of a railway. Considerable space is then devoted to treatises on the locomotive engine, rolling-stock, train resistance, the effect of gradients on train-loads, the influence of train-load on working expenses, assistant engines, the limit of maximum curvature, and the choice of gradients and devices for reducing them. The author next deals with the "Larger Economic Problems" affecting the construction of railways—embracing trunk lines and branches, light rails and railways, the improvement of old lines, cross roads and interlocking, and terminal facilities. Finally, the author discusses what he calls "The Conduct of Location," which he regards as being amongst the more important of the subjects in the book. This includes the "art of "reconnaissance," ocular illusions, when to make surveys, the field work of surveys, topography, and the estimation of quantities. In short, the scope of the book is most comprehensive. The various branches of the subject are discussed in a painstaking, methodical, and thoroughly practical manner, and are elucidated by numerous and elaborate tables of great interest, which bear testimony to the thought and labour bestowed on the subject by the author. The practical character of the book is aptly described in the following paragraph taken from the preface:—"The mathematical form of discussion has been intentionally avoided, first, because the book has been written for practical men as well as for students, and mathematical methods are apt to repel them; and secondly, and chiefly, because mathematical methods of solution are not only inexpedient, but positively dangerous for the class of problems considered. When the difficulty of a problem lies only in finding out what follows from certain fixed premises, mathematical methods furnish invaluable wings for flying over intermediate obstructions, but whenever the chief difficulty of a problem lies in the multiplicity and dubiousness of the premises themselves, and in reconciling them with each other, there is no safe course but to remain continuously on the solid ground of concrete fact."

The information embodied in the book, which contains 350 pages, is too extensive to admit of its being here gone into in detail in a manner which would do justice to the author. Suffice it to say that the sections devoted to the mechanics of curve resistance, to locomotives and rolling stock, to train resistance, and to working expenses, are specially interesting and instructive, and will amply repay attentive and thoughtful study. The treatment is able, clear, and thorough; although full assent may not at all times be accorded to the conclusions arrived at by the author. As an example, those based on a comparison of the "work done" by American and English locomotives may be cited as being open to question.

Modern American Methods of Copper Smelting. By E. D. Peters, jun. 8vo. pp. 342. New York: Scientific Publishing Company. 1887.

This is essentially a practical man's book. The author, who has at different times been engaged both in the assay of copper minerals and in the management of some of the larger smelting establishments in the United States, has, during the rare moments of leisure in a professional life, prepared several papers on the different operations of copper smelting, which are now collected and published. The volume is in no sense a complete treatise on copper smelting, but deals with points of practice that have come under the author's notice, and which as a rule are not noticed in the more formal volumes on descriptive metallurgy.

Among the matters of special interest may be mentioned the description of a modified form of the Cornish copper assay in use on Lake Superior, and a very full account of the different forms of blast furnaces, both round and rectangular, and with and without water jackets, which have come into general use on the other side of the Atlantic for the various fusion furnaces in copper smelting. Prominent among these is the account of a large Raschette furnace at Oxford, New Jersey, measuring 11½ft. by 3½ft. on the hearth, and blown by fourteen mouth tuyeres, which smelts 95 tons of ore daily, with a consumption of 12½ tons of coke and four tons of small anthracite for the blowing engine. The section describing the calcination ores and regulus, and the operations of refining blister copper, also contain much interesting matter, although in these there is not much in the way of novelty to report. It is unfortunate that the author has not been better supported by his publishers in the matter of illustrations, many of which are dark, smudgy woodcuts, that are quite unworthy of an otherwise handsome volume, and more particularly of the sterling matter that it contains.

THE PRESERVATION OF IRON AND STEEL SHIPS.

The inner surface of the side and bottom plating in the earliest iron ships was protected by paint, only against corrosion and such other wasting influences as might operate on the interior of the vessel. It seems to have been considered at that time that the greatest wear and tear would take place on the outer surface of the vessel below the water-line, and that it was sufficient on the inside to simply paint the surface of the iron, and lay close ceiling upon the frames as high as the upper turn of the bilges to form a platform for the cargo and keep it clear of the bilge drainage. But shipowners were not long in discovering that whatever might be the ultimate durability of the bottom plating, the wear and tear from corrosion proceeded at a much more rapid rate on the inside than upon the outside of the vessel. This was seen to be particularly the case in the flat of the bottom, where the inner surface of the plating and the rivet heads were exposed to the continual wash to and fro of bilge water with every roll of the vessel. This action was much intensified when hard substances, such as fragments of ballast and lumps of coal or other portions of cargo, found their way into the limbers; and as these accidental droppings through holes in the ceiling, or by reason of inattention when limber boards were lifted, proved to be of common occurrence, it became evident that some steps should be taken to provide greater protection to the inner surface than was afforded by two or three coats of paint. Among other means which were adopted, the employment of a thick layer of asphalte seemed for a time best calculated to meet the circumstances of the case. But after a time it was found that asphalte was not a stable protection, especially in the machinery spaces of a vessel. With a moderate rise of temperature the asphalte became sufficiently fluid to "run," and when a vessel had much rise of floor the protecting material would slowly leave the bilges and accumulate towards the middle line. Even the increase in temperature of such cargoes as grain or wool when stowed in the hold would at times be sufficient to soften the asphalte, and consequently expose a large area of the bottom plating, with its rivets and butt straps, to the wasting action of the bilge water and whatever hard substance might happen to be lying in the spaces between the frames. Ultimately, after trying various materials, the shipping community by common agreement pronounced Portland cement to be the most trustworthy substance with which to protect the horizontal portions of the inner surface of an iron ship's bottom. At the present day scarcely any other covering than this is employed, the only variation being in the proportion of sand which is added to the cement, and in the extent to which such substances as brick, broken tile, and coke are incorporated with the cement at places requiring a more than ordinary thickness of the protective material.

The internal structural arrangements in the early iron ships were very simple, so that when the inner surface of the bottom and the frames below the bilges were well plastered with Portland cement, and the remainder of the ironwork was thoroughly painted, as much was done as appeared necessary to avert wasting through corrosion and attrition. Competition for cargoes was not so keen in those days, and freights were sufficiently high to render shipowners comparatively indifferent regarding the weight of cement carried in the bottoms of their ships. It was not at all unusual to pour in cement between the floors to a height of 5in. or 6in. at the middle line, and to place at least an inch of cement where it was thinnest at the bilges. An advantage was found in this, inasmuch as a flush surface was prepared level with the limber holes in the floors, upon which the water in the limbers could flow freely to the pumps. Moreover, with such a great thickness of cement to be worn through before reaching the skin plating the presence of hard substances in the frame spaces became a matter of comparative indifference. It was when the cement was thickly applied to this extent that recourse was sometimes had to broken bricks, tiles, and coke, to economise both in regard to cost and weight. At the extremities of the vessel, in particular, spaces not sufficiently accessible to be kept properly clean and painted were, and still are, filled with a conglomerate of this kind.

The modern iron or steel vessel, whether of the mercantile marine or the Royal Navy, requires somewhat more attention in regard to the question of protection against internal corrosion than did the ships of a quarter of a century ago, or even a still more recent time. Subdivision into numerous compartments, cellular construction of bottom framing, double bottoms, and water ballast tanks, have each and all tended to increase the rapidity of internal corrosion, while they have diminished the accessibility to parts of the vessel which, in order to be kept durable, require constant and close attention. At the same time, while conditions calculated to diminish the natural lifetime of a ship have been accumulating, there has been simultaneously in progress a tendency to reduce the weight, and therefore the thickness, of the internal protective cement coating, with a view to increase her freight-earning capabilities, if a mercantile vessel, or to enable her to carry a greater weight of armour, coals, machinery, or whatever besides may contribute to her efficiency, if intended for war purposes. This reduction in the thickness of cement originated in the Royal Navy, and although the minimising tendency received a check by reason of the loss of the Megæra, which was distinctly attributable to internal corrosion in comparatively inaccessible, and therefore imperfectly examined spaces; yet, despite that disaster, the Admiralty have still persisted in applying lesser thicknesses than have so far received the general approval of mercantile shipowners. This is the more noticeable from the fact that H.M. ships are not usually provided with bottom plating of a substance corresponding to what would be expected from a consideration of their displacement tonnage. The double bottom spaces of a ship of war are, however, generally accessible at all times, and therefore can be examined with greater frequency than those of a mercantile vessel, which in the majority of cases, it is to be feared, are inspected only at intervals of three or four years. Only from ½in. to 1in. of cement is laid upon the inside of the bottom plating of ships in the Royal Navy, but great care is taken to ensure that the protection is of excellent quality and properly applied. As there is little or no risk of foreign substances, such as portions of the ballast or cargo of a merchant vessel, getting between the frame spaces, such a thickness of good Portland cement is doubtless sufficient to afford the needed protection against wear and tear of the plating. The use of thin cement in mercantile vessels cannot, however, be viewed with the same sense of sufficiency and safety, and unless very careful measures are taken to ensure free drainage to the pumps by means of holes in the frame angle bars, the saving in weight actually carried by the vessel is very doubtful. Such drainage holes must be of elongated oval form, with smooth edges to reduce the risk of their being choked, and they must be cut at the level of the cement in order that no lodgment of drainage water may exist. Unless these measures be taken it will become a matter of saving cement and carrying water instead. But when the inner surface of the bottom plating has been satisfactorily covered in the way described, the necessities engendered by modern steamship construction have by no means been fully satisfied. There are still the girders, floors, and bracket framing within cellular or double bottoms to be considered, and the protection of the upper surface of the inner bottom is to a yet more obvious extent a subject for attention. Iron and steel decks, when not covered with wood, have for some time past been displaying an alarming disposition to corrode, and wherever we turn in a steel vessel there appears a cause for anxiety in regard to the ultimate durability of the material. It was thought, when iron first displaced wood in shipbuilding, that the days of ship decay were past, and this expectation has, it is true, been largely realised. But although dry rot is not now encountered in ships, yet in its stead we find a very destructive enemy in the form of oxidation, which can only be repelled by constant examination, cleaning, painting, and otherwise protecting the material of which they are built. When that material is steel, much greater vigilance is required than in the case of iron.

Cellular bottoms and water-ballast tanks have now become very general in mercantile steamers, so that very few new vessels are now built upon the old-fashioned system with a single bottom and ordinary floors. In a very few years steam vessels without double bottoms will be rarely met with. But this system is not being generally adopted without abundant evidence being afforded from existing ships that it is accompanied with rapid wasting of the material of which the double bottom and its framing are composed. If it is necessary to frequently coat the outer surface of a ship to prevent corrosion, how much greater must be the necessity within such a space as a water-ballast tank? And yet instances are not uncommon wherein a water-ballast tank interior has never received a coat of paint or other protection from the time of building until the vessel was eight or nine years of age.

Now, in dealing with these cellular spaces, it is above all things important that the iron or steel should receive a thick coating of the protective material before it commences to oxidise. In the case of steel the black oxide scale which covers the newly rolled material must of course in all cases be removed before any paint or other substance is laid on. This is necessary both on the inside and the outside of the vessel, and if neglected the results will sooner or later be both expensive and annoying to the shipowner. But when that scale is off and the surface cleaned, the paint, or whatever else is used, should be put on without any delay. On the interior of the vessel, where exposed to bilge water or to water ballast, paint is of very little use. Most shipowners have coated the surfaces at these parts with "cement wash," or, in other words, with a very fluid preparation of Portland cement laid on with a brush. The same kind of coating has often been laid upon the upper surface of inner bottom plating, and with fairly good results. Elsewhere within the vessel iron or steel work should be painted, the thoroughness of the painting and the number of coats applied being of greater importance than the nature of the paint itself, which may be red lead, iron oxide, or white zinc, just as suits the taste of the person paying for it.

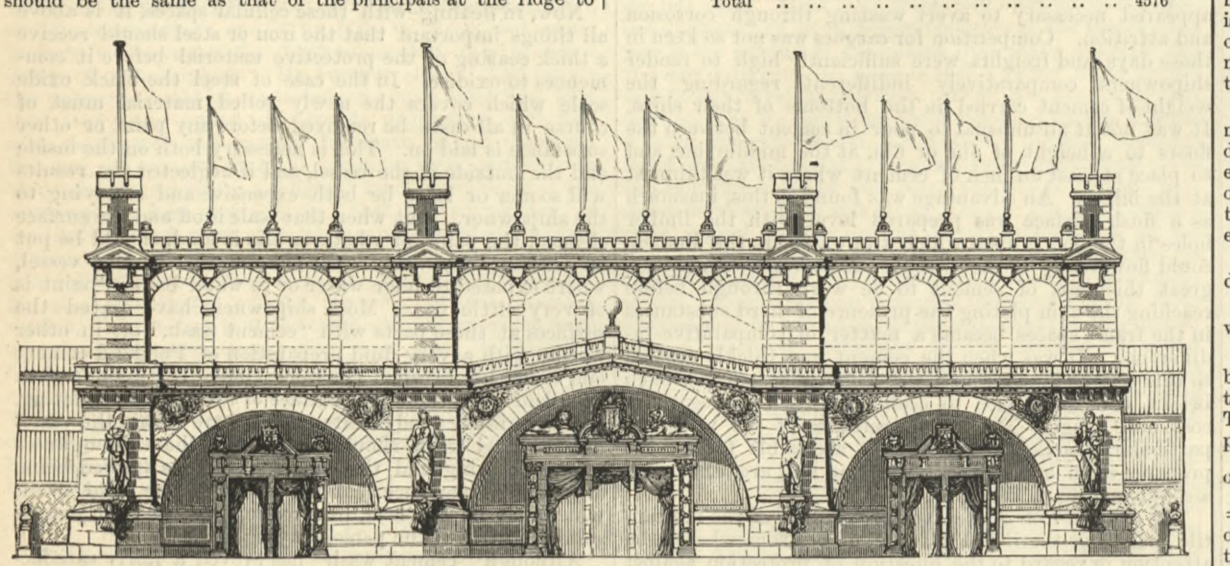
Although "cement wash" has proved a fairly satisfactory protection to the iron or steel work at the parts already referred to, yet recent experience tends to show that more advantageous results follow the use of Stockholm tar and Portland cement. The surfaces coated must in all cases be free from oxidation and quite dry. If at all damp the intended protection rapidly falls off. The surfaces are first coated with Stockholm tar, and at once sprinkled with dry cement powder until as much cement is applied as will stick to the tar. The tar and cement speedily amalgamate and slowly set; but when set the protection is quite hard and wholly impermeable to water. The upper surfaces of inner bottoms may advantageously be covered with this protection, more especially when under engines and boilers. Indeed, the wear and tear to inner bottom plating below machinery and boilers has been found to be so great that in all probability the placing of double bottoms at that part of the vessel will, to a large extent, be avoided in the future. As was stated in a recent article upon this subject in The Engineer, the wasting of double bottoms has become a serious question with the owners of some lines of steamers, and with the committee of Lloyd's Register. Unless some means can be taken to check the corrosive action which is so destructive at that part of the vessel, it will be necessary to add considerably to the scantlings, in order to provide a sufficient margin for possible and probable deterioration. The Stockholm tar and Portland cement remedy appears so far to meet the necessities of the case, and it is to be hoped that further experience will confirm present expectations regarding it.

Uncovered iron and steel decks continue to waste at a rapid rate, despite all the attempts hitherto made to check corrosive action. Coal tar and black varnish seem only to make matters worse, and the "let-alone" policy appears so far to be as good as any. Singularly enough, the more traffic there is on an iron deck the less the wear and tear is found to be. At the sides of large hatchways, for instance, the corrosion is less than at parts of the deck where men seldom walk. It is not difficult to explain this phenomenon. As is well known, oxidisation of iron progresses most rapidly in the presence of existing rust. The rust of copper prevents further corrosion, and only by the constant exfoliation on the surface is the bottom of a copper-sheathed ship kept clean. If that exfoliation is checked, the substance of the copper is preserved from wasting, but at the cost of a foul bottom. With iron the case is different. Oxidation engenders further oxidation, and hence the necessity for frequently scaling the surface of iron which is permitted to oxidise at all. The wear and tear of traffic near the hatchways wears away the scale of rust as it is formed, and consequently corrosion proceeds more slowly there than elsewhere on the iron deck. The constant falling of salt water on the deck is undoubtedly the cause of its rapid corrosion, and up to the present time no means appear to have been successful in keeping the water from acting on the surface of the iron. Probably the Stockholm tar and Portland cement remedy would be as efficacious as any if it were hard enough to endure, but that is doubtful. Under present circumstances, the best course seems to be to scale the deck frequently, and so imitate at all parts of the surface the action which nominally operates so advantageously at the sides of the hatchways.

The Westinghouse Automatic Engine.—A company is being formed in this country to manufacture the well-known Westinghouse high-speed engine. This engine is the invention of Mr. Henry Herman Westinghouse, brother of Mr. George Westinghouse, the inventor of the Westinghouse brake. A good board of directors has been got together, and a suitable site for new works near Glasgow has been secured; it has all facilities for traffic, and the new works can, it is considered, be erected, equipped, and in working operation within six months. Messrs. Alley and Maclellan will continue to manufacture for the company until the new works are ready. The capital of the company will be £100,000 in £10 shares.

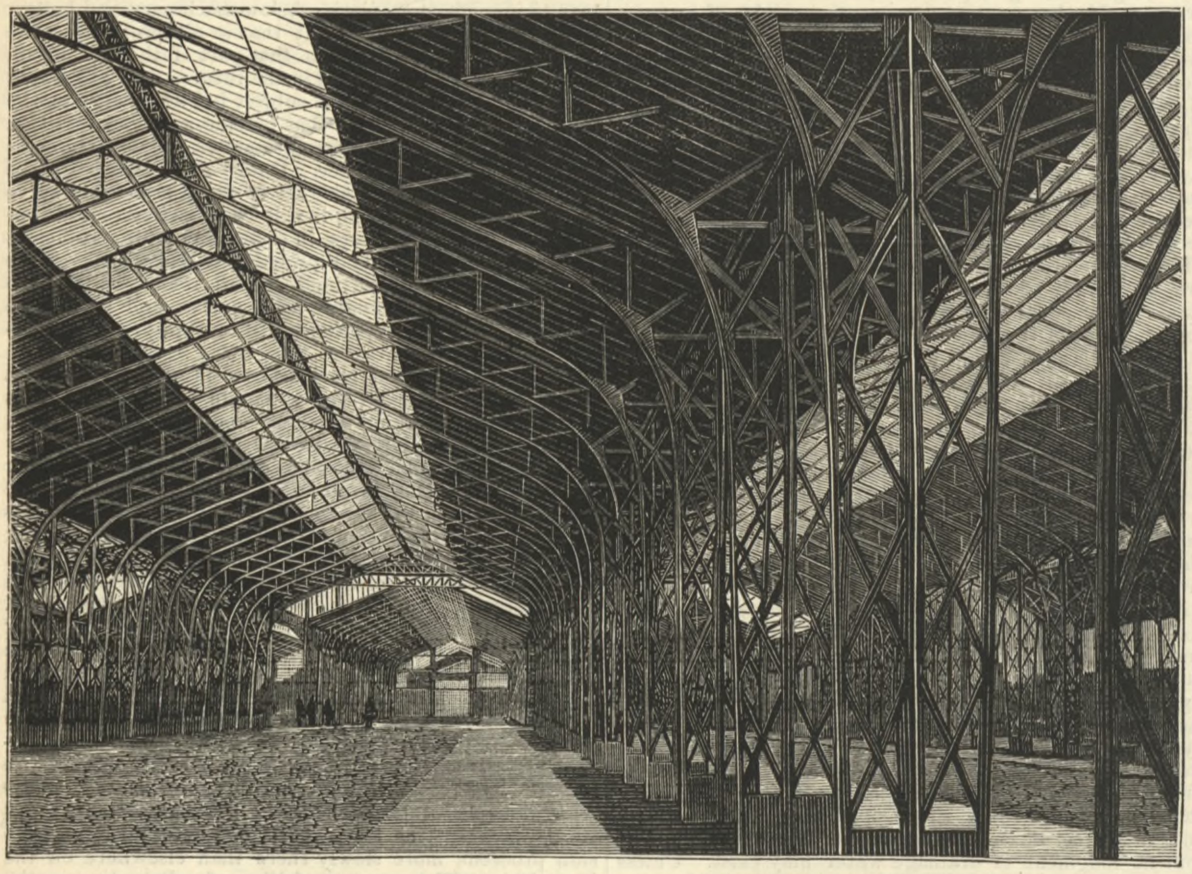
EXHIBITION AT VINCENNES IN COMMEMORATION OF THE FIFTIETH ANNIVERSARY OF RAILWAYS.

THE general plan of the Exhibition building at Vincennes—drawn up by the architect, M. Fouquian—is rectangular in form, 230 m. by 91·50 m., and covers an area of about 21,000 square metres. Having in view the old materials and ground to be dealt with, the span of the principals was fixed in accordance with the dimensions of the latter, that is to say, at 15·80 m. for the four middle galleries, and at 13·80 m. for the two ends. The centre was fixed at 5 m., corresponding to the length of the planks generally sold for roofing. The height of these galleries, to be in proportion with their width, was fixed at 7·15 m. at the springings and at 10·65 m. at the ridge, not comprising the skylight. These six galleries are cut across the middle by a central gallery 20 m. wide. The height of that at the springings should be the same as that of the principals at the ridge to



ENTRANCE, VINCENNES EXHIBITION.

which it is united, that is to say, 10·65 m. The height at the middle reaches 14·15 m.; the spaces between these principals could only be the openings to the longitudinal galleries by fixing intermediate supports, which would produce an ungraceful effect. To carry the roof and the glazing, the spans of the purlins should then be 15·80 m. and 13·80 m. The dimensions of these purlins were fixed by reference to those of the Dion principals of the Exhibition of 1878, which were 15 m. The profile and sections of the three principals had then to be decided upon. The use of metal had to be limited strictly to the necessary, and the maximum stress to which it would be exposed in every section taken into account.



PERSPECTIVE VIEW OF MAIN GALLERIES, VINCENNES EXHIBITION.

Such was the programme of construction with a view to absolute economy, and it was closely followed. The angle iron, 50 × 50 × 5 mm., was at first chosen for the principal as being that of the minimum weight which would permit the use of rivets; but upon trial it was found insufficient in strength to bear the required stress, and was therefore renounced for one of 60 × 60 × 6 mm., and the 50 reserved for the lattice. A certain number of the slanting bars of the 15·80 m. principals are also 60 × 60 × 6 mm. The height of the main rafter is continuous, and equal at 0·80 m. An arc 2·50 m. in circumference unites the rafter to the piers, which are 0·60 m. wide at this point, and at the foot of the 15·80 m. principals 0·45 m., and 0·40 m. at the foot of the 13·80 m. principals. The arched part of the inner angle iron for the 15·80 m. principals is 8 mm. thick.

The stresses which the principals may be called upon to resist are those due to their own weight, the wooden purlins, the lath battens, the covering, and the wind. The weight of the metallic portion of a complete 15·80 m. principal is 2200 kilogs., being 29 kilogs. per superficial metre. The wooden purlins, as well as those of the skylight, are placed on a perpendicular with the vertical uprights of the main rafter; they number six on each side for the 15·80 principals, and five for the 13·80, the glazed part being the same in both cases, 3·40 m. on the slope. The distance between the purlins is 1·15 m.; they are of pine wood, of a kind known as bastaing 18 × 7. The twelve weigh about 550 kilogs.; the battens rest directly upon the purlins, without any intervening trusses; they also are made of pine planks 0·03 m. thick, and from 0·11 m. to 0·13 m. wide, and weigh about 18 kilogs. per superficial metre. The roof is constructed of zinc No. 10 in the form of lozenges supplied by the Société de la Vieille Montagne. Three lozenges cover a square metre. The glazing of the skylight is of blown striated glass 4 mm. in thickness, and weighing 12 kilogs. per square metre. Total weight of a bay of 15·80 m. extending over 5 metres :—

	Kilogs.
Metal	2200
Purlins	520
Battens 5·60 m. × 2×5 m. = 56 m. × 20 kilog..	1120
Roof	280
Glazing..	456
Total	4576

Being per 1 superficial metre	58
Wind strain valued at	62
Total supposed weight uniformly distributed and per superficial metre	120

Calculation of stresses :—If the principal were considered as a girder resting freely upon its supports, and receiving from these a vertical reaction only, the yielding momentum would be represented by a parabola, the maximum ordinate of which would be $\frac{P\,l^2}{8}$. But on account of the form of the girder, there is added to the reaction of the supports—a vertical force equal to half the weight of the girder—an unknown horizontal effort acting in an 'nverse direction to the vertical reaction. This tends, in fact to open the principal, while the horizontal reaction tends to close it. The roof has been illustrated and described at length in the *Genie Civil* by M. C. Canovetti, from whose description that which we publish is a translation.

On the other hand, the fastenings at the foot of the principals, and to their detriment, the friction produced by the vertical reaction, prevent the principal from being displaced in a horizontal direction. The opening which might be produced by the weight is counteracted by the closing-up tendency of the thrust, to say nothing of the smaller influences—that is to say, the *moment d'encastrement* at the points of support, and the deformation due to longitudinal compression. M. de Dion states that the thrust is determined by these conditions, and that the necessary value is attained thereby.

It is sufficient then to explain that the elongation due to the weight is equal to the shortening due to the thrust, in order to get an equation which will prove it.

M. de Dion has also proved that these deformations, or more correctly speaking their horizontal projection, were expressed by $\int \frac{\mu\,y}{I}$, being the moment of deflection at each point. This integral must be eliminated, or μ is for each section equal to the difference between the moment of flexure due to weight and the moment due to thrust.

When the scale of the forces is such that the neutral axis represents the moment of the thrust, the parabola of the moments of deflection cuts this neutral fibre, and the value of the effective moment of deflection is represented—in the same scale—by the difference between the ordinates of the two curves. Under these conditions, the value of μ multiplied by the value of $\frac{y}{I}$ of each section considered ought to be such that the integration could result in 0: in other words, that in carrying over to the developed neutral axis the sums of $\frac{\mu\,y}{I}$ as ordinates, the two surfaces obtained should be equivalent.

When this condition is satisfied, the maximum ordinate of the moment of deflection due to weight, the absolute value of which is known, gives the scale of the forces. The ordinate at the ridge, on this scale, gives the value of the thrust multiplied by the maximum ordinate on the neutral line; and as this is known the value of the thrust is deduced therefrom.

This is the unknown part of the problem; this once determined, the force acting on each section can be graphically deduced, and the projection normal to this section gives the effort of compression. The projections permit the decomposition of these forces in every bar of the lattice, and to show the stress to which each piece is subjected. The effective compression in each section of the principal being known, it is added to or deducted from the value which is given by the ratio $\frac{\mu}{\frac{I}{V}}$, the value of the effort per square millimetre in each section.

Calculations relating to the 15·80 *m. principal.*—The principals being 5 metres apart, and weighing 120 kilogs. per square metre, the weight to be supported is equal to 600 kilogs. per lineal metre. The theoretic opening, measured between the centres of the points of support, being equal to 15·35 m., the maximum ordinate of the parabola would amount to $m = \frac{600 \text{ kilogs.} \times 15{\cdot}35^2}{8}$ = 17·671 kilogs.—Fig. 1. The neutral fibre being represented on the scale of 0·01 m. per metre, in order that the equivalence of the two surfaces may be obtained, this maximum ordinate must be represented by 135 mm., from which it is deduced that the scale of forces is equal to 0·0077 m. for 1000 kilogs. The maximum ordinate N y of the neutral fibre measured by this scale is equal to $\frac{10{\cdot}225 \text{ m.} \times 0{\cdot}01 \text{ m.}}{0{\cdot}0077 \text{ m.}}$, because y is equal to 10·225 m.; thus $N = \frac{0{\cdot}01 \text{ m.}}{0{\cdot}0077} \times 1000 \text{ kilogs.} = 1298$. Carrying over a vertical line the values of the greatest effort for each of the points considered, and combining this effort with the constant value of N, we should have for each section the resultant which projected normally from each section, gives the compression effort, and dividing this strain by the section expressed in millimetres the compressive stress per square millimetre is obtained—Fig. 3. It is sufficient to trace the values of μ measured graphically between the curves, divided by the value $\frac{I}{V}$ give the means of tracing the curve of the effort per square millimetre which is developed under the action of the moment of deflection alone. By adding or deducting the value due to compression we have the real effort per square millimetre to the scale of the diagram, horizontal lines representing the value of this effort in proportion to 5, 6, 7, 8 kilogs. to give at a glance the whole of the efforts. These calculations show that the maximum strain in the main rafter does not amount to 6 kilogs., while in the supporting part it is nearly 9 kilogs. for the inner angle iron and in that section that follows the curved part which has been strengthened. It might have been preferable to continue as far as this section the use of the 8 mm. angle iron instead of the 6 mm. It is in order to simplify construction that the use of the former iron has been limited exclusively to the curved part. A slight increase in the thickness of the supporting portions would have produced the same result. These principals, to the number of 180, were constructed in the factories of M. Moisant in less than $2\frac{1}{2}$ months. The dimensions of the 13·80 m. principals are identical to those of the 15·80 m., except a diminution of 0·05 in the width of the supporting columns at the springs, and the suppression of the extra thickness of the interior angle iron. The principals of this type were constructed in the factories of "La Société Nationale d'Ivry." They number 84.

20 *m. principals.*—For the principals of the central gallery the calculations have been made reckoning for a distance of 15·80 m. apart. Notwithstanding the diminution of space between the two last bays and that of the weights on the upper principals, they have all been made alike for the sake of simplicity, and each principal may be used indiscriminately. The purlins are supplied with a complete joint in the middle, that they may be lengthened or shortened as required. A load of 120 kilogs. per superficial metre has been assumed, and as the metallic portion is 50 kilogs. per superficial metre, the wind-pressure effort is reduced to 41 kilogs. On the other hand, the co-efficient of work per square millimetre is less than that allowed for in the small principals, and only amounts to 7·5 kilogs. in the curved part of the pier and in the 15·80 m. purlins. The load on the principal per lineal metre is 15·80 m. × 120 kilogs. = 1896 kilogs. The maximum ordinate of the parabola is then

$$\frac{1896 \text{ kilogs.} \times 19{\cdot}40 \text{ m.}^2}{8} = 89{,}197 \text{ kilogs. (Fig. 5),}$$

the principal being represented on a scale of 0·01 m. per metre, in order that the two areas $\frac{\mu\,y}{I}$ may be equal—Fig. 8. This ordinate must be equal on the diagram at 0·165 m.; from which it is concluded from the scale of forces that 0·00185 m. represents 1000 kilogs. N y by y = 13·62 m., being represented by 13·62 m. × 0·01 m. N is equal to $\frac{0{\cdot}01 \text{ m.}}{0{\cdot}00185 \text{ m.}} \times 1000 \text{ kilogs.} = 5400 \text{ kilogs.}$ Following the above method, the longitudinal pressure and the actual effects can be calculated in each section—Figs. 9 and 10. On account of the presence of the plate filling, and web in one part of the inner angle-iron work, the ratio $\frac{I}{V}$ must be calculated separately for the extrados and the intrados, because the neutral fibre no longer corresponds with the medial fibre. The 15·80 m. purlins are 0·60 m. deep, and are 1·616 m. apart in horizontal projection. They are constructed with 60 × 60 × 7 mm. angle irons, and weigh about 200 kilogs. per lineal metre. The maximum effort in the middle of their span is 7·500 kilogs. The shoes which receive the end of purlins, and the skylights of the longitudinal bays, are composed of 70 × 70 × 8 mm. angle iron, and their depth is 0·80 m. Two angle irons in a parallel direction to the main rafter of the principals receive the ends of the purlins. These angle irons are suspended by irons bolted into the lower angle iron of the wall plates. The total weight of this part, comprising skylights and all the connecting pieces, is 54 kilogs. The half of this weight is made up of the purlins on account of their great span. The absence of the wooden purlins, which are here reduced to a simple—*fourrure*—in order to facilitate the fastenings of the battens, compensates for the weight of the metal.

The skylight principals are heavier in proportion to the others, because the angle irons which support the former do not form part of the purlins. Besides this, the greater span has necessitated the use of 35/40 wood, instead of 30/35 used for the other principals. The skylight weighs 15 kilogs. per square metre, instead of 9 kilogs.; but if it be taken into account that the wall plates take the place of a running principal, and that the weight is divided over a surface of 25 m. instead of 20 m., by adding the half weight of the purlins and lateral skylights, the average weight is not more than 45 kilogs. per square metre; and with a skylight of the same weight as the small principals, this weight would not be more than 40 kilogs. The increased weight is partly due to the larger size of the gallery, which has made it necessary that each piece should be of larger dimensions. In fact, the weight per lineal metre of the 20 m. principal is only 215 kilogs. Now, that of the 15·80 m. is 81 kilogs., and supposing the same weight could have been realised for a 20 m. principal, with a space of 5 m., it will be seen that more than three of these principals would have been required to take the place of one of 15·80 m., and that the weight would have been greater than that employed—243 kilogs. instead of 215 kilogs. In reality, instead of weighing the same as a 15·80 m. principal, the 20 m. principal for 5 m. from centre to centre would have weighed 160 kilogs.; that is to say, just double, for only the plates and webs could have been suppressed without diminishing the other parts.

However, the lesser weight of the purlins and skylight would have been a great economy if other requirements had not rendered it preferable to do away with the intermediate principals. It might have been possible to have a 20 m. principal weighing only about 46 kilogs. per square metre, taking the medium between the minimum of 5 m. and the maximum of 15·80 m. In spite of that the weight is much reduced for a strain not exceeding 7·5 kilogs.

The formation in one of the arc and the supporting part was a happy idea—due to M. Dion—harmonising the æsthetic and the useful, and it is suggested that wherever the principals of this type can, without inconvenience, be used, in which a stress is set up in opposition to the thrust, it should be done, for the supplementary strain in the points of support, without the necessity of increasing their dimensions, is sufficient to be able to dispense with the use of ungraceful tie-rods. This type of principal has over others—such as the Polonceau—the advantage of greater stiffness in the transverse direction.

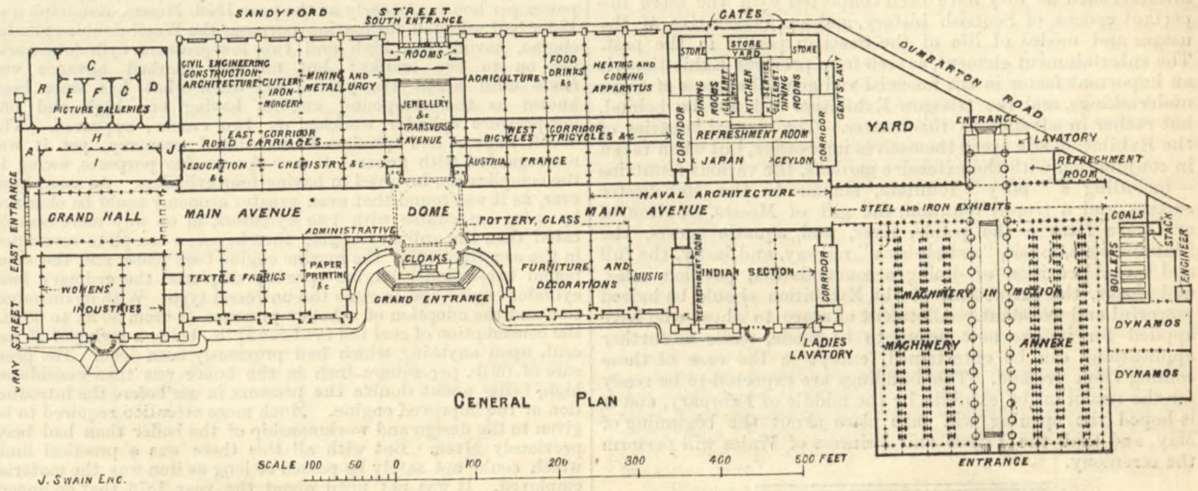
The 15·80 m. and 13·80 m. principals rest upon blocks of rubble masonry; large webs of iron fixed by flush rivets to the foot of the principal intervening. Each masonry pier is 1·40 m. × 0·80 m. × 0·80 m., being about a cubic metre of masonry. The beds are all perfectly levelled by a coat of soft cement. The principal, stiffened by two *chèvres*, rests on the plate, and its solidity is immediately secured. A brace to the upper part is then sufficient to maintain the equilibrium.

THE GLASGOW INTERNATIONAL EXHIBITION, 1888.

The foundations for the buildings of the forthcoming International Exhibition at Glasgow were completed about the middle of July, and already—in less than four months' time—the enormous area lying between the river Kelvin and Dumbarton-road, on the bank opposite to that on which stands the noble pile of Glasgow University, is almost completely covered with substantial buildings in various degrees of progress. Exhibition buildings are proverbially behind time, but if one may judge from the degree of progress already made, the vast erections at Glasgow will not only be finished in every detail by the proposed date of opening, but in their main features they will be complete before the winter weather sets in, which in the experience of other such undertakings has proved so formidable a hindrance to progress. It may probably not be known to our readers, but the buildings as they are being erected cover a considerably larger area than at first proposed. At an early stage it was seen that the demand for space would probably exceed the original anticipations, and it was therefore determined that the buildings should be as large as the available site would permit. The increase is proportionately greatest in the machinery annexe. It has been extended in area fully 35 per cent., and the main building 15 per cent., the total increase being about 20 per cent. The annexe amounts to over 92,000 square feet, being 330ft. in length by about 250ft. in width. This gives an area quite seven times larger than that devoted to the same purpose in the Edinburgh Exhibition of last year, but somewhat less than the corresponding department in the Manchester Exhibition. As the class of exhibits, however, which may be most plentifully expected in the Glasgow display, will occupy less space, per exhibit, than those at Manchester—cotton spinning and other textile machinery—which require large floor area, the collections at Glasgow will not be less numerous or representative of the engineering industries. The Messrs. Penman and Co., Glasgow, William Wilson, Glasgow, and Messrs. Galloway, Manchester, are to supply the boilers required for the machinery in motion.

The whole area covered in amounts to over 10½ acres, or about 3½ acres more than the roofed-in space of the Edinburgh Exhibition. From the general plan of the buildings and grounds, which we give on this page, it will be seen that a grand central avenue, 60ft. in width, extends the whole length of the main portion of the buildings—1050ft.—intersected at the centre by a transverse avenue of the same width. On either side of the former is a series of courts 50ft. in width, and varying from 100ft. to 190ft. in length. At the east end of the grand avenue the large concert hall, capable of seating 3000, and 160ft. long by 100ft. wide, will be situate. A grand organ, by Messrs. J. W. Walker and Sons, of London, will be fitted in a recess, and in front there will be a spacious platform for an orchestra and chorus.

The measure of progress attained in the erection of the various sections of the building may be briefly outlined. The principals of the timber roofs over the whole of the main building, with a small exception, have now been erected, braced, and purlined. The roof-lights have been fitted on the main avenue, the whole of the south courts and some of the north courts; and all the courts are nearly covered in with galvanised iron, the contractors for this and other features being Messrs. F. Braby and Son. The flooring is laid throughout all the courts, being of the ordinary open-jointed kind used in such buildings. The external walls or gables of the courts along the south front of the buildings are nearly completed, and considerable progress has been made with the gables and small towers along the principal front—that facing the park and University. Much of the heavy work connected with the great centre dome is well advanced. This outstanding feature is over the point of intersection of the main with the transverse avenue, and is 80ft. diameter by about 140ft. extreme height. The main framework for this feature will consist of the dome of the Exhibition at Manchester, the purchase of which has been effected by the Glasgow building committee. Strong supports are necessary for carrying the weight of the dome structure, and these are supplied in the form of four massive octagonal brick towers spanned at the top by four strong iron girders, on which the dome will rest. The contractors for this and other girder work in the buildings are Messrs. Arrol and Co., Glasgow.

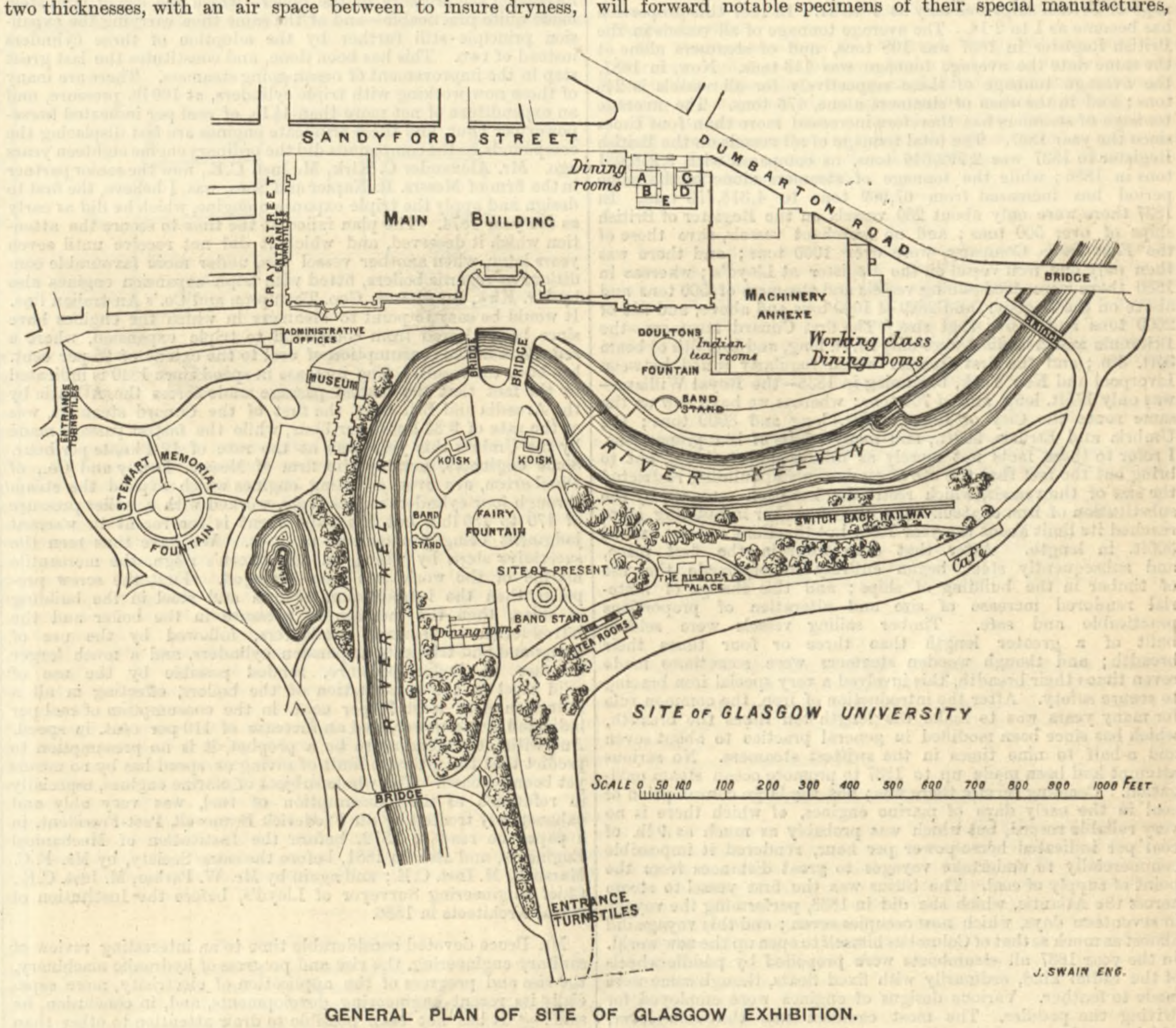


THE GLASGOW EXHIBITION.

In making accommodation for the fine arts section, which it is intended shall be one of the most important departments of the whole Exhibition, special care is being taken that the temporary housing for the reception of the exhibits shall protect them from every preventible injury. The external walls of the section are composed of brick, 18in. thick, built in two thicknesses, with an air space between to insure dryness, while the internal walls are 9in. thick and built solid. Iron couples support the roof of this section, all connected with which is in a forward state. The floor is laid solid on concrete, and all the openings between the various galleries will have Messrs. Chubb's patent fire-proof doors, as in the Manchester Exhibition. The heavy digging and building work connected with the machinery annexe is now completed, and the iron standards for the roof, designed also to carry the shafting, are nearly all erected, while the roofing is framed and ready for erection. Within a few days the construction of the dynamo sheds, boiler house, and chimney stalk will be proceeded with.

The dredging of the river Kelvin, which flows through the grounds, is being rapidly carried out, together with the formation of embankments and promenades. Applications have already been made by several firms and individual inventors for permission to exhibit launches and other craft propelled by steam or electricity, and others in which the fuel used is oil or combustibles other than coal. Several shipbuilding firms have agreed to show various classes of torpedo boats propelled by electricity. The river and its banks will be used to show the practical working of a new patent ship-railway, which will take up a boat from the river, and after carrying it some distance, launch it again into the water. The boat will carry some twenty or thirty passengers. This demonstration of the practicability the ship-railway on a small scale, if successful, should have considerable bearing on the larger scheme with reference to the transport of ships and other heavy objects, such as ordnance, &c., from point to point.

As a matter of course, marine engineering and shipbuilding will be represented in the Exhibition in a way worthy of the Clyde's world-wide fame in these departments. All the Clyde shipbuilding and engineering firms are preparing excellent models of the ships and engines they have produced. The great amount of important work recently turned out by several firms for our own and other navies is being made the subject of representation in such a style as shall impress every visitor. From the North-east coast of England similarly interesting exhibits are promised. Glasgow and the West will also be to the front with superb locomotive engines, steel manufactures, mining and mechanical engineering specimens of every description. The manufacture of carpets, cottons, linen, &c., will be demonstrated, together with the speciality of Turkey-red manufacture. The chemical industries of Glasgow and district will assume a prominent place in the Exhibition, together with special manufactures, such as gutta-percha, sperm candles, and silk production and spinning. Paper-making and printing machinery—Edinburgh's speciality—will form no inconsiderable portion of the machinery in motion section. Perth, Dundee, and Kirkaldy will forward notable specimens of their special manufactures, Aberdeen likewise, while Paisley, Greenock, Kilmarnock, Ayr, and other western towns will be well to the front. From all parts of England applications for space are being made, while in the cases of Birmingham and Sheffield there will be organised representation of the varied manufactures of these cities, Glasgow being a large consumer and exporter of such. From the colonies of Britain, as well as America, Canada, and Continental towns, many notable exhibits are expected; while so far as India is concerned, it is abundantly clear that the special section devoted to that vast empire will form a more representative display than has ever been brought together anywhere apart from the special Indian and Colonial Exhibition in London last year. Influential committees which have been organised in the several provinces of India and Ceylon guarantee a varied and comprehensive representation of native art manufacture and products. It is expected that, wholly or in part, the Prince of Wales' valuable collection of Indian presents will be placed on view, and the carved screens purchased on behalf of the Glasgow Exhibition at the close of the Indian and Colonial last year, will go to form decorative structural work in the section, as well as to provide fronts for the spaces to be occupied by Indian importers. Arrangements are being made for bringing from India a number of native artisans to show their modes of work, and in the Indian tea room the model of a native tea garden will be fitted, illustrating the whole process of



GENERAL PLAN OF SITE OF GLASGOW EXHIBITION.

growing, manufacturing, and packing tea. Eight courts altogether are being set aside for foreign and Colonial exhibits, and several other courts for a "Women's Industries" and an "Artisan" section, the aim of the promoters being to make these last two sections so thoroughly representative and generally interesting as to give them an importance which has never hitherto been secured for them in undertakings of the kind.

The architects and executive of the forthcoming Exhibition are not following in the beaten track of previous displays in the matter of counterfeiting "Old" Glasgow, although fitting subjects for reproduction are by no means wanting. Only one such feature will be erected: that of the Bishop's Palace or Castle of Glasgow, which formerly stood near the Cathedral, and was associated with many notable events in the history of Old Glasgow. This interesting and picturesque edifice will be used as a repository for souvenirs, hierlooms, and objects of antiquarian interest, such as may have been connected with the more important epochs of Scottish history, and are illustrative of the usages and modes of life of the Scottish people in the past. The entertainment element, as seen from previous Exhibitions, is an important factor in the financial and general success of these undertakings, and the Glasgow Exhibition will not be behind, but rather in advance in this matter. The natural beauties of the Exhibition site are in themselves impressive, but when taken in conjunction with the extensive gardens, the various fountains —including a "fairy" fountain, similar to the Manchester success, and a trophy fountain, the gift of Messrs. Doulton, of art ware fame — the ponds, river, and aquatic sports, the illuminations, music, "switch-back" railway, and lastly, the full and varied provision of dining accommodation, pavilion, cafes, and kiosks, the attractions of the Exhibition should be indeed powerful and constant. Allotment of space to those who have applied for it, has now begun to be made, while no further applications can be entertained, except in the case of those coming from Ireland. The buildings are expected to be ready for the reception of exhibits by the middle of February, and it is hoped the opening will take place about the beginning of May, and that the Prince and Princess of Wales will perform the ceremony.

THE INSTITUTION OF CIVIL ENGINEERS.

PRESIDENTIAL ADDRESS.

(*Concluded from page* 391.)

Mr. Bruce next dealt with the changes in the manufacture of iron and steel, and the great extension in their applications.

Steamships.—Great indeed have been the changes during the last fifty years in the building of ships and in the means of their propulsion; these changes I will endeavour shortly to trace. In 1837 the proportionate tonnage of steamers to the total registered tonnage of British ships was only as 1 to 41. In 1887 this proportion has become as 1 to 2·14. The average tonnage of all vessels in the British Register in 1837 was 108 tons, and of steamers alone at the same date the average tonnage was 113 tons. Now, in 1887, the average tonnage of these respectively for all vessels is 246 tons; and in the case of steamers alone, 476 tons. The average tonnage of steamers has therefore increased more than four times since the year 1837. The total tonnage of all vessels on the British Register in 1837 was 2,792,646 tons, as compared with 9,246,051 tons in 1886; while the tonnage of steamers alone in the same period has increased from 67,969 tons to 4,318,153 tons. In 1837 there were only about 230 vessels on the Register of British ships of over 500 tons; and no merchant vessels, save those of the East India Company, were over 1000 tons; and there was then only one iron vessel on the Register at Lloyd's; whereas in 1886 there were 4883 sailing vessels and steamers of 500 tons and above on the Register, and 2829 of 1000 tons and above, and 385 of 2000 tons and above that size. The first Cunard steamers—the Britannia and Arcadia—were only 207ft. long, and breadth of beam 34ft. 4in.; and the first steamer which regularly sailed between Liverpool and New York, beginning in 1838—the Royal William—was only 175ft. long, and of 700 tons; whereas we have now on the same route the City of Rome, 550ft. long and 8000 tons; the Umbria and Etruria, 500ft., and many others of like proportions. I refer to these facts not merely as interesting statistics, but to bring out the fact that the use of timber in shipbuilding restricted the size of the vessels, which restriction has been removed by the substitution of iron or steel. The use of timber in building ships reached its limit about the year 1850, but this limit did not exceed 300ft. in length. After that date iron, in the first place, and subsequently steel, began entirely to supersede the use of timber in the building of ships; and this change of material rendered increase of size and alteration of proportions practicable and safe. Timber sailing vessels were seldom built of a greater length than three or four times their breadth; and though wooden steamers were sometimes made seven times their breadth, this involved a very special iron bracing to secure safety. After the introduction of iron, the common rule for many years was to make the length ten times the breadth, which has since been modified in general practice to about seven and a-half to nine times in the swiftest steamers. No serious attempt had been made up to 1837 to promote ocean steam navigation. Coasting service there was; but the large consumption of coal in the early days of marine engines, of which there is no very reliable record, but which was probably as much as 9 lb. of coal per indicated horse-power per hour, rendered it impossible commercially to undertake voyages to great distances from the point of supply of coal. The Sirius was the first vessel to steam across the Atlantic, which she did in 1838, performing the voyage in seventeen days, which now occupies seven; and this voyage did almost as much as that of Columbus himself to open up the new world. In the year 1837 all steamboats were propelled by paddle-wheels of the radial kind, ordinarily with fixed floats, though some were made to feather. Various designs of engines were employed for driving the paddles. The most common was the side lever, which may be regarded as the type of the marine engine of that period, at all events for ocean-going steamers. It will be in the memory of the older members that in the year 1840 the Archimedes steamer, fitted with a screw-propeller, made a voyage round the coasts of Great Britain, calling at various ports to exhibit the first practical introduction of the screw in place of paddles, which, for ocean-steaming, it has now almost entirely displaced. The introduction of the screw was gradual, and as late as 1862 the Cunard Company built the large steamer, the Scotia, with paddles. That, however, was the last they so constructed. Up to that date the improvement made in the marine engine was mainly due to an increase of size and power; gradually improved workmanship and design in details, and some economy gained by improved boilers and increased steam pressure. This may be illustrated by reference to some of the Cunard vessels as follows:—The Arcadia was built in 1840, and fitted with a pair of side-lever engines, with cylinders 72½in. in diameter and 6ft. 10in. stroke; boilers of the old flue type, and a working pressure of 6 lb. to 7 lb. The indicated horse-power at sea was about 700, and the consumption of coal about 5 lb. per indicated horse-power per hour. Subsequent paddle steamers of the Cunard Company had engines of the same kind of gradually increasing size, but still with flue boilers, until the Persia was built in 1855. This vessel had cylinders 100in. diameter and 10ft. stroke, but was fitted with tubular boilers worked at a steam pressure of about 20 lb. These engines indicated about 3500-horse power, and consumed about 4 lb. of coal per indicated horse-power per hour. The Scotia, built in 1862, had cylinders 100in. diameter and 12ft. stroke, with tubular boilers working at a pressure of 25 lb. per square inch. The indicated horse-power was about 4000, and the consumption of coal a little less than 4 lb. per indicated horse-power per hour. It will be seen that as the boiler pressure increased the consumption of fuel decreased, but other conditions altogether were necessary before further economy could be secured. The introduction of the screw propeller necessitated an entire change in the design of marine engines. As it was necessary to drive the screw at a greater number of revolutions than it was deemed wise to drive the engines, the screw shaft was, in the earlier vessels, driven by the intervention of spur gearing at a greater speed than the engine itself. By degrees engineers took courage and applied direct-action engines, which are now universal for mercantile purposes. The next improvement in marine engines was the introduction, or rather the revival, of the surface-condenser, about the year 1862, followed by gradually increasing pressures, the use of larger cylinders worked more expansively, by which the consumption of coal was reduced to about 3 lb. per indicated horse-power per hour. As early as the year 1856, Messrs. Randolph and Elder had adapted for marine purposes the Woolf double-cylinder engine, having two high and two low-pressure cylinders working on to two cranks; but no very marked advance was made until about the year 1868, when what has since been known as the compound engine, having one high and one low-pressure cylinder working on two cranks, appeared. The Woolf engine had produced undoubted economy, yet it was not regarded with general favour for marine purposes, owing to the complication involved in having four cylinders. As soon, however, as it was found that even greater economy could be obtained by using an engine with two cylinders, in no way more complicated than the ordinary engine then in use, a complete revolution in the construction of the marine engine took place, and the compound two-cylinder engine speedily displaced the ordinary two-cylinder engine and became the universal type. With its introduction and the adoption of a boiler pressure of from 50 lb. to 60 lb., the consumption of coal fell to about 2¼ lb., being a saving of 25 per cent. upon anything which had previously been done. The pressure of 60 lb. per square inch in the boiler was then considered high, being about double the pressure in use before the introduction of the improved engine. Much more attention required to be given to the design and workmanship of the boiler than had been previously given. But with all this there was a practical limit which could not safely be passed so long as iron was the material employed. It was not until about the year 1876 that engineers generally had confidence enough in mild steel, produced by Sir William Siemens, to use it for marine boilers, and by its introduction alone was it possible to go on increasing the boiler pressure. In a few years compound engines came to be worked at a pressure of from 90 to 100 lb. with a consumption of somewhat less than 2 lb. of coal per indicated horse-power per hour, or as Mr. F. C. Marshall, M. Inst. C.E., gave it in his paper in 1881, 1·828 lb. Thus in 1880 a horse-power cost in fuel only a little more than one-third of what it had cost in 1837, estimating that at 5 lb. per indicated horse-power, and it was probably usually a good deal more. Engineers did not, however, rest content with the economy thus far effected, and the only known way of advancing in this direction was by increasing the pressure in the boiler—which the use of mild steel made quite practicable—and at the same time carrying the expansion principle still further by the adoption of three cylinders instead of two. This has been done, and constitutes the last great step in the improvement of ocean-going steamers. There are many of these now working with triple cylinders, at 160 lb. pressure, and an expenditure of not more than 1½ lb. of coal per indicated horse-power per hour, and these triplicate engines are fast displacing the compounds, as the compounds did the ordinary engine eighteen years ago. Mr. Alexander C. Kirk, M. Inst. C.E., now the senior partner in the firm of Messrs. R. Napier and Sons, was, I believe, the first to design and apply the triple expansion engine, which he did as early as the year 1874. The plan failed at the time to secure the attention which it deserved, and which it did not receive until seven years later, when another vessel was, under more favourable conditions as regards boilers, fitted with triple-expansion engines also by Mr. Kirk, for Messrs. Geo. Thompson and Co.'s Australian line. It would be easy to point to steamers in which the engines have since been altered from compound to triple expansion, where a reduction in the consumption of coal to the extent of 25 per cent. has been the result. The increase in speed since 1840 is indicated by the fact that the fastest passage made across the Atlantic by the Arcadia and Britannia, the first of the Cunard steamers, was at the rate of 9·33 knots per hour, while the fastest passage made by the Umbria this year was at the rate of 19·4 knots per hour. Some engineers, notably the firm of Messrs. Denny and Co., of Dumbarton, are even adopting engines which expand the steam through four cylinders successively, worked with a boiler pressure of 170 to 180 lb.; but the experiment is too recent to warrant judgment being pronounced upon it. We have thus seen the successive steps by which, in our Queen's reign, the mercantile marine of the world has been changed. First the screw propeller, then the introduction of iron and steel in the building of ships, then the increase of pressure in the boiler and the introduction of surface condensers, followed by the use of compound and triplicate expansion cylinders, and a much larger increase in boiler pressure, rended possible by the use of mild steel in the construction of the boilers, effecting in all a reduction of at least 70 per cent. in the consumption of coal per indicated horse-power, and an increase of 110 per cent. in speed. And without pretending to be a prophet, it is no presumption to predict that the ultimate limit of saving or speed has by no means yet been reached. The whole subject of marine engines, especially in reference to the consumption of fuel, was very ably and exhaustively treated by Sir Frederick Bramwell, Past-President, in a paper he read in 1872, before the Institution of Mechanical Engineers, and also, in 1881, before the same Society, by Mr. F. C. Marshall, M. Inst. C.E.; and again by Mr. W. Parker, M. Inst. C.E., Chief Engineering Surveyor of Lloyd's, before the Institution of Naval Architects in 1886.

Mr. Bruce devoted considerable time to an interesting review of sanitary engineering, the rise and progress of hydraulic machinery, the rise and progress of the application of electricity, more especially its recent engineering developments, and, in conclusion, he said:—"It has not been possible to draw attention to other than the most prominent features of changes which have come over things engineering during the reign of our gracious Queen. While to matters relating to instruments of war, whether guns or ships, I have purposely made no reference; the subject, though full of interest and importance, was too vast to be introduced. There is more satisfaction, too, in looking at the work of the civil engineer from its manifestly beneficent side. In viewing it as providing readier means for the passage of men and merchandise from one part of the earth to the other, whether by sea or land; for the advancement of commerce and all that concerns human weal and progress; helping to make famines impossible because the food of the lands blessed with 'years of plenty' is brought ready to the aid of lands where for the time the 'ears are withered and blasted.' There is something, too, more in accord with the sound of 'Jubilee' connected with the reign of a gracious Queen when we tell of progress which speaks of 'peace on earth' rather than of progress in that which deals in munitions of war, which, however inevitable it may be, is always very terrible. I cannot sit down, gentlemen, without thanking you for the honour yeu have done me in placing me in the presidential chair, the highest seat a civil engineer can occupy. Noble men have sat here. To speak only of the dead, to me it is full of interest that I sit in the chair once occupied by my revered master, Robert Stephenson; and it will be my aim whilst here to do nothing on which he would have looked askance; he whose career, entwined with that of his father, remains an instructive and pleasant memory to all of us who knew him, and within these walls will ever be a tradition never to be let go."

LETTERS TO THE EDITOR.

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

TIDAL ESTUARIES AND THE BAR OF THE MERSEY.

Sir,—The communication from Mr. Wheeler which appears in The Engineer of 11th inst. is very interesting, and, with your permission, may lead to an important discussion and valuable results. I hope to escape being thought presumptuous when I say it seems to afford more examples of partial observation leading to fallacious conclusions, and consequently to erroneous advice.

For instance, Professor Reynolds, in his model of the upper estuary, appears to ignore the effect of wind. Now, for between twenty and thirty years there have been monthly surveys of this estuary, and the constant change in the position of the navigating channel has been recorded, but without soundings. Some of these I have carefully studied, and have found strong evidence of the influence of wind as a very important factor in the changes recorded, and in causing the "frets" to which Mr. Wheeler refers. Any one who realises the extent of the tidal basin known as the upper estuary will, I think, see that the wind, principally through its action on water, must produce important effects, and that its action cannot be prudently ignored.

Again, Mr. Wheeler and Mr. Shelford appear to ignore all surveys of Liverpool Bay prior to 1833, and also the tidal phenomena of the Irish Sea. Mr. Wheeler speaks of the old Formby Channel, when he does not mean the original Formby Channel which passed Formby Point, and is now represented in part by Formby Pool, but refers to one of the numerous modern upstarts by which the name of Formby Channel has unfortunately been inherited. I venture to suggest that no one should attempt to advise any special remedy for the defects in Liverpool Bay until he has carefully studied every authentic chart. The series extends over two centuries, and he who restricts his inquiries to one-fourth of that period will, I think, be stranded on fallacies.

It would occupy too much of your space to dwell on all the numerous points in Mr. Wheeler's paper which provoke discussion; their name is legion; but I should like to address myself to the prescription which with many is very attractive, and, in one form or another, has been often suggested. In a few words, it is to deepen the channel across the bar through the agency of the ebb, which, Mr. Wheeler very strangely remarks, "being a descending current, naturally has the greatest effect." From this it appears that the current of the flood does not descend; and so, I suppose, must ascend or be horizontal, which is utterly at variance with my observation. As I understand the action of the tide, it raises the water, in this locality, as much as 30ft., and in consequence of that raising, causes currents downwards, which vary in velocity with the length of the slope down which they flow. Assuming this explanation to be correct, it then appears that the scouring effect of the ebb or the flood will depend on the relative mass of water which passes in the same time. Roughly speaking, the flood lasts for five and a-half hours, the ebb for seven hours; with the ebb there also passes the land-water, which, as Mr. Wheeler observes, is but trivial in proportion to the whole volume of water; and, further, it is distributed through three outlets. Therefore it would seem that the average velocity of the ebb is something less than that of the flood, as the ebb occupies more time for the same quantity of water. If this be so its scouring power must be so much less.

It is said that without any works of heroic magnitude the bar could be swept away. Omitting for the present all reference to the stone mounds or training walls continuing the line of Great Burbo Sands, I would invite attention to the works requisite for removing the bar—sweeping it away—and for preserving the resulting waterway. Assuming the depth of water to be 30ft. at ordinary low-water springs, and the width as at the Formby lightship, the dredging would be over an area of 3000 yards by 800 yards; the extreme depth 18ft. to 20ft., running out to nothing. The mounds of rough stone rising 4ft. above low water would be 34ft. high, exclusive of the depth into which they would sink below the bottom of the channel, and that is very uncertain, as the material which underlies the sand and the thickness of the bed of sand are unknown. I think your readers will now perceive that the works proposed are of considerable magnitude, if not exactly heroic, especially as the line of the Great Burbo Sands is about seven miles long.

Will Mr. Wheeler kindly explain how are calculated the 1500 million and the 500 million cubic yards of water he mentions? Is it on the assumption that the whole area of the bay and of the river are filled up to the brim at one and the same time?

Liverpool, Nov. 14th. Joseph Boult.

Sir,—In the article which appeared in your last week's issue, Mr. W. H. Wheeler, after stating that "the popular received idea that bars are due to matters carried in suspension being deposited at the site where two opposing currents meet, or to a decrease of the velocity of the current owing to the increased area of the space into which the channel discharges, is not borne out by facts, as there are instances where those conditions prevail where there are no bars, and of bars existing where there is little or no matter in suspension," goes on to say that "there are instances of rivers discharging on sandy coasts, and at times carrying large quantities of alluvium, which have no bars," instancing the Humber, the Thames, and the Severn.

In the case of the Humber, practically the whole of the suspended matter is what has been brought into the estuary by the heavy flood tides. The whole of the plain extending northward nearly to York, and westward up the valleys of the Trent and the Aire, has been formed in this way. Formerly, when land was of little or no value for agricultural purposes, a great portion of this plain was marsh covered by the tides. The current not being confined in any way, rapid accretion took place, and islands were formed here and there. With the advent of peaceful times, steps were taken to reclaim these marshes. Sir Cornelius Vermuyden, in the seventeenth century, drained Hatfield Chase, and after him Smeaton and Rennie recovered many acres in the south-east parts of Yorkshire lying about the Trent, the Don, and the Ouse. Flood banks were constructed, and the tide in this way confined. As these banks were extended, a change gradually took place in the features of the river. Where formerly a great portion of the detritus from the cliffs of Holderness was deposited on these low-lying marshy lands, the bed of the river below was scoured, and a uniform depth maintained. Now the flood tide, being confined, is encroaching again on the high water lines up the Ouse and Trent, removing the loose friable soil originally deposited there, and re-depositing it in the Humber, where the scour is diminished owing to the exclusion of the tidal water above. The comparatively recent formations of Bromfleet and Reed's Islands are instances of this accretion in the Humber.

When at Goole in 1886, I took various samples of the water, with a view to determining the proportions of silt at different seasons and times of tide. It was invariably the case that this proportion was greatest on a spring flood tide, and that the drier the weather the thicker the water became.

On the spring tide of February 18th, at low water, the proportion of silt was 48 grains per gallon, and at high water 144 grains per gallon. Passing on to the spring tide of May 5th, I determined at low water 120 grains per gallon; at half flood, when the speed of the current was strongest, 360 grains; and at high water, slack, 128 grains per gallon. Going back to February 12th, when the tide was not quite half spring, and about 3ft. of fresh water in the river, I found at low water 12 grains per gallon, and at high water 8 grains per gallon.

In the winter of 1886-87—a moderately dry season—the silt in the river Ouse did not extend more than two miles above Selby; beyond that no trace was to be found. But with the exceptionally dry summer we have had, and consequently the small discharge, the silt reached Naburn Lock—the tidal limit—much sooner than what has usually been the case, and it has accumulated to such an extent that whereas in May there was a minimum depth at low water, between Selby and Naburn, of 5ft., in September there was an available depth of only 1ft. 3in., it having silted up 3ft. 9in. during the dry weather. Speaking from superficial observation, I may say that the land water of the Ouse, during heavy floods, is remarkably clear and free from alluvial matters in suspension.

I wish to point out from the above remarks that the wetter the seasons are, and consequently the more fresh water there is discharged, the less suspended matter there is in the river; so that the river Humber cannot be instanced, in the way the context of Mr. Wheeler's article implies, as one of "rivers discharging on sandy coasts, carrying large quantities of alluvium, which have no bars."

The tidal volume of the Humber, Ouse, and Trent, on a spring tide, is approximately 3,000,000,000 cubic yards, and the amount of land water is stated to be equal to an average daily flow of about 43,000,000 cubic yards, or about one-eightieth of the tidal water entering daily. Assuming that it was the case that the land water brought down the greater portion of the suspended matter, this 40,000,000 cubic yards, charged with silt, could not throw up a bar at the mouth of the Humber, in opposition to the 3,000,000,000 cubic yards of tidal water sweeping in every tide.

But bars are formed in the Humber, and are formed where the forces of the land water and tidal waters are more nearly in equilibrium than is the case at the entrance. This happens immediately below the confluence of the Ouse and Trent, and where their combined waters passing through the contracted channel at Faxfleet are able to cope with the muddy tidal water, thus throwing up the extensive Whitton Sands. At this place the relative proportions of the discharge and flood waters are as follows:—The average tidal capacity of the Ouse is 57,023,119 cubic yards; of the Trent, 29,378,643 cubic yards, making a total average tidal volume of about 86,500,000 cubic yards. The fresh water discharge of the Ouse is about 22,401,024 cubic yards, and of the Trent 19,663,395 cubic yards, making a total fresh water discharge of about 42,000,000 cubic yards, or, say, that the fresh water discharge is about one-half of the tidal water passing at this place, as compared with one-eightieth at the entrance.

Taking all the above into consideration, I am inclined to think that so far as the Humber is concerned the popular idea of the formation of bars at the entrance of rivers is correct, and that where no bars exist it is due to the fact that there is no current which can offer appreciable resistance to the volume of the water in which the alluvial matter is suspended.

Naburn, near York, A. F. Fowler.
November 14th.

THE RIBBLE SCHEME.

Sir,—More than fifty years ago the Commissioners of the river Blyth wishing to improve the harbour had a small steam dredger built, which was delivered in 1833 and put to work to excavate and remove the obstructions in the harbour, which was kept at work all the season and the following one, and as the navigation was so improved, the Commissioners considered they did not require the dredger any longer; and the Ribble trustees having applied for a dredger, this one was sold and taken away to Preston, where I understood it was put to work and found not adapted for the Ribble, as the flow of the tides was so rapid, that soon after it could be got to work the bucket ladder would not reach the bottom of the river. For Blyth harbour, with only a 6ft. flow of tide, it was not required to excavate more than 14ft. or 15ft. below the water surface. The Ribble trustees should not have purchased this dredger without fully ascertaining its capabilities, and the Commissioners of the Blyth should not have sold it, as they were obliged to hire another about two years after to remove some obstructions which again accumulated; but what was done here was a considerable improvement, both as regards the navigation and the river banks.

Market-place, Southwold, Suffolk, G. E. Child.
November 12th.

FREE TRADE AND NO TRADE.

Sir,—I have been very much interested in reading the letters on above in your valuable paper. I, like "Trader," am stupid on this question, but I am also, comparatively speaking, young and willing to learn. I have been doing my best in this direction since boyhood, and have not been altogether unsuccessful in picking up a little information which, with your kind permission, I should like to place before your readers. Before, however, contrasting, as I wish to do briefly, the working of Free Trade in England and highly protected trade in Holland, I should just like to point out to Mr. W. Muir solves his difficulty as to the importance of our having spare hands to go on with improvements in a very satisfactory manner by his assertion, if correct, that Protection would result in a great increase in the population, which I hardly think can be a disadvantage to the country from Mr. Burt's point of view. Now let us turn to Holland. Here a small duty is practically placed upon everything imported. In addition to this, a consumption duty is placed upon sugar, cheese, butter, &c., &c., manufactured in the country. Consequently, the Dutch florin of one shilling and eightpence will purchase little more than a shilling will in England. Every trader must take out a licence or "patent," as it is called, for each separate branch of his business. He must also serve a certain term of his life as a soldier, or must be a member, and a working one, too, of the Fire Brigade. Holland naturally has nothing but agricultural produce and the intelligence of her inhabitants as merchants to depend upon for her existence. Workmen do not get higher wages than in England at any rate; but what is the condition of Holland? You can go from north to south, from east to west, and where can you find barefooted, starving children in the streets? Can you find beggars? Can you find loafers or cornermen? Can you find workhouses? Is starvation rampant? or is there any sign of the misery we see in every city, town, and village of our Free Trade England.

The Dutch have discovered a grand open secret; they find employment for the greatest number of the population, and do not let other nations do work they can very easily do themselves, but do their best to make every individual self-supporting. I never could understand why hundreds of thousands of pounds sterling are paid in hard cash to the Dutch for growing vegetables, fruit, &c., for us; and I was simply astounded when I first saw the enormous quantities of blackberries that are consigned to England from Holland, when in many instances they are allowed to rot on our hedges in England. Coming as much of the agricultural produce does from North and South Holland to Rotterdam for shipment, it seemed simply marvellous to me that it should pay to send comparatively valueless fruit so far, until I became a little better acquainted with our system of railway charges in England; and this is a matter that requires very careful looking into from a Fair-Trade point of view. Of course there are plague spots in Holland as well as England; but these do not affect the question under consideration.

In reference to population in Holland, as a man's family increases so are his rates and taxes diminished, giving a premium of no mean consideration to the father of a large family, as the more children he has the less he has to pay the Government in this way, so there is no attempt made to stop the increase of population.

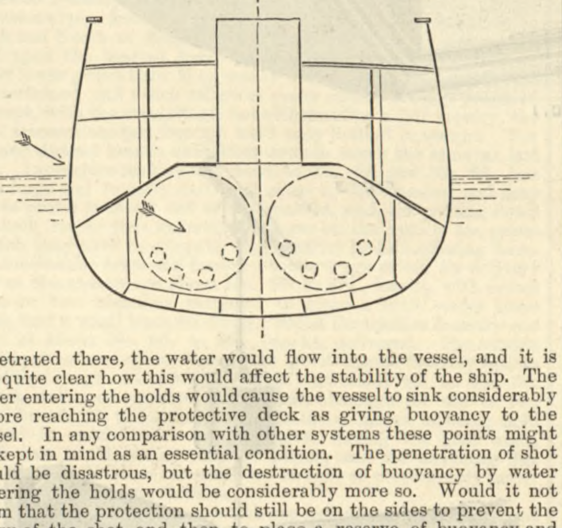
I do not wish to dispute what I believe to be a fact, that Free Trade, if universally adopted, is right both in principle and in practice; but I do not think that England is the world, and until all other nations of importance agree to carry on their commerce on a Free Trade basis, I must continue to consider—unless converted—that our so-called Free Trade system is a plausible snare. We have Protection in its worst form with railway companies, gas companies, trades unions, &c., and yet close our eyes to the benefits that might accrue from it in other ways for the simple cry—I cannot call it reason—that we may be mistakenly called a Free Trade nation. T. Fredk. Ransome.

Liverpool, November 15th.

BELTED CRUISERS.

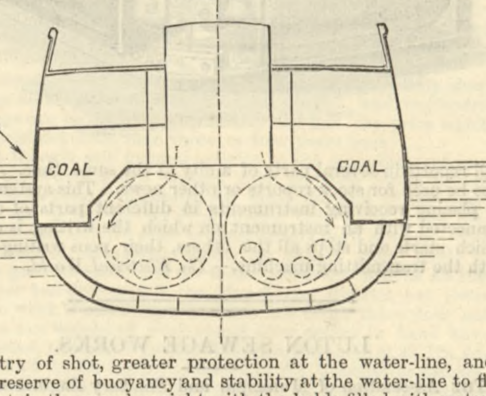
Sir,—The illustrations of the Spanish cruiser Reina Regente, in your issue of October 28th, shows a method of construction of internal belts, sides, or casings, with a protective deck over the engines, boilers, and the lower portions of the vessel, extending the entire length of the vessel. This method of protective deck has been partially adopted in the Inflexible and other war vessels, but the inner skins, sides, or casings are additions to and improvements on the system of side protection, with the protective or sloping deck, as shown in the Reina Regente. With the ordinary thickness of side it would seem that the outer skin might be easily penetrated by shot; the shot entering the vessel would be resisted probably by the sloping or protective deck, and if not penetrated, this would deflect the shot upwards or in a diagonal direction into the interior of the vessel. If the deck is penetrated the shot would fall below or into the interior or holds of the vessel. Again, by the protective deck meeting the sides of the vessel so close to the water-line, a shot striking there would not have far to penetrate to the interior or holds of the vessel, as indicated by the arrow in the small sketch, Fig. 1, annexed; and the side being

FIG. 1



penetrated there, the water would flow into the vessel, and it is not quite clear how this would affect the stability of the ship. The water entering the holds would cause the vessel to sink considerably before reaching the protective deck as giving buoyancy to the vessel. In any comparison with other systems these points might be kept in mind as an essential condition. The penetration of shot would be disastrous, but the destruction of buoyancy by water entering the holds would be considerably more so. Would it not seem that the protection should still be on the sides to prevent the entry of the shot, and then to place a reserve of buoyancy and stability within the vessel by means of the internal skins, sides, or casings, as shown in sketch 2? This would give outside protection

FIG. 2



from entry of shot, greater protection at the water-line, and a positive reserve of buoyancy and stability at the water-line to float and maintain the vessel upright with the holds filled with water.

In your issue of November 2nd, 1883, there is a letter advocating this principle, which says:—"This seems to be an admirable arrangement for protection by coal from shot, and as giving a power or reserve of buoyancy for supporting the vessel in the event of injury to other portions of the hull by torpedoes or other destructive agents. If this principle of construction were more generally adopted, there would be one element given to the vessel for protection from foundering or sinking;" and again the writer says:—"The principle might be introduced with advantage into vessels of the merchant service and mail steamers—especially the large class passenger vessels intended to be used as cruisers in time of war—as protection from sinking. These internal sides, skins, or casings along the vessel give not only protection from sinking, but also a reserve of shoulder and stability for prevention from capsize. They may be constructed of light scantlings, and divided by partial bulkheads or diaphragms, and the spaces utilised for storage of coal, mails, specie, passenger baggage, light and valuable cargo, and for other purposes of the ship as desired. The principle has been recorded in the Patent-office since 1878, and is one worthy at least of adoption by the large mail and steamship companies, and for all kinds of war vessels, especially to large class armour-clads."

London, November 12th. J. A.

WATER-TUBE BOILERS.

Sir,—With reference to your last article on water-tube boilers, also to my previous letter on the subject, and noting your kindly remarks thereto, I beg again to venture to explain, but more fully, my ideas of circulation, which I have found correct in practice.

You suggest that, as an experiment, a tube be placed in the flame over a burner and stopped at one end, will give you little or no circulation—how can it? It is merely like a pot on a fire, the particles of steam generated are simply struggling to get through the water by gravitation only, but, if you will try the following experiment of placing the neck of a bulb glass over a burner and communicating with a container which again communicates with the bulb as a return, you will get a complete circulation at the rate of about 30ft. per minute, and the solid water entering the neck and passing over the burner with the particles of steam distinctly visible, as generated in the neck, to the container above. This represents the circulation in a water-tube boiler, as preferred on the Continent and in the United States, the principle being apparent in the MacNicol, De Nayer, and Babcock and Wilcox boilers, and is what I term in my previous letter, a one-current circulation, which is not subjected to any cross currents, and continually sweeping the water tubes, leaves little or no deposit; and having receptacles provided at the lower and coolest part of the boilers for the deposit to accumulate, the water in it is stationary and deposits the heavier portions as it passes to the tubes. This circulation was distinctly shown in a glass model boiler by Messrs. Coles and Matthews at the Preston Show, some years since, as their tubes have precisely the same result.

My contention, Sir, is that what contributes to the success of these water-tube boilers is that by the one-current circulation the particles of steam as generated are so quickly taken to the steam space, and being continually replaced by water of lower temperature, that continual absorption takes place, and continuous circulation and not spasmodic ebullitions.

Having dealt with the circulation, I come to the question of their advantages as heat absorbers. In ordinary flue boilers the ignited gases pass away from the furnace in large volumes, and lose their efficiency through carbonic oxide being formed—the outer portions touching the plates being absorbed only—before they impinge on the plates of the flue; the advantages of a Galloway tube showing this. But in these water-tube boilers, the tubes being placed so that all the products of combustion are disseminated and cut up and impinging on the increased tube surface, the heat is better transmitted to the water than through thick plates; and a combustion chamber being formed immediately beyond the tubes any gases not mixed and absorbed in their passage around the tubes combine and are ignited in this chamber, and the heat taken up by the container above. This may be seen in actual work to be taking place.

Not having been required to furnish so large a boiler as to evaporate 100 cubic feet of water per hour, I cannot adduce you the workings, but in dealing with land boilers I should prefer to use two boilers which would occupy about the same space as an ordinary Lancashire and about 10 per cent. less weight. I find 8½ to 9 square feet of heating surface per indicated horse-power to be sufficient, but this differs with the differences of fuel; and I find evaporation is with the best fuel 3½ lb. water per square foot of heating surface. In some cases I have found a much higher rate.

The cost of water-tube boilers to that of ordinary Lancashire or Cornish at low pressures is in excess; but for high pressures they can compete favourably, and, as to safety, they certainly can claim advantages.

I am just now embodying the principles I have explained in a Cornish boiler by the insertion of circulating water-tubes. When completed, I shall be pleased to give you the results; and I may add that this water-tube system, as added to the front end of a Cornish or Lancashire boiler, is largely in use on the Continent, and has been added repeatedly without even removing the boiler from its seating, and doubling its heating surface, the old boiler merely being the container.

I hope, Sir, we shall see some other opinions and experiences on this question, as it needs ventilating; also the comparison with other forms of boilers, as I find it is difficult to get really trustworthy data, as I saw published a few weeks since that a Lancashire boiler had evaporated 12½ lb. of water per lb. of coal. Where did the water go to? T. W. Baker.

12, Wormwood-street, London, E.C., November 9th.

CONTINUOUS BRAKES.

Sir,—In your issue of yesterday's date, Mr. Clement E. Stretton invites me to explain what vacuum brake I allude to in my letter of last week, and if I may trespass upon your space to the extent of a few lines, whatever mystery there may be shall at once be dispelled.

The vacuum brake I referred to was that with the Gresham ball valve, and the efficiency of this system is shown—curiously enough on the succeeding page to that in which you print Mr. Stretton's letter—viz., by the extract from Colonel F. H. Rich's report upon the accident on the Belfast and Northern Counties Railway, on September 28th.

Mr. Stretton mentions the Midland, North-Western, and Great Northern Railways as having a brake that is not interchangeable; but in this respect he is wrong, as those companies are now rapidly fitting in a way that will ensure complete interchangeability.

The presence of the universal coupling for vacuum brakes must now very soon render the double pipe connection referred to by Mr. Stretton a matter of ancient history. G. Mitchell.

Windsor, November 12th.

A FRAUD.

Sir,—We have received a letter this morning from Düsseldorf, Germany, of such a remarkable character that we think its contents ought to be made public, although it is marked "strictly private." We do not think it necessary to publish the writer's name, but the original letter can be seen here by any representative you choose to send, on your undertaking to suppress names.

Exporters.

12, Waterloo-street, Glasgow, November 16th.

Düsseldorf, 14th November.

Dear Sirs,—Will you kindly inform me whether you are buyers of Swedish steel bars for the India or China markets?

There is now made in Germany a quality of steel bars, stamped and all with Swedish brands, which to all practical purposes is equal to the real article.

If you like to try the quality, I can send you some samples, and if you decided to buy some afterwards you need not get the works to stamp any brand which you may decide upon putting on. This you can get done after the bars have left the works, or the works will do this for you.

This is strictly private, and I shall be glad if you will kindly treat it as such, only some people I know are making these days enormous profits out of this.

LIQUID FUEL.

Sir,—Will Mr. Henwood give the analyses of the oil and the coal used in the comparative tests with his system on the Thames or better still, would he give their value tested by a calorimeter. The figures he has given are worse than useless as a test of efficiency. Balance.

Liverpool, November 16th.

The "Craven Scholarship" at the Yorkshire College.—An interesting gathering took place at the Great Northern Railway Station Hotel on Saturday evening, when Mr. Joseph Craven, the surviving member of the firm of Messrs. Smith, Beacock, and Tannett, having completed fifty years of partnership in the firm, was entertained at dinner by a number of his friends connected with the different branches of the engineering trade, and was presented with a cheque for £721, which he requested the committee to invest for the purpose of founding a scholarship in the engineering department of the Yorkshire College. In our "Jubilee Supplement" we gave a sketch of the history of the engineering trade in Leeds, and pointed out that the works with which Mr. Craven has been so long and so honourably connected were the first established in the town for the manufacture of engines and flax machinery. The business was commenced in 1798 by Messrs. Fenton, Murray, and Wood, at the Round or Victoria Foundry, in Water-lane. In the year of her Majesty's accession to the Throne, Messrs. Smith, Beacock, and Tannett became the owners of the works, which had long been the most distinguished competitors of the well-known firm of Messrs. Boulton and Watt, of Birmingham. The new firm devoted themselves entirely to the manufacture and improvement of engineers' machine tools, and made special tools of the largest kinds, especially for marine engine work. As makers of such tools the firm has largely contributed to the credit of Leeds, and tools bearing their name are to be found in all parts of the world wherever there are engineering works. Some time ago a movement was commenced to celebrate Mr. Craven's jubilee as a member of his firm, his friends in Leeds, in the engineering trade, aided by many other friends in the same trade in London and in Scotland, thinking it was a convenient opportunity to acknowledge his services, rendered in many ways, to the trade. It was determined to have a permanent memorial of Mr. Craven, which ultimately took the form of a subscription to found a scholarship in the Engineering Department of the Yorkshire College, to be called the "Craven Memorial Scholarship," and to be held by youths intended for the engineering trade. The scholarship, which is of the value of £25 a year, will be held for two years.—*Leeds Mercury.*

THE WRITING TELEGRAPH.

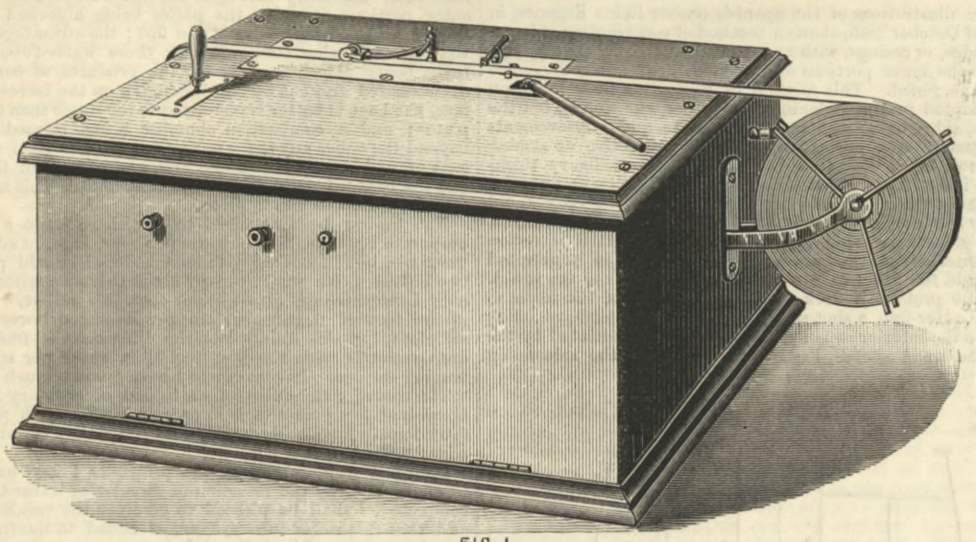


FIG. 1

FIG. 2.

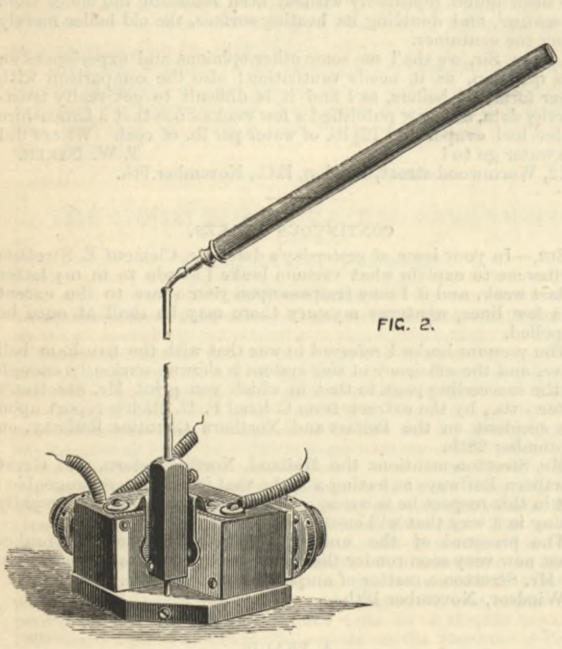
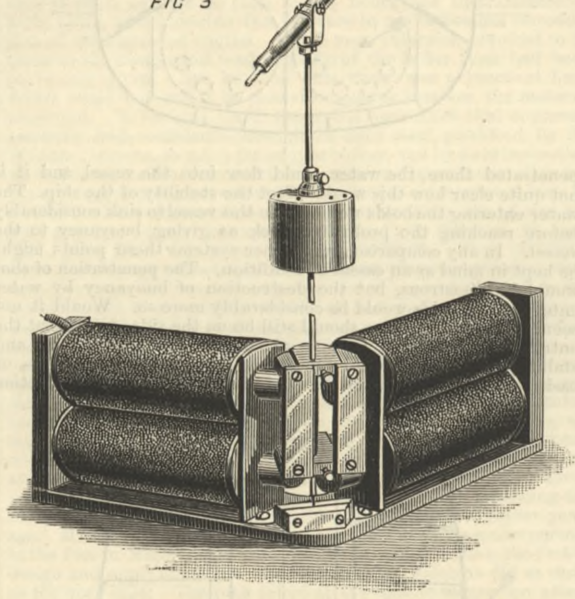


FIG. 3



THE WRITING TELEGRAPH.

One of the earliest objections raised against the telephone was that it left no written record of the communication, and hence to accomplish this object there was devised a writing telegraph. This system, to which we have already drawn attention in the past, is now in operation at the American Institute Electrical Exhibition, and attracts a great deal of attention. The entire apparatus is contained in the instrument shown in the accompanying illustration, Fig. 1. Two wires lead from this to the central office, where the batteries are situated, there being no local batteries required at the subscriber's. The transmitter, shown enlarged in Fig. 2, consists of two series of thin carbon discs about ⅛in. in diameter, placed at right angles to each other, in a hard rubber receptacle. The normal pressure of each series of discs is adjusted by a screw. The stylus rod has insulated pressure points opposite the piles of discs, and is supported at the base on thin wire, so that by taking hold of the handle it can be manipulated, as in writing. Each of these series of carbon discs is in circuit with one of the line wires which are led to the receiver, Fig. 3. This consists of two pairs of electro-magnets, each in circuit with one of the line wires and placed at right angles to each other. The rod which carries the pen and the armature has a spring wire projection at its base, and is fastened at a point where the poles would meet if extended. The armatures for each pair of magnets have a brass connection and are placed above the cores of the magnets. Above the armature is a German silver float which moves in a cup of glycerine and prevents any tremors appearing in the writing. The pen is a fountain pen and contains an ink which does not dry in the pen, and is always ready to write. The transmitter and receiver are placed in a case about 14in. long, 9in. wide, and 8in. deep. This case—Fig. 1—also contains a bell and the clockwork mechanism which moves the strip of paper. Above the box appears the handle of the transmitting stylus, and the armature rod carrying the pen. On the left is the switch for changing the current from the transmitter to the receiver.

When the stylus of the transmitter is pulled to the right its pressure point presses on the right and left carbon discs, the resistance in the circuits is reduced and an increased current is sent into the corresponding magnets of the receiver, which pulls the receiving rod to the right, in accordance with the strength of the current. A pull of the transmitting rod to the left in the same way pulls the receiving rod to the left, and the curves are the result of a pull, which sends two unequal currents at right angles to each other. A transmitter is readily adjusted to its receiver, so that the pen will follow every movement of the stylus, stop where it stops, and move where and when it moves. In writing the transmitter and receiver are both in circuit with the receiver of the instrument which is to receive the message. The sender watches only his receiving pen, and, taking hold of the handle of the stylus rod, pulls the receiving pen to form what letters he wishes, and the receiving pen of the distant instrument also makes a facsimile of every letter or mark. It takes but a short time to get used to the moving paper and to form the letters without moving the hand to the right, and that is all there is to learn to operate the instrument. We thus have a system of written telegraphic messages, and arrangements are perfected to work the same commercially in several cities.

The central exchange instrument and system of the Writing Telegraph Company will be shortly added to the exhibit. Every one of these instruments can be started and stopped at will from the central office. In from three to five seconds after a subscriber pulls over his switch, which drops the annunciator in the central office, he can be writing his message to the number he has requested. That subscriber is not called up, but the instrument is started from the central office, and the tapping of a bell notifies him that a message is being recorded. If he is in, he answers; but if he is away he finds the message sent him during his absence on his return.

Another style of instruments are those designed to report base-ball reports in several parts of a city at the same time. They can also be used for stock reports or other news. This system consists in placing receiving instruments in different parts of a city, all connected with an instrument on which the writing is done, and which starts and stops all the others, their pens writing in unison with the transmitting machine.—*The Electrical World.*

LUTON SEWAGE WORKS.

The Association of Municipal and Sanitary Engineers and Surveyors paid a visit to Luton Sewage Works on Saturday the 29th ult. The assembly took place in the Council Chamber, there being present Mr. J. Gordon, of Leicester, President; Mr. Louis Angell, West Ham; Mr. Ellice Clerk, West Sussex; Mr. J. P. Barber, Islington; Mr. John Lund, Bedford; Mr. E. Sharman, Wellingborough; Mr. G. Cannon, Aylesbury; Mr. W. H. Wilds, Hertford; Mr. J. P. Norrington, Fulham; Mr. C. Jones, Ealing; Mr. W. Weaver, Kensington; Mr. G. Weston, Paddington; Mr. W. B. Bromley, Heston and Isleworth; Mr. T. G. Lawson, Southgate; Mr. W. Santo Crimp, Wimbledon; Mr. R. S. Lloyd—Messrs. Hayward Tyler and Co.; Mr. T. de Courcy Meade, Hornsey, and others; also the Mayor—Councillor H. Blundell—Aldermen Higgins, Mayles, Weatherhead, Gentle, Toyer; Councillors F. M. Willis, Hart, Johnson, Bird, Barrett, Attwood, Tearle, Tomalin, Harden, Smart, J. T. Willis, and W. R. Phillips, with Mr. G. Bailey, town clerk; Mr. G. Sell, borough accountant; Major Flower, consulting engineer of the Lea Conservancy Board; Mr. C. Mees, J.P., Luton, and others.

Mr. W. H. Leete, borough surveyor of Luton, read a paper on "Luton Sewage, Past and Present," dealing historically and minutely with the whole subject. The population at the present time is about 30,500, rateable value, £104,316; municipal area, 2600 acres, and there are thirty miles of roads and streets. Luton is situated at the head of the Lea watershed, and above the intake of the New River Company, and the large lakes on Luton Hoo estate. Between 1876 and 1885 the population increased one-third, and complaints again arose. After much inquiry the Town Council acquired the present farm, which comprises 71a. 12r. 27p., at an average price of £128 per acre. It adjoins the borough boundary, and its extremity is fully a mile beyond the pumping station. Its greatest height is 184ft. The soil for the most part has a shallow staple on a chalk base somewhat loose and free from large fissures. The land is served by a 16in. rising main 1541 yards long, prolonged by a 12in. main 220 yards in extent, with eleven valves serving eleven levels from 10ft. to 184ft. There are four earth-made tanks—two at 62ft. height, one at 117ft., and one at 125ft., each having a small sludge bed. The tanks will hold 1,023,700 gallons, and may be filled twice in twenty-four hours. They cost 9s. per 1000 gallons. The conduits from the various levels are simply earth cuts to a fall of 1in. per chain following the contour of the hillsides. They extend slightly over three miles and cost 8⅔d. per yard. About nine acres at the foot and side of the hill are levelled and ridged to secure uniform distribution of sewage without any large accumulation at the foot of the hill. The cost was £16 an acre. The chief crop is rye grass, with about sixteen acres arable growing corn for the Corporation houses. As to crops, some years we have been able to show a profit, but last year's superabundant produce caused the crops to be almost given away, entailing a deficit. As the sewage enters the works it passes through a series of screens. Three tanks holding about 700,000 gallons are used to hold the night flow. They are connected with a well in the new engine house, 9ft. in diameter and 14ft. deep, into which the 18in. suction pipe of the new pumps is carried. The boilers are equal to 130-horse power. The new engines are 100-horse power, coupled, horizontal, rotating, high-pressure, condensing engines, &c. The pumps are 19½in. diameter, of the horizontal double-acting type. The new plant is capable of raising 1½ million gallons of sewage per day of twelve hours 200ft. high. As to coal consumption, twenty days' working at various levels showed a cost of ½d. per thousand gallons, taking coal at 11s. per ton on the works. Two days' consumption of coal working to the highest lift showed a cost of $\frac{7}{8}$d. per 1000 gallons. The new machinery was designed and executed by Messrs. Hayward Tyler, Howard, and Co., of London and Luton, the contract being £2760, which with a few extras will possibly bring the amount in round figures to £3000. The results of the working from May 21st to the present time have been very satisfactory. Luton now disposes of its entire sewage without an outlet to the river. The dry weather flow of sewage in twenty-four hours is 820,521 gallons; in wet weather it is more than double. The old engines repaired will raise 800,000 gallons in twelve hours. With them and the new plant we can lift 2¼ million gallons in twelve hours. The town water supply equals 750,000 gallons per day. A few months ago there were over 2000 cubic yards of sludge about the pumping station. It has all been removed to the neighbouring farms, and the sludge is now daily pumped with the sewage to the new farm a mile distant. At the request of the Town Council, the whole of this work was designed and carried out by himself, Mr. Leete, excepting the machinery, the design for which was the result of a competition. The engine-house, boiler-house, shaft, &c., cost £2173. We have been able to keep within the estimate, £20,000, and so far the result has been quite satisfactory. The Association may have viewed more scientific work as regards the construction of the tanks and conduits, but larger outlay was avoided on account of the distance of the farm from the town and the river, particularly as we have a splendid chalk base of a possible depth, as has been stated by geologists, of 300ft. or more.

After some discussion of the paper, the party drove to the sewage works, where they inspected the machinery and arrangements. They then proceeded to the farm, and highly commended the irrigation scheme for its simplicity and effectiveness. A visit was then paid to the waterworks for the inspection of the engine and pumps, which were highly approved. On returning the visitors were shown over the factory of Messrs. Carruthers Brothers, and witnessed the various processes of manufacturing straw and felt bonnets and hats. It had been intended to inspect the dye works of Messrs. T. Lye and Son, but time did not allow of it.

On returning to the Council Chamber, the visitors and members of the Corporation were etertained at luncheon by the mayor, who invited remarks upon what had been seen.

Mr. Ellice Clark said the works were exceedingly ingenious and well-designed, and, as far as could be seen at present, did their duty most effectively. But they did not find what people generally saw first at such works, namely, the effluent. He thought that in a few years if they could not see it, somebody would find it out for them. Their works might go on so for some years, possibly for this generation, but depend upon it some day or other they would have to deal with an effluent.

Mr. W. Santo Crimp, Wimbledon, thought the finest thing in connection with a sewage farm was to have no subsoil drains and no effluent, and he believed the day was far distant when they would require either. If such a time came, then their troubles would begin. Meantime, they might enjoy the advantages to be derived from their very excellent system of sewage disposal.

Mr. C. Jones (Ealing) said: In a Hertfordshire town when a sewerage system was proposed, the clerk to the Authority thought it needless, and pointed to a cesspool on his premises which had existed for ninety years, and had never had anything in it. It was suggested that his neighbours down below got the benefit of it. "Well," he said, "perhaps they do, but they don't thrive very much on it." Should the eventuality predicted by Mr. Ellice Clark ever arrive, they would hope that those to whom it might go would thrive upon it.

Mr. J. P. Barber (Islington), said Luton had been fortunate in having a surveyor capable of designing a sewerage scheme without having to call in a consulting engineer. The system which they had inspected was quite unique, and seemed to be very successful. The farm was admirably situated, and the soil of such a character as in that position to be almost self-cleaning, so that it was almost impossible that there could be any smell from it, while the poor nature of the soil could absorb any quantity of sludge and be the richer for it.

Mr. Louis Angell (West Ham), said he considered the works the perfection of simplicity, and he had never seen sewage got rid of so easily and so cheaply. Luton was at the head of the river Lea, and he represented the district at the tail. They were the head and tail of the offending. But while Luton had lifted itself out of that position, West Ham remained in it. He congratulated them on being able to cast aside wretched chemicals which were both costly and unsatisfactory.

The President said he pressed on Mr. Leete that the meeting of the Association should be held here, as, having seen the works, he knew that it would be difficult to find elsewhere a scheme so simple and unique. With their chemical processes Luton seemed to have had the same experience as other towns. None so purified sewage as to provide an effluent fit to go into a stream from which drinking water was drawn. As to pollution to water from the scheme, it might possibly occur at some very remote period, but the subsoil of chalk must become saturated to a very large extent before any impure water could be chemically traced in the Lea. Possibly twenty or thirty years hence an effluent might be perceived, but even then the sewage would have passed through such a quantity of chalk that the impurity remaining would be infinitesimal and never found in the river. He thought they need not have much fear on that account. Still, the quantity of land was phenomenally small, and one day it might occur. In all they had 93 acres for 30,000, whereas one acre for 100 was the general calculation. But their position was unusual, and in the soil they had, with its base of chalk, lay their salvation.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—William Giles, fleet engineer, to the Minotaur, to date November 24th; Alexander G. Smith staff engineer, to the Constance, to date November 17th.

A Curious Railway Accident.—Somewhat peculiar railway accidents happen occasionally in America, as the following extract from a New York newspaper testifies:—"Six cars owned by Robinson's circus, and containing wild animals, were derailed and then run into by a freight train at the Union Station, St. Louis, on the evening of November 3rd. One man was killed and others were injured. A Bengal tiger escaped from its cage, bit a man in the crowd, and ran up a flight of stairs. There the circus employés threw canvas over him and held him down till he could be caged again. Nine cages are demolished and two pumas are dead. The loss to the company will be 30,000 dols. Fourteen animals in all got loose. A lion was overpowered with pikes and canvas under a freight train, a leopard was shot in the head, an ibex was captured slightly injured, a big boa-constrictor was cut to pieces under car wheels, and the Bengal tiger has three bullets in him and numberless pike wounds. The escaped animals created great terror in the southern section of the city for over two hours, but all were finally captured or killed by squads of circus men with fire-arms, pikes, &c., assisted by the police. The last secured was a puma, which fought desperately in a ticket-office until lassoed with strong ropes. The capture of one of the pumas was an exciting affair and required great courage on the part of his captor, who saw the brute under a freight car and at once grappled with him. For a few moments there was a desperate struggle, and nothing was to be seen but the revolving man and beast and a cloud of dust, but the man finally triumphed, and held the beast down to the platform until assistance came, and the cowed creature was dragged off to its cage.'

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

(*From our own Correspondent.*)

THE new orders being received at the mills and forges are of a rather limited extent, many consumers having now satisfied their requirements for the rest of this year. The export trade is also drawing rather to a close. Orders still on the books are, however, sufficient to guarantee regular operations at the mills. The sheet mills are running with their accustomed briskness, chiefly in the execution of orders from the galvanisers, whose demand continues unabated. The strong prices recently quoted are well maintained.

Fair profits are being secured by those black-sheet firms—and they are in the majority—who are obtaining £6 5s. for singles and £6 10s. for doubles. No inducements, however, will be given to proprietors to re-start idle mills until the figure for doubles reaches £7, and the attainment of this figure seems at present to be improbable.

There is a steadily increasing output of galvanised iron, the production having been augmented with a view to meeting the good inquiries from India, Australia, and South America. Shipments last month were again largely in excess of those for the corresponding month last year, the private returns compiled for the Galvanisers' Association showing 14,201 tons as compared with 10,000 tons for October, 1886, being an increase of 4200 tons. Spelter is still hardening, and another advance of 10s. is announced in zinc. The quotation of ordinary qualities of corrugated sheets of 24 gauge, delivered Mersey, remains at £11 nom.

The proposed extensions of the black-sheet works of the well-known galvanising firm of Messrs. John Lysaght afford food for discussion. Whether the firm will enlarge their present two establishments at Wolverhampton by the laying down of four additional mills, or whether they will start a third black-sheet works at Bristol or at some other site on the coast, is at present a matter of conjecture. A definite decision will be made when the senior partner of the firm returns from his latest visit to Australia.

The transference of the galvanising works of Messrs. Tupper and Co. from Berkley-street, Birmingham, to a new site at Bradley, near Bilston, has, it is understood, been accomplished largely in consequence of difficulties which had been placed in the way of the firm by the Corporation of Birmingham; in part also because of the proximity of the new site to an abundant supply of black sheet iron. The new proprietors, who have been introduced into the concern—which now becomes a joint stock company—are the partners in the Albion Iron Company, of Bilston and West Bromwich, who will manufacture the black iron needed by the concern. The main galvanising shop which has been built is a spacious erection some 115ft. long by 40ft. or 50ft. broad, and will allow of the work being got out in first-class style.

No better tone is perceptible in the bar, hoop, and plate trade, and prices are so devoid of stability in the first-named two branches that makers have much difficulty in sustaining them. The quotation of best marked bars is still £7, with the usual advance for special brands. Second-class branded sorts are £5 15s. to £6, and though £5 is the market quotation for ordinary bars, £4 15s. will still secure supplies of minimum sorts as used by the fencing and some other local manufacturers; £5 5s. to £5 10s. is quoted for hoops; £5 10s. also for bedstead strips, cut to lengths; £5 for common gas strip; £6 10s. for best tube strip of narrow sizes; and £7 10s. for wide sizes; while horseshoe bars are £5 5s.

Demand at the local blast furnaces is vigorous, and prices show less fluctuation than in many other centres. Some makers of medium and common pigs declare that they cannot make deliveries fast enough, and some agents for imported pigs report that their deliveries were never larger. All-mine pigs are 50s.; part-mines, 35s. to 42s. 6d.; and cinder pigs, 30s. Imported sorts are 36s. 6d. to 38s. delivered, for Northampton and Derbyshire makes, and 40s. to 41s. for Lincolnshires.

The important restrictive policy which has just been decided upon by the West Cumberland hematite producers will, it is hoped, have its resultant effect upon the Staffordshire best pig market. Hematites being stronger, the makers of native all-mine pigs have some justification for anticipating a strengthening of their own iron. Hematites have for some time been held to be cheaper than was warranted by the state of the demand. They are this week quoted at 53s., delivered here, for forge sorts of the Barrow Company's make.

The colliery owners express much satisfaction this week that the local colliers have postponed the notice for a 10 per cent. advance, which they had intimated they intended to give, until after the adjourned national conference in Newcastle. Thus one hindrance to trade has been for the moment removed, and there is less hesitancy by makers to book forward.

The recent discovery by the Pelsall Coal and Iron Company of a seam of coking coal seems likely to prove of material value to the district. Blast furnace owners who have experimented with samples of coke made from the seam report favourably upon the nature of the fuel, and it will shortly be seen whether the company intend to enter into coke manufacture upon a commercial scale.

Engineers engaged upon rolls and other machinery for iron and steelworks purposes just now show a little more activity. Orders are arriving from European and some other export countries with increased vigour, but there is still abundant room for further enlarged buying.

Further declared advances are advised in hardware prices. On Monday, the Wrought Iron Tube Makers' Association, which embraces the whole of the kingdom, reduced discounts on all blacked tubes 2½ per cent., equal to a 5 per cent. advance, making gas tube discounts 75 per cent. This advance succeeds upon a similar advance announced recently in galvanised tubes. All the cast iron hollow ware makers of England have been organised by a local firm, and also announced on Monday a 5 per cent. advance on the net on tinned hollow ware. New discounts become 52½; brass and copper tubes, sheets, and wire, are now advanced an aggregate of 1d. per lb. on the minimum prevailing before copper went up. Other advances are expected.

The Cradley Heath chainmakers, who have nearly completed the second year of their strike, are reviewing their position with more confidence. Orders for chain are being received in the district with more briskness, and it is their opinion that trade will shortly be better than for a considerable time past.

A meeting of the North Staffordshire Mining Institute was held at Stoke-on-Trent on Monday, when Mr. Woodworth read a paper on "Practical Economy of Steam combined with Efficiency obtainable in Winding Engines." No doubt, he said, the study of fuel economy had been much neglected, but he hoped his remarks would lead to investigation and improvement, as the matter was sufficiently important even to colliery owners with their cheap fuel supplies, and if reasonable care in design and arrangement of winding machinery were used such proportions of steam used to useful effect, developed as 1·0 to 1·20 or 1·40, could be obtained in a majority of instances. Mr. E. Mould showed his patent coal getter, which was portable, durable, simple, and economical, and would answer as an hydraulic jack.

An installation of electric light has been laid down at the "Wild West" Show at Birmingham, by the United Electric Engineering Company, London. There are ten large arc lamps, having a total illuminating power of at least 150,000 candles. Each light requires for its production a 6-horse engine power. The lighting plant consists of two large Victoria dynamos—such as are used for the lighting of mills, &c., with incandescent lamps—each of which is capable of lighting all the lamps.

The trade year of the potteries district, which is now completed, cannot be pronounced a profitable one. Yet from America, with which the great bulk of the foreign trade is done, there has been an enlarged demand notwithstanding the competition of the American makers, which is steadily growing keener. There has also been a call for Staffordshire earthenware for Brazil. With the East Indies, also, an increased trade has been done, but there has been an enormous falling off in the exports to Australia.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The iron trade of this district remains in a weak, depressed condition, with any prospect of improvement still as remote as ever. Common pig iron is only saleable at excessively low prices, which only under very exceptional circumstances can in any way be remunerative to the makers, whilst in many cases it is quite evident that iron is being sold at less than the actual cost of production. As I mentioned last week, hematite makers are endeavouring to strengthen their position by a restriction of the output, and some furnaces have been blown out, which here and there has given rather more firmness to prices, but has not so far appreciably affected the market generally. The manufactured iron trade is kept busy in sheets for galvanising purposes, for which there is a fairly good demand both for India and the Colonies, which is likely to be maintained; but in other descriptions, although makers are mostly well supplied with orders for the present, the outlook for the future is not very promising.

There was about an average attendance on the Manchester iron market on Tuesday, but the business doing was very small. So far as common pig iron was concerned, the excessive weakness in Scotch and North of England irons had necessarily a depressing effect upon the market here. Buyers were encouraged to hold out for lower prices than they would otherwise have expected to be entertained, and which sellers in many cases were not prepared to accept, with the result that, notwithstanding a fair inquiry, the actual transactions put through were only limited in weight. For local and district brands quotations remain much the same as last week. Lancashire makers still hold to 38s. 6d. and 39s. 6d., less 2½ for forge and foundry delivered equal to Manchester, and they seem to prefer to stand out of the market, and are putting down into stock, rather than entertain business on the basis of the prices at which they have to compete with district brands offering here. For Lincolnshire forge and foundry the average prices for delivery equal to Manchester are about 36s. 6d. to 37s., less 2½, with sellers in one or two instances prepared to come a little under these figures, and a small business doing; whilst Derbyshire foundry can be got at about 39s. 6d. to 40s., less 2½, delivered. For outside brands prices are again easier, and good named foundry brands of Middlesbrough can be bought readily at about 40s. to 40s. 6d. net cash, delivered equal to Manchester, although for one or two special brands 6d. to 1s. per ton above these figures is being held for, and in special sales has been got, during the past week. Scotch iron is offered at very low prices, and for anything like quantities can in some instances be bought at considerably under the maker's nominal quotations.

As a result of the attempts which are being made to bring about a combination for the restricting the output of hematite, but which so far has only been very partially carried into effect, there is in some quarters an indifference about selling just at present, and the tendency of the market is in the direction of a stiffening in prices. There are, however, still low sellers in the market, and buyers do no not show any great anxiety to place out orders. For good No. 3 foundry brands, delivered in the Manchester district, 52s. 6d., less 2½, may be taken as about an average quoted price, but quite 1s. per ton under this figure has been actually taken.

In the manufactured steel trade business continues only slow; boiler-plates do not average more than £6 17s. 6d., and engineers' steel forgings can be got at pretty nearly one-half the price which was being paid not more than three or four years back.

Although there is still general activity in the manufactured iron trade, and the orders which makers have on their books will, in most cases, keep them fully employed until the end of the year, it is only in one or two special departments that there is the prospect of continued activity after present orders have run out. The better qualities of galvanising sheets for export seem likely to continue in good demand, and for these prices are firm at £6 10s. to £6 15s. per ton delivered in the Manchester district, but lower qualities are weak if anything; for bars and hoops there does not appear to be any weight of work ahead after orders in hand have been completed, and prices are only barely maintained at £4 12s. 6d. for bars, and £5 5s. for hoops, delivered in the Manchester district.

In metals the recent rapid rise in raw materials has tended somewhat to disorganise the market; in all descriptions of manufactured goods there has been a more than corresponding advance in prices, which has tended to check any further buying except for absolute immediate requirements, whilst where business is offered representatives of manufacturers are in most cases only in a position to accept subject to any further advance in list rates, and for the moment there are no really priced quotations.

The condition of trade in the engineering and machinist branches of industry remain much the same as I have reported for several weeks past. Firms generally are kept fairly employed on work taken at low prices. Boilermakers and machinists are perhaps the best off for work, and in most cases are fairly busy; but machine toolmakers would seem to be getting rather quieter, and, if anything, to secure orders, prices are in some instances being cut lower than ever.

In the locomotive building trade there is, if anything, a little more work stirring, but the most important incident just at present in connection with this branch of industry is the contemplated removal to Glasgow of Messrs. Sharp, Stewart, and Co., one of the oldest locomotive building concerns in the district. Although yet requiring the formal ratification of the shareholders, I understand that the removal of the business from Manchester to Glasgow has been practically decided upon, and that arrangements have been made for carrying on the business in conjunction with Messrs. Neilson, of the Clyde Engine Company. This removal of Messrs. Sharp, Stewart, and Co., who, I believe, will be accompanied to Glasgow by a large proportion of their present staff, marks another step in the gradual withdrawal of important works from the centre of Manchester which has been going on for several years past, the most recent being Messrs. Crossley Brothers and Sir Joseph Whitworth and Co., who have both built large works in the outskirts of the city. The withdrawal of Messrs. Sharp, Stewart, and Co., who, when fully going, have given employment to upwards of 2000 hands, but recently have perhaps not averaged more than 1000 to 1500, is, however, a withdrawal from the district altogether, which must of necessity be more seriously felt, but which would seem to be only the legitimate outcome of the more favourable conditions under which this branch of industry can be carried on in Glasgow as compared with Manchester.

Following immediately upon the close of one memorable and successful undertaking in Manchester—the recent Royal Jubilee Exhibition—a commencement has been made in the actual operations of another undertaking still more important in the influence it is likely to exert upon the trade and industrial interests of Manchester and the district. On the day following the close of the Manchester Exhibition, the chairman and directors of the Manchester Ship Canal proceeded, in a strictly private and informal manner, to Eastham, where the proposed canal will join the river Mersey, and, without any ceremony, each one of them cut a small portion of the turf upon the site of one of the locks to be constructed at this point. In this simple and unostentatious manner was commenced one of the most important engineering schemes of the present time, and the contractor, Mr. T. A. Walker, is now actively engaged in the work of constructing the canal. Already I understand about 500 men are employed at this point, and the contractor has got together a complete plant for the requisite work, including a number of locomotives, steam navvies, and massive cranes; whilst all kinds of requisite material in rails, timber, &c., are being rapidly collected at different points. So far, I understand the directors have secured the land required for about 15 miles of the canal, or about half the distance, and at the commencement of each month they hope to complete the purchase of the additional land, so that the contractor if he likes can commence operations at different points; but during the remainder of the present year I believe it is the intention of Mr. Walker to confine his attention to the two lower sections of the canal. I may add that about twenty-four locomotives, required for the ship canal work, have been ordered by the contractor from Leeds firms; the order being divided between Messrs. Kitson, Manning and Wardle, the Hunslet Engine Company, and Hudswell, Clarke, and Co.

At the meeting of the Manchester Association of Engineers, held on Saturday, Mr. Alderman Bailey, the president, in the chair, an interesting paper on the modern cotton carding engine was read by Mr. Joseph Nasmith, in which he described the revolving flat card as the type of machine which is now being universally adopted and which, he said, but for the enormous strides made in the accuracy of workmanship during the last few years was a machine which would not have been successfully made. It was not a new type, but had fallen into disuse by reason of certain developed defects which were apparently mechanical and not intrinsic; now it had become the machine of the day, and the adoption of template work had facilitated their revival, without which the successful making of the machine could not have been attempted.

In the coal trade the demand during the past week has again been only moderate for house fire coals and engine classes of fuel, and extremely poor for the common round coals for steam and forge purposes, with supplies plentiful in the market, and price in many cases barely maintained its late rates. A change in the weather, of which there seems some indication, would of course stimulate the house coal trade and help to strengthen prices; but at present quotations remain at 9s. for best coals; 7s. to 7s. 6d. seconds; 5s. 6d. to 6s. common house coals; 5s. to 5s. 6d. steam and forge coals; 4s. 6d. to 5s. burgy; 3s. 6d. to 4s. best slack; and 2s. 6d. to 2s. 9d. common sorts.

Shipping continues extremely dull, with prices for steam coal delivered at the ports in the Mersey still averaging 6s. 6d. to 6s. 9d. per ton.

Barrow.—There is a continuance of the improved tone which I noted last week in the hematite pig iron trade of the district, and as the demand is maintained and the production of iron restricted, there is full reason to believe that something like permanency may be expected in the change. There is a good demand for Bessemer qualities of pig iron, which are selling in parcels mixed Nos. 1, 2, and 3 at 44s. per ton net f.o.b., and 43s. 3d. for No. 3 forge and foundry iron. Warrants, in which less business is doing, are quoted at from 41s. 6d. to 42s. per ton, but those warrant holders who have no cause for needy sales are waiting for the improved prices which are expected to follow in the train of a fuller demand and restricted output. The business doing in steel is brisk, and the inquiry for rails is especially good. Prices are a trifle firmer on the week, and heavy sections of rails are now quoted at £4 2s. 6d. per ton. Makers are very well sold forward. Blooms are in quiet inquiry. Billets are in good inquiry, and orders are held to a large extent. Slabs are quiet, and there is not much doing in plates, angles, or merchant steel. There is a fair but not very brisk trade in Siemens-Martin steel, but this cannot be expected until more business is doing in plates, angles, and other classes of steel for shipbuilding purposes. Shipbuilders are not better employed, and no new orders are noted. Engineers are very quiet, and both in the marine and general departments there is a very slow trade. Ironfounders, boiler makers, and forge workers are indifferently employed. Iron ore enjoys a better demand, owing to the increased cost of Spanish ores imported by Welsh or Cleveland steel makers; 9s. to 12s. per ton is the current quotation for native iron ore at the mines. Coal and coke are both firmer in tone and price. Shipping is fairly but not briskly employed. The iron makers in the Whitehaven district have conjointly determined to restrict the output of pig iron, and have mutually agreed to give notice to their employés of a ten per cent. reduction in wages. No similar steps have been taken in the Fremers district. The death of Mr. H. W. Schneider removes from the iron and steel world a gentlemau who has played a prominent part in it for the past thirty-seven or forty years. He was the means of discovering the great bed of iron ore at Park, and laid the foundation of the town of Barrow by starting the Barrow Hematite Steel Works, of which he remained an active director up to the time of his death. His generosity knew no bounds, it being roughly calculated that he gave from £67,000 to £68,000 away in gifts to churches, chapels, and various institutions since 1850. It is contemplated to perpetuate his memory by the erection of a statue in Barrow.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE leading cutlery and plating firms are now very busy. Messrs. Joseph Rodgers and Sons report that business is exceedingly brisk, particularly for the United States, where a much more expensive class of goods is being ordered. It is regarded as evidence of the rapidly-growing wealth of America that in nearly all the better known centres the cheaper kinds of table cutlery and other household requisites are being superseded by the best qualities of goods. This is all in favour of Sheffield, where skill and good material form the principal characteristics of the standard houses. Even in such articles as camp knives, the better establishments are having the work to do. One firm received by a single visit this week two orders representing nearly 1000 camp knives. German competition in the higher grade of goods is far easier to meet than in the lower articles; but in scissors it keeps as keen as ever. It is calculated by an expert who knows the Sheffield trade extremely well, that there are more German scissors sold in Sheffield than are made in the town. German houses have branches in Sheffield, from which they supply their English and other customers.

In the plated departments, Messrs. James Dixon and Sons, of Cornish-place, have found business steadily increase all the year, and during the last two months it has advanced almost "by leaps and bounds." The silver-plating hands are now working overtime, and will continue to do so until Christmas. The two heaviest orders for spoons ever received in these parts are now in course of execution at Cornish-place. Recent orders are mainly for foreign markets, the home requirements in silver and plated goods being somewhat light, except in season specialities for Christmas and the New Year. A patented teapot, the property of which belongs to a large Manchester house, is being manufactured solely by Messrs. Dixon, and is commanding a most extensive sale both at home and abroad.

From South Africa the advices received continue to be most gratifying. Edge tools, picks, spades, shovels, and mining apparatus of all kinds, are ordered in increasing quantities. These goods are being followed by other requirements in cutlery and carpenters' tools. As the new towns, which spring up swiftly around the gold and diamond regions, get into shape, the people settle into civilised life, and seek home comforts. These lead to large demands upon Sheffield's productive resources. It is expected that there will be a remarkably important trade done with South Africa in the spring of next year. Several Sheffield gentlemen with business interests in the Cape have acquired property in the districts which are being rapidly developed. It is stated that the representative of a leading firm of agricultural implement and machinery makers recently resigned his situation, for the all-sufficient reason that he had purchased a plot of land in a locality so luckily that he cleared £25,000 out of the transaction. Other well-authenticated instances of successful enterprise have come to hand, and these tend to extend and deepen the interest felt in South African trading.

The Sheffield Coal Company, which owns what are known as the

"Birley" Collieries, has decided to sink a new shaft to the Silkstone seam of coal near the Rainbow Forge. The new shaft is to be 16ft. in diameter and 300 yards in depth. It will be about a mile nearer Woodhouse Junction than the present surface works, and will be used first for purely ventilating purposes, and as an "in bye" shaft for the workmen who have, at present, nearly a mile and a-half to walk underground before reaching their work. The shaft will ultimately be used for drawing coal, and will be capable of passing 2000 tons per day and find employment for about 1000 hands in addition to the 1500 already employed by the company.

Pit-head meetings are being held in the South Yorkshire district this week to elect delegates to a conference to be held at Barnsley on Saturday. The questions then to be submitted for consideration are:—(1) Eight hours a day for single shift, and seven hours a day for double shift; (2) one general holiday each week, to be generally observed, even although the men may have been idle on any preceding day that week; (3) to clear off surplus stocks and secure 10 per cent. advance, one week's holiday to be taken simultaneously all over the kingdom, or such other number of holidays as may be necessary to secure these objects; (4) these propositions to be placed before the miners and their opinions ascertained by ballot or otherwise, and another conference to be held on 22nd November next and following days, to fix date for the proposals coming into force should they be confirmed.

On Thursday the Dore and Chinley directors met at Derby. It is understood that the outcome of their deliberations will be their abandonment of the present Bill, with a view to the undertaking passing into the hands of the Midland Company. They will include the Bill in their proposals to be placed before Parliament this session.

Messrs. James Oakes and Company, the proprietors of the Alfreton Ironworks, in the neighbouring shire of Derby, have just discharged 100 of their work people, and others are under notice. Mr. T. H. Oakes, J.P., the senior partner of the firm, referred to the matter at a meeting on Monday night. He said it had given the firm great pain to have to take this course. There was no denying the fact that at present large quantities of the commodities which they manufactured were being imported from abroad. Messrs Oakes and Company are the largest employers of labour in the Alfreton district. It is hoped that with the advent of spring a better trade will set in.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE prices of Cleveland pig iron advanced slightly towards the end of last week, but again receded when the retrograde movement took place at Glasgow. Consequently the tone of the market held at Middlesbrough on Tuesday last was exceedingly quiet. Merchants, after having raised their quotations for No. 3 g.m.b. to 31s. 6d. per ton, were again willing to accept 31s. 3d., and one or two small lots were sold at slightly less. Some of the makers are now eager to sell, and would probably take 31s. 6d. for delivery to the end of the year, or 3d. less than their lowest figure last week. Forge iron, after advancing to 30s. 6d., has fallen to 30s. 3d., and sales are even reported at 3d. less.

Stevenson, Jaques, and Co.'s current quotations: "Acklam Hematite," Mixed Nos., 44s. per ton; "Acklam Yorkshire," Cleveland, No. 3, 33s.; "Acklam Basic," 35s.; refined iron, 48s. to 63s., net cash at furnaces.

Warrants were a week ago sold at 31s. 6d. per ton, but on Tuesday they fell to 30s. 10½d., and few buyers could be found at that price.

For the first time for some months the stock in Messrs. Connal and Co.'s Middlesbrough store increased to the extent of 853 tons during last week. The quantity held on Monday last was 326,165 tons.

Middlesbrough shipments have been so far this month much below the average, only 25,577 tons having left the port up to Monday evening last. The corresponding returns for October amounted to 33,952 tons.

There is no change to record as to the position of the finished iron trade. Several inquiries for sheets are at present in the market, but good plate specifications are scarce, and the prices obtainable quite unremunerative. Current quotations are as follows:—Common bars, £4 10s.; best bars, £4 15s.; ship plates, £4 7s. 6d.; angles, £4 5s.; and sheets, £5 12s. 6d.; all free on truck at makers' works, less 2½ per cent. discount.

The first meeting for the session of the Cleveland Institution of Engineers was held at the rooms of the Institution, Newport-road, Middlesbrough, on Monday evening, the 14th inst. Mr. R. Howson, who has been elected president for another year, occupied the chair. He opened the proceedings with a short presidential address. The annual report shows that there are now about 250 members upon the list, and that the finances are in a satisfactory condition. Mr. Edward Crowe, of Middlesbrough, read a paper upon the "Heat of Dissociation." Mr. Crowe is well known to have made many experiments on this subject, which is, indeed, a speciality of his. The main ideas which he submitted to the meeting were originally suggested to him by observing that a Bunsen flame burning in a firebrick tube gradually elongates as the tube becomes heated. He found that whatever the temperature of the tube at any particular time, the point of maximum heat was always just inside the entrance of the tube, and not farther on, as same might have supposed. The general conclusion he appears to have arrived at is that in mixtures of combustible and inert gases, the greater the proportion of the latter the lower is the heat at which dissociation takes place, whether the inert gases are simple or compound. Considerable discussion took place upon the paper, the main points raised being the principle and mode of action of the so-called radiating furnace, the limit of temperature obtainable by the regenerative system, the value of superheating steam, and the degree of super-heat obtainable, and the general theory of dissociation. An opinion was expressed, and met with general favour, to the effect that the heat-resisting power of the materials of which regenerative furnaces are composed is far below the dissociation point of the gases within. A hearty vote of thanks to the reader of the paper was unanimously accorded.

One of the Siemens furnaces in the new steel works just erected by the Consett Iron and Steel Company has been successfully started. Mr. Noble, hitherto the manager of this department, is leaving, in order to undertake similar duties at the Britannia Iron and Steel Works, Middlesbrough, and on the 9th inst. a complimentary dinner was given to him by the officials and others connected with the first-named works. The present output at Consett is about 1000 tons per week of steel and 500 to 600 tons of iron plates. The former product, however, is likely to increase and the latter to diminish.

It is becoming a matter of speculation and concern to many in the North of England as to where all the hematite pig iron is to come from which within a year or two will be required to supply the steel furnaces now being erected, or in contemplation. Most of these so far are on the acid Siemens principle, which requires hematite pig iron, and is dependent on the importation of Spanish ore. At Eston there is a furnace with a basic lining, and the new ones in contemplation at Port Clarence are understood to be on the principle advocated by Mr. Pourcel, which is to have a bottom composed of a neutral material. These are, so far, the only exceptions.

Concurrently with this prospect of an increased demand for hematite pig iron a considerable rise in freights has taken place; there is also some advance in the value of ore at Bilbao, and a tendency to restrict the output at the mines there. Consequently a rise in the value of hematite pig iron and of steel made therefrom, may be anticipated. This, however, will in turn, no doubt, stimulate the development of the basic Siemens process, and so come to increase the demand for iron made from native ores.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been less firmness in the Glasgow pig iron warrant market this week. At the opening on Monday the tone was firm, but prices fell away when it became known that an unusually large quantity of iron was being sent into store. Prices have since been weak, with occasional fluctuations. The past week's pig iron shipments amounted to 8133 tons, as compared with 7202 in the same week of last year. The total included 1890 tons to the United States, 202 to South America, 320 to Australia, 410 to France, 685 to Italy, and 476 to Germany. The inquiry from abroad is reported by makers and merchants to be slow at the moment. Messrs. William Baird and Co. have put out one of their furnaces at the Eglinton Ironworks, and the total number now blowing is 84, as against 74 at this date last year. Storing is proceeding in the public yards at the rate of from 2000 to 3000 tons a week.

The current values of makers' pigs are as follows:—Gartsherrie, f.o.b. at Glasgow, No. 1, 45s. 6d.; No. 3, 42s.; Coltness, 50s. and 42s. 6d.; Langloan, 47s. and 44s.; Summerlee, 48s. 6d. and 42s.; Calder, 46s. 6d. and 40s.; Carnbroe, 41s. 6d. and 38s. 6d.; Clyde, 45s. and 40s.; Monkland, 41s. 3d. and 38s.; Govan, at Broomielaw, 41s. and 38s.; Shotts, at Leith, 46s. 6d. and 44s. 6d.; Carron, at Grangemouth, 49s. and 43s.; Glengarnock, at Ardrossan, 46s. 6d. and 40s.; Eglinton, 41s. and 38s.; and Dalmellington, 42s. and 38s. 6d.

The ironworks, plant, and collieries of the Monkland Iron Company have been sold by public auction for £50,000, the purchasers being understood to be an influential firm of Scotch iron merchants. Monkland, which was at one time a very prosperous affair, paying in wages £20,000 a month, was made into a limited company about fourteen years ago, with a capital of £500,000. After struggling a few years it went into liquidation, and was taken up by a new company with a capital of £200,000. This company fared no better than its predecessor, and now the concern has gone into private hands at what must be considered, even in these times, as a very cheap price.

The malleable iron trade is at present in an encouraging position, the works being quite busy, with, it is said, a prospect of this state of matters continuing. Prices are, however, low, merchant bars bringing no more than £4 13s. 9d., less 5 per cent. discount. Scrap iron and steel rails are dull.

During the past week there was shipped from Glasgow locomotive machinery to the value of £3500 for Japan and £580 for Bombay; £16,000 worth of marine and general machinery; £2000 sewing machines; £8700 steel goods; and £28,800 general iron manufactures.

The Clyde Locomotive Company, of Glasgow, has received an order to build two locomotives and tenders for the Midland Uruguay Railway of South America, and it is expected that these are but the earnest of others that are to follow.

In the coal trade there is more inquiry for household sorts, owing to the cold weather. Hitherto the season has been so open that this branch of the trade has been unusually slack, and it has not been possible to obtain any advance in prices. As the shipping demand is now much easier, in consequence of exports to the Baltic and elsewhere having ceased, the prospect of the coalmasters being able to raise prices before the end of the year, as generally happens, is not at present very encouraging. The past week's coal shipments were not quite so good as could be desired. From Glasgow, 21,465 tons were despatched; Greenock, 917; Ayr, 7487; Irvine, 2335; Troon, 5736; Ardrossan, 2040; Burntisland, 16,845; Leith, 2925; Grangemouth, 5300; Bo'ness, 6096; Granton, 1040; and Dundee, 1183; total, 73,369 tons, as compared with 81,417 in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE Cardiff Corporation have had a preliminary discussion respecting the supply of water to the Dowlais Works, in the event of their removal to the East Moors, at Cardiff, and it was fully agreed that they would be enabled to supply, and at the minimum cost.

The public mind continues to be exercised on the subject of the proposed removal of Dowlais Works to Cardiff, and its results upon the hill district. The only consolatory fact is that the transfer will take a long time. The idea is to have two Bessemers in good going order in two years from date. I fully expect other developments of the scheme shortly. It is rumoured that the course resolved upon by the Dowlais Company has startled competing ironmasters quite as much as the public, and that more than one look to the seaboard as the future location. The life of a steel rail is so long, and the home country so well railed, that the chief business of the future must be colonial and foreign. Japan, China, and Burmah are regarded as the future great buyers, and hence the position of works upon the hills is a known drawback.

The Cardiff coal trade was very indifferent last week, and the total exports were fully 40,000 tons below the average. A cause assigned is the late storms, and it is very probable that is the case in having prevented a good deal of tonnage from coming into port. This explanation may be taken as satisfactory, since the demand for coal is fairly good. Prices keep low. Small steam is quoted at 3s. 3d., large at 9s., house coal, 8s. 3d. Best Rhondda, No. 3, is getting firm at 8s. 6d. Cokes on 'Change were firm at the old price, 14s. to 16s., according to quality.

On 'Change, at Cardiff, pitwood was freely offered at 15s. this week, prices having fallen in consequence of large cargoes coming to hand.

I find in several parts of the colliery district a certain amount of dulness prevailing. Thus at Dowlais, in the Bedlinog Valley, the levels which work the upper coals are stopped. Most of them are worked out. Dowlais now works little coal in the Merthyr parish, but most in the parish of Gellygaer. In the Aberdare Valley some concern has been expressed at the notices issued at Cwmpennar colliery, intimating that all contracts will stop at the end of the present month.

An important decision has been arrived at by the colliers of the Navigation, which may lead to disagreement between the men and the officials of the Miners' Provident Fund. The decision of the men was to oppose any alteration by the managers of the fund in the rate of payment or of relief. The fund has worked so admirably that it is to be hoped for the general good that no restrictions of its usefulness will result. At the same time, the fund is too much neglected both by landowners and the general public. The former have had their property increased immensely by the development of the coal underneath their land, and the latter have received considerable benefit in the reduction of the poor rates, consequent upon the colliers providing for their own wants in cases of misfortune. I hope to hear of efforts during the coming winter in every town to strengthen the fund.

The Barry Dock and railway are progressing well, and some anxiety is manifested with regard to the effect on local railways and on the town of Cardiff.

Swansea Exchange was busy on Tuesday, the prevailing subject of comment being the high figure for tin. The latest price quoted was £137. All were agreed that only two courses remained open for adoption—the first, that of putting up the price of plates to a point that would cover the increased price of tin; the other, that of stopping the works until the tin "cornering" has come to an end. Orders for forward deliveries were only taken at an advance of 2s. per box. This course had a marked effect on business. Quotations generally this week are as follows:—Prompt delivery, cokes, 14s. to 14s. 3d.; Bessemers, to 14s. 6d.; Siemens, to 15s.

The stocks at Swansea remain low, 77,000 boxes. Exports during last week totalled up 46,166 boxes. Other quotations on 'Change were: Steel rails, £4 5s.; bars, £4 7s. 6d.; pig, Glasgow warrants, 39s. 4d.

A collier at one of the Rhondda collieries this week was buried under a fall of coal, estimated at 400 tons.

An interesting exhibit of the power and continuance of the gas of collieries can now be seen at Merthyr Vale Colliery. For the last three months a "blower" has been lit at the top of the pit giving forth sufficient light at night for all purposes. Old authorities relate, as a curious fact, that it was the existence of a blower at one of the Workington pits which first suggested the lighting of towns with gas.

Tin bar is being made freely at the leading works. For steel sleepers the demand is slight, and at all works an abundance has been put in stock. Rails are not in great demand. Prices I have quoted as current at Swansea Exchange are scarcely obtainable. Iron ore, Rubio, remain at 12s. 3d. at port.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE demand for crude iron is rather less active than it was, but as yet this has had no unfavourable influence on other branches nor on prices, which, indeed, it has been in some cases possible to advance; otherwise there is no noticeable change in the condition of the iron market in Rheinland-Westphalia. In Silesia the market shows a firm front both for pig and manufactured iron, and the former prices can be fully maintained. The slackening in the demand for steel ingots and billets from America is beginning to tell unfavourably in the former district. The enhanced sea freights on Spanish ores is considered likely to favourably affect the native mines, so as to bring up the prices to what the ores commanded a short time back, but had latterly lost again. There is little to remark about the pig iron trade. It is going on steadily, and as contracts have been closed for the quarter, and prices are once for all—*i.e.*, for a time at least—settled by the convention, there is not much room for speculation, and there will not be till the next quarter has turned. The lower railway rates for pig iron from the Siegerland to Rotterdam have now come into force, which should give a fillip to the export trade in spiegeleisen, which of late has not been so active to America as it formerly was. Now that the Saar and Moselle group of works has definitely joined the others, a continued stable trade in wrought iron may with certainty be looked forward to. Foundry, Bessemer, and basic pig are in moderately good request, otherwise no change is observable. The large quantities of rails lately given out by the State compensate in a great measure for the falling off in the American orders for steel goods, which helps to keep the market steady. The prices of bar iron are firm and remunerative, but the demand this month is certainly in some quarters not so good as it was in the last, for specifications are here and there wanted, especially for export. Already the Rhenish-Westphalian bureau of the convention has entered into numerous contracts for the first quarter of 1888, and from that date the base prices for wrought iron are to be raised, and not without reason, so as to bring them into harmony with those of the raw materials. The present price of bar iron has lately been fixed at M. 122½ and 125 p.t. for the inner and outer radius of sale respectively. Girders are just now slow of sale. There is a very full demand for hoops, and dealers are endeavouring to close bargains over lengthened periods, the price being at the moment M. 125 p.t. As to boiler and other plates, there is nothing new as to prices or demand to note, whilst sheets have gone up to M. 142 p.t. The Siegerland works are nearly all full of orders, but the Westphalian ones complain of not being so well off; however, the present price at least will now cover the cost of production. There is no change to note in wire rods. All seems in abeyance till the projected syndicate to regulate prices is formed. In railway material the most interesting feature is the recent tendering for steel rails for Roumania. English, Belgian, German, French, and Austrian works tendered. The lowest offer was from Belgium, at frs. 121 f.o.b. at Galatz. The German tenders ranged from frs. 123·75 to 132½ p.t. The iron and steel works here are raising their voices against the continued use by the State of so many wooden sleepers, which are obliged to be imported, to the great loss of the works, when steel ones could be substituted. The machine shops and foundries are satisfactorily engaged, and in order to combat with the enhanced price of raw materials, thirty-three of the Rhenish-Westphalian works have sent out circulars announcing an increase of price for castings of M. 20 p.t.; so at last, it is to be hoped, the continued complaint of unremunerative prices has ceased for a time. On the 18th inst. eighteen locomotives are to be tendered for at Altona.

The gross receipts of the German State Railways for the year 1886-7 were £27,335,000, and 346 kom. of new lines came into operation. The first half of the present business year shows improved receipts as compared to the corresponding period of the last year of upwards of a million pounds. The receipts per kilom. have improved from £781 to £810 from 1885-6 to 1886-7.

The ironworks in the Nord Department are now seriously considering a plan for improving the French iron trade, and so far a similar arrangement to that in Germany of a common sales bureau for all the works seems to have recommended itself for their adoption, and is near a conclusion, it is said; but to make this successful all the four groups of ironworks must unite, which, judging from experience here, is a most difficult undertaking. However, so far as the works are concerned, the general condition of business is improving in consequence of this projected combination, and a satisfactory quantity of orders is flowing into the rolling mills again. At last the "Chambre Syndicate des Marchands de fer" has vouchsafed a rejoinder to the numerous attacks in the press on their recent policy of keeping down prices. The large dealers say that they were forced to do this in self-defence, in face of the action of some of the rolling mills and of the small dealers, who kept no stocks, but simply acted as commissioners for producers, and that so soon as they cease their action a rise in prices can at once ensue.

The Shanghai *Courier* confirms the news that China has given orders to France for war material, principally for de Bange cannon, to the amount of nearly 21 million francs.

As touching the importation of raw materials into France, it appears that in future all such which enter into manufactures and which are afterwards exported are, in this case, to pay the duty as if they had not been exported; in a word, the *admission temporaire* would cease to have effect. Negotiations on the subject are going on, because this is very important for the French iron and steel industry.

There is nothing particular in the coal trade to note, but a deputation of the colliery owners in the Nord and Pas de Calais have interviewed the Ministry with the object of inducing the Government to grant a subsidy of 25 million francs towards carrying through the Grand Canal du Nord.

Last week only 29,400 t. of ore were shipped at Bilbao, and the market was dull. Price of best red ore, 6s. 7d. to 6s. 10d.; Campanil, 7s. to 7s. 3d. The year's export till now, 3,649,758 tons.

The Belgian iron market is, as heretofore, firm, and is so far satisfactory. The John Cockerill Company paid 5 per cent. dividend for the last working year. The total value of the output was 34⅓ million francs; the gross profit, 2,281,105f.; and the net profit, 828,729f. Beyond the coal, coke, pig and manufactured iron, castings, machinery, and constructive ironwork, 93,000 t. of Bessemer and Siemens steel were produced, against 62,700 t. the year before, and the output for the current year is set down to come up to 120,000 tons.

MESSRS. THOMAS ROBINSON AND SON, Limited, Rochdale, have been awarded the first order of merit for their exhibit of wood-working machinery at the Adelaide Jubilee Exhibition.

NEW COMPANIES.

The following companies have just been registered:—

Chambers' Brick Machine Company, Limited.

On the 28th ult. this company was registered, with a capital of £150,000, in £1 shares, to acquire British, colonial, and foreign patent rights relating to the making of bricks, and compressing and otherwise treating earth, clay, ore, and other materials by machinery. The subscribers are:—

	Shares.
Wm. Powter, 72, Durley-road, N., secretary ..	1
J. H. Newman, 47, Walterton-road, W., secretary	1
J. Owen, 127, Packington-street, N., clerk	1
C. E. Green, 6, Well-street, Gray's-inn-road, clerk	1
L. H. Benjamin, 29, Sandringham-road, Kingsland, clerk	1
D. Durnford, Old Charlton, accountant..	1
E. J. Churchouse, 60, Almack-road, Lower Clapton, registrar	1

The number of directors is not to be less than three, nor more than nine; the subscribers appoint the first. The qualification will be fixed at the first or any subsequent general meeting. The remuneration of the board is to be 5 per cent. of the net profits, but not to exceed £500 per annum for each director, to be divided as they may determine, except that no director shall receive less than £150 per annum, and in the event of the profits not being sufficient for the payment of the latter amount, the same will be paid or made up out of the assets of the company, irrespective of profits.

Lee, Howl, and Company, Limited.

This is the conversion to a company of the business of Lee, Howl, Ward, and Howl, of Tipton, engineers. It was registered on the 2nd inst., with a capital of £50,000, in £10 shares, whereof 300 are 6 per cent. accumulative preference shares. The subscribers are:—

	Shares.
Wm. Lee, Tipton, engineer	120
E. Howl, Tipton, engineer..	150
O. Howl, Tipton, engineer..	75
T. White, 57, Highbury-hill, N.	1
E. White, Arlington Park-gardens, Chiswick ..	1
Miss E. J. Howl, Sedgley	1
Miss C. Howl, Sedgley..	1
Arthur Howl, Sedgley..	1

The number of directors is not to be less than three, nor more than ten; the subscribers to appoint the first; the company in general meeting will determine remuneration; qualification for directors other than the first, £250 in shares or stock.

Barrow-upon-Soar and District Water Company, Limited.

Registered on the 4th inst., with a capital of £25,000, in £5 shares, to erect waterworks for the supply of Barrow-upon-Soar and other places, in the county of Leicester. The subscribers are:—

	Shares.
J. Church, C.E., 55, Parliament-street	1
W. H. Hardy, 5, Great Winchester-street, chartered accountant	1
C. H. Woolley, 2, Great Winchester-street, solicitor	1
W. Moss, Loughborough, builder	1
H. Black, Barrow-upon-Soar, builder	1
W. E. Woolley, Barrow-upon-Soar, surveyor.. ..	1
G. Erant, C.E., 39, Herne Hill-road..	1
E. A. R. Ewen, Merton, Surrey..	1
W. E. Walter, 33, Farleigh-road, Stoke Newington, secretary to a company	1

Registered without special articles.

British Watch Company, Limited.

This company was registered on the 3rd inst., with a capital of £100,000, in £10 shares, to manufacture and trade in watches, clocks, electric bells, batteries, telephones, gas-lighters and regulators, and electric and scientific apparatus generally. The subscribers are:—

	Shares.
W. W. Pilkington, St. Helen's, Lancashire, glass-monger	1
R. S. Daglish, St. Helen's, ironfounder..	1
C. Spenceley, Knowsley, solicitor	1
T. P. Hewitt, Prescot, watchmaker..	1
A. Eccles, Liverpool, cotton broker..	1
J. Masson, Liverpool, merchant	1
W. Lees McClure, Prescot	1

Registered without special articles.

General Zinc Recovery and Lighting Company, Limited.

This company was registered on the 7th inst., with a capital of £250,000, divided into 5000 preference and 20,000 deferred shares of £10 each, to carry on in all branches the business of an electric light and power company. The subscribers are:—

	Shares.
H. Ferguson, 4, Wilton-street, S.W.	1
F. H. Forrester, 66, Mark-lane, merchant	1
Sir W. Vavasour, Bart., Tadcastle	1
J. J. Dunnington-Jefferson, York	1
J. F. Jackson, Bexley, merchant	1
S. M. Fergusson, Stock Exchange, jobber	1
T. Rome, Charlton House, near Cheltenham ..	1

The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first; qualification, twenty-five shares; maximum remuneration, £500 per annum, to be doubled when £10 per cent. is paid on the preference, and £5 per cent. on the deferred shares.

Schallehn's Patents Company, Limited.

This company proposes to acquire and work certain letters patent for improvements in pianoforte actions, domestic fire-places, and in apparatus through which air is supplied to the furnaces of steam boilers. It was registered on the 5th inst., with a capital of £2000, in £1 shares. The subscribers are:—

	Shares.
*S. Moffatt, 191, Gresham House, merchant ..	1
*K. McLea, 151, Gresham House, merchant.. ..	1
N. Clayden, 16, Willes-road, Kentish Town.. ..	1
*H. Schallehn, 191, Gresham House, engineer ..	1
F. Fearon, 25, Parliament-street, solicitor	1
C. F. Bidder, The Vicarage, Varna-road, Fulham	1
J. W. Wright, 39, Lombard-street, merchant ..	1

The subscribers denoted by an asterisk are the first directors.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

8th November, 1887.

15,169. Appliances for Cutting Wire, &c., A. S. Gore, London.
15,170. Cutting and Trimming Rocks, F. H. Butler, London.
15,171. Chess and Draught Pieces, W. Brierley.—(*— Oppenheimer and — Sulzbacher, Germany.*)
15,172. Weft Fork or Weft Stop Motions, J. E. Stephenson, Halifax.
15,173. Closing, &c., Doors, J. H. Bean and W. Gaines, Leeds.
15,174. Teapot Strainers, H. Manning, Birmingham.
15,175. Brakes for Railroad Cars, G. A. Boyden, London.
15,176. Galvanometer, M. Immisch, London.
15,177. Tea and Coffee-pot Strainers, W. H. Douglas, Birmingham.
15,178. Cleansing or Scouring Wool, C. Robeson, Birmingham.
15,179. Road Carriages, A. B. Walker, Manchester.
15,180. Telescopic Stands for Lamps, F. R. Baker, Birmingham.
15,181. Flanged Metallic Articles, S. Fox, London.
15,182. Music Stay Pins, E. A. B. Beaumont, Brighton.
15,183. Syphon Aerated Water Bottles, H. Goffe, Birmingham.
15,184. Tramway Rails, J. R. Osborn, Bradford.
15,185. Hollow-ware, M. Swain, Manchester.
15,186. Preventing Accidents from Overwinding, M. Easthorpe, Sheffield.
15,187. Guard Forks, J. Gregory, Sheffield.
15,188. Raising and Lowering Window Sashes, &c , G. Wicks, Ayton.
15,189. Salt and Generation of Steam, F. J. Thompson, Hertford.
15,190. Metallic Boxes, &c., W. and C. Crawford, Glasgow.
15,191. Washing Machines, D. T. Dewar, Dundee.
15,192. Shoulder Strap for Cyclists, T. Cummings, Birmingham.
15,193. Metallic Bedsteads, &c., J. Phillips and T. Waterhouse, Birmingham.
15,194. Attaching Cogs to the Shoes of Animals, T. Hyde, Birmingham.
15,195. Bar Breaker, S. M. Yeates, Dublin.
15,196. Hot-air Gas Stove, G. F. Restall and J. M. Copeland, Bournemouth.
15,197. Lessening the Slamming of Doors, D. Allport, London.
15,198. Revolving Pumps, G. Pinnington, Chester.
15,199. Protection from Obliteration of Trade and Private Marks, &c , F. C. Huddle, London.
15,200. Metallic Handles, J. Walker, Birmingham.
15,201. Cut-off Gear for Engines, E. A. Whitehead, Charlton.
15,202. Prevention of Hydrophobia, &c., T. Maccall, Morecambe.
15,203. Water-waste Flushing Cisterns, J. West, London.
15,204. Tightening of Window Blind Cord, N. Lobb, London.
15,205. Door Curtain Rod or Spring, W. H. Hopkins and J. Hall, Birmingham.
15,206. Carbonising Steel Wire, E. and A. Smith, London.
15,207. Nozzle Chemical Fire-extinguishers, &c., J. Haslam, London.
15,208. Mules for Spinning, H. Ashworth, London.
15,209. Memoranda Tablets, De F. Pennefather, London.
15,210. Driving Sewing Machines, G. Shann, London.
15,211. Wire Lathing, A. J. Boult.—(*C. A. Sackett, United States.*)
15,212. Purses, F. Wich, London.
15,213. Reversible Supports for Shelves, W. P. Thompson.—(*C. C. Blakeley, United States.*)
15,214. Saw-hammering Mechanism, A. J. Boult.—(*W. Gowen, United States.*)
15,215. Tinned or Terne Plates, F. J. Legge, Liverpool.
15,216. Jack Mechanism for Boots and Shoes, A. J. Boult.—(*F. W. Stone, United States.*)
15,217. Measuring Currents of Electricity, W. Lowrie, C. J. Hall, and H. W. Kolle, London.
15,218. Brass Rings, W. J. Gibbons, Birmingham.
15,219. Portable Egg Case, D. Clan-Alpine Thatcher, London.
15,220. Lighting Cigarettes, &c., R. S. Barnes and J. Curran, London.
15,221. Calculator, J. Yates, London.
15,222. Informing Drivers and Guards of Trains of Danger Signals, J. T. Thornton, Halifax.
15,223. Mounting Coins, &c., H. Barrett, London.
15,224. Collar Studs, G. Krementz, London.
15,225. Washing Machines, S. W. and W. Leach, London.
15,226. Mouthpiece for Cigarettes, J. R. Cook, London.
15,227. Securing Bolts of Rail Joints, J. A. McLaren, London.
15,228. Storage Warehouses, P. A. Newton.—(*P. G. Hubert, United States.*)
15,229. Machines known as "Willows," J. Holt and J. Tweedale, Manchester.
15,230. Moulding Impressions of Type, &c., W. Heighway, London, and J. Foster, Tooting Graveney.
15,231. Coating Carriage Bodies, &c., P. M. Justice.—(*M. B. Church, United States.*)
15,232. Recording Spoken Words, &c., E. Berliner, London.
15,233. Sliding Cover Engines, H. H. Lake.—(*S. E. Jarvis, United States.*)
15,234. Spectacle Temples, R. Bradley, jun., London.
15,235. Lancets, &c., R. Mathieu, London.
15,236. Bushes for Tap Holes of Earthenware Filters, P. P. Kipping, London.
15,237. Conversion of Phosphates into Thermo-phosphates, L. R. Bazin, London.
15,238. Filter Presses, E. A. Cowper, London.
15,239. Gearing Mechanism for Rolls, W. F. Cochrane, London.
15,240. Relief Mechanism for Rolls, W. F. Cochrane, London.
15,241. Gearing, W. F. Cochrane, London.
15,242. Gearing, W. F. Cochrane, London.
15,243. Roller Mills, W. F. Cochrane, London.
15,244. Roller Mills, W. F. Cochrane, London.
15,245. Connecting Rods, D. H. Dugar, London.
15,246. Barbed Wire Nails, &c., J. E. Emerson and T. Midgley, London.
15,247. Gas Meters, H. J. Bell, London.
15,248. Composition for use with Confections, H. Jeffryes, London.
15,249. Making Collar Buttons, &c., G. Krementz, London.
15,250. Automatic Stem Pessaries, A. O. McCord, London.
15,251. Logometers, C. Sperry, London.
15,252. Projectiles, H. A. Schlund, London.
15,253. Driving Bands, W. R. Lake.—(*G. Meacom, United States.*)
15,254. Glass and Porcelain Lamps, S. Clarke, London.
15,255. Obtaining Carbonate of Soda, &c., G. W. Hart, London.
15,256. Refining Hydrocarbon Oils, S. Pitt.—(*T. G. Hall, United States.*)
15,257. Welding Steel, W. B. Middleton, London.
15,258. Fuel Economiser, E. Church, Beckenham.
15,259. Voltaic Batteries, T. J. Jones, London.
15,260. Cartridge and Cartridge Case, K. McLea and R. Punshon, London.
15,261. Rotary Engines, G. Dietz and E. Tamsen, London.
15,262. Coin-freed Delivery Apparatus, E. Lecker, London.

9th November, 1887.

15,263. Oil or Spirit Lamps, C. and C. K. Welch, London.
15,264. Salt Holder, H. G. Boston, York.
15,265. Dye Matter, G. Thomas.—(*H. Schulz, Germany.*)
15,266. Opening, &c., Fanlights, J. Dunning and B. Priestley, Bradford.
15,267. Tires, C. Challiner, Manchester.
15,268. Fixing Adjustable Sockets on Tubes, J. J. H. Holt, Manchester.
15,269. Rollers for Expanding Fabrics, J. H. McKean, Manchester.
15,270. Pickers in Looms, G. Jackson and R. Crook, Manchester.
15,271. India-rubber Springs, J. McHardy, Dollar, U.S.
15,272. Combined Hat Rack, &c., W. and J. McHardy, Dollar, U.S.
15,273. Socket or Barrel Bolts, C. Showell, Birmingham.
15,274. Preventing Oxidation of Tin, &c., M. and E. Darnbrough, Drighlington.
15,275. Regulating the Flow of Fluids, H. Trott, London.
15,276. Internal Combustion Motors, J. Hargreaves, Liverpool.
15,277. Mineral Oil Lamps, &c., T. and A. Rochford, Dublin.
15,278. Fabrics, &c., for Horse Sheets, T. F. Firth, Halifax.
15,279. Dishes for Exposing Butter, &c., for Sale, R. Sutcliffe, Manchester.
15,280. Napkin, V. Bailey, London.
15,281. Fastening for Boots, &c., H. W. Huckvale, Chipping Norton.
15,282. Automatic Fire-escape, J. Longworth, jun., Ramsbottom.
15,283. Shuttle Guards, J. C. Fielden and W. Slater, Manchester.
15,284. Portable Weighing Apparatus, D. France, Manchester.
15,285. Loose Running Wheels, W. Mellor, Manchester.
15,286. Bottle Stopper, C. H. Wall, Aberdeen.
15,287. Automatic Turning Lathes, F. J. Pettit, Birmingham.
15,288. Indicators for Cabs, H. Haes, London.
15,289. Gearing for Lathe Headstocks, T. Humpage, Bedminster.
15,290. Shifting Slides, A. Gilchrist, jun., and J. Hannan, Glasgow.
15,291. Miles Potato Masher, W. S. Simpson, London.
15,292. Safety Appliances for Lifts, R. Middleton, Leeds.
15,293. Manufacturing Perforated Blocks, J. A. Yeadon and R. Middleton, Leeds.
15,294. Textile and Woven Bands, S. Ogden, Manchester.
15,295. Production of the Florides of Magnesium, A. Feldmann, London.
15,296. Attachment for Printing Machines, J. Thomlinson, Glasgow.
15,297. Grinding Grain, A. Stevenson, Liverpool.
15,298. Stopping Perambulators, L. L'Hollier and G. Asher, Birmingham.
15,299. Meters for Measuring Electricity, E. Perrett, Birmingham.
15,300. Corset Cloth, J. Hartley, London.
15,301. Boots and Shoes, H Standley, London.
15,302. Roasting Raw Grain, S. Judd, London.
15,303. Railway Signalling, &c., W. H. Gallaway, Glasgow.
15,304. Packages for Sample Post, J. Hertz, London.
15,305. Two-wheeled Carriages, W. Danks and H. Rogers, London.
15,306. Water Meters, J. C. W. Pauwels, London.
15,307. Joining Pieces of Wood, J. C. W. Pauwels, London.
15,308. Manufacture of Ice, H. H. Leigh.—(*G. Dubern, India.*)
15,309. Manufacturing Manuring Compounds, J. Davenport, London.
15,310. Aero-dynamic Motor, T. C. Boutet, London.
15,311. Releasing the Bolts of Locks, D. J. Mito, London.
15,312. Tricycles, G. D. Leechman, London.
15,313. Packing, W. and A. Plöger, London.
15,314. Making Soap Free of Water, H. Wiesinger and L. Rissmüller, London.
15,315. Cases of Padlocks, J. Banks, London.
15,316. Locomotive Engine Guards, &c., C. A. Noble, London.
15,317. Safety Apparatus for Railways, R. Crichton, London.
15,318. Starting-gear for Tramcars, T. B. Waterfield, London.
15,319. Telegraph Posts, A. Muirhead.—(*J. S. Blomfield, South Australia.*)
15,320. Coloured Marking Ink Pencils, J. Hickisson, London.
15,321. Electrical Storage Batteries, J. Pitkin, London.
15,322. Filter Presses, H. E. Newton.—(*The Maschinenbau Actiengesellschaft, Austria*)
15,323. Fastening Lids, &c., on Boxes, A. M. Hart, Plumstead.
15,324. Kneading Machine, E. Michelon and J. Barbier, London.
15,325. Rotary Engines, E. Schergen, London.
15,326. Steam Boilers, J. P. Bordone, London.
15,327. Iron and Steel Flooring for Bridges, M. am Ende and A. Buchanan, London.
15,328. Galvanic Batteries, A. Schanschieff, London.
15,329. Covering Insulated Electrical Conductors with Lead, &c., R. W. Eddison.—(*E. McKnight, United States.*)

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15,330. Rabbit-run, Rat, Dog, &c., Traps, W. Glover, Wednesfield.
15,331. Box for Matches, E. Bablin, London.
15,332. Cleansing Bottles, W. A. Ross, Belfast.
15,333 Straining Paper Pulp, H. J. Rogers, Watford.
15,334. Safety Centre Pinion for Watches, J. F. Cassidy, Birmingham.
15,335. Prevention of Accidents with Straps and Drums, J. Quarmby and W. Hall, Huddersfield.
15,336. Extinguishing Lamps, J. Duggan, Liverpool.
15,337. Picture Hooks, F. Flavell, Aston.
15,338. Braces, W. H. Key, Birmingham.
15,339. Friction Clutch for Driving Machinery, T. O. Arnfield, Manchester.
15,340. Vehicles, W. H. Blackwell, Brightside.
15,341. Knickerbocker Boot, J. Harries, Llanelly.
15,342. Hydraulic Lifts, S. and S. R. Chatwood, London.
15,343. Preventing Loom Shuttles from Flying, J. Shackleton, Halifax.
15,344. Regenerative Gas Lamps, T. G. Marsh, Manchester.
15,345. Steam Traps, P. Fyfe, Glasgow.
15,346. Sewing Machines, S. S. Bromhead.—(*J. A. Brautigam, United States.*)
15,347. Musical Instruments, S. S. Bromhead.—(*J. D. Loppentein, United States.*)
15,348. Locks, S. S. Bromhead.—(*F. M. Ware and G. W. Benjamin, United States.*)
15,349. Mowing Machines, S. S. Bromhead.—(*G. A. Weaver, United States.*)
15,350. Washing Materials, M. Ashworth and R. Wild, Rochdale.
15,351. Cutting Boiler Tubes, &c., T. Elcoate, Liverpool.
15,352. Locks and Latches, R. W. Juckes, Longton.
15,353. Braces, T. Blenkiron and W. Varney, London.
15,354. Ventilators for Ships, D. Cowan and A. Robertson, Glasgow.
15,355. Brick Making Machinery, A. Patrick, Glasgow.
15,356. Brick Making Machines, A. Patrick, Glasgow.
15,357. Window Blind Rollers, J. Colby and J. Chambers, Lowestoft.
15,358. Presses for Hollow Articles, R. Clarke, Birmingham.
15,359. Shunter, J. Mackenzie, Egglescliffe.
15,360. Latch Needle Knitting Machines, J. J. Lish and H. Igel, Newcastle-on-Tyne.
15,361. Tennis Balls, J. McHardy and R. Brand, Dollar, N.B.
15 362. Peeling Potatoes, &c., F. Fissi, London.
15,363. Self-adjusting Carriage Window, A. Hopton, London.
15,364. Treating Wool, D. Mason.—(*A. Schlumm and F. à Brassard, Germany.*)
15,365. Loading Vessels, W. E. Kochs, London.
15,366. Nails, &c , T. Turner, Dublin.
15,367. Boxes, &c., J. MacCallum, London.
15,368. Universal Key, L. Wiese, Glasgow.
15,369. Switch-back Railway, J. S. Brown, London.
15,370. Saddle Bar, J. Williams, London.
15,371. Drawing Cotton, &c., T. Farrington and E. Fletcher, London.
15,372. Ventilator and Chimney Cowl, J. Morris, London.
15,373. Mechanism for Lamps, R. Wallwork and A. C. Wells, London.
15,374. Red Colouring Matters for Dyeing, &c., J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
15,375. Coin-freed Delivery Apparatus, M. R. Marelle, London.
15,376. Boiler Feeder, W. G. and C. W. G. Little, London.
15,377. Photographic Apparatus, W. P. O'Reilly London.
15,378. Velocipedes, M. Jackson, London.
15,379. Perambulators, &c., W. Banks, Glasgow.
15,380. Hydraulic Cartridge, C. Wells and H. Thatcher, London.
15,381. Paint or Varnish, K. McLea and R. Punshon, London.
15,382. Preserving Timber, &c., K. McLea and R. Punshon, London.
15,383. Conducting the Game of Curling, T. B. Sharp, London.
15,384. Disinfecting Impure Liquids, E. Hermite, E. J. Paterson, and C. F. Cooper, London.
15,385. Disinfecting Impure Liquids, E. Hermite, E. J. Paterson, and C. F. Cooper, London.
15,386. Paper, C. Morfit, London.
15,387. Stop Cocks, J. G. Flint, London.
15,388. Reels for Cotton Threads, &c., H. F. Wood, London.
15,389. Holding up Dresses, G. W. Forbes and R. H. Cunliffe, London.
15,390. Keeping Ships Afloat, D. S. McDonald, London.
15,391. Portable Hand Pumps, C. Bade, London.
15,392. Primary Batteries, H. J. Haddan.—(*B. Scheithauer, Germany.*)
15,393. Starter for Gas, &c., Engines, S. Griffin, London.
15,394. Cement Tubes, D. Zisseler, London.
15,395. Bricks, &c., R. A. McGregor, London.
9389a. Aluminium, C. A. Burghardt and W. J. Twining, Manchester. — 2nd July, 1887. — [Received 11th November, 1887. This application having been originally included in No. 9389, a.d. 1887, takes, under Patents Rule 23, that date.

11th November, 1887.

15,396. Starting Tramcars, W. Brierley.—(*A. Jenel, Breslau.*)
15,397. Boring Machines for Rock, &c., R. Wilson, Bishop Auckland.
15,398. Bullet, W. C. Nangle, Whitechurch.
15,399. Gas Cooking Apparatus, T. Thorp, Whitefield.
15,400. Scraper, S. Kallend, Taunton.
15,401. Reversible Garments, R. Brand, Glasgow.
15,402. Household Bellows, &c , G. Thorpe, jun., R. Laxton, and T. Duke, Sheffield.
15,403. Belts for Driving Pulleys, J. A. Leeming, Halifax.
15,404. Bicycle and other Wheels, R. B. Helliwell Liverpool.
15,405. Ventilating Fans, W. Yates, Manchester.
15,406. White Lead, A. Orr, Glasgow.
15,407. Straps for Neck-ties, J. C. W. Masterman Southsea.
15,408. Pie-dishes, J. L. Dubois, London.
15,409. Organs, J. Stringer, Longport.
15,410. Meters, W. E. Price, Hampton Wick.
15,411. Handles for Plate Iron Hollow-ware Vessels, J. Hill, Lye.
15,412. Apparatus for Propelling Cycles, W. H. Blessley, Middlesbrough.
15,413. Picture Frames, J. M. Baines and G. Jackson, Bradford.
15,414. Steam Generators, J. Woodcock and J. Bowker, Manchester.
15,415. Fixing a Vulcanite Disc to Shaft, J. Hope, Dalkeith.
15,416. Spinning Machinery, E. Haigh and E. Hargreaves, Halifax.
15,417. Coating Cast Iron, T. Slater and J. Laidlaw, London.
15,418. Fan-lights, W. J. Payne and A. J. W. Johnson, London.
15,419. Paper, C. Morfit, London.
15,420. Apparatus for Scoring at Billiards, W. Taylor, London
15,421. Steam Jacketted Stoves or Ovens, W. Nichol, London.
15,422. Aluminium, J. Nicholas and H. H. Fanshawe, London.
15,423. Thin Copper Chains for Soldiers' Caps, J. C. W. Pauwels, London.
15,424. Metallic Bottom Engines, J. C. W. Pauwels, London.
15,425. Galvanising Metals, J. Westgarth, Manchester.
15,426. Fire-stoves, H. Walker, London.
15,427. Heating Stoves, J. Harding, A. Cocks, and G. Boaz, London.
15,428. Antiseptic Garments, &c., C. S. J. Ostrorog, London.
15,429. Filters, T. Newman, London.
15,430. Gas Lamps or Burners, J. Gale and J. M. Lamb, London.
15,431. Chemically Charging Water-closets, W. C. Roberts, London.
15,432. Dyeing, J. Grunhut, London.
15,433 Fish Hooks, J. Savage, London.
15,434. Moving Granular Materials, C. A. Jensen.—(*Messrs. Schüchtermann and Kremer, Germany.*)
15,435. Protection of Flowers, H. Briscoe-Ironside, Foot's Cray.
15,436 Attachment of Woven Wire, E. Peyton, London.
15,437. Curtains for Theatres, &c., W. Smethurst, London.
15,438. Automatically Extinguishing Lamps, J. Y. Johnson.—(*A. Berry, Canada.*)
15,439. Scrapers, G. Tidcombe, London.
15,440. Stoves for Heating Tailors' Irons, J. Croft London.
15,441. Gas, &c., Meters, A. J. Boult.—(*V. Liegheus, Belgium.*)
15,442. Drying Coffee, A. F. de Lacerda, London.
15,443. Combined Compasses, &c., A. J. Boult.—(*H. Blanke, Germany.*)
15,444. Hanging Looking-glasses, A. J. Boult.—(*F. Hiroux, Belgium.*)
15,445. Controlling the Speed of Engines, E. Jones, London.
15,446. Bearings for Spindles, T. K. Hattersley, London.
15,447. Lighting Lamps, H. Trotter, London.

15,448. Spongy Lead for Secondary Batteries, G. Trier.—(*E. Fischer, Denmark.*)
15,449. Producing Devices upon Glass, D. Grant, London.
15,450. Protecting the Edges of Wristbands, H. A. Marshall, London.
15,451. Rail Sawing Machines, E. C. Smith, London.
15,452. Waterproof Material, &c., H. J. Lockyer, London.
15,453. Fire Alarm, &c., G. F. Redfern.—(*L. Digeon, France.*)
15,454. Projectiles, G. Kynoch and H. A. Schlund, London.
15,455. Connecting Electrical Conductors, W. S. Rogers, London.
15,456. Washing Plates, &c., H. A. Davis, London.
15,457. Draining, &c., Land, B. Schneider, London.
15,458. Roundabouts, R. H. Bishop and J. F. Phillips, London.
15,459. Yellow Colouring Matters, S. Forel, London.
15,460. Cask-making Machinery, O. Hartley, London.

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15,461. Velocipedes, E. Easthope, Wolverhampton.
15,462. Deck Seats for Ships, J. M. Lóvold, Liverpool.
15,463. Ruffles, J. Webb, Manchester.
15,464. Wire Brushes, W. Taylor, Halifax.
15,465. Pickers of Looms for Weaving, W. H. Armistead, Halifax.
15,466. Dobbies of Looms for Weaving, J. Southworth and F. W. Jepson, Halifax.
15,467. Ventilators, G. B. Bulmer, Leeds.
15,468. Cooking Ranges, J. Kinnaird, Glasgow.
15,469. Direction Indicators, C. Stout, Seacombe.
15,470. Mixing Tea, E. Burke, Dublin.
15,471. Heating Bakers' Ovens, J. McPherson and A. Duncan, Middlesbrough-on-Tees.
15,472. Wine Bins, F. Pontifex, London.
15,473. Cutting tha Pile of Woven Fabrics, J. Newhouse and J. Sampson, Manchester.
15,474. Pulverising Minerals, H. Hobson, Manchester.
15,475. Silent Waste-water Preventer, T. W. Letheren, Exeter.
15,476. Ventilating, E. Lofts, London.
15,477. Raising, &c., Window Blinds, C. L. Templer, London.
15,478. Cork-screws, H. E. Delarbre, Liverpool.
15,479. Magazine Rifle Batteries, C. R. Fuhrmann and F. Ruderisch, London.
15,480. Shuttle Guards for use in Looms, R. Brown, Preston.
15,481. Pentagraph Tracing Machines, J. Bryce and G Stewart, Glasgow.
15,482. Water Motor, T. Ormston and J. Malam, London.
15,483. Automatic Indicator for Water-closets, J. Poulter, London.
15,484. Electrical Circuits, P. Cardew, London.
15,485. Switch-back Railwaye, &c., W. H. Dunkley, London.
15,486. Sewing Machines, T. H. Williams, London.
15,487. Carpets, J. Brinton and Co. and J. H. Pearse, London.
15,488. Wire Fencing, J. C. Mewburn.—(*A. Bère, France.*)
15,489. Repeating War Rockets, J. Bowden, London.
15,490. Expressing Oil from Substances, J. W. Lord, London.
15,491. Treatment of Oils for their Purification, J. W. Lord, London.
15,492. Seam for Oilskin and other Garments, J. Taylor, London.
15,493. Billiard Cue Chalker, W. W. Horn.—(*E. W. Smith, Canada.*)
15,494. Boxes, Cases, &c., G., N., and H. V. Kilvert, London.
15,495. Chaffers for Heating Bakers' Ovens, J. G. Miller, London.
15,496. Oval Fronts, &c., for Lamps, H. Millward, Birmingham.
15,497. Securing Screw Studs to Horseshoes, G. Eayres, Sheffield.
15,498. Shutter Switch Shield and Reflector, J. Gale, London.
15 499. Safety Apparatus for Small-arms, J. Marks, London.
15,500. Screw Plates, R. Allen and W. J. Wakefield, London.
15,501. Stoppers for Bottles and Taps, R. W. Thomas, London.
15.502. Preserving and Sweetening Agent, A. Horn, London.
15,503. Pumps, W. H. Beck.—(*H. A. Delgorge, P. H. Grandjean, and F. X. Kioque, France.*)
15,504. Separating Precious Metals, A. N. Contarini, London.
15,505. Rifle Chamber, &c., for Target Practice, J. O'Kelly, London.
15,506. Aerated Beverages, C. G. Matthews and G. H. U. Harrow, London.
15,507. Delivering Goods in Exchange for Coin, C. H. Bingham, London.
15,508. Delivering Goods in Exchange for Coin, C. H. Bingham, London.
15,509. Warming and Ventilating Buildings, R. Oakley, London.
15,510. Embossing Machines for Paper, &c., M. Heimann, London.
15,511. Churns, J. A. and J. Hopkinson, London.
15,512. Hot-air Engines, G. Schimming, London.
15,513. Thermometers, J. Sudmann, London.
15,514. Facilitating the Insertion and Removal of the Rollers of Rotating Platforms, &c., R. C. Christie, M. Gledhill, and H. H. S. Carrington.—(*J. B. G. A. Canet, France.*)
15,515. Production of Aluminium, &c., A. B. Cunningham, London.
15,516. Gas Heating Apparatus, G. F. Redfern.—(*F. M. and H. Mertz, France.*)
15,517. Storage of Saleable Articles, W. E. Johnson and W. H. Nicholas, London.
15,518. Threshing Machines, J. Hauer, London.
15,519. Exhausting or Consuming Foul Air or Gases from Sewers, &c., S. Holman, London.
15,520. Jointing Stoneware and other Pipes, W. H. C. Stanford, London.
15,521. Feeding Materials to Sewing Machines, C. Stuart, Fenny Stratford.
15,522. Giving Rotary Motion to a Spindle for Driving Sewing Machines, C. Stuart, Fenny Stratford.

14th November, 1887.

15,523. Promenade and Landing Piers, H. S. S. Copland and J. C. Gilmour, London.
15,524. Draining Steam Jackets of Steam Engine Cylinders, J. J. Royle, London.
15,525. Supplying Wind to Church Organs, H. T. Newbigin, Alnwick.
15,526. Water Softening Appliances, W. Tapp, Bristol.
15,527. Fireproof Revolving Screen for Grates, &c., G. Davis, Aberystwyth.
15,528. Preparing Food for Human Consumption, W. Garthwaite, Great Grimsby.
15,529. Gas Fires, S. G. Rhodes, Leeds.
15,530. Aerated Beverages, T. Child, Leeds.
15,531. Inlet Ventilators, J. W. Dyson, Newcastle-on-Tyne.
15,532. Electric Explosives, S. Joyce, jun., London.
15,533. Checking Shuttles employed in Looms, J. Heap, J. Hoyle, and F. Crosland, Halifax.
15,534. Fire-escape and Ladder, J. B. Archer and G. D. B. Thomas, Newcastle-on-Tyne.
15,535. Fitting up Cabinet Stands, &c., R. Highet, sen., and R. Highet, jun., Kilmarnock.
15,536. Lighting of Musical Instruments, R. Child, London.
15,537. Electrical Switches, R. W. Paul, London.
15,538. Web or Strap Holder for Braces, C. Steer, Bristol.
15,539. Punching, &c., Machines, A. W. Wilson and B. Silver, Leicester.
15,540. Distillation of Ammoniacal Fluids, G. E. Davis, Manchester.
15,541. Absorbent Plug for Tobacco Pipes, T. F. Pearse, London.
15,542. Ventilating Sewers and Drains, T. P. Worthington, Blackpool.
15,543. Pulp Engines, W. W. D. Jeffers, London.
15,544. Chair, E. E. Welch, London.
15,545. Bellows Regulators for Water-closets, J. Lawrence, London.
15,546. Dress Stands, &c., A. Gems, London.
15,547. Forging, &c., Metals, A. Wilson and H. Baxter, London.
15,548. Preventing Unevenness in Sliver, P. Knowles, London.
15,549. Cutting Files, J. T. Hill and E. L. W. Bellhouse, Sheffield.
15,550. Cartridge Extractors, C. H. Maleham, Sheffield.
15,551. Fire-escapes, J L Savage, Manchester.
15,552. Liquid Fuel Cartridge, D. C. A. Thatcher, London.
15,553. Fixing Corks in Bottles, C. McDonald, London.
15,554. Displaying Announcements in Hotels, A. W. Hosking, Manchester.
15,555. Electric Motors, W. M. Mordey, London.
15,556. Type-writing, L. T. Wagner, London.
15,557. Motor Engines, W. Clarke, J. B. Furneaux, and C. Dowsen, London.
15,558. Automatic Exhibitor, W. Britain, London.
15,559. Pack Saddles, H. R. Stewart, London.
15,560. Fire-proof Scenery, B. Finch, Manchester.
15,561. Balance Wheels, H. Ostermann and A. Prip, London.
15,562. Adjustable Holder, F. W. L. Shaw, London.
15,563. Extinguishing Lamps, &c., W. G. Cloke, London.
15,564. Antiseptics, A. Boake, F. G. A. Roberts, A. Shearer, and W. B. Giles, London.
15,565. Cleaners for Globes, N. W. A. and L. W. Lee, London.
15,566. Pulping Coffee, G. W. Gordon.—(*T. Lang, Guatemala.*)
15,567. Spherical Balloons, H. Lane, London.
15,568. Differential Screw Action, &c., J. Swift, London.
15,569. Blow-pipe, R. J. Lee, London.
15,570. Advertising Machines, H. A. Burt, London.
15,571. Sewing Machines, E. Cornely, London.
15,572. Liquid Meters, H. S. Price, London.
15,573. Blast Furnaces for Locomotives, J. Y. Smith, London.
15,574. Extraction of Gold, &c., C. T. J. Vautin, London.
15,575. Separating Solutions of Metallic Salts, C. T. J. Vautin, London.
15,576. Artificial Limbs, B. Smith, London.
15,577. Boots, W. J. Lemon, London.
15,578. Brown Bread, J. Hofmann, London.
15,579. Cutting Lamp Wicks, T. W. Platten, London.
15,580. Footballs, W. Howard, London.
15,581. Preserving Water Pipes, C. H. Fitzmaurice, London.
15,582. Steam Engine Cylinder, J. Miller, South Australia.
15,583. Electric Tramways, B. J. B. Mills.—(*T. A. Edison, United States.*)
15,584. Boot Cleaning Machine, &c., R. Günther, London.
15,585. Bath Brush, H. Neuman, London.
15,586. Evaporating Apparatus, W. F. Pamphlet, London.
15,587. Alkaloids, C. D. Abel.—(*W. Roser, Germany.*)
15,588. Dynamo-electric Machines, J. Y. Johnson.—(*W. C. Rechniewski, France.*)
15,589. Press for Meat, G. Pasquier, London.
15,590. Drying Substances, W. Creswick, London.
15,591. Correcting Devices for Compasses, L. Sirieix, London.
15,592. Gun Carriages, R. C. Christie, M. Gledhill, and H. H. S. Carrington.—(*J. B. G. A. Canet, France.*)
15,593. Aluminium, L. Grabau, London.
15,594. Steering Apparatus, W. Shapton, London.
15,595. Dentists' Burring Tools, S. Pitt.—(*A. W. Browne, United States.*)

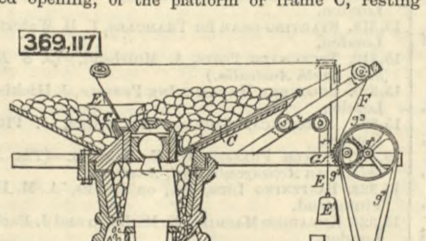
SELECTED AMERICAN PATENTS.

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

369,117. Feed Regulator for Crushing Machines, *D. Marchant, Chicago, Ill.—Filed October 27th,* 1886.

Claim.—The combination, with the crusher having a hopper with inclined wall and a circular bottom with feed opening, of the platform or frame C, resting

369,117

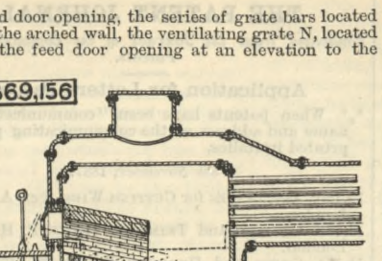


loosely on said inclined wall, and operating mechanical devices, constructed and arranged as described, whereby it can be moved continuously outward while feed is in the hopper and during the crushing operation, substantially as described. The combination, with the hopper of a stone crusher, of the platform or frame C, chain E, suitable guide pulleys, weight E^1, chain F, drum G, and means for operating said drum, substantially as and for the purpose described. In combination with the hopper of a stone crusher, the platform or frame C, chain F, drum G, driving pulley *a*, and suitable connections between the driving pulley *a* and drum G, gear wheels g^1 g^2, pulley g^3, and belt g^4, substantially as and for the purpose described. The combination, with the hopper, of the feed-regulating platform resting loosely thereon and having the vertical portion c^3, and movable outward from the centre to the periphery of the hopper for freeing the stone in the hopper, the stone crusher, and hopper having a feed-opening, substantially as described.

369,156. Locomotive Furnace, *A. Backus, Jr., Detroit, Mich.—Filed June 11th,* 1887.

Claim.—(1) In a furnace, and in combination, the fire-box, the inclined frame, the arched and side walls supported thereon, the series of clinker breaking grates, the dumping grate, the ventilating grate located in the rear end of the fire-box, and the feed door opening through the fire-box below the arched wall, substantially as and for the purposes specified. (2) In combination with the fire-box, the arched wall, the feed door opening in said fire-box below the arched wall, the inclined frame having journalled therein the series of grates 10, the ventilating grate N, located at the rear end of the fire-box and below the feed door opening, and the mechanism for tilting the grates 10, substantially as specified. (3) In a furnace, the combination of the fire-box, the feed door opening, the arched wall located in the rear end of the fire-box over the feed door opening, the series of grate bars located below the arched wall, the ventilating grate N, located below the feed door opening at an elevation to the

369,156

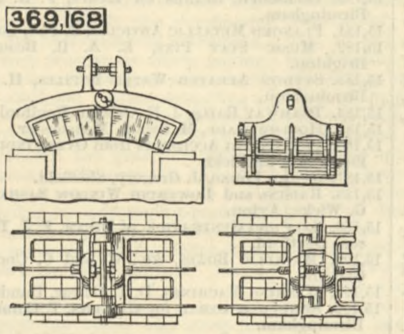


series of grate bars 10, and the dumping grate located in the front end of the fire-box, as and for the purposes specified.

369,168. Cover for Heating Forges, *M. Deering, Syracuse, N.Y.—Filed February 28th,* 1887.

Claim.—In a furnace cover, the combination, with an arch of refractory blocks, of two metallic binding plates hinged together over the crown of the arch, and constructed with concave lower surfaces bearing

369,168

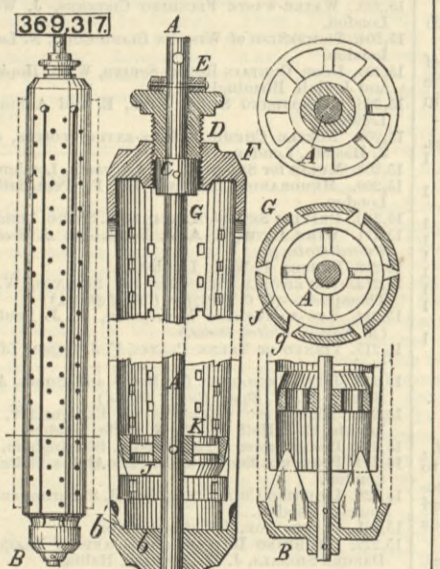


against the upper side of the arch, and provided at their outer ends with rigid flanges which bear against the ends of the arch, and near their inner ends with upwardly extending arms connected by an adjusting device, whereby the end flanges are pressed against the arch by separating said arms, substantially as set forth.

369,317. Collapsible Core Barrel, *D. G. Coppin, Newport, Ky.—Filed June 23rd,* 1887.

Claim.—(1) A core bar or tube carrying a longitudinally slotted barrel, means for advancing and retracing the barrel along said bar, and devices for expanding and contracting said barrel, substantially as described. (2) The combination, in a collapsible core apparatus, of the supporting bar or tube A, head B *b* b^1, fixed

369,317

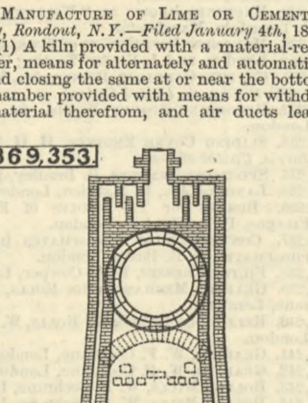


collars C E, screw-threaded adjuster D, screw-threaded head F *f*, longitudinally slotted core barrel G *g*, inwardly inclined projections J, expander K, and chamfered bearings L, for the purpose described. (3) A collapsible core barrel whose segments G are separated by inwardly flaring longitudinal slots *g*, for the purpose described.

369,353. Manufacture of Lime or Cement, *H. Mathey, Rondout, N.Y.—Filed January 4th,* 1887.

Claim.—(1) A kiln provided with a material-receiving chamber, means for alternately and automatically opening and closing the same at or near the bottom, a drawing chamber provided with means for withdrawing the material therefrom, and air ducts leading

369,353

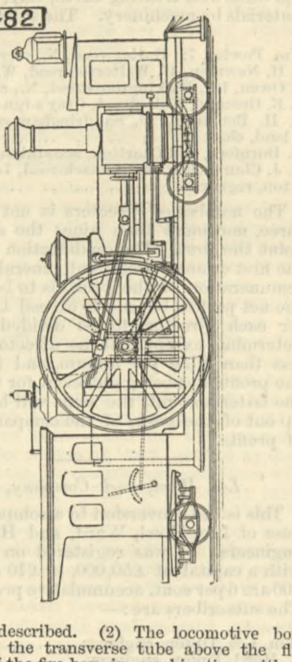


therefrom, whereby a current of cold air is maintained in said chamber and the material oxidised and cooled, as set forth. (2) In a kiln, the combination, with means for heating the material, of a receiving chamber, means for automatically opening and closing its lower end, a drawing chamber, and means for withdrawing the calcined material, and air ducts leading from said chamber to the top of the kiln, as and for the purpose set forth.

369,482. Locomotive Engine, *William J. Tripp, New York, N.Y.—Filed November 4th,* 1887.

Claim.—(1) The boiler of a locomotive engine, having the transverse tube fitted in it above the flues and in front of the fire-box, in combination with the axle, passed through the tube, the drive wheels, of large [diameter, and the frame, supporting the boiler and suspended from the springs, supported upon the axle-boxes, whereby the preponderance of weight of the boiler is below the axle and the boiler relieved of the jar of the drive wheels, sub-

369,482



stantially as described. (2) The locomotive boiler provided with the transverse tube above the flues and in front of the fire box, in combination with the axle, passed through the tube, the drive wheels of large diameter, and the cylinders, elevated to a line with the axle, and the steam chests, placed beneath the cylinders, whereby the weight of the steam chest falls below the axle, substantially as described.

369,524. Automatic Oil Injector, *P. Hubert, Buda Pesth, Austria-Hungary.—Filed March 23rd,* 1887.

Claim.—In a force feed lubricator consisting, essentially, of two flanged hollow cylinders fastened together and having suitable inlet and outlet pipes, connecting tubes, and oil-passages, with screw-

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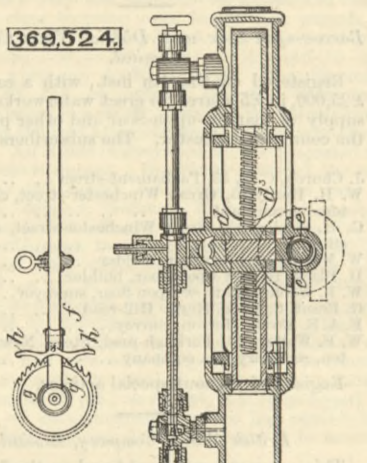
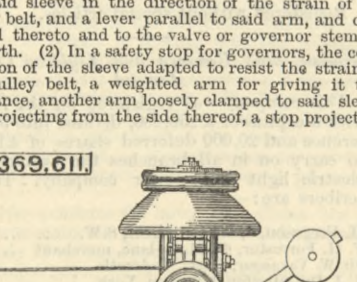


threaded pistons working differentially in the interior of said cylinders, the operating lever *f*, the ratchet-wheels *g* g^1, and pawls *h* h^1, in combination with shaft e^1, worm *e*, and recessed worm wheel *d*, revolving on hubs d^3, all constructed and operating substantially as set forth.

369,611. Safety Stop for Governors, *B. V. Nordberg, Milwaukee, Wis.—Filed February 26th,* 1887.

Claim.—(1) In a safety stop for governors, the combination of the above to which the pulley is studded, and means for giving it a tendency to turn against the strain of the pulley belt, with an arm projecting from the said sleeve in the direction of the strain of the pulley belt, and a lever parallel to said arm, and connected thereto and to the valve or governor stem, as set forth. (2) In a safety stop for governors, the combination of the sleeve adapted to resist the strain of the pulley belt, a weighted arm for giving it this resistance, another arm loosely clamped to said sleeve and projecting from the side thereof, a stop projecting

369,611.



from said sleeve in position to strike a pin on the last-named arm, and a hinged lever connected to said arm and to the valve or governor stem, as set forth. (3) In a safety stop for governors, the combination, with the sleeved bearing, of the sleeve, to which the pulley is studded, means for giving the latter a tendency to turn on its bearing against the strain of the pulley belt, a shaft, and gearing connecting the said shaft with the pulley and the driving sleeve of the governor, and an arm and lever connecting the sleeve with the valve or governor stem, as set forth. (4) In a safety stop for governors, the combination of the sleeve adapted to resist the strain of the pulley belt, a weighted arm for giving it this resistance, another arm loosely clamped to said sleeve and projecting from the opposite side thereof, a stop projecting from said sleeve in position to strike a pin on the last-named arm, and a hinged lever connected to said arm and to the valve or governor stem, and a spring for returning it when released, as set forth.