THE TRIANGULATION AND MEASUREMENT OF THE FORTH BRIDGE.

By Reginald E. Middleton, M.I.C.E.

No. II.

Triangulation of distances A-I, I-VIII., I-E, I-XI.—In order to again check the distance A-I, a short base line I-R 636ft. long, part of the base line I-P was measured and the distance triangulated, the resulting dimension being A-I 846·857 as against 846·92, I-E 436·19 as against 436 214, I-VIII. 671·232 as against 671·245, I-XI. 1175·32 as against 1175 285, and I-XIV. 1690 36 as against 1690·285, the final measurement of the distance along the girders made it 1690·337. The measurement from XIV. to XV. could not be carried on in a line parallel to the centre line of the bridge owing to the stage no longer following this direction, but turning inwards, and being in the centre line at XV. A pole was therefore placed on the stage in the centre line of the bridge somewhere near where the southern Queensferry Piers, Station XV., should come, and this station was triangulated from O. Three angles could not be taken owing to the unsteadiness of the stage, and this unsteadiness affected the other angles, as the pole would not always lie in the centre line. The distance between I and this pole having been angulated, a direct measurement was made by squaring off from the centre of the south cantilever pier, station XIV., and fixing a point 88ft. $4\frac{9}{16}$in. from the centre line of the bridge, measuring to the pole already fixed, and calculating the base as that of a right-angled triangle. The results were, by triangulation, March 14th, 1884, I-θ 2360 827; I-XV. should be 2375·004, then θ XV. would be 14·177, and the distance XIV. XV. 684·719, by measurement as above 684·725. This distance was repeatedly measured, and showed a constant elongation in the stage as under:—

June 19th, 1884	684,775
July 15th, 1884	684,965
January 1st, 1885	685,028
July 30th, 1885	685,277

therefore the stage had evidently moved northwards in this period ·552. There was also a movement northwards at station XIV. of ·151 total, ·703 of this ·441 had been corrected, leaving an error northward of ·262ft., or taking the averages of observations—

Direct measurement, July 30th, 1885 ...	2375·266
Triangulation, 1884	2375 334
„ 1885	2375·312
Wire measurement, 1885	2375·380
Average	2375·323
Correct length	2375·004
Average error north	·319
By direct measurement	·266
By triangulation	·323

Triangulation more accurate than direct measurement.—From these figures it will be seen that a better result would have been obtained if the author had trusted entirely to triangulation, and that in such a situation a direct measurement is not to be relied on.

Setting out stations XVII. and Q.—The southern Inch Garvie piers, station XVII., being both, when built, situated in deep water, and there being at this time—June, 1883—no staging near them, and it being necessary to arrive at the contour of the rock on which the caisson would eventually rest, a station had to be set out, which should be in the transverse centre line of these piers. For this purpose an arbitrary angle I XVIII. Q = 48 deg. I Q = 4240·40ft., Q, being the new station, was decided on; this line was marked down in the rock, the angle from I which would intersect this line and the transverse centre line of the southern Inch Garvie piers in the same point was calculated, and this line also laid down with the theodolite, a masonry pier was built over the points so found, and the operation repeated and checked. The angle at I was necessarily very acute, and that at Q very obtuse. XVIII. I Q being 4 deg. 3m. 18s., and XVIII. Q. I. 127 deg. 56m. 42s., and therefore unfavourable for accurate measurement, the error in the position of Q was, however, not more than $1\frac{1}{4}$ south of true position.

Obtaining contour of rock at southern Inch Garvie piers.—The arrangements used for obtaining the contour of the rock at and about the sites of the southern Inch Garvie piers was a raft 69ft. 8in. diameter, the caissons being 70ft. diameter; on this was laid a circular road, on which a carriage travelled, carrying the drum on which the sounding line was wound. There was considerable difficulty in finding a satisfactory sounding line. Copper wire stretched and broke, and three or four sinkers were lost and considerable delay caused thereby. Fortunately, most of these mishaps occurred in sounding round the northern piers, where no great accuracy was required. The sinker eventually used was made of a bar of $\frac{5}{8}$in. iron, 10ft. long, with a lead weight cast on it about midway in its length, the whole weighing about 60 lb., and the sounding wire was of steel $\frac{1}{20}$in. in diameter, and marked at the feet with pieces of copper wire soldered on, and with brass tallies tied on with string and stamped with the number of feet from end of sinker. A 28 lb. lead sinker was also used on occasion with sufficient wire attached to it to make the length the same. The tallies frequently broke off, and had to be renewed, but though wire and other attachments were tried, nothing was found to answer so well as the string.

Setting raft for sounding.—For setting the raft four moorings were laid down and the cables brought on board to four crabs, and at the times of high and low water—the utmost time for sounding being 1 hour and 30 minutes—the cables were hauled taut, a theodolite was placed at XVIII. and another at Q, the angles necessary for bringing the raft into position were laid off, and the cables manipulated until both instruments bore on the centre of the raft, and also the theodolite at Q on a nail placed in the circumference to serve as a starting point, and to bring this point right two check ropes were used. The circumference of the raft was marked in feet, and the wire hanging 2in. clear traversed a circle 70ft. in diameter. An assistant was told off to read the tide gauge every five minutes, the traverser was set over the nail at the starting point, the sinker lowered and the level of the water read; the sinker was lifted clear of the ground and traversed 1ft. to the right, lowered again, and the same process repeated, one of the assistants on the raft booking the readings and the position of the traverser on the circumference of the raft at each five minutes so as to correspond with the tide gauge readings. If anything soft was met with the sinker was dropped until it passed through it to the rock, and then brought to the surface and inspected as to the nature and thickness of the material passed through; frequent observations were also made with a tallowed hand lead to ascertain the nature of the bottom. The rate of progress was about two soundings per minute.

Contour of rock outside piers.—Where the raft was in the position the caisson would eventually occupy soundings were taken at every foot, and the whole circumference was gone over twice. As it was desired to obtain soundings for about 35ft. outside the foundation of the caisson, the angle which would give 35ft. was calculated for each theodolite, the full angle taken in the one case and one-seventh of it in the other and the raft shifted to this position and soundings taken at every 5ft. of the circumference, then the angle on the first theodolite was altered one-seventh less, and that on the other increased one-seventh, and the raft brought into this position, and the process repeated until twenty-eight circles of soundings had been described round the first, the centres of these circles being approximately on the circumference of the first circle.

Number of soundings.—The total number of soundings taken from the raft was about 3000.

Using 10ft. sinker.—In using a sinker of 10ft. length care must be taken that it be lifted quite clear of the bottom after each sounding, as it is not easy to tell whether the point or the head is touching, the general run of the soundings must also be kept in memory so that any sounding which appears to be abnormal may be checked.

Setting caissons 70ft. in diameter in position.—It may be interesting to show how the caissons, which are 70ft. diameter at the bottom and 60ft. diameter at the top, the diameter of the temporary caisson being 61ft. 8in., were set; the means used varied in each case, but the general idea was the same. Where possible two points were marked on the stage at known distances from the true centre of the pier, one point being in the longitudinal and the other in the transverse centre line of the pier. The distance above the cutting edge was marked on the caisson in feet; four points were marked on the top of the caisson in the longitudinal and transverse centre lines, levels were taken at these four points, and the inclination of the caisson to the level of the stage was thus arrived at; then the distances from the marks on the stage were taken and added to the semi-diameter of the caisson, and thus the divergence of the caisson from its true position at the level of the stage was found, and this, corrected by the inclination, gave the true position at the cutting edge. If owing to the unreliability of the stage or other cause this course could not be adopted, then the position of the skin of the caisson was triangulated from known points and corrected for inclination, and not unfrequently both courses were pursued as checks on each other. In two cases, namely, those of the Queensferry north-east and north-west caissons, neither system was applicable on account of the distortion of the caissons, and in these cases the positions of a plumb bob and of a point in the circumference were triangulated and a survey made of the caisson at the top and bottom of plumb line, the axis of the caisson found and transferred to the level of the cutting edge. This process having been gone through once, and the actual shape of the caisson determined, it was possible to proceed as for the other caissons.

Final setting of station XVII. by triangulation.—The final setting of the Southern Inch Garvie piers, station XVII., from the northern ones, station XVIII., was made by triangulation; two points were marked down about half-way between the piers and respectively in the centre lines of the eastern and western piers, all four sides of the quadrilateral figure thus obtained were measured, and all the angles observed. Three of the triangles agreed exactly, and the difference in the fourth was ·012ft. The dimensions given by the three agreeing triangles was accepted, and when a direct measurement was eventually made the difference was $\frac{1}{32}$in. in a length of 270ft. The distance of the poles for centreing the caisson piers apart was checked by triangulation, the original measurements having been made with the rods on very side-long ground and transferred with the theodolite, the dimensions arrived at by triangulation were 59·9976ft. and 60·0043ft. respectively for 60ft. In the same way other marks near the north cantilever pier put in for the same purpose were triangulated with a resulting error of ·002ft.

Setting out wind bracing on Inch Garvie.—The lines for the wind bracing between Inch Garvie skewbacks were put in entirely with the theodolite, and the first half of the bracing, which was put in before the author left the Forth, fitted to $\frac{1}{32}$in.

Measurement between stations XIV. and XVI. with steel band.—The measurement between the south cantilever pier station XIV. and station XVI. of July, 1885, was made, not with the rods, but with a steel band, the procedure being to mark down on the stage a standard measured with the rods of 192ft. The steel band was referred to this standard with the thermometer under it; the temperature and correction for length were booked, and the band transferred to the line to be measured, the length marked down and the temperature booked. It was again referred to the standard, and this process was repeated until the whole length of about 840ft. was measured. The greatest extension of the band was $\frac{17}{32}$in., and the least $\frac{15}{32}$in., the temperature varying from 72 deg. to 78 deg.

Wire measurements between stations XVI. and XVIII.—In July, 1885, the stage being sufficiently set by the Queensferry piers, three of which were built, and the centres of the southern piers permanently fixed, it was decided to check the distance XVI.-XVIII., which, if correct, would be 1969·912ft., but which the triangulation of 1884 gave as 1969 66ft., and that of 1885 as 1969·68ft. By the wire a proper distance was therefore measured as before on the railway, and the wire stretched on three different occasions so as to test, if possible, the action of changes of temperature in it, it was, however, found to be quite impossible to deduce any result from this cause which, apparently, was not constant for the length, and did not affect the wire to any appreciable extent. The wire was placed in position July 17th and 22nd, when the results given were 1969 67 and 1969·74 respectively, and the greatest difference between them and the triangulation was ·08, and the least ·01, the average being that the distance as measured by the wire was ·035 longer than the average of the triangulated distances. On July 17th when the wire had been up a short time the wind began to rise, but though the deflection of the wire sideways, the versed sine being 23ft., amounted, as tested by the theodolite, to about 14ft., the centre did not rise above its normal position of 23ft. below the points of support, when, however, the deflection sideways was more than 14ft. it rose very rapidly, proving, it may be presumed, that up to 14ft. deflection the wire stretched to meet the extra strain put on it. The wire when placed in position on the railway showed no alteration, the difference between the observations of July 17th and 22nd being $\frac{1}{16}$in. By experiment on the railway 1in. pull on the wire gave 3in. rise at the centre and 1in. drop of wire gave a fall at centre of $3\frac{5}{8}$in.

Small triangulations.—Several small triangulations were made in different places, amongst which may be mentioned that for checking the distance between the Fife piers, the correct length as measured by rods was 154·994ft., by triangulation this was 154 992ft.

Setting out steelwork.—The whole of the steel for the cantilevers being constructed at the Forth Bridge works, it was necessary that this should be set out most accurately to agree with the setting of the piers. For setting the tubular members it was only necessary that these should be maintained in a straight line, and for this purpose at one end of the timber cradles on which the tubes were erected and drilled angle iron standards were built into brick piers, and on each standard was placed an iron plate having a 1in. hole drilled in it at a given height, and in the centre line of the cradle; at the other end was placed a timber stage, and on this a theodolite was placed and brought to the centre line of the cradle and also to the given level; then wooden pieces were fitted at the feet so that the theodolite could at any time be put up in the same position, the theodolite was levelled and brought to bear on the hole in the plate, cross strings were put in the tube to be sighted and the tube was moved until the cross strings coincided with the theodolite line. For the main tubes over the piers these lines must be parallel, 120ft. between centres and the whole must be square, also the cross lines through the centres of the bed plates must be at the proper distances apart and square to the centre lines of the tubes; to secure this a centre line parallel to one tube was carefully marked down along the line of a steel standard 400ft. long, which was put down for reference as to the proper setting out of the steel, a line was put in at each end of the drilling roads square to this, and then on the other side a line square to these and parallel to the first, and the whole of these lines were carefully measured with the rods, the possible error being found to be $\frac{1}{8}$in. The centres of the tubes, which should have been 120ft., were found to be, owing to the rods being long where this setting was done, 120ft. $0\frac{3}{32}$in., and the distances between centres of bed-plates for which the dimension was 145·037, were proved by several independent measurements to be $\begin{cases} 145·0468\text{ft. and } 145·0334\text{ft.} \\ 145·0504\text{ft. and } 145·0367\text{ft.} \end{cases}$ The measurements for the Inch Garvie bed-plates, which were done later, were correct in both directions.

Comparison of rod measurement and that made from steel standard.—The variation between two rod measurements along one side of the drilling roads, and the same measurement as made by means of the steel standard and corrected for temperature, were 433·0334, 433·0347, and 433·0359, the greatest difference being ·0025, or $\frac{1}{32}$in.

Use of steel rods for setting out steel work.—The author pointed out at an early stage of the work that the steel ought not to be set out with wooden standards, but with steel rods, which if made standard at a given mean temperature would produce work which, whatever the temperature at which it was set out, would have the same relative dimensions and the same absolute dimensions at the mean temperature, which would not be the case with work set out with wooden rods, which were, moreover, very often inaccurate in themselves, which inaccuracies those who used them had no means of checking. This was not, however, done, wooden rods being used until lately; the author, therefore, prepared the following approximate table of corrections for work set out with the wooden rods during different months in the year, which is as follows, and shows the amount of error likely to arise from this cause:—

	Average Temp.	Feet.	Feet.
Jan., Feb., March, Nov., Dec.,	42 subt.	per 100 ...	·01637
April	46	„ ...	·01398
May, October	51	„ ...	·01099
June, September	57	„ ...	·00739
July, August	60	„ ...	·00560

SCREW PROPELLER EFFICIENCY.

By Professor A. G. Greenhill.

No. V.

(56) A consideration of the previous equation (ii.) in (45), giving

$$P = \frac{1}{\rho}\frac{d\varpi}{dr} - \frac{w^2}{r}$$
$$= 8\pi^2 nr\left(n - \frac{u}{q}\right) + 4\pi^2 r^2 \frac{u^2}{q^3}\frac{dq}{dr},$$

shows that, for the above motion and equations to hold, a certain radial component of impressed force P must be supplied from the reaction of the propeller blades, and this is effected by curving the blades spirally backwards in a certain empirical form, as is the propellers of Hirsch, Dundonald—Fig. 14—and Thornycroft—Fig. 15. These figures are taken from an article, "*Recherches Analytiques sur l'Effet de la Courboure de la Génératrice et de la Directrice*

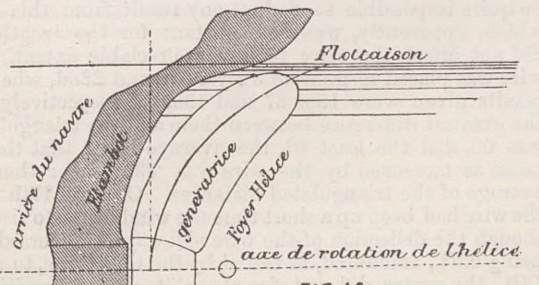


FIG 14

dans le Travail des Hélices," par M. le Lieutenant de Vaisseau du Rocher du Quengo, published in the *Revue*

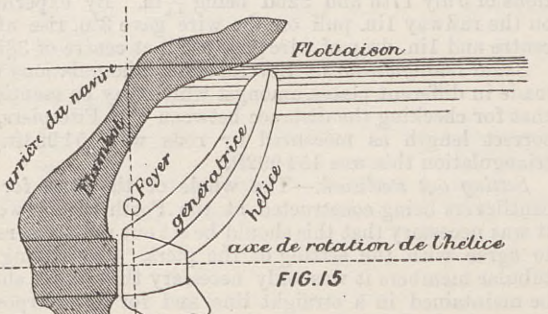


FIG.15

Maritime et Coloniale, June, 1881 — an article which received the Plumey Prize of the French Academy of Sciences, 1885.

Exactly as in the theory of the Turbine—Unwin, "Water Motors"—the chief point to be considered is the curvature at the tips of the blades, any fair curve continued up to the boss of the propeller being practically immaterial.

(57) As a numerical illustration, take the case of the s.s. Normandie, described in *Engineering*, February, 1884, as of 7656 tons displacement, and of I.H.P. 8000 for 63 revolutions a minute and a speed of $17\frac{1}{4}$ knots, the diameter of the propeller being 22ft., and the pitch varying from 31ft. to 32ft.

Then with our units, taking 6086ft. to a nautical mile, $u = 29{\cdot}16$, also $n = 1{\cdot}05$, $d = 22$.

In order to receive the water without shock, the initial pitch of the propeller should be $\frac{u}{n} = 27{\cdot}7$; but in the actual propeller, the pitch increasing from 31ft. to 32ft., the mean value of $p = 31{\cdot}5$, and the mean speed of the screw $n p = 33{\cdot}075$.

Then the mean apparent slip

$$s = 1 - \frac{u}{n p} = {\cdot}12,$$

and the percentage of apparent slip is 12.

Neglecting at first the speed of the wake, and supposing the blades of the propeller fan-shaped, so as to form a complete column of revolution in the wake, rotating with uniform angular velocity

$$2\,\pi \left(n - \frac{u}{p}\right),$$

when p denotes the final pitch of the propeller; then from the formula

$$L = m\,(A^2 - B^2)\,u \left(n - \frac{u}{p}\right),$$

we shall find

$$L = 103{,}100,$$

putting $p = 32$, and supposing the diameter of the boss one-third the diameter of the propeller; so that

$$\frac{B}{A} = \frac{1}{9};\ \frac{B^2}{A^2} = \frac{1}{81};$$

also m is put equal to 2 for sea water, of density 64 lb. to the cubic foot, when L is measured in foot-pounds of moment.

Then, for turning the propeller, the requisite

$$\text{I.H.P.} = \frac{2\,\pi\,n\,L}{550} = 12{,}400;$$

55 per cent. more than the total observed I.H.P. 8000.

(58) Suppose, however, the speed of the wake is one-tenth the speed of the vessel; then in the above formula for L we must put

$$u = 26{\cdot}25,\ p = 32,\ n = 1{\cdot}05;$$

so that $n p = 33{\cdot}6$;

and now the real slip of the propeller in the water

$$s = 1 - \frac{u}{n\,p} = {\cdot}22,$$

or 22 per cent.

Then we shall find

$$L = 173{,}100, \text{ about};$$

and now the requisite

$$\text{I.H.P.} = 20{,}750;$$

two and a-half times what was really required.

This shows incidentally that by increasing the size of the blades by making them more fan-shaped, as in tug and torpedo boats, we can with moderate diameter utilise enormous power for purposes of propulsion. For instance, in a torpedo boat constructed by Shichau, of Elbing, a propeller 2·2 metres in diameter used up 1500 I.H.P. at a speed something over 20 knots.

(59) Returning to the Normandie, we see that the propeller must have been more of the shape described in (52).

Such a propeller of the same diameter and final pitch would require

$$\frac{2\,B}{A + B} = \frac{1}{5}$$

of the above I.H.P., and therefore 4150-H.P., since $\frac{B}{A} = \frac{1}{9}$, if we assume the diameter of the boss one-third the diameter of the propeller.

But with 8000 I.H.P. and an engine efficiency of ·8, and a propeller efficiency of ·78, the slip of the propeller in the water being ·22, then the thrust horse-power—T.H.P. in the "Determination of the most Suitable Dimensions for Screw Propellers," by R. E. Froude, Trans. I.N.A., 1886—will be

$$8000 \times {\cdot}8 \times {\cdot}78 = 5000;$$

implying at a speed of $17\frac{1}{4}$ knots a thrust in tons

$$\frac{5000 \times 326}{17\frac{1}{4} \times 2240} = 42{\cdot}2.$$

Supposing the "augmentation" of resistance due to the action of the propeller is 40 per cent. of the net resistance to towing, equivalent to supposing the hull efficiency to be $\frac{5}{7}$ (Trans. I.N.A. W. Froude, 1876; R. E. Froude, 1886), then the net resistance at this speed should be about 30 tons, and the E.H.P., that is, the horse-power due to net resistance of vessel, should be about 3571; so that the efficiency is about 45 per cent.

Assuming that the net resistance is due to surface friction, with a co-efficient of ·23 lb. per square foot at 6 knots, this net resistance of 30 tons implies a wetted surface

$$S = \frac{30 \times 2240 \times 6^2}{{\cdot}23 \times (17\frac{1}{4})^2} = 35{,}320 \text{ square feet.}$$

The dimensions of the Normandie were given as—length, 460ft.; breadth, 50ft.; depth, $37\frac{1}{2}$ft.; and draught, $20\frac{1}{2}$ft.; and the average speed on a voyage is said to be 16 knots; but in order to make accurate calculations of her performance, further details of the shape of the propeller and the lines of the hull as affecting the speed of the wake are requisite.

(60) The "augmentation" of the net resistance due to the action of the propeller is still an unexplained difficulty in the theory of the subject. Rankine allowed for it by augmenting the wetted surface according to an empirical rule, using this "augmented surface" in calculating the thrust resistance. But Froude treats the augmentation as due to a sucking action of the propeller, causing a diminution of pressure in front of the propeller and on the stern of the vessel equivalent to an increased head resistance, and uses the empirical rule that this augmentation should be taken as 40 per cent. of the net resistance to towing the hull without any propeller.

Suppose, for instance, in the Normandie that the action of the propeller caused a diminution of 5 per cent. in the pressure in front; the resultant augmentation would be one-twentieth of the hydrostatic thrust on the disc, and of the propeller; equivalent with a propeller 22ft. in diameter, just immersed, to

$$\frac{1}{20} \times 64 \times \frac{1}{4}\pi \times (22)^3 \div 2240 = 12$$

tons nearly; agreeing with the above results.

If the augmentation is large, due to some peculiarity of design, then the propeller will on starting tend to drive the vessel astern, whichever way it goes; an instance of this kind has been given by Sir Frederick Bramwell—"Marine Propellers," by S. W. Barnaby, p. 23.

I beg to express my thanks to M. Lisbonn for kindly pointing out the numerical error in (35), and thus producing a more satisfactory practical result, namely, that a slip of about 8·4 per cent. gives the greatest efficiency in certain cases when fluid friction is taken into account; and I hope that he will continue to verify and check these calculations.

V.—Comparison of the Efficiency of the Paddle Wheel and the Screw Propeller.

(61) The paddle wheel acts on the surface of the water, driving a current astern, and the momentum generated in this current per second is equal to the thrust on the paddle shaft; the paddle wheel must therefore be compared in its action to the impulse turbine.

Denoting by n the number of revolutions a second of the wheels, p the circumference of the circle passing through the centre of pressure of the floats, a the area of a pair of floats, and u the velocity of the vessel in feet per second, then neglecting the wake-producing effect of the vessel in the water in which the wheel acts, every second a quantity of the water $m\,a\,u$ lb. has a velocity $n p - u$ imparted to it, and therefore the thrust on the paddle shaft

$$T = m\,a\,u\,(n p - u).$$

Comparing this with the action of the screw propeller, we see that p corresponds to the pitch of the screw, and $\frac{a\,p\,c}{2\,\pi}$ to $A^2 - B^2$. Also $\frac{u}{n}$ is the circumference of the "apparent rolling circle," corresponding to the pitch of the screw of zero slip (Rankine, "Trans. I. N. A.," 1865, p. 22).

The "apparent rolling circle" is the circle on the wheel, which appears to advance by rolling on a fixed horizontal plane a little above the surface of the water, as if teeth on this wheel engaged on a horizontal rack at this level.

(62) Then the turning moment of the engines

$$L = \frac{T\,p}{2\,\pi} = \frac{m\,a\,u}{2\,\pi}\,(n p - u),$$

and the efficiency of the paddles

$$e = \frac{T\,u}{2\,\pi\,L\,n} = \frac{u}{n p};$$

also the slip ratio

$$s = 1 - \frac{u}{n p} = 1 - e,$$

or, $e + s = 1$,

as before, for a screw propeller (7).

The loss of energy per second by the paddles

$$2\,\pi\,L\,n - T\,u = m\,a\,u\,(n p - u)^2$$

of which one-half is carried away by the wake, the other half being the loss of energy due to the shock of impulse of the floats in the water.

(63) The thrust T for a given speed u being determinate, the value of $n p$ is determinate, except by change of a, so that the only way of increasing the efficiency of paddle wheels is by increase of a, the area of a pair of floats, keeping the product $a\,(n p - u)$ constant.

Taking the formula for the resistance R in pounds, as

$$R = {\cdot}23 \times S \times \left(\frac{\text{speed in knots}}{6}\right)^2 = {\cdot}00234\,S\,u^2,$$

where S denotes the area of wetted surface, and u the speed in feet per second; then without "augmentation" R = T, enabling us to determine the ratio of a to S, when u and $n p$ have been decided upon.

(64) But in the case of the paddle wheel we can see one cause of the "augmentation" and determine its corresponding value. For if b denotes the breadth of a float measured radially, then the stream of water acted upon is of depth b in front of the wheel, supposing a float just immersed when vertical; but behind the wheel this stream, being driven past the vessel with relative velocity $n p$, is of depth $\frac{b\,u}{n p}$ only, so that there is a fall in the mean level of the water behind the wheel

$$b\left(1 - \frac{u}{n p}\right).$$

This fall of level is sufficient to produce an "augmentation" of resistance equal to a hydrostatic thrust of a head of $b\left(1 - \frac{u}{n p}\right)$ feet of water, acting over the midship section, B suppose, of the vessel; so that now

$$T = {\cdot}00234\,A\,u^2 + 64\,b\,B\left(1 - \frac{u}{n p}\right) = 2\,a\,u^2\left(1 - \frac{u}{n p}\right);$$

the augmentation of resistance being

$$64\,b\,B\left(1 - \frac{u}{n p}\right) = \frac{32\,b\,B}{a\,u^2}\,T = \frac{16\,B}{c\,u^2}\,T,$$

when c denotes the length of the floats of each wheel. Therefore the net efficiency of the paddles in overcoming the net resistance of the vessel is

$$\frac{u}{n p}\left(1 - \frac{16\,B}{c\,u^2}\right).$$

(65) The question of Screw *v.* Paddle was still a disputed point up to twenty years ago or less ("Trans. I. N. A." 1865, p. 163) though now the preponderating number of screw steamers seems to have finally settled the question, the disputed point now being chiefly the relative advantages of twin and single screws. Paddle steamers still hold their own for navigation in shallow water, but in deep water navigation the screw steamer has the advantage because all parts of the propeller are simultaneously at work, while only one or two pairs of floats of a paddle-wheel are in action at a time; besides the screw engine working with more revolutions can be made of less size and weight for the same work.

(66) The feathering paddle may be supposed equivalent to a mechanical arrangement which lays hold of the water without shock and gradually imparts a velocity $n p - u$; and is therefore analogous to the screw propeller of increasing pitch, increasing from $\frac{u}{n}$ to p.

Then since

$$2\pi\,L\,n - T\,u = \text{loss of K. E. in wake} = \tfrac{1}{2}\,m\,a\,u\,(n p - u)^2,$$

and $T = m\,a\,u\,(n p - u)$, the momentum generated in the wake, as before; therefore,

$$2\pi\,L\,n = \tfrac{1}{2}\,m\,a\,u\,(n^2\,p^2 - u^2),$$

and the paddle efficiency

$$\frac{T\,u}{2\pi\,L\,n} = \frac{2\,u}{n p - u} = \frac{1 - s}{1 - \frac{1}{2}s},$$

where the slip ratio $s = 1 - \frac{u}{n p}$, as before; so that the paddle efficiency is increased by this feathering arrangement.

(67) The oar is generally adduced as one of the most efficient modes of propulsion, the water acted upon being gradually put into motion, and in this respect the oar resembles in its action the feathering paddle wheel, and the screw propeller of properly increasing pitch.

But in the propulsion of a boat by oars, particularly a light racing boat, the problem is complicated by the backward and forward motion of the bodies of the oarsmen.

Thus the forward (*i.e.*, sternward) motion of the bodies between the strokes tends to keep up the way of the boat while the oars are out of the water; the way of the boat being most checked by the backward momentum of the bodies at the moment the oars catch the water again. With the oar too there is no "augmentation," as the blades act at a sufficient distance from the boat to make their disturbance of the water inappreciable at the boat.

(68) In the ideal feathering paddle-wheel the float should enter the water with relative velocity zero, gradually increasing to $2\,(n p - u)$, so that the average velocity through the water is $n p - u$; and then, the area of a pair of floats being a, the thrust T equals momentum generated per second equals $2\,m\,a\,u\,(n p - u)$, so that for the same thrust T, at the same speed u, the area a of a pair of floats need be only one half what is requisite with a non-feathering paddle-wheel. Since there is now no loss by shock of impulse on the floats,

$$2\,\pi\,L\,n - T\,u = \text{loss of K. E. in the wake per second} = 2\,m\,a\,u\,(n p - u)^2;$$

so that

$$2\,\pi\,L\,n = 2\,m\,a\,n\,p\,u\,(n p - u);$$

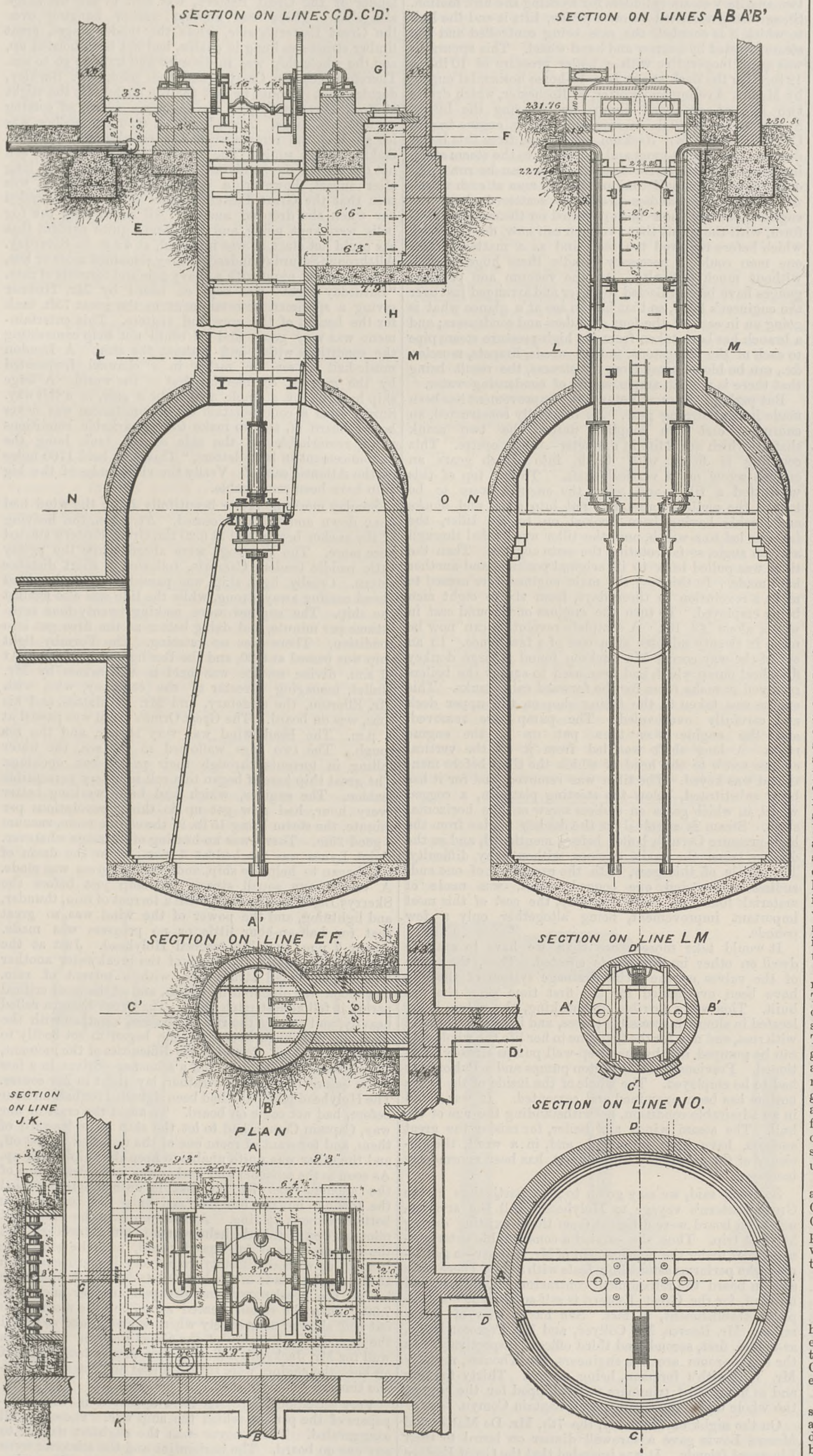
and the paddle efficiency

$$\frac{T\,u}{2\,\pi\,L\,n} = \frac{u}{n\,p} = 1 - s,$$

the same as for a non-feathering wheel; but now the area of the floats may be diminished one-half.

PETERSFIELD WATERWORKS.

MR. HENRY ROBINSON, M.I.C.E., WESTMINSTER, ENGINEER.



The augmentation of resistance, however, due to the increased sternward velocity of the wake will be now

$$64\,\mathrm{B}\,h\,\frac{np-u}{np-\frac{1}{2}u},$$

instead of

$$64\,\mathrm{B}\,h\left(1-\frac{u}{np}\right).$$

(69) Let us apply these formulæ to the case of the paddle steamer Admiral, considered by Rankine—Trans. I.N.A., 1865, p. 22.

Here p is the circumference of a circle of radius 10·25ft.; so that $p = 64{\cdot}4$.

Also, the revolutions being 24 a minute, $n = 0{\cdot}4$; so that $np = 25{\cdot}76$.

The slip s being ·22, therefore $u = 25{\cdot}76 \times {\cdot}78 = 20{\cdot}09$, equivalent to 11·89 knots.

Also the area of a pair of floats a was 42 square feet. Therefore, with non-feathering paddles, the thrust is

$$\mathrm{T} = 2\,a\,u\,(np - u) = 9570.$$

But with feathering paddles, as in (68), the thrust is doubled, and

$$\mathrm{T} = 19{,}140,$$

against the number 12,271, given by Rankine.

(70) Supposing the midship section is 50 square feet, and the paddles each 3ft. broad and 7ft. long, then the thrust deduction or augmentation due to fall in level of the wake, would, with non-feathering paddles, be

$$64\,\mathrm{B}\,h\left(1-\frac{u}{np}\right) = 2112\ \mathrm{lb.},$$

implying a net resistance of

$$9570 - 2112 = 7458\ \mathrm{lb.}$$

But with paddles, feathering as in (65), this augmentation would be

$$64\,\mathrm{B}\,h\,\frac{1-\frac{u}{np}}{1-\frac{1}{2}\frac{u}{np}} = 2400;$$

implying a net resistance of $19{,}140 - 2400 = 16{,}740$ lb.

In the first case, the horse-power consumed by the paddles would be

$$2\pi\,\mathrm{L}\,n \div 550 = 304{\cdot}65,$$

but with feathering paddles, double this number, namely, 609·3.

The I.H.P. being 744, the first case implies an engine efficiency ·468, and the second case ·936.

But the feathering paddles, working as in (66) would require 448-H.P. to drive them, implying an engine efficiency ·6.

PETERSFIELD SEWERAGE AND WATERWORKS.

THE town of Petersfield, Hants, has just been provided with a sewerage system, and with waterworks, under the advice of Mr. Henry Robinson, C.E., of Westminster, and their completion was the occasion of a public celebration on the 26th July, by the sanitary authority of the district. Of these works we published one page of engravings in our last impression, and their illustration we complete by the engravings we now publish herewith and on page 304. The want of a proper sewerage system has long been felt, to prevent the serious pollution of the pretty river Rother, which flows through the town. The preliminary steps to secure the carrying out of these works have been the occasion of several Local Government Board inquiries. The town, having a population of about 2000, is situated in a valley, with the chalk downs rising at a distance of two miles to the north-west and south-west. Dipping away below these are the Upper Greensand beds overlying the impermeable Gault clays. Then follow the lower Greensand, the Folkestone, Sandgate, and Hythe beds, which rest on the Atherfield clay beds, which again join the Weald clay. The strata have a general south-west dip under the chalk, falling away with an articlinal roll which passes through Petersfield. The water supply is derived from the Hythe beds by a shaft with collecting chamber, 16ft. in diameter, and adits. The selection of a spot for sinking the shaft required a good deal of consideration, as overlying the Hythe beds are the Sandgate beds, which contain ferruginous gravel, and the water derived therefrom would be unfit for use. A spot was selected by the engineer near the outcrop of the Sandgate beds; and a shaft sunk to a depth of about 60ft. struck water of great purity and softness, entirely free from iron, and sufficient in quantity for the present requirements of the town. Before completing the underground works in this shaft, the engineer sunk a borehole to test the strata beneath, and an additional spring was struck of great volume and excellent in quality, at a further depth of 21ft. The water thus secured is sufficient for a town many times the size of Petersfield. At this spot a permanent pumping station has been erected, as shown on page 287 *ante*. The water is raised by duplicate horizontal engines connected by gearing with the pumps. They are of the following dimensions:—Steam cylinders, 7¾in. in diameter, 14in. stroke; 3in. diameter crank-shaft, working in phosphor bronze bearings; fly-wheel 5ft. in diameter and 6in. wide. Each boiler and engine works a set of three-throw pumps having a 5in. suction pipe, 5in. diameter barrels, 12in. stroke. The water is delivered through a 6in. rising main into a covered reservoir holding 180,000 gallons, which commands the highest building in the town. The engines are capable of raising 8000 gallons of water from a depth of 75ft., and forcing it through a 6in. rising main, 600 yards long, to a level of 90ft. From this reservoir it is distributed by pipes from 6in. to 3in. in diameter throughout the town.

The sewerage of the town has been carried out on the "separate system," by which the large bulk of the rainfall is excluded. The sewers are 6in. and 9in. in diameter, delivering into a 12in. outfall. They are stoneware pipe sewers, concreted where necessary, and with a length of iron pipe through some bad ground. The gradients vary from 1 in 30 to 1 in 400, which is the gradient of the outfall sewer. At all "dead ends," Field's automatic flushing tanks are placed. At all changes of direction manholes and lampholes are placed. The sewage discharges by gravitation to screening tanks, and then to a plot of land of about two acres, which has been carefully prepared for the filtration of the sewage. Illustrations of these works are shown on page 304. Arrangements have also been made whereby the sewage and sludge can be conveyed over adjoining land for utilisation.

The contractor for the sewerage works, and for the engine and boiler houses, shaft, and reservoir, was Mr. Dearle, of Chichester. The contractors for the water pipes were Messrs. Gould and Mackay, of Southampton. The engines, boilers, pumps, &c., were supplied by Messrs. Warner and Sons. The whole of the work was designed and carried out by the engineer to the Board, Mr. Henry Robinson, M. Inst. C.E., Westminster.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—James D. Chater, chief engineer, to the Swallow; Harry G. Andrews, assistant engineer, to the Swallow; Charles E. Stewart, staff engineer, to the Galatea; C. W. Thorne, engineer, to the Elgerine; and Charles Dawe, chief engineer, to the Curlew, re-appointed on promotion.

MINING IN NEW ZEALAND.—The Bay of Islands Company is steadily increasing its weekly output of coal. Last week there was an average of 120 tons in the twenty-four hours, being 772 tons during the week sent down for export to Opua by train. The boring operations of the company have at last shown more favourable results, and from an outcrop of a 2ft. seam, about one mile eastward of the works, and on the company's land, which is supposed to be the continuation of the valuable seam now being worked, steps are being taken to open up an intermediate shaft, to get at the leader, and work it with a tram road to the point of export. It is calculated that this extent of seam will give full employment and the best of coal for fully fifteen to twenty years to come, from the vast extent of this seam now exposed at both ends, a matter of very great importance to our struggling community. The operations of the Prospecting Company—Messrs. Masefield and Co.—have not recommenced on the new site for boring yet, but all the boring tools and apparatus arrived by the last week's steamer, and another trial is at once to be made. The work at the two places where manganese is now being mined has made some progress. A large amount of the ore is on the surface, but owing to the state of the roads, and the continuous wet weather, there has not been any exported for some time, and as the County Council refuse to repair the road, application will be made to the Government, as the railway to Opua would be largely benefitted in the transport of this ore to Opua from Kawakawa.—*New Zealand Herald.*

THE GREAT EASTERN STEAMSHIP.

In our impressions for May 7th and 14th will be found an account of the voyage of the Great Eastern Steamship from Milford Haven to Liverpool. She remained there until last Friday, and during the five months that she was at anchor in the Sloyne she was visited by nearly 600,000 persons. It will be remembered that she was purchased last spring by Mr. De Mattos, and that Messrs. Lewis, of Liverpool, made arrangements with him for employing the huge vessel as a show ship. The agreement having terminated, it was decided that the great ship should be taken to Dublin, there to remain on show during the winter, while in spring she is to proceed to Havre, and there lie during the time the Havre Exhibition is open. The Liverpool port authorities regarded with some apprehension the stay of the ship during the winter, in a tideway up and down which the water rushes at five or six miles an hour; and the Dublin port authorities have thrown every possible obstacle in the way of her admission to the Liffey, for reasons not quite so obvious. In Dublin she would lie in the Alexandra basin, at the back of the great wall constructed by Mr. Stoney of béton blocks weighing 30 tons each, and quite out of the tideway. However, these objections were at last overcome, and on Friday the Great Eastern left Liverpool for Holyhead, there to be exhibited for a short time. Before describing her voyage we must say something concerning the work that has been done in the machinery department during the period the vessel lay in Liverpool.

It will no doubt be remembered that very great difficulties were encountered last May in getting the screw engines, after lying idle for twelve years, to start. At first no fewer than twenty-four men were required on the reversing wheels on the starting platform to get the link motion up or down, an operation which even then required nearly half-an-hour. A complete change in this department has been effected by Mr. Jackson, the chief engineer of the ship. It will also be remembered that a mysterious accident occurred to the main steam pipe, three holes being punched, so to speak, in it from the inside when the pressure in it did not exceed 5 lb. The cause of this has been found, and there is no longer need for any hypothesis about the percussive action of water. One of the first things done by Mr. Jackson on the arrival of the ship in Liverpool, was to have the steam pipe examined and repaired. It is of wrought iron, rivetted like a boiler shell, and no less than 4ft. 6in. in diameter outside—that is to say, in the vertical portion of it in the engine room. A short distance above the junction of the two branch pipes leading to port and starboard, was fixed a throttle valve, 4ft. in diameter, working inside a ring which contracted the passage through the pipe to an orifice 4ft. in diameter. This throttle valve was of cast iron, about 1½in., thick, and ribbed to strengthen it. The valve turned on two gudgeons of gun-metal, 2½in. in diameter, cottered into bored bosses. One gudgeon was prolonged through a stuffing box, and fitted with a lever worked by a hand wheel and screw from the engine-room. What object Messrs. Boulton and Watt had in putting in this huge affair it is impossible to divine, seeing that there are besides no fewer than four throttle valves, one to each cylinder, in the steam branches. The valve was quite too weak in the gudgeons for the load to be carried. The area of the valve was 1809 square inches, and when the boiler pressure reached 20 lb. a load of 1809 × 20 = 36,180 lb., or over 15½ tons, had to be carried by the spindles. On the trip from Milford one of the gudgeons gave way, the throttle valve broke in half, and the sharp edges of one portion falling a height of about 6ft., knocked three holes in the steam pipe. The other half of the valve, that fitted with the lever which moved it, remained in place; and until Mr. Jackson entered the steam pipe nothing was known of the smash. Mr. Jackson examined the steam pipe thoroughly, and found it in a condition simply appalling. With great ease he drove his hammer through it in many places; and portions of the plates cut out he has retained for inspection in the smith's shop on board the ship. These more resemble old rusty iron tea-trays than sound plates. The lives of all in the engine room hung on a thread during the trip from Milford; and it is to be remembered that the machinery of the ship had been surveyed by the Board of Trade and pronounced seaworthy in every respect. We do not know who the inspectors were, but we do not hesitate to state that there was a scandalous neglect of duty somewhere. The inspectors seem never to have entered the steam pipe; and yet its enormous dimensions and its old age must have called attention to the absolute necessity which existed for inspecting it with as much if not more care than the boilers. If it was examined and passed as safe, then the examiners did not know their duty, for, as we have said, it was only necessary to use a light hand hammer to discover that it was decayed to the last degree. If they did not get into it and sound it, then they grossly failed in their duty. At any moment a piece of the steam pipe as large as this page might have been blown out in the engine room, at a time when there were thirty men in it, not one of whom would have escaped being literally boiled to death; and the consequences would not, we need hardly tell our readers, have been confined to the engine-room. If such a disaster had happened, the reputation of the marine department of the Board of Trade would have been ruined. As it is, in what a position is this public body placed! What can be urged in defence of those who granted a certificate to a steam ship with machinery in such a condition? Mr. Jackson has had all the bad plates cut out and made good with new plates. The pitting and decay are very irregular, and largely confined to the vertical pipe. All the other portions are more or less corroded, but not sufficiently so to weaken the pipe materially, and the whole length having been carefully scraped, ventilated, and dried, was given two coats of Portland cement wash, so that further deterioration is not to be feared. The boilers have been carefully overhauled, and were tested by the Board of Trade up to 40 lb. hydraulic pressure without any evidence of weakness; so that as the safety valves blow off at 18 lb., there is nothing to be feared in this direction.

The improvements effected in the engine-room by Mr. Jackson supply an interesting illustration of what can be done by an engineer of ability with very small resources. With practically nothing but what was to be found in the ship, Mr. Jackson has revolutionised the system of handling the engines. It will be remembered that there are two auxiliary steam cylinders for working the link motion. Steam being admitted below a piston, lifts it and the link to which it is coupled, the rate being controlled and the steam assisted by a screw and hand wheel. This apparatus was quite inoperative with a boiler pressure of 10 lb. or 12 lb. On the deck above is a 10-horse horizontal engine by Messrs. Aveling and Porter, of Rochester, which drives two sets of deep-well pumps for clearing the bilges. Steam at about 60 lb. is supplied to this engine from a Cornish boiler. Mr. Jackson led a pipe from this boiler down to the engine-room and coupled it to the steam starting gear, and with 50 lb. steam the links can be run up or down in less than half a minute by one man at each wheel. All the various handles previously scattered about the engine-room have now been collected on the starting platform, with the result that two men can now do the work which before required ten men, and as a matter of fact one man could if necessary handle these huge engines without much difficulty. All the vacuum and pressure gauges have been collected together and arranged just over the engineer's head, so that he can see at a glance what is going on in each of the four cylinders and condensers; and a branch has been taken from the high-pressure steam pipe to each of the Kingstons, so that weeds, limpets, muscles, &c., can be blown away from the strums, the result being that there is now an ample supply of condensing water.

But perhaps the most noteworthy improvement has been made in the turning gear. As originally constructed, an enormous cast iron coupling unites the two crank shafts—which are 24in. in diameter—in the centre. This coupling is fitted with teeth, into which gears an endless screw on a vertical shaft. To the top of this was fitted a tiller, and when the engines were to be turned the endless screw was put into gear, and blocks and tackle having been hooked on to the tiller, the fall was led to a winch, and the tiller was pulled through a given angle, so far rotating the main engines. Then the tiller was pulled back to its original position, and another haul made. In this way the main engines were caused to make a revolution in three days, from six to eight men being employed. To turn the engines once round cost in wages alone £4 10s. A complete revolution can now be made in twenty minutes at a cost of a few pence. In an out-of-the-way corner Mr. Jackson found a large donkey fly-wheel pump which had been used to supply the boilers removed to make room for the forward cable tanks. This engine was taken to the fitting shop on the upper deck and carefully overhauled. The pump was removed, and the engine was then put up in the engine room. A long shaft was led from it to the vertical endless screw to the head of which the tiller before mentioned was keyed. The tiller was removed, and for it has been substituted, below the starting platform, a cogged wheel, in which gears an endless screw on the horizontal shaft. Steam is supplied to the donkey engine from the high-pressure Cornish boiler before mentioned, and so the donkey turns the main engines without any difficulty. The whole of this gear, with the exception of one endless screw and one cogged wheel, was made of materials found on board the ship, the cost of this most important improvement, being altogether only a few pounds.

It would take more space than we have to spare to dwell on other improvements effected. Thus, the whole of the valves on the entire drainage system of the ship have been overhauled for the first time since she was built. This was a terrible undertaking, the valves being located in almost inaccessible places, and in most cases solid with rust, and now for the first time in her life the whole ship can be pumped dry by the deep-well pumps already mentioned. Previously the Downton pumps and a Pulsometer had to be employed. The whole of the inside of the ship's bottom has been examined and cemented. It was found in an admirable condition, notwithstanding the age of the hull. The steam winch and boiler, for raising the great anchors, have been improved, and, in a word, the efficiency of the machinery throughout has been enormously increased.

So much said, we may go on to give particulars of the Great Eastern's voyage to Holyhead. All the arrangements on board were different from those existing during her first trip. Thus she carried a considerable entertainment staff, under the management of Mr. Hubner—a gentleman who performs astonishing feats with a rifle. There were also on board the refreshment contractor, Mr. Powell, and his staff, for the Great Eastern is self-supporting—a complete establishment, in fact. She has a crew of thirty sailors; Mr. Reeves, Mr. Collyer, and Mr. Freeston being, as before, first, second, and third officers respectively. In the engine-room are five engineers, Mr. Thomas, recently Mr. Beckwith's foreman, being second. Thirty firemen and as many coal trimmers were shipped for the voyage, the whole under the command of Captain Comyn.

On the night of Thursday, the 7th, Mr. De Mattos and Messrs. Lewis gave a farewell dinner on board to their Liverpool friends. It was intended that the Great Eastern should sail about 2 p.m. on Friday. Two of the anchors had already been got, out of the four which she had down. The forenoon was spent in getting the other two. One was raised with its chain by Mr. Gibney by means of a steam anchor barge. The other was raised by the ship's windlass. It was a long job in both cases, as the anchors, after lying five months in the river, had become deeply imbedded. However, about 5 p.m. a start was made. The engines behaved beautifully. The vessel was taken in tow by two powerful tugs, the Ranger and the Rescue. Mr. Gibney was left to follow with the anchor he had weighed, to be taken on board further down the stream. The ship went out against a strong tide and made little headway, as her bottom is probably in a worse condition—if that be possible—than it was when she came round from Milford. The engines made about twenty revolutions per minute. The landing stages and every available place were covered by crowds come to see the big ship off. After proceeding for some distance it was found that Mr. Gibney in his steam barge could make no way against the tide with an 11-ton anchor hanging over his bows, so the Cambria, the tender of the Great Eastern, was sent to tow the barge alongside. There was another anchor hanging over the Great Eastern's side, while the tender stages, great timber structures hung in chains, had not been hoisted up, and the whole ship was in disorder and unfit to go to sea. Therefore Captain Comyn, and the pilot, Mr. Buckley, decided that it would be best to drop anchor for the night at Rock Ferry, and give Mr. Gibney a chance of coming up with his barge. Accordingly at 6 30 the anchor was let go, and the remainder of the evening was spent in making things snug. The weather was perfect, the sun hot during the day, and only a gentle breeze. Not long after sunset, however, a dense fog set in, and it was seen that the Great Eastern's usual good luck attended her when she dropped anchor. All night long the fog bells were kept going, and it became quite evident that she could not start, as was intended, at 4 a.m. on Saturday. All through Saturday, indeed, the fog remained more or less, breaking up at night with a heavy gale and torrents of rain. "Saturday night" was kept on board by Mr. Hubner giving a specimen entertainment in the great 75ft. tank for the benefit of the crew and visitors. This entertainment was very good; and we could not help contrasting the conditions within and without the ship. A London music-hall at sea, or rather in a channel frequented by the greatest commercial fleet in the world. A huge ship hanging by a single anchor in a gale, in a tideway. Surely such a concatenation of circumstances was never before heard of, and to make the remarkable conditions more remarkable, on the side of the tank hung the announcement in large letters, "This tank held 1760 miles of the Atlantic cable." Verily the vicissitudes of the big ship have been remarkable.

Sunday morning broke beautifully fine; the wind had gone down and the rain ceased. At 5 a.m. the heaving of the anchor began, and at 6.20 the Great Eastern started once more. The two tugs were ahead, while the pretty little paddle tender, Cambria, followed a short distance astern. Crosby light ship was passed at 7.50, the wind ahead coming away strong, while the tide was also against the ship. The engines were making twenty-four revolutions per minute, and doing better as the fires got into condition. There was no priming. The Formby light ship was passed at 8.20, and the Bar light ship at 9.5. At 11 a.m. divine service was held in the saloon by Mr. Hallet, managing director of the company, who, with Mr. Ellerton, the secretary, and Mr. De Mattos, and his sons, was on board. The Great Orme's Head was passed at 1 p.m. The head wind was very strong, and the sea rough. The two tugs wallowed in the sea, the water falling in torrents through their paddle-box openings. The great ship herself began to a roll in a very perceptible fashion. The engines, which had been working better every hour, had now got up to thirty revolutions per minute, the steam being 15 lb. in the engine-room, vacuum a good 25in. There was no heating of bearings whatever. Point Lynas was reached at 1 p.m., when the drain of tide began to help the ship, and good progress was made. A very heavy squall struck the ship just before the Skerrys Light was reached, with a torrent of rain, thunder, and lightning, and the power of the wind was so great that for half-an-hour little or no progress was made. About 7 p.m. the ship reached Holyhead. Just at the moment she passed the head of the breakwater another tremendous squall struck her, with a torrent of rain. The moon was obscured by clouds, and at the most critical period it fell almost pitch dark. The Great Eastern rolled heavily, and getting the run of the sea, together with the wind, on her huge broadside, she began to set bodily to leeward very fast. To add to the difficulties of the moment, two vessels—a barkentine and a schooner—driven in a few hours before by stress of weather, lay right in her course. The Holyhead pilot, who had been signalled for half an hour before, had not come on board. To avoid the craft in her way, Captain Comyn had to let the ship go to leeward of them, and for want of room one of the tugs had to cast off, and the other was quite unable to keep the ship's head up. As soon as the schooner and barkentine were cleared one of the anchors was let go, but it unfortunately fouled the towing hawser inboard, and only just touched the bottom without holding. At this juncture the Holyhead pilot came on board; the helm was put hard a starboard, and the engines turned full speed ahead, and the ship was brought up without difficulty from a very dangerous position at the Anglesea side of the harbour to her berth under the lee of the breakwater, and dropped another anchor at 7.30. Then the squall cleared away, and the moon came out and showed us precisely where we were, and so ended the second recent voyage of the Great Eastern. It speaks well for Mr. Jackson's handling gear that in less than half an hour the engines were turned ahead and astern twenty-one times.

Very sensational accounts have appeared in the newspapers of the peril in which the ship was. These are all exaggerated. There never was the slightest danger to any one on board. The barkentine and the schooner were in considerable peril of being run down at one time owing to the drift of the great ship. She herself was for a couple of minutes too close to the shore to be pleasant, but she never was in shallow water. The whole of the trouble was due to three causes:—First, the heavy squall with its attendant darkness; secondly, the presence of two vessels where they had no business to be, and from which they had been ordered by the harbour master, and in which they remained contrary to his orders; and lastly, the absence of the Holyhead pilot, who, if he had been on board in good time, would have known the precise position of the intruders, which could not be known accurately in the darkness by Captain Comyn. The fact that the Great Eastern was got so easily and safely out of her difficulties as soon as her precise position was ascertained goes far to prove that she is not a difficult vessel to manage. If only her bottom was clean there would be no trouble whatever with her, as she steers beautifully even at the five miles an hour which seems to be her best speed, even when the screw is going about 12 knots.

On Monday the ship was thrown open, and about 1000 visitors came on board. In the evening her deck was lighted by forty Jablochkoff lamps. The lighting arrangements are in charge of Mr. Mitchell, representing the Jablochkoff Company. Current is supplied by two Jablochkoff dynamos, driven by the 10-horse horizontal pumping engine, before referred to, and which, we may add, has no governor. Yet the lighting was very good and steady. The machines have a potential of 250 volts. There are twenty lamps on each dynamo, in series of five.

It was intended that the ship should leave for Dublin on Tuesday evening; but all Tuesday morning it blew a furious gale from south by west, and the weather was too threatening to proceed to sea, although it fell a flat calm, with torrents of rain, about twelve. This was held to be the centre of a cyclone, and it was anticipated that the wind would come away strong from the north-west; so the ship remained for the night in Holyhead Harbour, but a telegram informs us she arrived off Dublin at 9 a.m. yesterday, the engines and boilers having worked well.

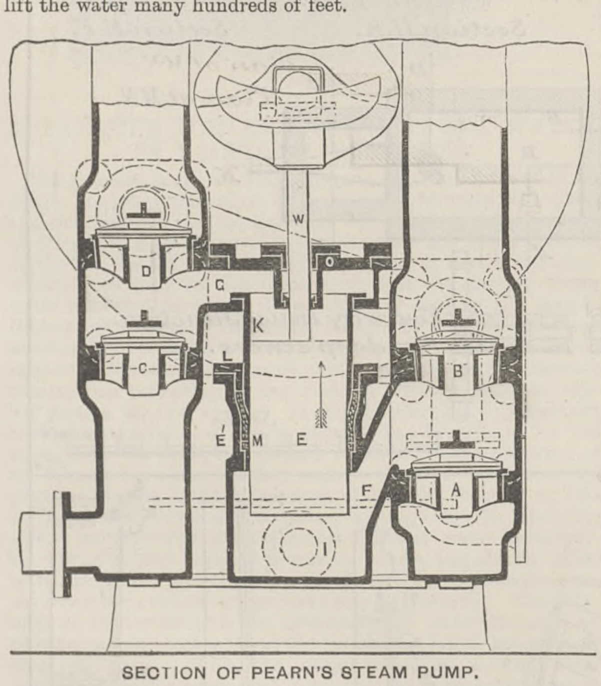
PEARN'S PUMPING MACHINERY.

In the Liverpool Exhibition is exhibited a fine specimen of a new form of pump which is now being made by Messrs. Frank Pearn and Co., of West Gorton, Manchester, and one of which has recently been specially made for the Hodbarrow Mining Company, of Millom, Cumberland. Messrs. Pearn and Co. have for a long time taken a leading position amongst pump makers, and they have lately laid themselves out to produce not only the pumps by which their name has become so well known, but others which shall excel in every way the pumps which have been introduced into this country from abroad, and particularly to supply a fly-wheel double cylinder—and therefore positive action—pump, at any speed between zero and maximum, at the price of foreign pumps without the fly-wheel.

On page 308 we illustrate one of the new quadruple-acting pumping engines as made by Messrs. Pearn and Co. for the Hodbarrow Mining Company. As this pump possesses some striking characteristics, and the duty assigned to it in this instance is somewhat novel, and of high interest in mining circles, we append full particulars. The pumps are 15in. diameter and 15in. stroke, the lifting capacity is 100,000 gallons per hour, and the steam cylinders are each 20in. diameter, with 15in. stroke, and so arranged as to be worked either by compressed air or steam.

The pumps are of the ram class, and are packed externally with ordinary packing, so as to be easily taken out and renewed when necessary without trouble or difficulty in any way. The rams, pump barrels, valves, and lids are of gun-metal; the engine throughout is made with exceptionally large wearing surfaces, and built, as will be seen from the engraving on page 308, of extra strength, to meet the requirements of severe service.

The Hodbarrow Mining Company has practically, and with great enterprise, created a sea-wall to protect its property and ensure the safety of the miners. Large quantities of piles have been driven in for a considerable stretch along the coast-line in the vicinity of the mines, to intercept the water which would otherwise flow over the surface above, percolate down into the mines, flood the workings, and necessitate pumping operations to lift the water many hundreds of feet.



SECTION OF PEARN'S STEAM PUMP.

By an arrangement which has been adopted, any water that may pass over the piles or sea wall is collected in what may be described as a miniature lake and pumped therefrom, a distance of 50ft. only instead of hundreds as already stated. The mines are thus kept perfectly free from water, so far as the inroads of the sea are concerned.

In designing the pumping plant the minimum of attention when at work had to be kept in view and the lubrication of the machinery had to be automatic throughout. Only one visit per day has to be paid by anyone to keep the whole in thorough working order. This type of pumping engine, but of smaller size, has also been specially designed for boiler feeding purposes, and is largely used in connection with batteries of boilers and with feed-water heaters, more especially when the heaters are used for filtering and cleansing the water supply. When employed for this purpose the speed can be so adjusted as to give one uniform flow, thereby allowing any solid matter in the water to be precipitated to the bottom of the heater and not carried into the boiler. There is also a further arrangement by which boilers can be fed automatically, and a slight increase or decrease of pressure made to start or stop the pump.

The question of economy in boiler pumps on board steamships, and the value of a steady continuous flow to the boilers, has engaged the attention of many owners of large ocean liners, and this new type of pump has been made to work in connection with marine boilers working to a pressure of 150 lb. to the square inch. Another special use of this kind of pump has been brought about by the high insurances for the fire risks arising amongst othes causes from high-speeded machinery in textile mills. These high insurance rates have created a demand for automatic fire extinguishers, and these make pumps necessary that will start with certainty at any time.

The various types of "sprinklers" now before the public are necessarily dependent for their efficiency on a good water supply, which is usually provided either by a collecting tank on the top of the building or reliance is placed upon town's pressure in the mains. The former is a known quantity of no great importance, and the latter often proves delusive. For giving a constant supply Messrs. Pearn's pump is being used, and for it is claimed the advantage that the moment an outbreak of fire releases one or more sprinklers—no matter the class—the pump immediately starts into action, and as sprinkler after sprinkler yields to the spreading flames the pump speed increases until its maximum capacity is reached.

Certainty of action is, of course, the first necessity, and unlike the ordinary stationary fire pumps which do not start until the arrival of the engineer or other person sufficiently acquainted with them to start them, the pumps must start themselves. In this respect Messrs. Pearn's pump acts as a watchman, and it is for this purpose the pump has been installed in the Liverpool Exhibition. The dimensions are:—Pump, 10in.; steam cylinder, 12in.; stroke, 9in.

Referring to our sectional engraving below, it may be stated that the pump columns are made in such a form that they carry both the steam cylinders and crank shaft by means of brackets and bearings, and act as air vessels. The pump is formed with boxes on each side of the pump columns, in which the valves A, B, C, D, are placed, doors being provided for access to each valve, and each side is connected by a suitable barrel or chamber in which the ram E works, having passages F G, the bottom and top barrels being cast to the main body. These are bored and faced at one setting, so as to secure accuracy. The barrel K is made loose, and securely attached to the main casting by bolts, thus completing the pump chamber on the top side of pump. The ram or plunger E is actuated by a steam cylinder placed above. It is packed at the centre E[1] of the pump by any ordinary packing M, and so arranged that it acts for both ends of the ram. The packing is secured by a gland L, which fits outside a portion of the upper barrel K of the pump, but does not come in contact with the plunger. The packing M is pushed down the stuffing-box E[1], and pressed well up to the pump plunger. As the gland does not touch the plunger, no injury will be done to the plunger by irregularly screwing up the nuts. A rod W passes from the plunger up through a stuffing-box on the cover O of the upper pump barrel, and connected with the piston-rod. There are two suction valves A C and two delivery valves B D, and these are situated within the columns which compose the framing. The suction chamber, which is common to both, is formed by a passage from one column to the other. The connection between the pump plunger and rod and the steam piston-rod is by means of a cast iron piece, having at its upper end a wrist pin for the tail end of the connecting-rod, which connects with the fly-wheel shaft crank. It will be seen from the preceding description that, when the plunger is moving in the direction of the arrow or up stroke, water is drawn through the valve A into the bottom barrel I, and discharging through the valve D, while on the down-stroke the delivery is through the valve B, and suction at the valve C on the top side, thus securing a continuous flow of water to and from the pump.

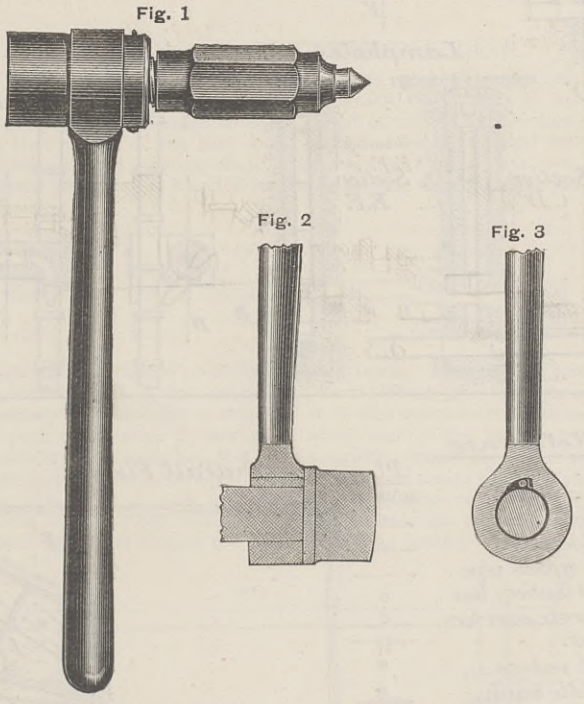
SILENT DRILL BRACE.

Messrs. Blaiberg and Marson speak of the brace here illustrated as a ratchet brace, but as there is no ratchet in it we may be excused if we give it the more indefinite name of drill brace. The brace is very neat in form, as seen from Fig. 1; and, as will

Fig. 1

Fig. 2

Fig. 3



be seen from Figs. 2 and 3, the action of the drill is effected by the little steel roller getting itself instantaneously wedged in between the spindle and the inclined surface in the boss of the brace. The action is, of course, silent, and the grip takes place anywhere. It is made by the above firm at Oozels-street, Birmingham.

ECONOMY OF TRIPLE EXPANSION ENGINES.

In our issue of 16th April of the present year we published a two-page engraving and other views, together with a full description of the triple expansion engines of the steamship Coot, built by the Central Marine Engineering Company, of West Hartlepool, which vessel had not at that time completed her first voyage, but had proceeded so far as to enable us to publish an extract from the report of the inspecting engineer, in which he stated that there was a prospect of the steamship Coot showing a saving of 100 tons of coal in a round Mediterranean voyage over that consumed by similar vessels owned by the same company fitted with ordinary compound engines.

We are now enabled to give the actual results of the voyage, from which it will be seen that these anticipations were far exceeded, the saving realised on the voyage over that of a sister ship on the same voyage at the same time being fully 200 tons, representing 28 per cent., in spite of the fact that the Coot had much the greater proportion of North-country coal and carried the heaviest cargo.

For the convenience of our readers we may repeat here that the Coot is a vessel of 2650 tons dead weight carrying capacity, is 270ft. long by 37ft. beam, and 18·5 draught above keel. Her triple engines have cylinders of 19½in., 32½in., and 53in. diameter by 36in. stroke, working on three cranks, and are all fitted with piston valves and dynamic valve gear, the propeller being one of Mr. Mudd's special differential type. The Moorhen, with which comparison of coal consumption and speed was made, is a vessel by the same builders, having a dead weight carrying capacity of 2455 tons, is 260ft. long by 32½ft. beam and 19 3 draft above keel. She is fitted with ordinary compound engines by an eminent North country-builder, the cylinders being 33in. and 62in. in diameter and 39in. stroke.

On the completion of the voyage, Captain Croft, the marine superintendent of the Cork Steamship Company, reported that the Coot had steamed 8258 miles on a consumption of 526 tons of coal, of which 320 tons were North-country coal of very inferior steaming quality, and 206 tons Welsh procured at Malta. The Moorhen steamed 7555 miles on a consumption of 692 tons, the ship having still 703 miles to go to make up the distance covered by the Coot, and the 692 tons coal being made up of 552 tons of Welsh and 140 tons of West Hartley coal. Captain Croft further states that "there were exceptional circumstances telling against the Coot, one being that the ship had to be put head to wind for several hours going from Alexandria to Smyrna, through heavy rolling and the cargo getting adrift; and on homeward passage from Malta the Coot had strong head winds, while the Moorhen had fair wind and fine weather."

The average speed of the Coot in moderate weather is 9¼ knots per hour when fully laden.

Mr. F. C. Kelson, of Liverpool, the engineer superintendent to the owners, reported, "As far as we can at present make out, the Coot burns 25 per cent. less fuel than the Moorhen, for the same length of steaming, which is of course very satisfactory, considering that Coot's average speed is quite equal to Moorhen's, and also that the Coot has greater carrying capacity than the Moorhen."

The quantity of coal consumed on the round voyage by these steamers is very considerably augmented by the very large number of times steam is let down and raised again at the ports of call in the Mediterranean and Black Sea, and the proportionately large use that is made of the steam winches and other deck engines.

STEEL PIPES FOR WATER MAINS.

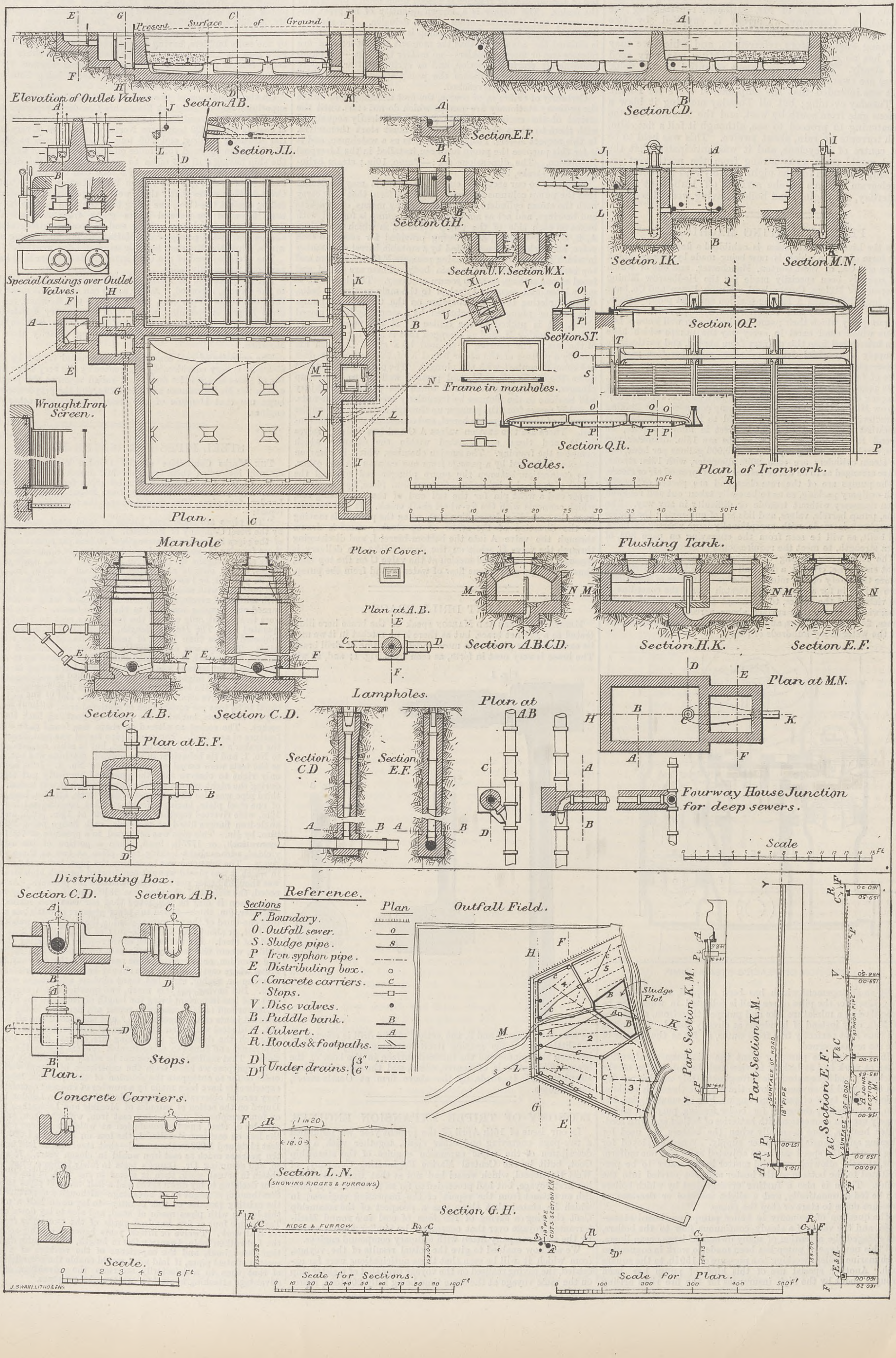
The Works Committee of the Dundee Water Commission recently instructed their engineer, Mr. James Watson, M. Inst. C.E., to test the suitability of steel pipes for conveying water under high pressure. He received from Messrs. Duncan Brothers, London, four pipes, 12in. diameter, and the following is from his report:—

"The pipes are made from plates of mild steel, manufactured by the Steel Company of Scotland. The plates forming the body of the pipes have a tensile strength of 30 tons per square inch, and those forming the sockets and spigots 26 tons per square inch. The pipes are in lengths of 10ft. 1⅝in., and ¼in. thick, made of two plates, coated outside and inside with black varnish, and weigh 18¼ lb. per foot, or 1 cwt. 2 qr. 17 lb. per length. The body plates and junctions with sockets and spigots are lap-jointed and rivetted with mild steel rivets, the sockets and spigots being welded and turned on a shaping machine to the usual forms. Three lengths were tested, but only one of the four pipes sent to Dundee was operated on. The Dundee length, when filled with water and subjected to less than 100ft. of pressure, leaked at the rivetted joints. The pipe was consequently removed and caulked on the ground, after which it was again put under pressure up to 700ft., when the joint leakage was still observable, but trifling in extent or quantity, and might be more fairly described as weeping at three or four parts of the longitudinal seam. This pipe was subjected to a net compressive strain of 40½ tons upon the end of the socket, or equal to 8½ tons per square inch of sectional area, without starting any of the rivets, but with the result of doubling back the steel socket. The socket so altered in shape was found to be without fracture of any kind. The second pipe tested was sent direct from the maker's works, and was uncoated, but in other respects similar to No. 1, and its behaviour in the proving machine was not, so far as the tests were caried out, quite up to No. 1. It is, however, only right to observe that the pipe was hurriedly put together during the night previous to the day on which it was tested. The third pipe was also 12in. diameter, ¼in. thick, 8ft. 7in. long, made of one steel plate, having a double-rivetted longitudinal lap joint 1⅝in. wide rivetted together by ⅜in. rivets at 1⅛in. pitch, and had angle-iron flanges fitted at the ends, each flange being 2¼in. by 2¼in. by ¼in. This pipe was subjected to a pressure of 760 lb. per square inch, or 1775ft. head, when a portion of the caulking yielded, and a slight leaking took place at two or three of the rivets. The intention was to destroy the pipe, but as the machine in which it was placed was not constructed for such high strains, it was thought better not to further increase the pressure. As before noted, the weight of the pipe was 18¼ lb. per foot, and by way of comparison it may be mentioned that our cast iron mains, 12in. diameter, ⅝in. thick—tested to a proof pressure of 600ft., or a little over one-third of the pressure applied to the steel pipe—weigh 88 lb. per foot, or about four and three-quarter times heavier than these made of steel. For works such as we require in crossing the Tay Bridge, where the railway traffic sets up considerable oscillation and vibration, or in crossing some parts of Strathmore—say, Meigle Moss, where cast iron to be safe should be laid on an artificial bed of stone or timber, steel has many obvious advantages over cast iron. But having said this much, two questions still remain, the first and less important being the length of time and the character of labour and tools necessary to repair any accident to the body or rivetted joints of the pipes *in situ?* and the second and all important, Will steel withstand the action of soft water and equal or approach the durability or working life of cast iron? Practical experience and time can alone furnish the answer to these questions. That malleable iron cannot be safely or profitably used for such a purpose we know from the experience of actual work. In order so far to anticipate the solution of this question, laboratory experiments have been made by a number of eminent chemists, and very careful observations were made last month in London by Dr. Dupré on the action of samples of Monikie and Lintrathen waters on four samples of metal, viz., cast iron, wrought iron, and two samples of steel, and the conclusion at which he arrived was that the loss on cast iron if called 1, the loss on steel was 1·020 in the first plate and 1·098 in the second—that steel would lose in about ten years as much as cast iron would in eleven years. If this be so, and assuming Dr. Dupré's tests to fairly indicate what would obtain in actual work, then it seems to me that, in the event of your deciding to lay down seven and a-half miles of pipes through Strathmore, it might be of advantage—although a departure from the existing practice of this country—to lay down half a mile of this length with pipes made of steel, and also to lay down on the Tay Bridge four or five hundred yards of the two miles required for that work. Twelve or fifteen years hence—probably sooner—the Lintrathen main, twenty miles in length, will require duplication throughout, and the experience of the working of a short section of steel pipes, if laid now, would enable the commissioners of that time to satisfactorily ascertain the advantage or disadvantage attaching to steel fo waterworks' purposes."

PETERSFIELD SEWERAGE WORKS.

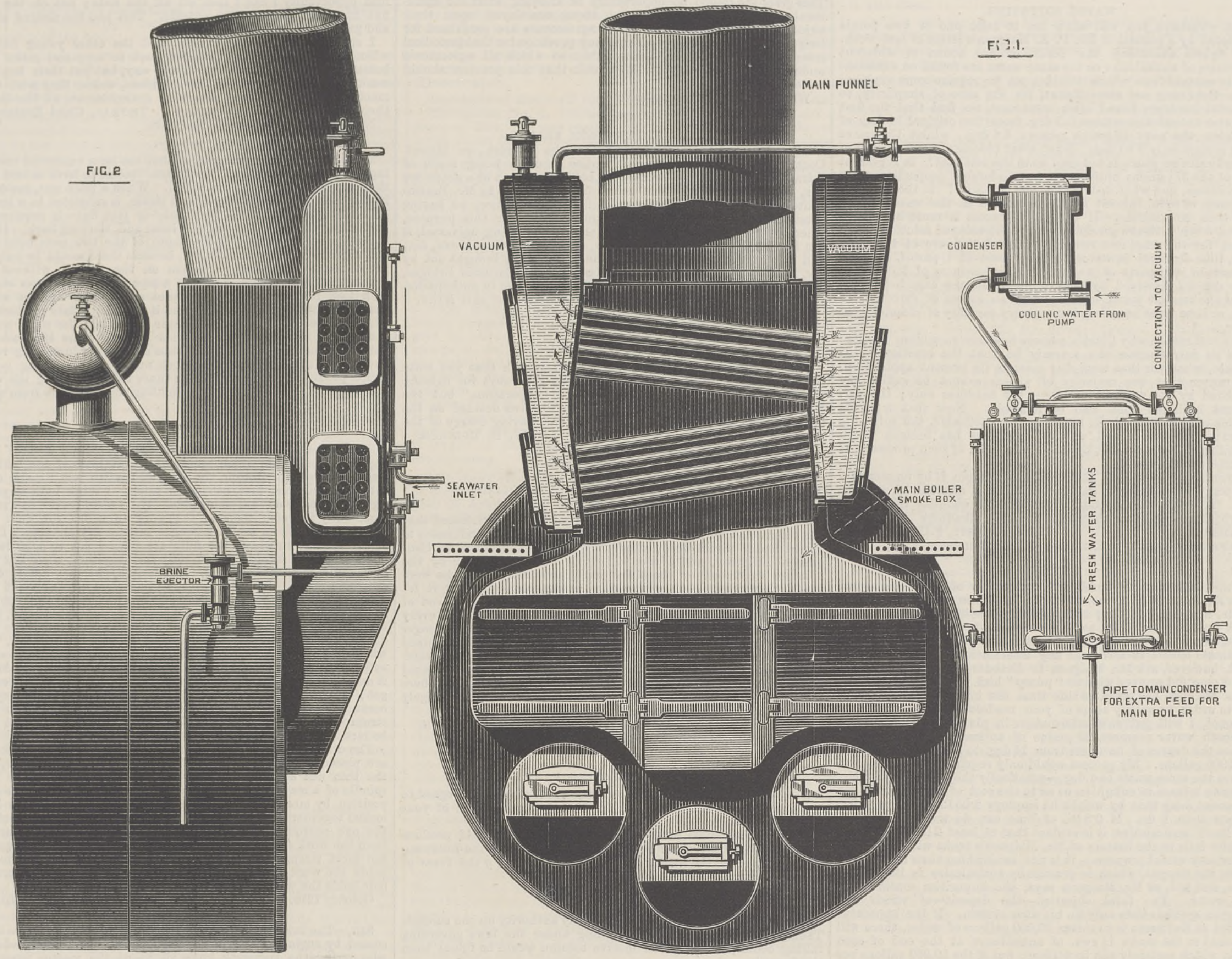
MR. HENRY ROBINSON, M. INST. C.E., WESTMINSTER, ENGINEER.

(*For description see page* 301.)



APPARATUS FOR EVAPORATING SEA WATER IN VACUO, S.S. BENTINCK.

MR. C. JONES, ST. GEORGE'S WORKS, LIVERPOOL, ENGINEER.

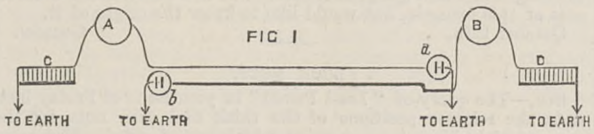


APPARATUS FOR EVAPORATING SEA WATER IN VACUO, S.S. BENTINCK.

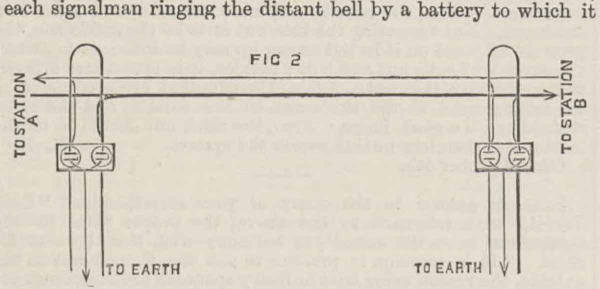
The increase in the working pressure of steam from 90 lb. to 160 lb. has led to the failure of many boiler furnaces both plain and corrugated. On inquiry into the cause of failure many theories have been advanced. In some cases the presence of oil on the furnace has been deemed the cause, in others the accumulation of scale on the furnace, or that the density of the water has been too great. Now, whatever may be the case, it is clear that as long as the furnace remains in the same condition as when the hydraulic test was applied, it will not collapse when subject to the working pressure, nor is there a recorded instance of a furnace collapsing at sea within a few days after the ship left port on her first voyage. It may therefore be fairly assumed that when the Board of Trade formula has been used for the strength of the plate, the absence of scale is the true cause of the furnace remaining perfect, and, on the other hand, that the presence of scale is the chief cause of failure. Bearing on this subject, we illustrate a new patent arrangement for changing salt or impure water into the purest distilled water for supplying the extra feed required in marine boilers, and also for other purposes. The plan explains itself, but for non-professional readers a few explanatory remarks may be desirable. The principle of the invention is the evaporation of water in vacuo, or, in other words, boiling away the water at a lower temperature than 212 deg. With the arrangement as shown, water is changed, by the waste heat passing up the funnel at a temperature of from 600 to 700 deg., into vapour at a temperature of between 90 and 212 deg., depending, of course, on the vacuum obtained in the condenser used for the purpose of lowering the pressure. After the vapour is given off it passes into a separate condenser of the usual type, but under vacuum instead of pressure. An arrangement of valves and pipes is provided by which the distilled water may be conveyed to water tanks and drawn off for drinking, supplying cattle, or for any other purpose required on board ship. When supplying the extra feed required for the boilers, the vapour is conveyed into the main engine condenser. In the process of evaporation the salt and other impurities are left in the evaporator, and consequently an ejector is used for ejecting these impurities. In combination with this arrangement, the water after condensation can be aërated and become as good as spring water. Doors are fitted in the uptake for sweeping the outside of the evaporator tubes. The plan shows an apparatus capable of supplying 2000 gallons of pure water per twenty-four hours. One good feature in this invention is that an almost unlimited supply of fresh water may be produced on board ship by using the waste heat passing up the funnel—in other words, without any additional cost or the usual loss of fuel, by taking live steam from the main boiler. The arrangement has been applied to the screw steamer Bentinck, and the water produced by it is of the purest quality and tasteless. Fig. 1 is a front view, partly in section, and Fig. 2 is a side view, the covers in the tube chambers being removed. As the lime is thrown down in the tubes at a very low temperature, the tubes are kept clean without any trouble.

EMERGENCY RAILWAY SIGNALLING.

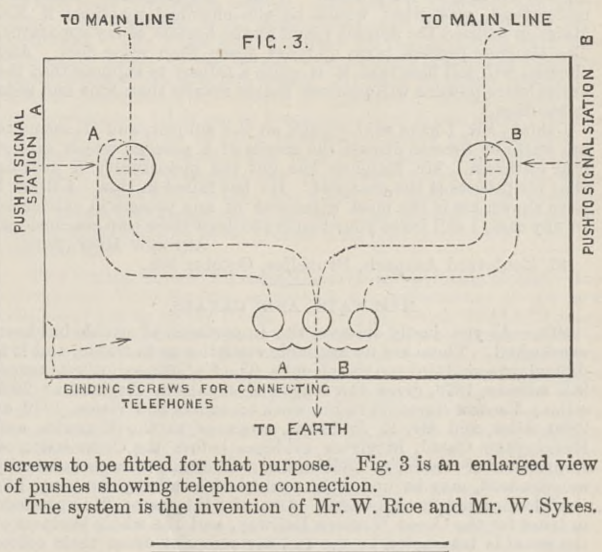
The primary object of this system is to establish on the railway a series of signalling points from which the officials at the stations can be informed of any accident or unusual obstruction, so that traffic of the line could immediately be stopped and assistance sent without delay. The essential apparatus is illustrated below. Let A and B represent electric alarm bells at the



two railway stations or ordinary signal-boxes. One pole of the motor of bell A has permanent earth connection through a battery *c*. The other is attached to a line which terminates in a push *a* at station B, this push, when used, giving earth connection and ringing bell at A. In a similar manner the bell B is connected to earth through the battery D, and also to a line which terminates in a push *b* at station A. As thus connected the lines serve for the ordinary signals between the two stations, each signalman ringing the distant bell by a battery to which it



is connected at its own station. With this arrangement either bell may be rung from any intermediate point by merely making earth connection and completing a circuit. Thus if the guard of a train on any part of the line from A to B wishes in an emergency to signal to station A, he can immediately do so by a temporary connection between the main line and the earth by means of any conducting medium. Another object of the system is to establish a series of permanent signalling stations from whence the guard or other person can at once communicate with the station to the left or right. This is accomplished by fitting to the telegraph poles or other supports a series of double pushers with short lines leading therefrom to the main line and also to the earth. The normal position of the push leaves the circuit open, but the moment it is pressed earth connection is established and the signal is given. This system may be made still more efficient by the adoption of the telephone. In this case the ordinary arrangements of the Telephone Company should be used at the stations, and the guard of each train furnished with a portable telephone, which he could at once connect at any of the signalling stations by means of binding



screws to be fitted for that purpose. Fig. 3 is an enlarged view of pushes showing telephone connection.

The system is the invention of Mr. W. Rice and Mr. W. Sykes.

German Trade.—The following has been compiled by the officials of the Commercial Diet. Although all the figures relating to the whole twenty-five years are not given, sufficient are to show the increase in production and continued expansion of the trade and industry of the country. Note: To avoid the repetition, the amount of trade, &c., of the starting point year is all through represented by 100. For instance, population, 1860 = 100, 1885, 124 1; production of pig iron, 1861-1885, quantity 617·1, value 282·0; raw sugar, 1871-1882, 602·3; imports, quantity, 1872-1884, 133·2, value, same period, 94 8; exports, quantity 190·7, value, same period, 131·2; length of railways, 1868-1883, 214·3; capital in railways, 1868-1883, 274·4; movement of goods, Schandau (Elbe), 1860-1884, 416 8; Hamburg (Upper Elbe), 1860-1884, 422·6; Berlin (Spree), 1860-1884, 171·0; Emmerich (Rhine), 1860-1884, 653·2; Manheim (Rhine), 1873-1884, 271·2; Eberswald (Finow Canal), 1873-1884, 143·7; Küstrin (Oder), 1873-1884, 511·0; sea tonnage, inwards, sailing vessels, 1874-1884, 156·5; steamers, 203·8; sea tonnage, outwards, same period, sailing vessels, 165·1; steamers, 198·9; consumption of pig iron, 1864-1883, 341·3; consumption of coal, 1872-1883, 156·6; consumption of lignite, same period, 177·5; consumption of petroleum, 1866-1884, 233 9; consumption of raw cotton, 1865-1884, 343·6; consumption of jute, 1866-1884, 3276·7; consumption of Chili saltpetre, 1872-1884, 674·1; coals raised, 1861-1885, quantity 412·5, value, same period, 374·8; beer brewed, 1872-1885, 128·4; number of post-offices, 1874-1883, 167·9; number of telegraph offices, 1874-1883, 225·4; postage receipts, 1874-1883, 151·1; telegraph receipts, 1874-1883, 183·7.

LETTERS TO THE EDITOR.

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

WATER SOFTENING.

Sir,—Perhaps you will allow me to raise one or two points suggested by a perusal of Mr. P. A. Maignen's letter of last week. The figures describing the result of the action of different quantities of anticalcaire on the same water are found on examination to contain facts which would seem to require some explanation. Confining our observations, for the sake of simplicity, to the total hardness found after treatment, we find that the first 10 grains anticalcaire remove 5·5 deg. from the original 14 deg. of hardness, the next 10 grains remove 4·6 deg., whilst 17½ grains more remove only 2·65 deg. Now, what becomes of the portion of the anticalcaire which is not used up in the last case? It is evident that of the 37½ grains anticalcaire a considerable proportion must be in excess, and what does this excess comprise? If the excess is carbonate of soda, it must remain dissolved in the water, which will then be alkaline. If lime is in excess it must have been carried down with the precipitate and have escaped solution in the water, for the hardness remains at the low figure of 1·25 deg. Now, lime dissolves in water to the extent of 1 part C a O and upwards in 1000 parts of water, giving a hardness of 120 deg. or more due to dissolved hydrate of lime. In the case before us, either the treated water must contain an excess of carbonate of soda, or lime must have lost its ordinary capacity of dissolving in water.

The real reason why Clark's process has been so seldom adopted since its introduction can scarcely be that the reaction is too delicate, whatever that term may mean in its present application, but rather that the majority of waters cannot be sufficiently improved by the removal of temporary hardness only; the permanent hardness must also be removed. Now that methods capable of removing all the hardness are practicable, the softening of water for steam and washing purposes has become worth attending to, as is evident by the rapid spread of such processes as can effect that object.

I would like to suggest that phenol-phthalein is by no means a safe test for alkalinity in waters, because it is affected by carbonic acid. A water may contain a considerable quantity of alkaline bicarbonates without showing decided alkalinity to phenol-phthalein. G. H. Beckett, F.C.S., A.I.C.

Laboratory, Stanhope Company, 20, Bucklersbury, E.C., October 5th.

Sir,—I am very much obliged to the writer of the letter signed "An Engineer," as he, too, seems to have been struck by the tone of Mr. Maignen's letters; his practical questions seem to be too much for this gentleman, as he passes them by unnoticed. I must confess I am ever on the alert to learn anything new, and use all legitimate means to arrive at any information I may desire. I must, however, ask Mr. Maignen to disabuse his mind of the idea that I ever did or ever wish to "pump" him.

Mr. Maignen has given us this time the information I desired, and in order to satisfy some of your readers on this side of the Channel, I will put this information in plainer language. The Lambeth water requires 20 grains of anticalcaire per gallon to reduce the degree of hardness from 14 deg. to 3·9 deg., or 2·85 lb. per 1000 gallons. My process would only require 0·8 lb. of lime to reduce the same water to 4 deg.—practically the same result. Mr. Maignen refuses to enlighten us as to the cost of his material, but he cannot deny that by weight he employs 2·05 lb. more per 1000 gallons than I do. If 0·8 lb. of lime can do the same work as 2·85 lb. of anticalcaire, it is evident that at least 2 lb. of the anticalcaire falls to the bottom of Mr. Maignen's tanks without having served any useful purpose. It is not astonishing then that he can utilise the deposit, which is practically anticalcaire in its original state, and not, as Mr. Maignen says, the impurities contained in the water. The fatal objection—the deposit—of which Mr. Maignen speaks exists only in his own system. If the apparatus erected at Battersea is to soften 80,000 gallons of water, there will be found in the tanks 1½ cwt. of anticalcaire at the end of each week, which certainly can be utilised; but if the 80,000 gallons per week were softened by my process, at an expense of 0·8 lb. of lime in solution per 1000 gallons, the deposit at the end of a week would be pounds instead of hundredweights. It is a singular fact that Mr. Maignen does not supply one tittle of practical information regarding the working of his process. What "An Engineer" asks, as I understand, was what would be the chemical reactions if Mr. Maignen utilised the deposit found at the bottom of my apparatus. The Maignen process takes up more space than mine does. Any chemist will tell him that it is quite a fallacy to suppose that the anticalcaire powder will produce better results than lime and soda in solution.

I think, Sir, I have said enough on the subject, and it seems to me waste of time to discuss the merits of a process which cannot bear criticism. Mr. Maignen has got the opportunity of proving that his process is the cheapest. He has failed in this. I think I have shown his is the most expensive of any process in existence. In any case, I will leave your readers to draw their own conclusions. Andrew Howatson.

46, Boulevard Anspach, Bruxelles, October 5th.

RAILWAYS AND CANALS.

Sir,—As you justly observe, the importance of canals has been overlooked. There are no available statistics as to traffic, and it is difficult to ascertain even their length. The *Encyclopædia Britannica*, 9th edition, 1878, gives the length of canals in England at 2360 miles; Vernon Harcourt in his work on canals and rivers, 1882, at 2800 miles, and Mr. E. J. Lloyd, engineer to the Warwick and Birmingham Canal, in giving evidence before the Commission on Depression of Trade, at 3850 miles. A canal, though nominally independent, may be under the control of a railway company, like the Thames and Severn Canal. Out of 2454 shares, 2144 are held in trust for the Great Western Railway, and the whole business of the canal is transacted by the railway company from their offices at Paddington Station. The railway companies have never lost an opportunity of purchasing such powerful rivals as canals. The Cromford Canal, which cost £46,000, was bought by the Midland Railway Company for £220,000. Although it paid a dividend of 18 per cent. on £46,000, it paid hardly any on £220,000. The Leeds and Liverpool Canal was leased for twenty-one years from 1853 to 1874 by a combination of railways. During that time the traffic fell off so much that the companies had to make up the balance of the guaranteed dividend of 16 per cent. payable to the canal shareholders under the lease. Since the expiration of the lease and the resumption of the canal by its shareholders the rates have been very largely reduced, and the revenue has increased to such an extent that dividends of 22 per cent. have been paid.

In 1860 the Great Western Railway instructed one of its employés to purchase the Avon navigation and the rates, tolls, and tonnage dues. They afterwards took possession of the river, and issued tickets headed "Great Western Railway Company," and by their own servants repaired the work of the river. This state of things went on until 1877, when certain traders applied to the Railway Commissioners to compel the railway company to maintain the river in a navigable condition. The railway company pleaded that they were not the legal possessors of the river; that such a possession would be *ultra vires*, and threw up the navigation and left it in a neglected state, the whole of the locks and weirs were blown up, and the traffic entirely stopped.

By the Railway Regulation Act, 1873, working agreements shall have no validity or operation, until they have been approved by the Railway Commissioners, and the Commissioners shall not approve without being first satisfied that the public and shareholders have had full notice of their contents, so that any who object to them, and are desirous of being heard upon their objections, have had time to bring them forward. In their twelfth report the Commissioners say, "It is the practice of some companies when they have a Bill in Parliament to get their agreements confirmed independently of the statute, by setting them out in a schedule to the Bill, and providing by a clause in the Bill for their being made binding. This gives the public no opportunity of knowing what the agreements are about, or of having them considered upon their objections. Not unfrequently the agreements are confirmed for long terms or in perpetuity without any provision for that periodical revision in the interests of the public to which all agreements under the Act are subject. We think that this practice should be stopped." C.

Westminster, S.W. October 6th.

ANGLE AND TEE-IRON FRAMES.

Sir,—In your interesting article of the 1st inst., on Messrs. Cochrane and Co.'s works, we notice mention being made of "frames for connecting two girders being made out of a single tee bar, so as to require only one weld." This in justice to Mr. Braithwaite we must claim, as being the first to introduce, he having specially adapted a horizontal hydraulic press for this purpose, whereby great saving of water is obtained; and being universal, it can likewise be used for angle frames, angle and tee-iron knees, &c., and also for pressing the heads of links, a method brought out by Mr. Braithwaite in 1874 in connection with the Carnatic Bridges, and since used by many engineers. Thanking you in anticipation for the insertion of this, Braithwaite and Kirk.

Crown Bridge Works, West Bromwich, Oct. 7th.

GAS BUOYS IN THE MERSEY.

Sir,—I notice in The Engineer of October 8th that you state the "Liverpool Corporation" has adopted gas buoys for lighting the Port of Liverpool. It is not the "Corporation," but the "Mersey Dock and Harbour Board" who have decided on the improvement, and who are the "authority" having charge of the port. W. B. Rickman.

Pintsch's Patent Lighting Company, Limited, 32 and 34, Clerkenwell-road, Oct. 12th.

MIXED TRAINS.

Sir,—In my last letter upon this subject it was mentioned that the recent circular issued by the Board of Trade with reference to mixed trains would be considered by the Railway Servants' Congress at Brighton, and I was willing to await and abide by the opinions expressed by the sixty practical railway men who were sent as delegates. It may interest your correspondents "C. R. I." and "R. S." to know that the Congress unanimously approved of the circular issued by the Board of Trade; and further, every speaker upon this subject was in favour of placing the passenger carriages next the engine, as being the safest place in a mixed train. The Congress also heard with satisfaction that some companies have already issued orders to this effect. I am very pleased to see that the subject is receiving so much attention, and there can be no doubt that the Board of Trade circular will very largely conduce to the safety of passengers in mixed trains. Clement E. Stretton.

Railway Congress, Town Hall, Brighton, October 13th.

MINE-VENTILATING FANS.

Sir,—I am in a dilemma as to certain particulars with regard to the above, on which I would like the opinions of some of your correspondents.

(1) The theoretical motive column which a fan should produce with a speed of periphery V is generally found from the following formula, h being the height of motive column and g the force of gravity:—

$$h = \frac{V^2}{g}.$$

For this I can find no reason given by any authority on the subject. Taking the air as a projectile coming under the laws governing falling bodies, the height of motive column would be found from the formula:

$$h = \frac{V^2}{2\,g},$$

giving a result exactly half of that got from the other formula. I would be much obliged to any correspondent giving me any information as to above.

(2) The equivalent orifice of a mine is stated as being equal to

$$\frac{\cdot 000385\ Q}{\sqrt{h}},$$

Q being the quantity of air in cubic feet per minute, and h being the height of water gauge in inches. I do not question the correctness of this formula, but would like to know the origin of it.

October 13th. Grison.

LOCK NUTS.

Sir,—The query of "Lead Pencil" in your issue of Friday last, as to the relative positions of the thick and thin nuts for the purpose of locking, is a question which is undecided. The usual position in actual practice for the thin nut is on the outside. In fact, I have never seen one placed inside. Is this the proper position? It is easy to prove that no matter how tight the inside nut is hove up with the spanner, the same force exerted on the outside nut will convert the inside one practically into a washer, *i.e.*, takes the stress from off the thread of the inside one. For the thread of the inside nut when hove tight re-acts on the opposed surface of the thread of bolt, then if the outside nut be hove tight it must ease the male thread of bolt from off the female thread of inside nut. *Ergo*, the outside nut takes the load, and must be a thick nut. But supposing the thin nut is to be the inside one, the pressure imposed on it in tightening up may be sufficient to distort the threads of both nut and bolt; besides, it is oftentimes difficult to spanner up a thin nut. Again, the educated eye is offended by the arrangement of the thick nut on the outside, and the experienced eye is a good judge. *Ergo*, the thick nut should be on the inside, and therefore no thin nut in the system. R. H.

Cork, October 5th.

Sir,—In answer to the query of your correspondent "Lead Pencil," with reference to the above, the proper place for the thicker nut is on the outside, in harmony with the views of his chief. "It is common in practice to put the thinner nut on the outside, the reason being that ordinary spanners are sometimes too thick to hold the thin nut when screwed home," but it is not a question of practice but of principle! The strain undoubtedly comes on the outer nut, and if "Lead Pencil" had taken the trouble to set out the things on paper, or consulted an authority—Professor Unwin for instance—he would have seen that his views on the subject were wrong, and also have saved the valuable space taken up by his somewhat elementary query. Loco.

Upton Manor, October 6th.

Sir,—In answer to the correspondent in last week's issue on "Lock Nuts," as a practical man, I can give the young fellow the information he requires.

He wants to know what is the general practice. The general practice is to put the thin or lock nuts on the outside. Here the question he asks is answered. Now I have told him what the general practice is, the next thing is, which is the proper and most secure way? The thick nut should in all cases be placed on the outside, because the nut, being thicker, is less liable to work loose. I have worked as a fitter and erector in this country and in some of the principal shops in the United States, and have had a varied experience in all classes of machinery.

I changed my idea on this subject three years ago, when serving as second engineer in an ocean-going steamer that had been constantly running for fifteen years. The threads of the bolts were badly worn, and it was a continual source of trouble to me to put on the lock nuts, as they worked loose and dropped off. So the first opportunity I had I took off all the nuts; put on the thin nut first and the thick nut outside. This had the desired effect, and gave no further trouble whatever.

I should advise "Lead Pencil" and the other young fellows, when making a drawing in future, not to copy and make it so because their forefathers did it that way, but put their heads to work and try to improve on the old ideas, unless they wish to be machines, in the hands of a leading draughtsman, all the days of their life. William J. Thomas, Chief Engineer.

Newcastle-under-Lyme, October 6th.

Sir,—The difference of opinion that has been expressed respecting the correct position of "lock nuts" seems to have arisen from their action not being fully realised. When a main nut, instead of having to bear a steady continuous strain, is subjected to a jerking or intermittent strain, a lock nut—or jam nut—is required for preventing the main nut working loose and slacking back. If the main nut were increased to the depth of the two nuts combined, this object would not be attained, because there would be only the proportionate increase of friction on the thread, without any jaming action. When, however, a separate nut is put on outside as a lock nut, the main nut cannot slack back without simultaneously rotating the lock nut, and it can only rotate the lock nut by means of friction between their faces; but the main nut in attempting to turn back for this purpose jams the lock nut harder against its screw thread, thus causing an increasing resistance to any slacking back of the lock nut by the increasing jaming action produced. The result is an inner main nut doing the work, and an outer smaller lock nut preventing the main nut from slacking back from its work. W.

October 11th.

Sir,—I have read the letter written by "Lead Pencil" with regard to lock nuts which appeared in your issue of the 1st inst.; also the answers thereto in the issue of the 8th inst. Some advocate the thin nut first, others the thick. I think both ways are right, but under certain conditions. If "Lead Pencil" had stated more fully the conditions of the work to which the nuts were attached, I think he would have got satisfactory answers. If the bolt or spindle on which the nuts are placed has to hold two or more pieces of machinery perfectly fast together, then the thick nut should go on first. Take, for example, the two halves of an excentric strap. The work must be tightened up "as tight as it will go" with the first nut. Now, if this nut be the thin one, you never could get it up, simply because the nut would strip, being too thin to take the first strain. Therefore the thick one must first be used. Now, those in favour of the thin nut will say, "But when we put the thin nut on the thick, it will take all the strain by pressing the thick one further on the thread." That, I maintain, it cannot do—first, because the thick nut is as tight as it can be got; therefore it cannot go any farther on the thread; secondly, because a nut half the thickness of another cannot put the same strain that a thick one can. In this case, then, the thin nut must be farthest from the work.

The other condition is: If the bolt or spindle on which the nuts are placed has to hold parts of machinery loosely together, then the thin nut should go on first. Take, for example, the valve spindle of a marine engine. The valve is loosely kept in its right position by means of nuts at either end of it. The nuts being locked together puts a strain on the thread in opposite directions, the one nearest the work straining towards it, the one farthest from the work straining away from it. This latter one, requiring the most strength, should be the thickest. So where the bolt holds the work fast, the thick nut nearest the work; where the bolt holds the work loosely, the thin nut nearest the work.

October 12th. Valve Spindle.

Sir,—The interest in lock nuts is likely to be instructive if discussed by engineers and not by such as "A.M.I.C.E.," and those who during the last week know all about the matter from text-books, and are prepared with conclusive arguments not their own to crush such as "Lead Pencil." I would, with your permission, somewhat enlarge upon my first communication, taking up the statements of text-books in the following questions.

(1) Seeing that the thin nut always used to be on the top, as described in my last communication—long before the modern text-books were thought of—what was it that brought about the change, and by whom?

(2) If the strain is put on the top nut, has a thin nut—on top—been known to strip?

(3) If such nuts have not stripped, what need was there for putting the cart before the horse, seeing that the locking is as effectual in one as the other? But, Sir, we are told about the inner nut being forced off the thread on one side and on to the opposite side. How is that done if the inner nut is already screwed up to its work, and the bolt in full tension? But they say it is so, and only then can the nuts be locked. If such is the case, I, for one, have never put two nuts together properly to form a lock nut. In conclusion, Sir, I have to learn, Is the inner nut screwed up to its work in the ordinary way with a spanner and a workman's strength and the nut locked; or not up to its work and the nut locked? I am aware from practice that it is necessary after screwing a nut hard up—say on a main shaft or connecting-rod bearing—to ease it off a little and fix the stop ring, but that will not answer the above conditions. All will, I think, agree that the inner nut should be well up to its work; then can they guarantee it is bearing equally well up to the opposite thread in order that when the nuts are locked the strain should be put on the top nut? I think not. J. T. W.

4, Madeira Villas, Plum-lane, Woolwich, October 12th.

Liverpool Engineering Society. — The members of this society recently visited the river Weaver and Mr. J. Thompson's rock salt mine at Northwich. At Weston Point, the party had the opportunity of studying the engineering works by which the Weaver has been converted into one of the most important non-tidal waterways in England. Arriving at Acton Locks, the members disembarked and examined the details of the construction and means of working the locks, of which there are two of different sizes side by side. The larger is 229ft. long by 42½ft. wide, and the smaller 220ft. long by 25ft. wide, the depth of water on the sill in each case being 15ft. The gates of the larger lock are worked by means of a Schiele turbine. The smaller lock is opened by hand-power, by means of capstan and quadrant wheels. The sluices designed by Mr. F. G. M. Stoney, M. Inst. C.E., were also examined with much interest, the ease with which they were opened being specially remarked. After inspecting the Acton Locks the party walked over to the Dutton sluices, which were designed and erected some six years ago by Mr. L. B. Wells, M. Inst. C.E., for the purpose of passing away the excess of land water more rapidly, and so reducing the flood level, which at Northwich occasionally rose to 12ft., at the same time maintaining the additional height of the water level required by the growing traffic. The sluices are eight in number, each with 15ft. clear span and 13ft. head of water above, the difference of level being ordinarily 9ft. 3in. After re-embarking the party proceeded up the Weaver to the Anderton lift, by means of which barges carrying from 80 to 100 tons of goods are lifted by hydraulic power from the river Weaver to the Trent and Mersey Canal, or through a vertical height of 50ft. 4in. After viewing the working of the lifts the party proceeded to the rock salt mines of Mr. J. Thompson, Northwich.

RAILWAY MATTERS.

A Vienna telegram says Herr Ofenheim, formerly general manager of the Lemberg-Czernowitz Railway, died on Sunday night.

The president of the Hudson Bay Railway Company has stated that arrangements have been completed in England for the construction of the line.

There is a rumour current that the North-Western Railway Company of India will increase its fares, and build third-class carriages for Europeans only—a change which is said to be likely to meet with a favourable reception.

Arrangements are made to run trains between Adelaide and Melbourne within seventeen hours, and the "interlocking" system is to be introducted forthwith at all the stations on the Southern Railway to the Victorian Border, to secure greater safety for trains running between these two towns.

A portion of the elevated rail on a single line of columnar supports—a sort of high bred post and rail railway—is being erected at Boston, U.S., on what is known as the Meig's system, a full description of which was given in a paper read before the American Society of Mechanical Engineers, by Mr. F. E. Galloupe, and printed in vol. vii.

The *Colonies and India* says, the "Cape Government has decided to admit mining, railway, and other machinery for all parts of South Africa free of duty through all ports of the Colony, and also undertakes to forward the same at special rates by railway to Kimberley, which is the nearest accessible point to all important places in the Transvaal and the interior."

According to a report just issued on the Forth Bridge, up to the present date 372,000 cubic feet of granite have been delivered, and 337,000 cubic feet set. About 98,000 cubic yards of rubble masonry and concrete work have been built, and about 20,000 tons of cement have been used. Including the horizontal and vertical tubes erected on the main piers, 4000 lineal feet of 12ft. tubes, and 4500 lineal feet of 8ft. tubes have been fitted and drilled. In all 27,232 tons of steel have been delivered. The average number of men employed on the works has been increased, and is now 2545.

The Wolverhampton Chamber of Commerce recently proposed to the Great Western Railway Company that Wolverhampton should be placed on the same footing as Birmingham in respect to the parcel rate over their lines to London. No definite reply has been received, but it is considered probable that the company will acquiesce in the suggestion, not by giving to Wolverhampton the advantages which belong to Birmingham, but to take away those advantages from Birmingham and place her on the same footing as Wolverhampton. In view of the possibility of such a course being adopted, the Chamber are about to confer with the Chamber of Commerce at Birmingham.

At a meeting of the members of the Congo Railway Syndicate held on Monday at Manchester, Mr. R. H. Houldsworth, M.P., presiding, the meeting confirmed the resolution that the Syndicate be voluntarily wound up, and appointing Mr. F. Higson, Manchester, Liquidator. On the other hand, the Brussels correspondent of the *Times* states that a syndicate will be formed this week at Brussels to subscribe the expense of studying the question of the construction of the Congo Railway on the spot. About eighteen months is considered necessary for this purpose. The syndicate will afterwards constitute a company in Belgium, which will issue an international loan for the execution of the project.

Our Birmingham correspondent says:—"An introduction of steel rails of German manufacture into Birmingham, for use in connection with the new cable tramway, has been happily averted. As the result of applications for tenders an unlimited supply of the German material was in the market. It is astonishing that the difference in price in favour of the Germans is as much as £500 upon a thousand tons of rails. The Tramway Company, who are the contractors, would naturally prefer the lower quotation, but fortunately, in deference to the wishes of the Public Works Committee of the Birmingham Corporation, they have decided not to employ foreign rails, and have arranged for a supply of 1000 tons from the Barrow Hematite Steel Company. Some of the mechanism for the tramway will be manufactured in Birmingham."

The Costa Rica Railroad has been taken up by an English company in London, and a contract has, we are informed, been made between Mr. M. C. Keith and the Costa Rica Railroad Company to finish the line. The engineer sent out by the company as resident engineer is Mr. Lucas, and works have actually begun in the interval from Lartage to the Atlantic coast. Since the beginning, about two months ago, six miles of grading has been done with about 600 native labourers, through comparatively light work, no rock has been met with. The masonry at present is only begun on some unimportant culverts, but will soon be started at different places as soon as the cement arrives from abroad; up till now everything is done in first-class work. There is till now no technically interesting fact, but will be as the works go on. The intention is to have the whole of the line finished within two years.

According to a recently issued Austrian report on the railways of all Europe, the proportion of railway mileage to the population was at the end of 1883 most favourable in Luxemburg—one kilometre of railway to every 572 inhabitants. The second place was occupied by Sweden, with its thinly-scattered population, the proportion being one kilometre to 697 inhabitants. Switzerland was third, with 1032 inhabitants to each kilometre of railway; Denmark fourth, with 1116; Great Britain and Ireland fifth, with 1184; Norway sixth, with 1226; France seventh, with 1278; and Germany eighth, with 1283 inhabitants. The proportion in the remaining countries was as follows:—Belgium, 1324; Finland, 1814; Austria, 1889; Holland, 1995; Spain, 2048; Italy, 3021; Portugal, 3097; Bosnia and Herzegovina, 3200; Russia, 3504; Roumania, 3553; European Turkey, 4690; Bulgaria, 9044; and Greece, 91,771 inhabitants to each kilometre of railway.

The Austrian Statistical Department, aided by the International Railway Commission, which consists of railway engineers and official statisticians appointed by the various European States, has issued its first report, printed in German and French. In an appendix to the report are given the mileage of the railways of every European country, and its proportion to their areas and populations. The report only deals with the railways up to the end of 1883. The German Empire had the greatest mileage open at the end of that year—namely, 35,749 kilometres. Great Britain and Ireland follow with 30,058 kilometres; then France with 29,469 kilometres; Russia with 23,940 kilometres; Austria with 20,535 kilometres; and, at a long distance, Italy, with only 9602 kilometres. The other countries dealt with in the report had the following mileage at the end of 1883:—Spain, 8251; Sweden, 6600; Belgium, 4320; Switzerland, 2798; Holland, 2118; Denmark, 1817; Norway, 1562; Portugal, 1520; Roumania, 1513; Finland, 1181; European Turkey, 1173; Bosnia and Herzegovina, 370; Luxemburg, 366; Bulgaria, 222; Greece, 22 kilometres. Relatively that is to say, compared with the area of the various countries, Belgium was best provided with railways, having, at the end of 1883, one kilometre of railway to every 6·8 square kilometres of area. It was followed by Luxemburg with one kilometre of railway to every seven square kilometres of area; Great Britain and Ireland, to 10·4; Switzerland, to 14·8; Germany, to 15·1 square kilometres. The other countries are ranked in the following order: Holland, one kilometre to each 15·6 square kilometres; France, 17·9; Denmark, 21; Italy, 29·8; Austria, 30·3; Portugal, 61·1; Spain, 61·5; Sweden, 67·1; Roumania, 86·8; Bosnia and Herzegovina, 140·8; European Turkey, 178·8; Norway, 203·7; Russia, 209·5; Bulgaria, 288·1; Finland, 316·3; and lastly, Greece, with one kilometre of railway to every 2940·4 square kilometres of area.

NOTES AND MEMORANDA.

Professors Thomson and Threlfall have noticed that nitrogen behaves very much in the same way as oxygen when subjected to the passage of the electric spark. From their experiments it would appear that nitrogen under these conditions undergoes an allotropic change causing a reduction in volume. In the case of oxygen, as is well known, three atoms combine to form one molecule of ozone, whereas the ordinary oxygen molecule contains only two atoms. An analogous combination, *Science* says, evidently takes place with nitrogen, reducing its volume as demonstrated.

The docks of the world 500ft. in length and over are as follows:—Birkenhead No. 1, 750ft. long, with a width of 85ft., and a depth of 25ft. To save repetition it may be said that the figures which follow for the other docks are in the same rotation as those above. Birkenhead No. 2, 750ft., 50ft., 25ft.; Portsmouth No. 10, 644ft., 88ft., 27ft.; Portsmouth No. 7, 644ft., 80ft., 25ft.; Carleton, N.B., 630ft., ——, 28ft.; Sydney, N.S.W., 630ft., 84ft., 30ft. 6in.; Gawel, Greenock, 515ft., 70ft., 24ft.; Liverpool, "Canada," 501ft., 100ft., 26ft.; Auckland, N.Z., 500ft., 110ft., 33ft. on the cill; Table Bay, South Africa, 500ft., 68ft., 26ft.; Cadiz, 500ft., 62ft., 26ft.; Quebec, 500ft., ——, 24ft.

In a recent paper on the "Spongilla in Main Water Pipes," by Mr. Desmond Fitzgerald, in the "Transactions" of the American Society of Civil Engineers, 1886, p. 337, the writer calls attention to the fact of the growth of the *spongilla lacustris* in the pipes of a water system. When the sponge is present in the sources of supply pieces of it find their way into the pipes. These, decaying, give an offensive cucumber or fishy taste to the water. The sponge is really an animal, and lays eggs, which float down with the water, and attach themselves in large quantities to the interior surfaces of the pipes. The eggs mass themselves in traceries like lacework. Sponge is brought forth, and grows in circular patches of green. Large mains, under a pressure of 100ft., have been filled with offensive masses of sponge closely packed between and around the tubercles. Flushing does not remove this growth, and it results is an increase of the taste. Scrapers or wire brushes are necessary.

The following is given by the *Engineering and Mining Journal* as an excellent record of an Alabama, U.S., furnace:—"On the 18th of August, the Woodward furnace, at Wheeling, entered upon the fourth year of its present blast, the fire never having been out of the furnace in that time. Up to August 31st, 1886, the make of the furnace has been as follows:—August 17th, 1883, to August 31st, 1884, 26,026 tons; September 1st, 1884, to August 31st, 1885, 30,856 tons; September 1st, 1885, to August 31st, 1886, 31,355 tons; total, 88,227 tons. This is remarkably regular working. The first year the furnace was stopped six weeks, by reason of the falling in of the draught stack, a coal miners' strike, and other causes. If allowances are made for these stoppages and for light running until the furnaces got down to work after being blown in, the average week's work of each of the three years is almost exactly the same, say from 10 to 15 tons a week difference. The cost of making iron at this furnace is the lowest in Alabama."

In a paper read by Mr. H. C. Russell before the Royal Society of New South Wales, "On Local Variations and Vibrations of the Earth's Surface," he records his observations on Lake George, made chiefly by means of an automatic recorder of the height of the water in the lake. Although the instrument used has not the extreme sensitiveness to minute vibrations which Mr. Darwin's reflecting mirror and similar instruments have, yet it was so placed that all such changes became magnified by the relatively enormous extent over which it extends its sensitive part, if this expression may be used; for any change in gravity, or the direction of the vertical, is not seen as it affects the base of a small instrument a few feet square, but as it affects a surface twenty miles long and five to six miles wide. Barometric and wind changes, too, so difficult to see in other instruments, at once, *Nature* says, became evident here by their effects on such a large body of water, and the lake-gauge for these reasons is not only capable of showing changes quite as minute as the Cambridge pendulum apparatus, but also of keeping a perfectly satisfactory record of these changes, so written that many, if not all, the causes can be traced in the curves which they produce.

In a recent paper on "The Glacial Erratics of Leicestershire and Warwickshire," the Rev. W. Tuckwell gives evidence of a south-western dispersion from Charnwood. In Stockton, between Leamington and Rugby, is boulder-clay containing abundance of Mount Sorrel granite, of so-called gneiss from Charnwood Forest, largely decomposed "pockets" of red sandstone, blocks of grey sandstone highly glaciated, Bunter pebbles, flints, carboniferous limestone, Lias rock of a different texture from that native to the district. Lying loose in the village street is a boulder from Mount Sorrel, glaciated, or at all events scratched, of nearly two tons weight. He notes extraordinary profusion of Mount Sorrel erratics as far as Leicester; at Rothley, Thurcaston, Anstey; "Stone," or "Ston," is a suffix of nearly all the villages along the line. The largest boulder found in Leicestershire is near Humberston, estimated at twenty tons, partly embedded in boulder-clay which is filled with Bunter pebbles and rolled slate from Charnwood. Charnwood stones re-appear north and south of Coventry, at Eathorpe, six miles south-west of Coventry, at Stockton, completing evidence of a south-west stream from the Charnwood elevation throughout the two counties.

Everybody, observes an American contemporary, who has used the Brooklyn Bridge, must have noticed the overlapping slides at the middle of each span that allow the structure to grow short or long as the weather is cold or hot, and the marks thereon, that indicate a distance of several feet between the extremes of contraction and expansion. Yet few suspect that the bridge contracts or expands sideways from the heat of the sun, though the degree is so small as to be almost imperceptible, and not nearly so great as if the bridge ran north and south. The same phenomenon has been noticed of late in structures of stone and iron. The Washington Monument leans to the east in the morning and to the west in the afternoon. A plummet line suspended in the interior of the dome of the Capitol at Washington was found by actual measurement to swing over a space of 4¼in., making a total dip from the perpendicular of 8½in. This movement involves the entire dome. Some years ago a learned monk in Rome suspended a plummet in this way from the top of the dome in St. Peter's, and was astonished to find this mysterious movement. He attributed it to a third and undiscovered motion of the earth, but it was afterwards explained as the effect of the action of the sun on the metal of the dome.

The director of the United States Mint estimates the gold produced during 1885 at 31,800,000 dols., being an increase of 1,000,000 dols. over 1884. The production of silver is estimated at 51,600,000 dols., an increase of 2,800,000 dols., as compared with 1884. Colorada is still the largest producer of the precious metals, California retaining the second position. The most notable changes have been in Montana and Idaho, the production of the former having increased from 9,000,000 dols. in 1884 to nearly 13,500,000 dols. in 1885, and the latter from 3,970,000 dols. in 1884 to 5,300,000 dols. in 1885. Nevada, Utah, New Mexico, and Dakota still hold their own, while the production of Arizona has slightly decreased. The coinage executed during 1885 consisted of 47,544,521 pieces, of the full value of 56,926,810 dols. Of this amount 3,002,313 pieces, valued at 27,773,012 dols., were gold coin, and 31,925,544 pieces, valued at 28,962,176 dols., silver coin. Gold and silver bars of the value of 27,490,095 dols. were manufactured by the mints and assay offices. The value of the bullion and coin imported into the United States was 41,418,129 dols. The exports of gold and silver were 44,697,749 dols., of which 11,417,207 dols. were gold and 33,280,542 dols. silver. While the United States lost by net exportation during the year 15,505,824 dols. in silver, it gained 12,228,104 dols. in importations of gold.

MISCELLANEA.

A Krupp gun weighing more than 100 tons was embarked at Antwerp last week for Spezzia on board the English steamer Engineer. The great shears at Antwerp are said to have lifted it with ease.

On the evening of the 12th inst. a series of ten lectures "On Marine Engineering" was commenced in the Town Hall, Bootle, by Professor Hele Shaw, professor of engineering in University College, Liverpool.

At opening meeting of the session 1886-7 of the Manchester Association of Engineers, Mr. W. H. Bailey, as president, delivered an interesting address entitled "The First Iron Boat, and its Inventor, John Wilkinson, the Father of the Iron Trade."

The *Brisbane Observer*, giving a short account of the Queensland National Association Show, states that the "Rider" hot air engine exhibited by Mr. T. Clark, Brisbane, was awarded the highest award the judges could give, viz., "The First Order of Merit."

In this column of our impression of the 1st inst. we mentioned that a large order for brindled bricks had been given Mr. Joseph Hamblett for the Cardiff Docks. These bricks are, however, we are informed, to be blue bricks of the same kind as those now being used on the Forth Bridge and Mersey Tunnel works.

The opening of the Firth College and the Sheffield Technical School took place on Tuesday evening. Mr. Emmerson, Bainbridge, presented the prizes in coal mining to the successful students:—(1) Mr. George Rhodes, Kiveton Park; (2) Mr. Perry Hill, Messrs. Vickers; (3) Mr. Edward Booker, Killamarsh. In a short address, Mr. Bainbridge advocated a knowledge of "political economy" for the mining students, and also stated that he bought steel rolled girders for building purposes at less than £5 per ton, made in Sheffield; while the Belgian iron girders cost £6 18s. per ton.

An idea of the value of British Columbia's forest wealth may be gathered from the fact that four logs recently cut near Vancouver contained 20,580ft. The logs were as follows:—One log 62ft. long, 40in. in diameter, 5299ft.; one log 53ft. long, 44in. in diameter, 5600ft.; one log 36ft. long, 54in. in diameter, 5625ft.; one log 24ft. long, 56in. in diameter, 4056ft. The Douglas pine has long been celebrated for its great size; but it has hitherto been, except where found near the water's edge, comparatively valueless. Now that the railway can carry it to the sea it will become an important export.

In our reports on the machinery at the Inventions Exhibition, last year, we mentioned a device for a rotary coupling—applicable at various angles—which attracted a great deal of attention, made by Colonel Cameron, R.A. The first practical application of this ingenious device may be seen in the Colonial and Indian Exhibition in driving the printing press of the *Canadian Exhibitor* in the machinery department. A coupling prepared for another purpose is utilised to connect the printing press with the main shafting of the department, in order to admit of the press being placed in the position desired by its owner. Accidental circumstances prevent direct connection by belt between the press and the shafting as now relatively placed.

The prospectus of the Royal Jubilee Exhibition in Manchester, in 1887, has been published. The site chosen is at Old Trafford, adjoining the Botanical Gardens, which it is proposed to incorporate with the Exhibition. It will cover a space of about thirty-two acres. The plans of the building are simple and compact. The main building consists of a central nave 1022ft. long and 56ft. high, with a transept across the centre 370ft. long and the same height, and two lower transepts near the ends of the nave 60ft. wide. At the intersection of the nave with the central transepts is a dome 90ft. diameter and 140ft high, and at the intersection of the nave with the low transepts are square pavilions of a lower altitude. The spaces between the nave and the arms of the cross are filled with Exhibition courts, in bays 30ft. wide. The machinery in motion will be provided for in a large annexe, separated from the main building by a 70ft. roadway, with a covered fireproof gallery of communication. All goods must be delivered before the 15th April.

General Boulanger, being anxious to induce the Chambers to vote a large sum for the adoption of what is called a new engine of war, invited the Budget Committee to accompany him on Monday to Malmaison to witness experiments with a monster mortar destined for the destruction of fortifications. The mortar is said to be a most formidable weapon. The shell it throws is one metre long. Its diameter is 22 centimetres, and its weight 110 kilogrammes. The Paris correspondent of the *Standard* says this projectile bursts by the action of a recently discovered chemical composition which is kept a secret. All that is known about it is that it produces all the effects of gun-cotton without having its inconveniences, for it can be transported easily, and never explodes of itself. "Plates of solid steel were pierced and shattered to atoms, and solid stone walls were demolished with a few shots. The shell has a very strong steel point, which enters into the walls of fortifications like a wedge into a block of wood. The projectile then bursts into thousands of pieces. The noise of the bursting of the shell is described as far greater than that produced by firing off the mortar."

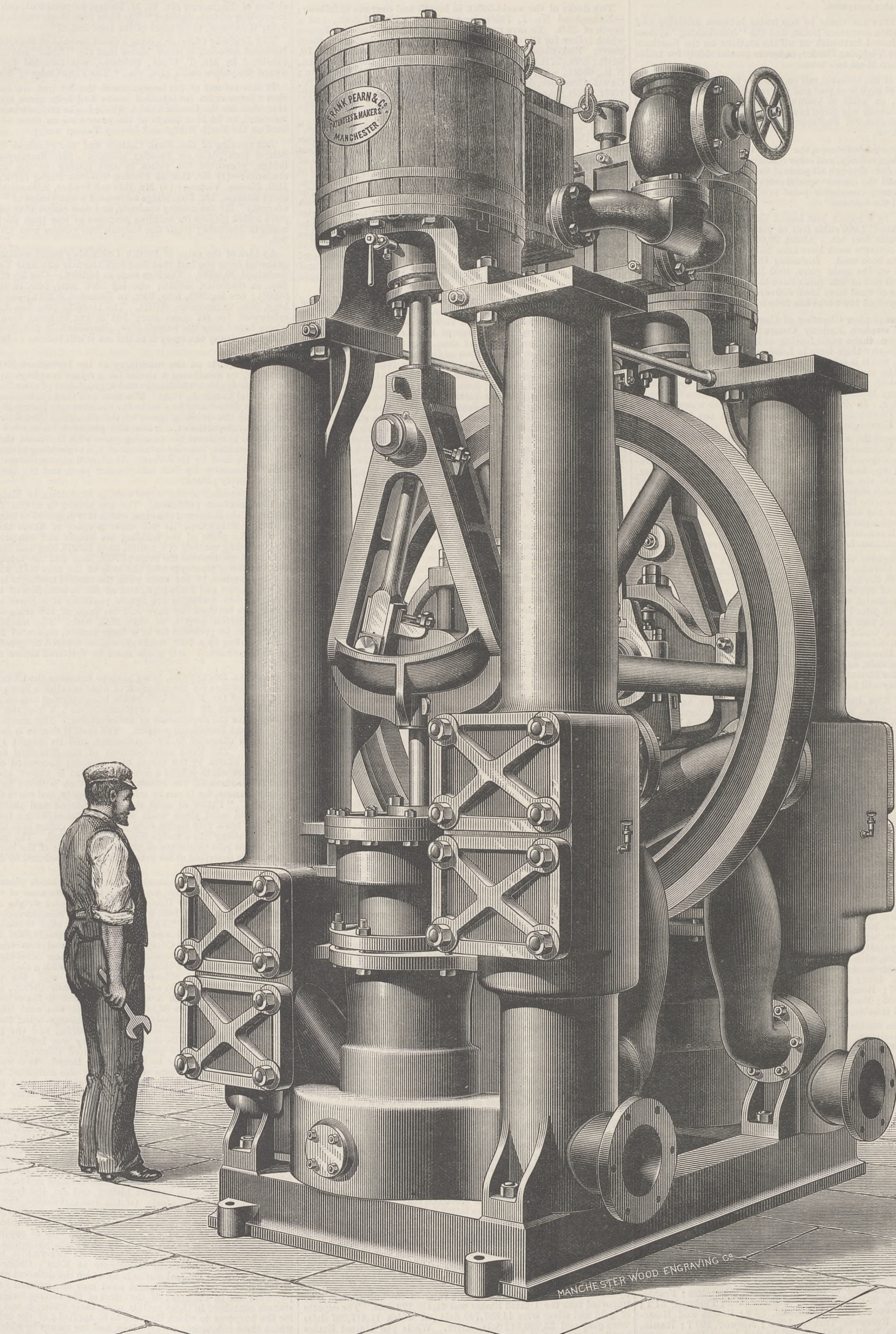
The United States Ordnance Department is much pleased—the *Army and Navy Register* says—with the performance of the new 8in. steel gun at Sandy Hook. "This gun, which weighs 13 tons, and whose length of bore is 30 calibres, was manufactured at the West Point Foundry. The tube and jacket were obtained from Whitworth, and the hoops and the breech mechanism forgings from the Midvale Steel Company. The gun was first tried with the German brown prismatic powder, when the following results were reached:—With a charge of 100 lb., and with a shot weighing 182 lb., the muzzle velocity was 2145ft., and the pressure 29,500 lb.; with a 235 lb. shot the velocity was 1942ft., and the pressure 32,250 lb.; with a shot weighing 286 lb. the velocity was 1795ft. and the pressure 32,800 lb. The gun was next tried with Du Pont's brown prismatic powder, the charge being the same. The velocity with a 235 lb. shot was 1937ft., and the pressure 32,950 lb.; with a 286 lb. shot the velocity was 1820ft., and the pressure 35,450 lb. The gun has been fired thirteen times, and will now be turned over to the Testing Board. It is worthy of remark that when this gun was designed the computed velocity with the 286 lb. shot was 1825ft., and the computed pressure 36,000 lb. This is almost exactly verified by the firing with the Du Pont powder."

The authorities of King's College, London, have announced the details of certain Courses of evening University lectures to be delivered at that Institution during the winter session, commencing from October 25th. The subjects will chiefly be treated with a view to assisting independent study, and the lectures, of which there will be at fewest eight in each course, are designed to have a similar scope to those given at the Universities. The subjects embrace French and German literature, ancient history and art, the geometry of Newton, and iron and steel. Of the two last named, the former will be treated of on Wednesdays from 7 to 8 p.m. by Professor Hudson, M.A., the lectures consisting of detailed explanations and illustrations of Newton's reasoning, and also of applications of Newton's method to the geometry of certain particular curves of practical importance. The latter is undertaken by Mr. McMillan, Demonstrator of Metallurgy at King's College, and will deal with the general methods by which the different qualities of malleable iron, cast iron, and steel may be produced and prepared for use in the arts; of the effect of the various foreign substances contained in these metals upon their strength and fitness for the purposes to which they are to be applied; of the extent to which these substances are injurious, and the means by which they are commonly eliminated. These lectures will be delivered on Tuesday evenings from 7 to 8.

DUPLEX DOUBLE-ACTING PUMPING ENGINE.

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

(*For description see page* 303.)



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CONTENTS.

TO CORRESPONDENTS.

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

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

Loco.—*The hook turns round into any position.*

T. L. and Co.—*Calculating from the figures you have given, and assuming values for those you have not, it would appear that 5s. per day for the steam is not merely a very reasonable price, but is a very low price.*

A Young Engineer.—*Your letter was received too late for answer last week. You do not give quite enough particulars to permit a satisfactory answer to your question. Apparently, from your particulars, you must take the loss of head due to the 24in. pipe, and that due to the 18in. pipe, and find the discharge due to remaining head. By assuming, in the first instance, a discharge, this may be affected by the rises in the pipes. You will find the question practically dealt with in Box's "Practical Hydraulics," published by E. and F. N. Spon.*

W. B.—*The answer to your question depends to some extent on the form of tube, whether plain, cylindrical, or corrugated, and whether the steam enters from the top or bottom, and whether the water to be heated flows away from the top or bottom. See* The Engineer, *30th October,* 1885. *Ordinarily a coiled tube is taken as transmitting about 300 units per square foot per hour per degree of difference between the temperature of the steam inside and the water outside the tube, but this quantity may certainly be increased to 800 or 900 units by a proper arrangement, form, and proportion of coil and water-containing vessel. See Box's practical treatise "On Heat;" but you will gain more recent figures from our article referred to above.*

STEEL SPRINGS.

(*To the Editor of The Engineer.*)

Sir,—I shall be much obliged to any of your readers who will tell me where I can get small coiled tinned springs. T. H.

Burton-on-Trent, October 12th.

METALINE BEARINGS.

(*To the Editor of The Engineer.*)

Sir,—Can any reader inform me who is the maker of metaline bearings, or any metal that would not require oiling, the bearing being in position difficult to get at? T. W.

Tewkesbury, October 12th.

THE LOCOMOTIVES OF EUROPE.

(*To the Editor of The Engineer.*)

Sir,—Will any reader be so kind as to inform me how, or where, I can ascertain what is the number of locomotive engines in use in the countries of England, France, Belgium, Norway, Sweden, Germany, Austria-Hungary, Luxemburg, Spain, Italy, and Russia. W. D.

Brighton, October 9th.

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

DEATH.

On Sept. 27th, at Mormugao, Goa, India, from the effects of an accident while in the discharge of his duties as one of the engineers on the W.I.P.R., George Holland, eldest son of the late Captain David H. Erskine, Gordon Highlanders, aged 27.

THE ENGINEER.

OCTOBER 15, 1886.

A SANITARY SURVEY.

An interesting and important volume has lately been issued by the Local Government Board, as a supplement to their annual report. From this extra publication we learn a variety of particulars bearing on the spread and prevention of cholera. The introductory statement by Dr. Buchanan, the Board's Medical Officer, shows the extent to which cholera has visited certain parts of Europe. The fatal power possessed by this disease where circumstances favour its development is shown in the case of Spain. At the commencement of last year there was a scattered prevalence of cholera in that country, but with the arrival of summer the disease spread with great rapidity, so that by the date of last March, when the epidemic ceased, cholera had invaded at least forty of the Spanish provinces, and had caused 120,000 deaths. An appended report by Dr. Thorne goes more into detail on this subject, and mentions that the first rumour of cholera in Europe, in respect to the last visitation, came from Toulon in June, 1884. How the outbreak originated is not officially determined. The presence of cholera on the Continent in the present year shows that the enemy is still active, and that there is need now, as before, to see that England leaves no open door for the entrance of the foe. Our surest defence, and practically the only one, consists in the removal of those unwholesome conditions which give the disease a foothold and favour its progress. We have had four visitations of cholera in this country, beginning with 1832, and the lessened mortality with each repetition shows the value of those sanitary improvements which have been carried out from time to time. But England is not invulnerable, and the weak points which invite attack are shown in the reports drawn up by the officers of the medical department of the Board. In order to ascertain the degree of preparedness in which the country stands with regard to cholera, a rapid medical survey of the chief English ports was undertaken in 1884, followed by a fresh sanitary survey on a larger scale last year. This latter investigation was extended beyond the ports and riparian districts, so as to include a number of other sanitary areas in England and Wales, and was still in progress when the present report was written. It was not intended to attempt a survey of each of the 1662 sanitary areas, but to examine those localities which were regarded as incurring the chief risk of cholera being introduced into them or spreading within them. The results of the survey, down to a period within the last few months, are reported upon by two of the senior medical inspectors of the Board, and are recommended for consideration and study not only as they relate to the prevention of cholera in England, but also as affording evidence respecting the general working of the health administration of the country. The general direction of the survey was entrusted to Dr. Ballard—except that Dr. Blaxall was left in special charge of the port survey, for which he had peculiar qualifications—and irrespective of the ports, the total number of sanitary districts examined and reported upon is 285, including eight waterside districts within the metropolitan area.

The state of the water supply is inseparably connected with the cholera question. Of the 188 urban sanitary districts included in Dr. Ballard's report, nearly all were found to be independent of private sources of domestic water supply, being provided with water derived from an extraneous source, and supplied either by the local authorities or a company. As a rule, the inspectors engaged on the survey have not found much occasion to complain of the quality of the urban water; but there are exceptions, and these are mentioned as being of a very serious character. In the rural districts the general state of the water supply falls far short of what it ought to be. Works of sewerage and drainage, the removal of refuse, the extent of overcrowding, and other matters, enter into the question of the public health, and it is seldom that we meet with a locality, in town or country, which is sound on all points. Some curious particulars are given as to the administration of sanitary laws by local authorities. Small towns are often great offenders, and villages are still worse, so far as mere neglect goes. At Gillingham, in Kent, where the population exceeds 21,000, Dr. de Chaumont says he found the local authority "very apathetic, to say the least." The medical officer of health does his duty by drawing attention to defects, "but cannot get them remedied." The inspector of nuisances has other duties in addition to those which properly belong to his office, and his work is described as inefficient. The only drainage is that which carries off the surface water; but the water supply to the town is good. Tonbridge is generally in a satisfactory state, but there is an unfortunate exception in the circumstance that about half the population take their supply of water from polluted wells. Erith, which has been loud in its complaint of the metropolitan outfalls, avoids the outfall difficulty in its own case, by generally dispensing with sewers and drains altogether. A few houses have the benefit of a surface drain, some others make use of a gravel pit, and beyond these arrangements there is nothing in the nature of drainage. Chatham, with a population of 26,000, has "only surface drainage," the sewerage question being "left in abeyance." At Sheerness the local authority is "not active," and the drainage is unsatisfactory. At Margate the houses generally drain into large cesspools in the chalk. Broadstairs is sewered, but the tide flows up the sewers for a mile, and drives the gases into the town. There is also a "suspicious well" in connection with the water supply. Ramsgate is "mostly sewered," but the outfall fails to give universal satisfaction. Dover appears to be faultless, but it is not quite so well with Deal. Sandwich is a perfect cholera trap. Folkestone is doing tolerably well, and there is not much to be said against Hythe. Lewes and Newhaven might be better than they are. The water supply of Worthing is not entirely secure against pollution, and the sanitary authority receives a hint on the subject. Chichester had a "lax administration" in June, 1885, but a month later the local authority was reported to be "alive to the necessity of action in the direction indicated by the inspector." Apparently there was much to be done. The city was not sewered, and a foul stream flowed through its midst. The public water supply was deficient, and the private supply liable to dangerous pollution. Portsmouth was found in no very satisfactory state, the sewerage and house drainage being "very faulty," and the water supply in apparent risk of pollution at its source. Remedial measures were contemplated. A deplorable description is given of Alverstoke, in Hampshire, a town with a population exceeding 20,000. There is nothing particular said in disparagement of the water supply in that locality, but everything else seems about as bad as it can be. The local medical officer is said to have been "originally energetic," but he has so far degenerated that he has learned "to acquiesce in an incompetent administration of affairs." Probably he has found it useless to do otherwise. The Isle of Wight, charming in respect to its scenery, is less lovely in some of its sanitary features. Exeter is reported "far from safe" in view of cholera, and the details given fully justify that conclusion. It is noted that this city suffered heavily in the cholera visitation of 1866. Plymouth is not as it should be, and the public water supply is described as inadequate, as also exposed to pollution in its open course through the town. We believe this has been recently remedied in a great measure, so far as the pollution is concerned, and there is a prospect that the supply itself will be enlarged.

The question of sewer ventilation often presents itself in the course of these inquiries. Towns are sewered—as in the case of Bristol—but the sewers are not duly ventilated. This appears to be the only salient defect in the sanitary condition of Bristol, and it is certainly a very common one. Liverpool—a very important port in our system of coast defence against cholera—is sewered, and the ventilation appears to be all right. The authorities are also on the alert in carrying out local improvements. The sanitary arrangements of Birkenhead are somewhat unsatisfactory. The authorities at Goole are setting their house in order by degrees. Kingston-on-Hull is improving, though an awkward place to deal with. There is a miserable little place called Pickering, where it must be almost a purgatory to live. We can readily believe that if cholera ever comes into such a place it will stop there. Newcastle has a public water supply, "constant, but rather scanty." Gainsborough, in Lincolnshire, is specified as a town where the local administration is "miserably inefficient," leaving the town "in a most dangerous condition for the advent of cholera." The reality of the danger is shown by the fact that Gainsborough suffered severely during the cholera epidemic of 1866. But if the towns have their sanitary faults, what is to be said of the rural districts? These are not always small in their respective populations, and the aggregate number of inhabitants amounts to a very considerable total. In many instances the villages are contiguous to towns, and possess a suburban character. In the list of rural districts we meet repeatedly with the words "lax administration." The medical officer of health may be burning with zeal, but the rural sanitary authority will in most cases throw abundance of cold water upon his good intentions. The villages in the Isle of Wight are generally in a very unsatisfactory state as concerns the drainage and water supply, although the dwellings of the poor are said to be in fair condition on the whole, subject to some exceptions. In one of the districts of Cambridgeshire, many of the dwellings are said to be mere hovels, unfit for human habitation. This applies to a rural district where the population is no less than 23,000. So also the villages in the Isle of Wight make up a population of 28,000. It will thus be seen that although a rural district may have a sparse population, the total of its inhabitants may be equal to that of a town possessing considerable importance. Groups of villages exist, nominally under the care of a local authority, and yet practically cared for by nobody, except it may be by the medical officer of health, who can only deplore his inability to get anything done for the improvement of his district. Such is the case in the rural district of Chesterton, where the sanitary authority "habitually ignores" the reports of the medical officer, until some outbreak of disease compels passing attention. Sewage nuisances in this district are described as being almost universal, and one of the villages is a suburb of Cambridge. The water supply in many of these places is reported as scarce and contaminated. In the rural district of Gainsborough, where the population amounts to 19,000, much attention is said to have been given to the drainage of the villages; but so favourable a report seldom occurs, and is the more remarkable when put in contrast with the verdict on the adjacent urban district, previously mentioned.

The picture of the rural districts is, on the whole, a painful one, and may be described as scandalous. The number reported upon is eighty-seven, and we should like to think that they constitute a bad sample. But the number is large, and it is to be feared that if none were omitted the general result would not be materially improved. Dr. Ballard fully recognises the fact that on the whole there is more laxity of administration in rural than in urban districts, and shows how this may be accounted for. One reason given is that sanitary work is often distasteful to the existing rural authorities, and accordingly is subject to systematic neglect, in which the delinquents have come to be so expert as to baffle the Local Government Board and nullify the Public Health Act. Dr. Buchanan gives us some grains of comfort in his review of the subject, by saying that the survey was designed rather to discover faults than to observe excellences, and accordingly a great many defects in the local health arrangements of the kingdom are recorded. It is more especially satisfactory to learn that the sanitary arrangements of port and riparian districts "have been found in places excellent," although in other places seriously defective. The work of sanitary improvement is going forward, and it is to be hoped there will be no abatement in its progress, even though our present preparations should suffice to repel the pestilence from our shores.

THE WAR DEPARTMENT.

No one can say that the charges brought against our Ordnance Departments are being allowed to drop. During the last few days several notices of them have appeared in the daily papers. First, a long letter to the *Times* from Sir John Adye, the Governor of Gibraltar, and late Surveyor-General of Ordnance, and previously Director of Artillery; secondly, a speech of Sir Wm. Armstrong at Elswick; and lastly, a speech made by General Alderson, the present Director of Artillery, at the Royal Arsenal at the annual dinner of the Foremen's Association of the Royal Arsenal. Sir John Adye in his letter gives a brief history of the first introduction of breech-loading guns, of their supercession for nearly ten years by muzzle-loaders, and of the eventual victory of the breech-loading system as applied to the long bores of the present day. This is written, as might be expected, ably and courteously, and it is fairly put from Sir John Adye's point of view. The object is mainly to show that the artillery authorities have not stood in the path of progress. At all events, that it is not for the Navy to attack them. He gives the notable instance of the 35-ton gun whose proportions were dwarfed to suit the requirements of the Navy. Afterwards when the Naval authorities saw how much more powerful was the 38-ton gun advocated by the Artillery, they managed to find room for it in their turrets, and handed over the 35-ton guns to the land forts, as forming the second line of defence. This, we believe, is a matter of fact; nevertheless, truth compels us to add that, with Sir Frederick Campbell, Sir John Adye opposed the introduction of breech-loading guns long after most naval as well as artillery officers had recognised the necessity of adopting them, and had actually clamoured for them.

Sir William Armstrong has explained the position of Elswick with relation to the British Government, showing that while England was indebted to Elswick for the introduction of the largest and most powerful types of guns, Elswick had not had for a long series of years any very large orders from the British Government, the great bulk of the company's manufacturing work depending on orders from foreign Powers. A leader in the *Times* dwelt on this, and argued that Elswick was the necessary complement to the Royal Arsenal. General Alderson has defended the character of the work done by our Government manufacturing establishments, reminding his hearers that he stood in a specially good position to speak without personality, inasmuch as he had never held a manufacturing appointment; but, on the other hand, for many years his duties had mainly consisted in trying, reporting on, and, as it were, criticising the guns, ammunition, and other war material turned out at Woolwich Arsenal. He was, however, of opinion that it would be desirable that the Navy should get their own stores separately if they wished it, and that the War Department should be freed from the duty of providing for them. He also said that he thought many changes were desirable, and evidently expected them.

We are glad to think that this is so, and that ample inquiry will be instituted, although we think Mr. W. H. Smith would have done still better had he accorded it before making his speech, and with less appearance of yielding to popular pressure. To declare a step unnecessary is not the best prelude to taking it. However, all is well that ends well. We have at present four Committees or Commissions on our establishments. One is on the civil service system and its working, and one on saddlery. These we do not now propose to notice. There remain the two which are of important manufacturing interest, namely, Lord Morley's Committee on the actual working of our manufacturing departments, and the Royal Commission just appointed under the presidency of Judge James Fitz-James Stephen. Both these will, we believe, sit at the War-office. Their functions should be clearly defined in order that they may not interfere with each other, but the scope of each is intelligible. Lord Morley's Committee should investigate all questions concerning the actual working and operations conducted in the Royal Arsenal. The Royal Commission is appointed to satisfy the country as to the equity of the administration of our departments, especially as to matters of supply. Lord Morley requires manufacturing and engineering ability and experience on his Committee. Judge Stephen should be assisted by men of clear judicial perceptions as to actual right and wrong, and the probable tendency of any system to introduce evil influences. In short, a good manufacturing engineer is the man for Lord Morley, and a good judge for the Royal Commission. In England we might expect that we should easily find both, yet we think it can be shown that such an expectation is by no means so easy of fulfilment as at first appears. The manufacturing engineer that Lord Morley wants should have experience, such as can hardly be learned without his becoming identified with certain establishments, or, at all events, certain processes of manufacture. In fact, we no sooner conjure up the image of the best and most able man that suggests himself to us on some grounds before we perceive him to be, on others the worst and most mischievous. Supposing him to be devoid of prejudice and self-interest, will his professional rivals believe this? An eminent man must have professional rivals. If he has made his mark he must have generally become identified with his own field of work. Dr. Percy is probably a man as little committed to any particular groove as could easily be found, but that is precisely because he has not actually had to conduct manufacturing operations. He has not had to deal with commercial and personal questions so much as with the abstract science connected with each operation. We need hardly tell our readers, however, that Lord Morley's Committee does not consist of such men as Dr. Percy, but of certain energetic members of Parliament and certain officials. This may have something to say for itself. The former have the qualification of being able to stir up the mud, and the latter may be supposed to have had such connection with Government Departments as will enable them to light the former to their prey. This suggests a searching investigation, if it does not defeat its own ends by want of sobriety and practicability. Many of us have our own views of the difficulties that beset Government manufacturing establishments, but few of us probably can suggest the remedy for each difficulty.

We do not at all expect to find much corruption brought to light. Those who expect this will, we think, be disappointed—pleasingly disappointed, let us hope. We certainly hold that temptation exists; in fact, we will go further, and say that the working of our system presents temptations that in the nature of things ought to end in mischief. Yet we must question if it can be found to have wrought mischief to any marked extent hitherto.

Take the position of the managers of our manufacturing departments for example. Is it wise or reasonable to promote a foreman to be the permanent working head of an establishment on which hundreds of thousands of pounds are spent per annum, and to put over him an officer who is "caught" and "told off" to the duty of superintendent for five years? Surely the workmen through the department must know that their future depends mainly on their permanent manager. Backed as he must be by them, are not manufacturing details necessarily dependent on his judgment? What officer would dispute with him the feasibility of making a particular furnace do its work economically or turn out some precise quality of product? Those who do not know the magnitude of our manufacturing establishments hardly realise what large issues may depend on questions of working detail. We will take an example. At one time all projectiles except those cast in chill were turned all over to bring them to the desired dimensions. Then the question arose whether it would not be possible to cast them to the required degree of accuracy. With the skin on they would be stronger and better, and hundreds of thousands of turning operations would be immediately dispensed with each year. The gain to the country would be obviously enormous; but, on the other hand, it would be a loss of work to workmen, and it would be a heavy loss to the contractor who supplied the lathes. Could it be reasonably expected that the question would be brought forward at all? Is it likely that an officer coming into his multitude of duties as superintendent or assistant would search it out? Or if he thought of it, ought we not to expect that difficulties would be put in the way, and that with all interests on the side of turning, it would easily be proved that turning was necessary? All honour to the Royal Laboratory then that this change has been instituted and actually carried out there. The superintendents, but especially the managers, deserve great credit for it, but who appreciates it? Have they received the due recognition and reward? Is it reasonable to expect that we can, in the long run, find it to be a satisfactory plan to select a foreman and give him a comparatively small salary, say, £500 per annum, and put him as permanent working head over thousands of men, including many of his own class, in charge of operations representing hundreds of thousands of pounds, and over him men who must be "admirable Crichtons" if they can appreciate half that he does.

We think the anomaly plain. Where is the remedy? On the face of it we should say there must be some one put in a better position who is able to appreciate the working details of each department. Something undoubtedly might be done by simply improving the manager's position; but a greater change is needed. This might be effected by doing away with the superintendent's limit of five years, and by instituting large pecuniary rewards to the staffs of each department for well-proved cases of improvement in efficiency and saving of economy—not like the reward for inventions that are now wrung out in an exceptional way in rare instances, but rewards held out in the hope that they will be won. Of course we must have a better tribunal to judge of such matters than at present exists. We must not, however, dwell longer on a single feature which we brought up in illustration of a needed change. There are many branches to investigate. At the present moment our departments are starved into a very stagnant condition as to *progress*, however large their turn-out of work may be. We have begun with the Laboratory, we will instance it again. For some years past it has been obvious that the great requirement in the way of projectiles was steel shells. Hard armour has come in, for which chilled iron projectiles are singularly ill suited. Abroad they would for many classes of work be called absolutely useless. Yet the Superintendent of the Royal Laboratory has never been allowed plant to manufacture steel shells even in a small tentative way. We question if a single armour-piercing steel shell has ever been cast in the department. Recently experiments have been instituted at Shoeburyness with French steel projectiles. Elswick, as the agents, have supplied some magnificent shells. Such splendid results have been obtained, that report says that hundreds of thousands of pounds are being spent in the country to commence the manufacture of Firminy or other steel projectiles in England. We fully hold that this is right, that the trade ought to be encouraged to supply war stores; but surely the Superintendent of the Royal Laboratory ought long since to have had the opportunity of making them on a small scale at least. Are we content that we should have to refer to Elswick and Sheffield for everything in the way of progress? Ought not our own departments to have the necessary money to keep abreast of them and check what is done? We put this question in the interest of economy, bare economy, as well as credit and science.

To keep within reasonable limits we must pass on to the Royal Commission and its work. The questions connected with supply and the dealings of our Government with manufacturers will doubtless come within the scope of the work of the Royal Commission. If the history of what takes place is gone into at length, we hope that the members of this Commission have an appreciation of character and a sense of humour or they will not fully do justice to the subject before them. The bitter attacks of disappointed inventors and the unaccountable prejudices that crop up are much better dealt with by one who can see the ludicrous side of each question sufficiently to lubricate the work and give him a pleasant and kindly spirit. Of course, this sounds frivolous if we contemplate the terrible charges that have been launched here made good. We may say at once that we are prepared to look at any actual instance of fraud in the most severe way as a thing to be stamped out thoroughly. We should desire the fullest investigation in every way that can be suggested; but of fraud in its full normal shape we expect to find very little, if any. Cruel and unfair dealing has been exercised towards individuals at times we believe, but not in the personal interest of those who acted. The country, we think, got the direct benefit, if benefit it can be called, in such cases. The general working of supply and orders is undoubtedly fitful and funny. The wish for economy on the part of Government causes progress to be regarded as an enemy, because progress means expense Individually of course an inventor is an enemy; nine out of ten are rather harmless enemies, but a really determined inventor is a dangerous enemy. His determination is often more dangerous than his ability. Successful inventors, we are satisfied, ought to receive an order, something corresponding to the Albert medal or Victoria Cross. Yet we must not put it all one way; nothing could be more idiotic than many of the inventions brought forward to harass and irritate our Committees. The first Iron and Steel Committee had submitted to them such designs as an armour plate that ran about on the side of a ship to cover any spot that the enemy might be known to wish to aim at, and vast forceps suspended at harbours to lift vessels into the air and let them drop or forcibly to submerge them. So again, the gun that was rifled outside, and used to rotate through a ring as it recoiled, was a little curious, though matter-of-fact and business like in comparison with some of the ideas that halted at earlier stages of development.

A common source of pressure as to what should be ordered for the service is found in the experience and convictions of the heroes of the last campaign, whatever it may have been. The more intelligent and energetic the staff, the more this is the case. Experience, let us suppose, has shown the continual need for strong ox wagons, capable of bearing the very rough travelling through the Cape country and South of Africa. It is those who command attention at the moment who press the demand, and it is at times irresistible. It is said that the service was only delivered from a serious infliction of such vehicles by the sudden demand for two-wheel carts for Egypt. But with two-wheel carts what strange devices also appeared—enormous barrels, containing water, to be rolled across the desert, and heavy iron filtering machines that heated the water to high temperature, and the like. Often an importunate man with an insane invention will by his importunity persuade an influential friend to get a trial for something that ought never to be tried at all. "There can be no harm in trying it," he argues, under the pressure of importunity. Beyond the stage of a trial a really bad thing would hardly get. Colonel Hope says otherwise. Let him prove it, and he will have done good service. It would be rash for any one to say that some corrupt individual cannot be found. As we have said, for every reason let a full investigation be carried out. At the same time, considering the reckless things that have been said and what has transpired so far, it appears as if most of the accused would have less to fear from investigation than the accusers.

COLLIERY PUMPS AT WORK IN STAFFORDSHIRE.

Much success is attending the operations of the pumping engines in South Staffordshire which are being employed to drain the mines now flooded, and to enable those in active operation to go on without hindrance from underground water. Some sixteen engines are engaged in the work in the Tipton and Bilston districts, besides others in the Old Hill district, which is a centre of less importance. Eight of these engines in Tipton are directly owned by the Mines Drainage Commissioners, and these are together raising an average of 8,700,000 gallons daily. The efficient work which the pumps are accomplishing is seen in the announcement made at the annual meeting of the Commissioners last week, that the effect of less than two months' pumping since the main Bilston ground was tapped has been to lower the flood of underground water over an area of nearly five square miles from 13ft. to 24ft., and over a further area of about one and a-half square miles to lower the flood from 6ft. to 9ft. By continuing their policy of driving levels the Commissioners are, it is gratifying to know, greatly lessening the cost of draining the mines. The working expenditure of the engines for the twelve months ending with Midsummer was something less than £10,000. This is a reduction of more than £5500 on the previous year, and of over £9600 on two years ago. It is anticipated that this year will show a further reduction to £7500. The South Staffordshire Mines Drainage Commissioners are to be congratulated upon the steady progress which marks their important and hazardous operations. A satisfactory and early issue in the search which they are now prosecuting to ascertain the safest point to successfully tap the Wednesbury underground flood is to be hoped for.

THE SAFETY-LAMP OF THE FUTURE.

At the Yorkshire College—Coal Mining Department—Leeds, the opening lecture of the session was devoted to "Safety-lamps." Mr. Arnold Lupton, the lecturer, set out with the statement that there was not a single safety-lamp in use at the present time which was not in effect a Davy, of which, he said, all other lamps were but modifications. The Muesseller lamp, the use of which was enforced by the Belgian Government, and the Stephenson lamp, if well constructed, were the best lamps for use. Where fire-damp was known to exist, the greatest essential was protection from the current of foul air and gas. The only means of protection therefore was to put the lamp behind a cover, and if the Davy lamp were put in a tin case, from being a most unsafe lamp it became one of the safest. The Royal Commissioners considered it might be safely used in a current of 2000ft. velocity per minute. In a safety-lamp there should be nothing between the glass and the oil pot, so as to secure the best possible light. It was still more important, however, for colliers and deputies, before a lamp was used, to see that all parts of the lamps were in their proper places, a departure from this rule involving far greater risks than the use of less safe lamps. After describing the Swan, Morgan, and other inventions, Mr. Lupton stated the lamp of the future would be one of the following:—"An electric, with secondary battery like Swan's, or with a primary battery like Walker's or the Regent Company's lamp, a bonnetted three-gauze lamp, a Morgan three-gauze lamp, a bonnetted Muesseller lamp, a Morgan three-gauze lamp, or a Clifford lamp, if it stood the tests as well as its inventor said it would."

THE IRON AND STEEL INSTITUTE.

In our last impression we gave an account of the proceedings of this Institute during the first day's—Wednesday—proceedings, which terminated with a paper on the erosion of guns, given in our last impression. A report "On the Iron-making Resources of our Colonies, as illustrated by the Colonial and Indian Exhibition," by Mr. P. C. Gilchrist and Mr. Edward Riley, was taken as read, and after luncheon the members went chiefly to Woolwich Arsenal, and in the evening to the annual dinner.

On Thursday the proceedings commenced with a paper by Sir Henry Bessemer

On Some Early Forms of Bessemer Converters.

Sir Henry selected ten different forms of converters, which are fairly typical of the whole, and which embrace the main features of the several forms of apparatus which he had from time to time designed for the conversion of crude iron into steel. These were fully illustrated by excellent wall diagrams.

Within the last few years much interest has been taken in the use of small converters for the production of steel and ingot iron. Without entering into the question of how far production on so small a scale can successfully compete with the larger Bessemer plant, it is unquestionably true that in certain cases these small converters may be used to great advantage. For example, it has been shown by Stirling, Fairbairn, and others that the strength of iron castings is greatly increased by an admixture of malleable iron, even when the fusion of the latter has to be made in the cupola along with the foundry pig; but when good hematite iron is converted into malleable iron, or mild steel, in the converter, and is mixed in the foundry ladle with a good grey pig, a marvellous change is produced. He had found this mixed metal excellently adapted for steam hammer faces, which stand an immense amount of work in comparison with those made of the best foundry iron. Some twenty years ago Messrs. Bessemer and Co., of Sheffield, supplied great numbers of stamp-heads for quartz crushing, in which case white pig and not foundry iron was used as the basis of the mixture. The grain of this metal, when annealed, was as fine as that of tool steel, and at a blood-red heat a stamp-head 5in. in thickness could be reduced to 4½in. under the steam hammer without cracking. Such metal would be considered a very brittle material if you called it steel, but it is wonderfully tough when viewed simply as cast iron, capable of being dealt with in the ordinary way in an iron foundry. Sir Henry then described at length the diagrams on the walls; without these the paper would be unintelligible.

The first tipping converter was put in operation at the works of his firm at Sheffield. It appeared probable that a single tuyere blowing vertically upward would throw a good deal of metal out of the converter, and hence an upper spherical chamber was contrived to prevent its doing so. This converter was lined with four moulded pieces of fire-clay, previously burned—the lower one, in fact, forming a simple large clay crucible—the space between which and the iron casing was rammed in with a sort of concrete. This converter discharged its contents over a lip or spout which was maintained in the same position, whatever the position of the converter might be, and could thus pour the metal into the moulds; for this purpose the trunnions on which it moved were placed excentric to the main body of the converter, but concentric with the pouring lip. Notwithstanding the great defects of this form of converter in not lifting the tuyeres above the metal at the time of pouring, it was successful in circulating the metal during the blow—as shown by arrows—and thereby equally and wholly decarburising it. This converter was chiefly used for the production of a very pure malleable iron by the conversion of Swedish charcoal pig, which was granulated by pouring into water and remelted in crucibles with a known weight of oxide of manganese and charcoal powder, thus producing steel of excellent quality. The author said that in looking over his rough notes he found that he had omitted to mention the fact that the tuyere orifice of this converter during the casting process was invariably stopped by means of a fire-clay ball, which was carried by the blast into the rear conical end of the tuyere, and thus shut off the air. He added that this converter was successfully and commercially employed for a considerable time, and that almost the first ingot that was cast from it was forged into the 3in. gun now in the possession of the Institute, and which it may be remembered on analysis was found to contain 99·78 per cent. of fine iron.

In the early days of the Bessemer process, when there was a great scramble among inventors to secure some patent claims that might entitle them to partake of the good things they saw looming in the distance, Sir Henry was driven to patent several modifications of the converter which he thought were necessary to protect his original invention from such attempts, just as a military engineer might erect a series of forts to bar the progress and ward off the too near approach of the enemy from the main citadel; and although some of these modifications were not calculated to add to his fame, either as an engineer or steel manufacturer, they were most successful in checkmating several ingenious attempts to convert melted pig iron into steel by a blast of air without infringing the letter of his patent. As an example, a well-known ironmaster proposed in his patent not to force a blast of air up through the metal, but to exhaust the hot gases and flame from the converter, and "suck" the air into it. The arrangement shown was somewhat similar to an ordinary gasometer, which would draw in air all round its periphery if exhausted in the interior; the air in that case bubbling up all round the inside of it to supply the partial vacuum within. Another equally ingenious inventor had persuaded himself that, by dividing a chamber by a partition which did not quite reach the bottom, and running molten iron into it, he would be at liberty to force air down upon the surface of the metal in one compartment, where its pressure would force the metal under the partition into the next compartment, and then the air, also finding an escape under the partition, would bubble up through the metal and convert it into steel. This, he considered, was forcing air on to the upper surface of the metal, and had nothing whatever to do with Sir Henry Bessemer's invention, notwithstanding the fact that the air so forced on the surface of the metal in one compartment passed upward through the metal in the other. He reverted to this particular scheme out of the many that were brought forward, because he found that so recently as March, 1881, Messrs. Clapp and Griffiths, in their patent, claim the exclusive right to construct apparatus for the manufacture of steel in which broad channels, open at their lower ends, allow the air which is forced on to the upper surface of the metal in one compartment to force it down and allow the air to escape upward through the metal contained in the other; the identity of this plan with his patent of March, 1855, was most remarkable.

The trouble and delay occasioned by the removal of a whole set of tuyeres induced him, in February, 1861, to design and take out a patent for a built-up tuyere, to be used in a spherical converting vessel mounted on axes, together with special hydraulic apparatus for lifting and lowering the tuyere, &c. After thus ranging over a rather wide field, and shaping the converter from time to time with a view of avoiding defects that were observed, or striving to gain some specific advantage not previously obtained, Sir Henry finally rested in that peculiar form of tipping converter with which all are now familiar, and which still holds its position after eight and twenty years of practical working in this and other countries. The first of these converters was erected at the works of his firm in Sheffield. Not only was this small and inexpensive converting apparatus successful at their works in producing excellent steel, but the first converter erected at the works of Sir John Brown and Co., and with which steel rails were first made—and sold at £18 per ton—was operated by hand-gearing in a similar manner to that shown.

At the conclusion of this paper the President said it was not often that they had the opportunity—in fact, he might say that he did not know of any other occasion on which they had had an opportunity of listening to the inventor himself, and hearing him discourse upon and accurately describe the successive stages through which that invention had passed up to perfection. There were many cases which might be adduced affording interesting matter to the metallurgical historian; for example, that of hot blast and various kinds of apparatus which have been introduced from time to time; but in those cases the improvements had been made by different persons; whereas in the case of Sir Henry Bessemer they had every detail recorded from the first incipient notion of the invention even to the last degree of perfection.

Mr. Hardisty then read a paper on

Modifications of Bessemer Converters for Small Charges.

The object of this paper was to present in a concise form the experience which has been gained in the manufacture of steel in small quantities by the Bessemer process in different forms of converters. The various modifications of fixed and tilting converters that have been proposed from time to time may be divided into two classes—side and bottom blowing. The former are in nearly every respect but slightly altered reproductions of the converter used by Sir Henry Bessemer in the earliest of his experiments, and of the early Swedish fixed converters. Their principal points of novelty are the arrangements of the tuyeres, the means adopted for preventing the metal running through the tuyeres, or being overblown whilst tapping, and the slag-hole for effecting the removal of the slag during the boil. Many schemes for reducing the quantity of blast passing through the tuyeres while tapping have been devised, and may be briefly described as follows, namely:—(1) Messrs Clapp and Griffiths' methods of partly closing the tuyeres by plugs and slides actuated by differential pistons. (2) The means adopted by Wittnöfftt, Hatton, Witherow, and others, in some cases by partially closing the blast valve whilst tapping, in others by closing the main blast valve and opening a smaller auxiliary valve, and also by reducing the speed of the blowing engines. (3) By inclining the tuyeres so that their outer ends may be higher than the surface of the metal in the converter, and thus admit of the blast being shut off entirely at the conclusion of the blow without allowing the fluid metal to enter the blast chamber. This arrangement has been used by Durfee, Wittnöfftt, Laureau, and others, but has not met with anything like the favour accorded to the first-named system; and lastly, as in the Walrand-Delattre and Brooke Iron Company's converters, by so arranging the tuyeres in the sides of the converter that when it is mounted on trunnions, and turned down at the end of the blow, the metal may lie clear of the tuyeres. All the experience that has been gained in the use of large converters with tuyeres in the bottom, is equally applicable to those of smaller dimensions, and the only modification of importance in the arrangement of these vessels is that by which the steel is run direct from the converter into the moulds without the intervention of a ladle. The author was aware that this has been attempted in Sweden and Germany for casting ingots, but it has not, so far as he was able to discover, been practised with anything like success for the manufacture of castings, where it is of the greatest importance that the metal should be run into the moulds entirely free from slag. Experiments have been made by Bessemer, Zenger, and others with converters having the air blast introduced through tuyeres, passing through the top of the converter and reaching almost to the bottom of the metal, and he was informed that, although good steel has been made in this way, the difficulty with the tuyeres was so great as to render this type of converter unable to compete successfully with those that have the blast introduced through the bottom, and it has consequently never passed the experimental stage. The difficulty with the tuyeres was due to the different expansion of the parts above and below the surface of the metal, causing them to break off before being half worn out, while the cooling effect of these large tuyeres and the removable cover made it difficult to get the metal sufficiently hot. It is well known that the first iron ever converted into steel by the simple action of a blast of air was treated in a fixed converter, and immediately after the results of these experiments had been described by Bessemer to the British Association in 1856, the further study of the process was prosecuted with such great vigour in Sweden that steel of very high quality was soon afterwards regularly made in an improved form of fixed converter, which, though worked successfully for many years, has now been almost entirely replaced by the ordinary tilting vessel of larger dimensions.

The author described these various converters in detail, and in conclusion said, "It would almost appear that the making of steel in small quantities is a step in the wrong direction, experience having led to an increase in the capacity of the converters, to reduce the cost of production as much as possible; but the desire felt by owners of small blast furnace plants to possess the means of converting their product into steel, and by the owners of ironworks who are no longer able to find work for the puddling furnaces to make sufficient steel to keep their machinery at work, rather than to be dependent on larger firms for a supply of ingots, has been sufficient to stimulate the large amount of attention which has of late been paid to the economical production of steel in small quantities. Small converters are especially suitable for works which do not possess the means of dealing with the whole output of larger vessels. Although it appears almost certain that steel cannot be made as cheaply in these small plants as in large ones, yet the difference in cost of production is not so great but that some firms have found it cheaper to use them than to obtain their ingots from larger establishments, provided that they can sell their product in the finished form.

"It has already been demonstrated that the low carbon steel made in small quantities with fixed converters is softer, and contains less silicon, than steel made in larger vessels, and containing the same amount of carbon. It has been lately shown by Fischer that this is likewise true of the steel made in the little converters at Avesta, and by Hupfield of the steel made in some experiments on small charges at Prevali in 1884. With regard to the Avesta converters, the analyses on which Fischer bases his statements are those of steel made since the practice of pouring the slag and metal together into the moulds was discontinued. Of sixty charges blown for soft metal in the small converter the average amount of silicon was ·028 per cent., and carbon ·116 per cent.

Of these charges 18 per cent. had under ·02 per cent. silicon.
48·6 per cent. had between ·02 and ·03 per cent. silicon.
18 ,, ,, ·03 ,, ·04 ,, ,,
11·6 ,, ,, ·04 ,, ·05 ,, ,,
3·8 ,, ,, ·05 ,, ·055 ,, ,,

The lowest silicon was ·014 per cent., and the carbon varied from ·08 to ·16 per cent. Of the corresponding charges in the large converter, when the same degree of softness was aimed at, the average was ·055 per cent. of silicon and ·126 per cent. of carbon. The extremes of silicon in the metal made in the large converters are, unfortunately, not given by Hupfield. Assuming, then, that the steel produced in side and bottom blowing converters, of the same capacity, to be equal in quality, the future of either for making soft ingots will mainly depend on the cost of production. This is a question not yet decided by experience, but the excessive waste of iron during conversion has been sufficient to deter many persons from adopting it, and to cause several others to discontinue its use after a few months' working. The only argument which can be offered as regards cost is the greatly diminished expense of tuyeres and bottoms as compared with the ordinary converter, and also the slightly lower cost of the blast. On the other hand, the period of the blow is a little longer for the fixed converter, and the extra loss of from 4 to 5 per cent. of iron is, I think, not only sufficient to cover the extra cost of tuyeres, bottoms, and blast, but leave a small margin of profit in favour of the ordinary converter. Before leaving this subject, it would perhaps be well to mention that the spectrum of the flame from the fixed converter is different from the ordinary one, and is so indistinct and irregular as to render the spectroscope useless for side-blowing converters."

In the discussion on these papers, Mr. Witherow, of Pennsylvania, said they had found in Pittsburgh for welding purposes the steel from the fixed converter was suitable for flanging and welding much more than that made by Bessemer; indeed, they had never found welded or flanged steel made by Bessemer, and for nails they were enabled to use pig metal containing $\frac{3}{100}$ of phosphorus; still the cut nails were excellent. They also found that when they were low in silicon and low in carbon, the phosphorus for nails seemed to do very little harm. It gave the nails a stiffening property for which an excess of carbon would have been required. They even considered that a small amount of phosphorus took the place of the carbon, and in many places, for steel that is not required for welding purposes, they found that phosphorus was not objectionable up to from 25 or 30 hundredths. But for fine qualities of steel they always used the best grey or Bessemer steel pig. They also returned or re-introduced into the cupola all the slag discharged by the converter, and by this means they got their waste down to from 12½ to 13 per cent., and for steel manufactories they considered their type of converter very economical. The results at M. Oliver's works, where he is making over 100 tons per day at less than 5 dols. per ton, allowing 2 dols., or 8s., for the loss or waste in the pig metal, and that was much less than puddling, and was very close to the Bessemer practice, and they considered that for steel plants and various rolling mills, where they could use a great deal of their scrap in the cupola, that the Clapp-Griffith, or the small converters, were of great advantage to them, because they could make more uniform stuff for their uses, and were not depending upon the large Bessemer plants. Moreover, they found that the large Bessemer plants did not furnish them regularly with uniform steel, and they could not run the risk of relying upon them for welding purposes. He thought that when this point had been tested in the coming year or two, they would find that the small fixed converters would take the place of the large converters for that class of work where parties wanted to do their own converting and not be dependent on the large Bessemer plants. The tendency in the United States was to adopt small Bessemer or small stationary converters. There were seven plants now in operation or completed, and as soon as the proper means for manipulating the ingot were obtained—that is, when they had hammers or blooming trains to handle or work the steel—they would be in a condition to determine the whole process.

Mr. Hatton remarked that Mr. Hardisty had said the waste in the fixed converter was from 13 to 15 per cent., and, adding the cupola, the waste was from 15 to 18 per cent. Over a period of five or six months' working, when they made 3000 or 4000 tons of steel, he—Mr. Hatton—estimated the waste to be from 13 to 14 per cent., including the cupola and converting. They charged 44 cwt. of pig, and they got 38 cwt. of ingots—not 35 cwt., as Mr. Hardisty said.

Mr. Gilchrist agreed with what Mr. Hatton said as to the usefulness of the slag-hole, as it enabled them to keep and retain as much of the basic slag as it was possible to keep and retain in such a vessel. In that way, as was well known, they got a lot of oxide of iron in their slag. They would keep far more of the basic slag in the Clapp-Griffith converter than it was possible to keep in the ordinary Bessemer converter. The very low silicon which these small vessels made was due to the low amount of oxide of iron within the slag, coupled, perhaps, with the temperature not being quite so high.

M. Gautier spoke of the great work of Sir H. Bessemer, as sketched out at Cheltenham thirty years ago by the inventor at the meeting of the British Association. The great results which had been since and could only be obtained if certain conditions were fulfilled, namely, a certain mass of metal upon which to act; secondly, an intense internal production of heat obtained by the combustion of some elements of the pig iron; thirdly, a quick burning of the element by a high blast pressure. These three conditions must not be lost sight of for the success of the converter, and they must be obtained also in the small size converters. But with the small converters they first reduced the bulk of the metal on which they acted. They had a certain cooling effect, which could not be neglected.

Mr. Stead, Middlesbrough, said a little time ago he investigated very carefully the authority for using a large converter in preference to a small one. Messrs. Hatton and Co. very kindly allowed him to go over their works, and to investigate the blowing operations there. He certainly was impressed, and surprised beyond expression, by the way in which that process was carried on at their works. It would be thought that it was very much easier than the ordinary Bessemer process. It was observed during the first part of the blowing that a considerable quantity of red smoke was produced and passed up out of the chimney. That at once directed his attention to waste, and he concluded that it was utterly impossible to blow in those small converters without a greater amount of waste than in the Bessemer process in the larger converters. After having obtained samples of the steels obtained from this process, he found that they were, as Mr. Hatton had stated, remarkably pure, the silicon being exceedingly low, and the carbon very low also. The next point was to ascertain why this silicon was so much lower than was generally found from similar steel in the larger converters, because he thought they must admit that, taken on an average, steel from the larger Bessemer converters was higher in silicon than that obtained from the smaller ones. That would account, he thought, for this extra waste of iron during the first part of the process, which remained in the slag and effectually removed the silicon from the steel. But the heat in those small converters was obtained in a great measure by the extra oxidation of the iron. He was very pleased indeed to hear what M. Gautier had just said in reference to the storing of oxide of iron in slag. It was a point he was going to mention. They had been in the habit always of imagining that the atoms of oxygen went running about among the atoms of molten iron, picking out the silicon first of all, and then went on to take out the atoms of carbon or manganese, and then, when the whole thing was done, that the converter was turned down. As a matter of fact, by a very careful investigation he had found 90 per cent. of the oxidation was through oxide of iron—that was, the blast was blown into a mass of metal, and in fact the whole of the elements were oxidised practically in the ratio in which they exist. It seemed to him that in allowing that valuable store of oxygen to blow up in that outlet in a small converter they were really throwing away a valuable stock. They had the oxide of iron in the slag. It was a very fluid slag; it contained a very large quantity of oxide of iron. It was certainly silicious; it retained the greater bulk of silicon, and it also contained a very large proportion of the oxide of iron; and if that was allowed to remain in the vessel they would have less waste in the converter. That oxygen from the oxide of iron would be taken to eliminate the carbon, and the iron from that slag would be precipitated into the batta. When the slag was used in a cupola-furnace, in all probability the greater part of that iron would be recovered, but it would be recovered in a very much easier way by allowing the slag to remain in the vessel. In the Hatton process they obtained very low silicon by a little extra oxidation of iron. They simply oxidised an extra amount of iron in the large converter to get the same result. This was done by the use of hot metal, and the oxidising of the iron by a short after-blow. If they had it in a cool state in a Bessemer converter, the silicon very readily passed out of it, and there was no need of an after-blow; but if it was very hot, Bessemer men would know that there was great danger of leaving silicon in the steel. The steel made from small converters was very simply and easily made; still, there was the matter of cost, that was the great point. They could make the same article in the larger converter quite as pure.

Sir Henry Bessemer, in reply, said he thought it would be necessary only to make a very few observations on the very interesting discussion that had been raised on his paper. There appeared, he thought, from the evidence which had been placed before them, a general opinion that the small converter was more wasteful in producing steel than when the work was done on a larger scale. Indeed, that would seem almost the inevitable result, but a large portion of that result was due to what he had always observed in the use of a fixed converter. With the tuyeres only at a short distance below the level of the metal, and with a very light blast, he had always observed a vast amount of brown smoke being made by a great quantity of iron being wasted in early stages of the process which in bottom blowing had never been seen; and it was, indeed, from that reason to a great extent that he first turned his attention to blowing vertically upwards. Another reason of this waste was that in the fixed converter the momentum of the current of air was so slight, and it had to encounter such a very heavy mass of iron, that instead of penetrating to any great distance it blew up in great bubbles by the side of the vessel. He had seen in that fixed converter just where the tuyeres entered after a certain quantity of work, the lining cut half way through by the oxidation cutting up the inside of the vessel and showing incontestably that the air was not driving up into the general mass. The result of that would be that a large pool in the centre would be very imperfectly done, but for general adoption it would never be done at all, and would remain the same pig iron as that put in, but the large amount of motion that was produced gradually mixed it; but he took it to be impossible that the blast going in only a short distance from the outside, and going in vertically, and naturally finding its way to the level of the metal by the shortest possible route, and not dividing itself much off into separate streams, that the air so taken in would not affect the centre until after the outer portions of the metal had long since been converted into malleable iron and were undergoing the process of oxidation in the course of the whole process. He, however, might say with regard to the vertical blow upwards, and using a very high blast, that the air the moment it was liberated divided itself off so violently as to go up in a sort of shower of bubbles. He made an interesting experiment in order to ascertain that fact by using a large square tank of glass, into which he put 3ft. depth of water, and put three different kinds of tuyeres into the bottom of it, and being a transparent medium, and being air passing up through a fluid, he naturally supposed that was very much the same effect that would take place in the fluid iron, and he found that by a violent blast—20 lb. to the inch—that the air immediately on issuing went up as a huge cone as white as snow. It was very much like taking the cork from a champagne bottle, and the fixed air going out all at one time. He took it that that fixed division of the air into small streams or globules was a better way of doing it than allowing large gulps of air to go up from the surface of the metal from the side of the tuyeres. With regard to one point, it has been stated, on more than one occasion, that the side blowing vessel will give you a nearer approach to pure iron—that was to say, that the charge was milder steel. Now, that could not be the case, inasmuch as, with reference to the bottom blowing converter, he happened to have some of the work done by that; indeed, it was in the possession of the Institute. He had a gun weighing about 3 cwt. That was put, as he mentioned in reading his paper, among the first batch of ingots ever made by that upward blowing—and that was a very deep blowing, as they would observe. He might also say that in the case of the tuyere shown there with a single jet, the first part that went up was immediately divided into a vast number of little holes. He had an illustration of twelve years ago, but he was sorry it had been mislaid, he having left it on the table, as he would like to have shown it to them, of the falling of one of these tuyeres that had accidentally taken place, and which one of his old workmen was kind enough to send him only a few days ago, he having kept the relic for some twelve years by him. The division of he blast had the effect of entirely decarburising the piece with the sample which he spoke of, the small gun, and which had on two occasions been analysed by his friend Mr. Riley, and was found to contain no less than 99·78 of pure iron; so that they would see that minute portions of impurities took up silicon, carbon, manganese, or any other matters which might be present, showing that, so far as decarburisation went, nothing could be more perfect in any vessel than that which could be done in bottom-blowing vessels, of which that was a living proof. M. Gautier in his remarks hit the point very conclusively. He went to show that those small quantities were only done with difficulty and disadvantage, or by overcharging the metal with silicon. In the large mass, as M. Gautier explained, they retained the heat, their surface for radiation was smaller, and a greater accumulation of temperature was easily obtained in a flat spread-out surface; the metal flowing from the outside, a large proportion of the heat flew off, and they had to make up for that by burning the iron or by having an extra quantity of silicon. He did not know that there were many other points that had been touched upon that he need take up their time by reverting to. There were so many gentlemen present who were thoroughly and practically acquainted with what was now called the Bessemer process, that he thought without any difficulty they would eliminate the seed from the chaff, and would know exactly how far to give credit to the different views that had been enunciated on the question.

Mr. Hardisty also replied.

A paper was then read by Mr. Frederick Siemens

On Combustion, with Special Reference to Practical Requirements.

In all heating operations, the main object is to produce the greatest amount of effective work with economy of fuel, material, and labour. In order to do this it is of the utmost importance that combustion should be as perfect as possible. This, however, would not alone in all cases meet practical requirements, the form and dimensions of the furnace and many other points having also to be considered. This paper was in many respects similar to that read by the author two years ago before this Institute, in which he described a method of working regenerative gas furnaces by employing radiant heat alone within the heating chamber, and drew attention to an important point connected with combustion, namely, that a flame requires free space for development if it is to burn properly and effectively. He then showed, from results obtained in practice, that a flame burning within an enclosed space should be directed so that whilst in active combustion it does not come into contact either with the sides or roof of the furnace, or with the materials contained therein, as when flame is allowed free space in which to burn, and is not interfered with by solid bodies, not only is there an increase of the work performed, but that work is accomplished in a better manner, and a considerable saving of fuel, furnace material, and other advantages are realised. Since that time this system of applying radiant heat, which it is now preferred to describe under its more general term, as heating with free development of flame, has been largely adopted, and the author's theoretical investigations have been born out by the results of practical experience.

The theory which best explains the nature of flame is the one under which it is regarded as a rushing together of gases, the molecules of which, being chemically excited, are in violent motion towards or against one another. Such motion is a primary condition of combustion, which could not take place without it, so that anything interfering with the motion of the gaseous particles prevents that chemical union which exhibits itself as combustion. In order to insure perfect combustion the following means have to be adopted:—(1) The gases must be supplied in the exact chemical proportion in which they are required for combustion. (2) The gases must be brought together in such a manner that the different molecules which have to enter into combination may readily do so. (3) Everything must be avoided which might interfere with the motion of the gases while combustion is proceeding.

Although the particular materials chosen by nearly all the physicists who have experimented on dissociation with small vessels or tubes—mostly clay, porcelain, or asbestos—have no direct chemical action on the dissociated gases; yet the influence of surfaces in general, and especially of highly heated surfaces, have been entirely overlooked. Heat expands the molecules of gases, and thus tends to weaken the chemical affinity of their atoms, until, at a certain high temperature, expansion overpowers chemical attraction, and dissociation takes place; but if highly heated surfaces are present which tend to attract or condense one or other of the elements constituting the gas experimented upon, dissociation is facilitated, and will necessarily occur at a much lower temperature. Hitherto physicists have been satisfied to prove dissociation by showing that a flame became longer with increase of temperature. It was maintained that, as the temperature of the flame increased, dissociation set in more and more, thus causing an extension of the flame, combustion and dissociation being repeated over and over again.

After an explanation of the construction and working of a burner on his system, Mr. Siemens replied to a few questions, and the business of Thursday was brought to a close. The members and visitors went to the Woolwich Arsenal in the afternoon, and in the evening to the annual dinner.

The Communal Administration of Brussels has reported to the Town Council that the proposals, made by an English syndicate, for the cutting of a maritime canal to Brussels should not be accepted, as they would impose on the town sacrifices out of proportion with its resources.

Junior Engineering Society.—At the opening meeting of the fifth session of the Junior Engineering Society, Professor Kennedy, in his presidential address, dealt with the question of steam engine testing and economy. It was an undoubted fact that only a comparatively small portion of the heat put into an engine was used, but the statements that were so freely made in prospectuses and other documents, that certain new engines utilised 50 per cent. more heat than any previous inventions, were altogether erroneous; but, unfortunately, there were many persons who, seeing such statements in print, accepted them as correct. In dealing with this question of economising heat in steam engines, he said the most careful calculations and experiments were necessary to arrive at anything like an accurate conclusion, and he desired to impress upon the members that perfect accuracy was one of the chief essentials of an efficient engineer. The loss occasioned by the clearance spaces, for instance, might be very much reduced by the use of very proper compression or "cushing." It was a pity that the clearance spaces of a steam engine were not considered as among its most important dimensions. The use of a non-conducting material in the cylinder liners would also save considerable loss, but at present no satisfactory material had been found for the purpose.

HYDRAULIC PRESSES FOR CANAL LIFTS.

The accompanying woodcuts illustrate the hydraulic cylinder which was made by the Société John Cockerill, and shown by them at the Antwerp Exhibition, for ascertaining the ultimate resistance of cast iron cylinders hooped with steel; the multiplying apparatus, for indicating the expansion of the metal under the successive increments of pressure; and a diagram, constructed by Mr. Lionel Clark, from the results of the experiments.

In 1881 the Belgian Government offered a prize for the best method of transporting over hills a canal boat weighing 300 tons, or 1000 tons including its load; and the prize was awarded to Messrs. Clark and Standfield, whose plans for the Seneffe Canal were adopted. That project was not executed, as the canal had merely to traverse a narrow ridge of hills, and it was found cheaper to make a tunnel. Messrs. Clark, Standfield, and Clark were subsequently, however, appointed consulting engineers for the Canal du Centre, connecting the Mons and Condé Canal with branches of the Brussels and Charleroi Canal, and having a total rise and fall of 89·456 m., or 293ft. This is being carried out by the Department of Ponts et Chaussées for cheaply conveying the products of the Belgian coal-field to the North of France, and especially Paris, the great centre of consumption.

Without going into the details of this scheme on the present occasion, it will be sufficient to state that the first section from Mons to Thieu—a prolongation of the Mons and Condé Canal—is 14 kilom., or nearly 9 miles long. It was constructed with ordinary locks at a cost of 5,000,000f., or £200,000, and is already in active operation; while the second section, between Thieu and La Louvière—9 kilom., or 6 miles long—is estimated to cost 13,000,000f., or £520,000. It is designed with a lock of 4·2 m., or 14ft., rise and fall, leaving a height of about 66 m., or 217ft., to be gained by four pairs of hydraulic lifts. The first of these, at La Louvière, constructed by the Société John Cockerill at a cost of 662,500f., or £26,500, for a rise and fall of 15·397 m., or about 50ft., is now being erected; and the three others—two at Houdeng, and the third at Thieu—will have a rise and fall of 16·933 m., or about 56ft. The lifts are 43 m. long by 5·8 m. wide by 3·25 m. deep, or 141ft. by 19ft. by 10ft. 8in., and are each supported on a single press.

Attention had been particularly called to hydraulic presses for canal lifts by the failure of the Anderton press, and several different designs of presses were proposed and tested. The Terre-Noire Company of France proposed a cast Siemens steel press, having a thickness of 2in., to work under a pressure of about 4 tons per square inch. Some segments were cast and tested, the bars showing an average strength of 49 kilogs. per square millimetre, or 31 tons per square inch, with an elongation of 8·6 per cent. On trying one of the actual segments, however, it burst with an internal pressure of 70 atmospheres, or 1050 lb. per square inch, this low bursting point being due to a serious defect in the metal and to the sealing of the mould. It was, perhaps, unfortunate that these presses were not cast a little thicker, as the slight thickness of 2in. rendered the operation of moulding extremely difficult; and it is to be regretted that further trials were not made, so as to set at rest the question whether cast steel could be employed for presses of such dimensions. Cails, of Paris, then proposed a press of rolled Siemens steel plate rivetted, the steel having about 60 kilogs. per square millimetre, or 38 tons per square inch, breaking strain. A segment was built up and tested, when it proved a complete failure, leaking badly under a pressure of 30 atmospheres, or 450 lb., per square inch, and breaking at the cover plates under about 70 atmospheres.

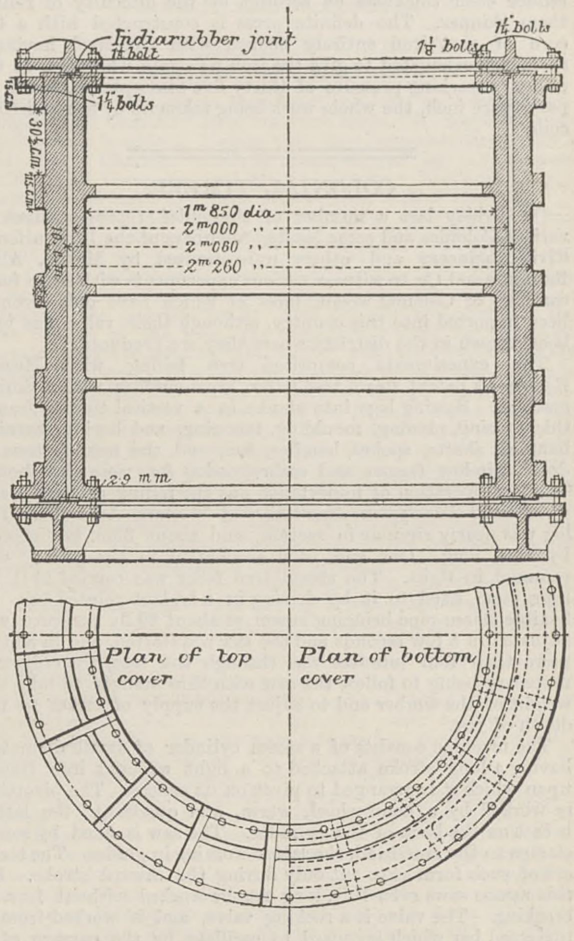
In the presence of these failures, the Belgian Government was specially anxious that crucial and exhaustive trials should be made, in order to ensure success and safety. Messrs. Clark and Standfield then proposed the form of press illustrated; and the Cockerill Company went into the matter with great spirit, sparing no expense in carrying out the tests. Profiting by experience gained in previous failures, they made experiments at their own cost on a press designed at the works, built up after the manner of great guns, the cast iron cylinder being strengthened by steel hoops shrunk on. Accordingly a cylinder was constructed of 2·06 m., or 6ft. 9in. internal diameter, and of the same height, with a thickness of 10 cm., or 4in., strengthened by steel hoops of about 6in. by 2in. section, rolled in the tire mill, and shrunk hot on turned annular projections about 1ft. apart.

The cylinder was prepared for trial by receiving a casting, representing the ram, of 2 m. or 6ft. 6¾in. diameter and the same height, leaving an annular space between the two of 30 mm., or about 1⅛in. This space was closed in by cast iron rings, that at the bottom forming the seat, with joints composed of flat india-rubber strip, with plies of canvas interwoven, and tied down by bolts of the number and diameter shown in the plan and section. The holes in the top and bottom outer steel angle hoops are oval to allow the whole of the cylinder to expand freely under pressure. The water from the force pumps was introduced into the annular space by a small pipe led through the casting that took the place of a ram, a small cock being screwed in for allowing the air to escape, and also the pipes leading to a couple of pressure gauges. Before commencing the tests the diameters of the press and of the hoops were carefully gauged; and the pressure was gradually raised until that of 120 atmospheres, or 1800 lb. per square inch was attained, the expansion being carefully taken after each increment of pressure.

The speciality of this system consists in constructing these steel hoops smaller than the body of the press, so that, when shrunk on, they put a calculated amount of compression on the cast iron core, thus relieving it of so much strain. This compression was to be so regulated that with the ordinary working pressure of thirty-five atmospheres, or 517½ lb. per square inch, the internal fibre of the cast iron core should only have a strain of 2½ kilogs. per square mm., or 1·59 ton per square inch, whereas, with the unhooped core, the same pressure would exert a strain of 3·75 kilogs., or 2·35 tons on the metal. At the same time the steel hoops were limited to a tension of 7½ kilogs. per square millimetre, or 4·76 tons per square inch. But each hoop had sufficient shrinkage for the strain on the fibres furthest removed from the hoop not to exceed the maximum standard.

During the trials the joints held well up to the pressure of 120 to 125 atmospheres, or between 1775 lb. and 1850 lb. per square inch; but beyond this point, without actually giving way, they allowed the water to escape more freely than the pump could compensate. The reason of this is, that under such high pressures the press bulges out considerably and becomes shorter, while the piston in compression does not yield in a like degree, so that the outer press is forcibly torn away from the upper joint. Indeed, the tendency to tear asunder is so great that the upper joint cover has been cracked all over between the bolts.

The first series of trials took place in the presence of the Belgian Minister of the Interior, the Director-General of Ponts et Chaussées, and most of his chief engineers, including M. Genard. They were very satisfactory in all respects, no permanent deformation being noticed, nor any leakage through the material of the press. But the leakage of the joints prevented a pressure of 120 atmospheres, or 1772 lb. per square inch, being exceeded. A series of careful experiments were subsequently made for determining, under various pressures, the actual elongation of the circumferences both of the hoops and of the press itself between them. In order to accurately observe the elongations, a light steel band was placed round the press, furnished

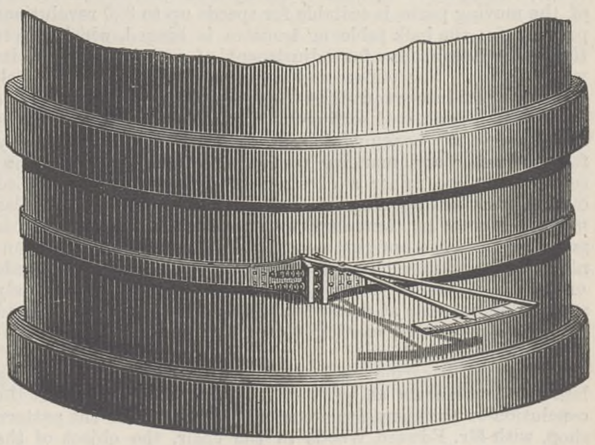


HOOPED PRESS TUBE.

with a multiplying indicator which recorded the elongations twelve times their real size, as shown on the accompanying sketch. The annexed table gives the mean of the results reduced to actual elongations of the circumference.

The results are also graphically represented on the accompanying diagram, to which a probable curve of elongations has been added. The maximum pressure obtained during these trials was 131 atmospheres, or 1936 lb. per square inch. At this point the joints again failed, allowing the water to escape in greater quantities than the pumps could supply, which is not to be wondered at considering the great length—nearly 100ft.—over which the joint had to be made. After these trials some slight permanent deflection of the press must have taken place, for when the top joint cover was removed it was found that the press itself had become permanently shorter by about a millimetre. Ultimately the flat india-rubber strip of the top joint was replaced by a Bramah cup joint of gutta-percha, with a view to burst the press, but only about 130 atmospheres, or 1921 lb., were attained, the general leakage of the joints being too great to be compensated by the pumps.

During the trials only one measurement of elongation was broken, viz., one at 125 atmospheres. This was measured after



MULTIPLYING INDICATOR.

the press had remained some time under pressure, and is much higher than any of the previous measurements. The probable explanation of this is, that it takes some time for the fibres of the press to attain their full extension. All the previous measurements taken at short intervals are no doubt misleading on this point; and this is allowed for in the probable curve of elongations. The preceding table gives the calculated maximum tensions on the internal fibres (1) of the press under one of the coils; (2) of the coils themselves; and (3) of the cast iron midway between two coils, the weakest part of the whole press.

With an internal pressure of ten atmospheres, the internal fibre of the press under the coils is not yet in tension, the external pressure from the shrinking of the coil exceeding the internal pressure. Although the tension of the press between the coils cannot be estimated exactly, as it depends on what compression the coil has been able to exert, it must be between the two limits given, for they represent the maximum and minimum strain put on by the coil. The tensions under the ordinary working pressure of thirty-five atmospheres, or 517 lb. per square inch are, for the cast iron under the coil, 1·35 kilog. per

Fig 8.

Diagram of Elongations of Hooped press.

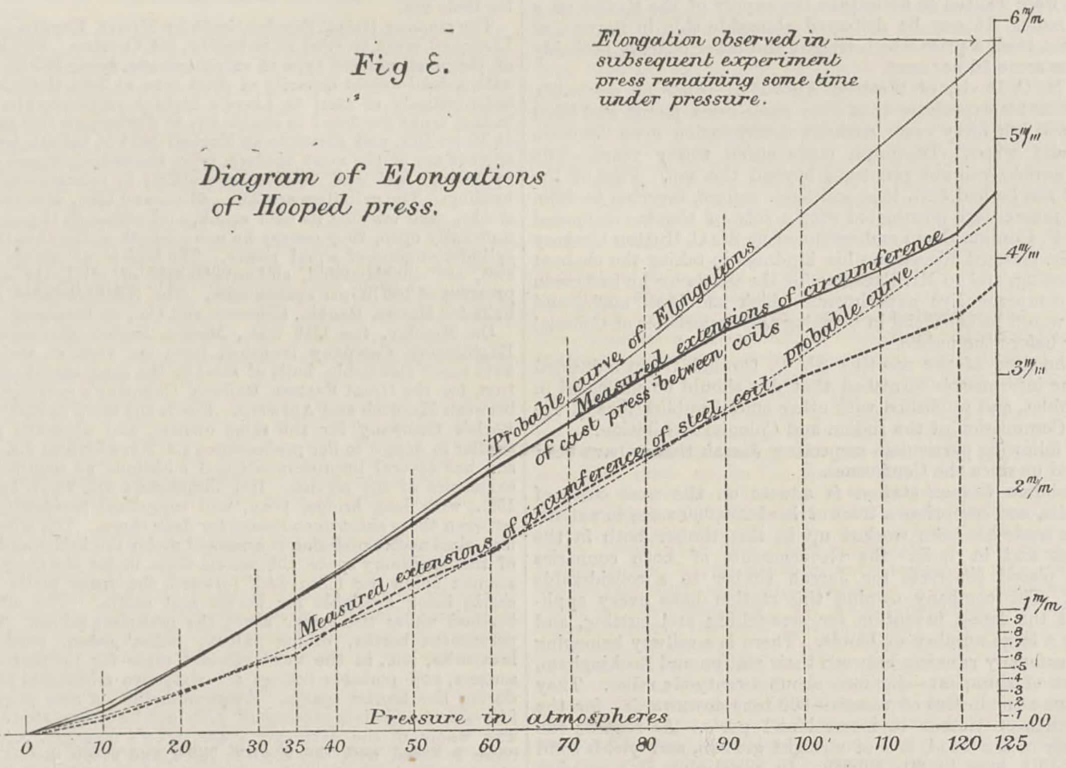


Table of Elongations.

Atmospheres	10	20	30	35	40	50	60	70	80	90	100	110	120	125
Between coils. ..	·0082	·0226	·0378	·0413	·0535	·0714	0·088	·1047	·1209	·1358	·1464	·1565	·1675	·1812 in.
	0·208	0·573	0·960	1·05	1·361	1·805	2·235	2·662	3·07	3·447	3·717	3·966	4·254	4·604 mm.
On coils.	·0053	·01374	·0228	·0262	·0348	·0488	·0637	·0777	·0913	·1061	·1177	·1315	·1368	·1482 in.
	0·134	0·349	0·578	0·666	0·884	1·240	1·618	1·974	2·318	2·696	2·992	3·242	3·475	3·766 mm.

1 atmosphere = 14·78 lb. per square inch.
25·4 millimetres = 1 inch.

Table of Tensional Strains.

Atmospheres	10	20	30	35	40	50	60	70	80	90	100	110
Under coil (1) ..	0·381	1·145	·6032	·8572	1·092	1·587	2·076	2·508	2·984	3·429	3·841	4·25 tons per square inch.
	·6	·18	·95	1·35	1·72	2·5	3·275	3·95	4·7	5·4	6·05	6·7 kilogs. per square mm.
On coil (2).. ..	2·73	3·24	3·84	4·06	4·32	4·89	5·46	6·00	6·57	7·17	7·71	8·25 tons per square inch.
	4·33	3·15	6·05	6·4	6·85	7·7	8·6	9·45	10·35	11·29	12·15	13·03 kilogs. per square mm.
Between coils (3)	0·667	1·28	1·905	2·2	2·51	3·08	3·65	4·22	4·88	5·397	5·94	6·667 tons per square inch.
	1·05	2·025	3·00	3·475	3·95	4·85	5·75	6·65	7·60	8·5	9·35	10·5 kilogs. per square mm.
	0·362	1·079	1·714	2·01	2·316	2·889	3·45	4·019	4·59	5·143	5·7145	6·28 tons per square inch.
	0·57	1·7	2·7	3·175	3·65	4·55	5·43	6·33	7·23	8·1	9·0	9·9 kilogs. per square mm.

square mm., or 0·857 ton per square inch; for the cast iron between the coils, 3·475 to 3·175 kilogs. per square millimetre, or between 2·2 tons and 2·01 tons, per square inch; and for the steel coil, 6·4 kilogs. per square millimetre, or 4·06 tons per square inch. The limits which the Belgian engineers considered safe were for cast iron 2½ kilogs. per square millimetre, or 1·59 tons per square inch; and for the steel, 7½ kilogs. per square millimetre, or 4·76 tons per square inch. It is evident therefore that, though that portion of the press directly under the hoops, and doubtless for some distance on each side of them, is within the limits, there is a spot where this limit is exceeded; the steel coil, however, remains well within the limits. It follows that the shrinkage given to the coils was not sufficient to compress all the surrounding region of unsupported iron; and it was eventually decided to hoop the entire press with juxtaposed rings, thus considerably simplifying the matter, though it was not found practicable to reduce their thickness on account of the difficulty of rolling them thinner. The definite press is constructed with a 4in. core of cast iron entirely hooped with 2in. steel, having a shrinkage calculated to give the iron no strain whatever, at the ordinary working pressure of thirty-five atmospheres, or 425 lb. per square inch, the whole work being taken up by the encircling coils.

COLONIAL TIMBER.

On Friday last a number of the chief representatives of various Colonies and some leading members of the Institution of Civil Engineers and others were invited by Messrs. Allen Ransome and Co. to witness various experiments with some forty varieties of Colonial woods, most of which have only recently been imported into this country, although their value has long been known in the districts where they are produced.

The experiments comprised tree felling with Messrs. Ransome's patent steam tree feller, cross-cutting with a similar machine. Sawing logs into planks in a vertical timber frame, thicknessing, planing, moulding, tenoning, and boring, turning hammer shafts, spokes, handles, &c., and the manufacture of doors, window frames and sashes, casks, &c., were also shown. The first operation of importance was the felling of hard Karri wood—the *Eucalyptus diversicolor* of Western Australia. The log was nearly circular in section, and about 33in. in diameter by 15ft. long. One end of it was buried in the ground and rammed in tight. The steam tree feller was carried to it by four men, fixed to it by driving in a trident-pointed bar. A flexible steam pipe bringing steam at about 60 lb. pressure was adjusted in a few seconds and the saw was started, and in a little more than four minutes was through the tree, the only care necessary being to follow the saw with thin wedges to take the weight of the timber and to adjust the supply of steam to the depth of cut.

The machine consists of a steam cylinder of small diameter, having a long stroke attached to a light wrought iron frame, upon which it is arranged to pivot on its centre. The pivotting is worked by a hand wheel, worm, and quadrant; the latter is cast on the back of the cylinder. The saw is fixed by screw clamps to the crosshead, the latter working in guides. The teeth are of such form as to cut only during the inward stroke. By this means saws even 10ft. long can be worked without fear of breaking. The valve is a rocking valve, and is worked from a turretted bar which is caused to oscillate by the passage of a slot in the crosshead; the cut-off is adjustable by set screws. By having a steam pipe of sufficient length considerable numbers of trees can be cut before moving the boiler, the machine working all round the boiler to the "length of its tether"—the steam pipe. By removing a rod 4½in. in depth, the trees can be felled at ground-level, thus saving in each stump several cubic feet of the best timber, which by hand-felling would be cut into chips. A machine similar to the one described, but with a different frame to enable it to traverse in a vertical instead of a horizontal plane, was then shown in action, cross-cutting a tree into lengths. The advantage of doing this on the spot is very great, rendering the subsequent moving and handling of the logs so much easier. This operation on a 32in. log took three minutes forty-five seconds, the timber being as hard as English oak.

The next operation witnessed was the preparation of railway sleepers of standard dimensions by a special machine, which in about fifty-five seconds adzed the chair seatings for them and bored the four spike holes. The planing, tongueing, grooving, and beading at one operation of boards from each sample of timber were next shown, the speed at which the planks passed through the machine ranging from 24ft. per minute for the softer woods to 12ft. for the harder. The single deal and flitch frame, which, in consequence of the lightness and careful balance of the moving parts, is suitable for speeds up to 320 revolutions per minute; the balk table or transom is hinged, which leaves the swing frame clear for adjustment of saws throughout its whole length. The joiners and boxmakers' cross-cut saw bench was brought into requisition for several experiments. It is fitted with a graduated setting-out bar, with a spring stop, which can be set in any position along it, thus avoiding the necessity for measuring and marking wood beforehand; and at Ransome's complete joiner a diversity of operations were carried out, such as sawing, cross-cutting, planing, moulding, circular moulding, grooving, tenoning, mortising, and boring. In this general joiner the upright spindle used for moulding, and running 4000 revolutions per minute, was carried on a footstep made of the Cape wood Umzumbit, which it is expected will largely replace lignum vitæ at much less cost. Near this was a band saw, with self-acting canting tables, very suitable for pattern-makers and shipbuilders.

Trying up, squaring, and mortising machines and copying lathes where shown at work on the Colonial woods. At the conclusion of the operation a conference was held in the pattern shop, with Mr. Edward Woods in the chair, the object of the conference being to elicit information as to the relative merits and prices of various kinds of timber.

Mr. Allan Ransome opened the proceedings by announcing the conclusions to which he had come with regard to the samples submitted to his notice. Among the forty species some stood out as eminently suitable for the English market. Iron bark—*Eucalyptus crebra*—and mountain ash—*Eucalyptus Siberiana*—from New South Wales, both suited to wheelwright's work, and the former for piles and sleepers as well. Blackwood—*Acacia melanoxylon*—suitable for carriage-building, cabinet work, and case-making. Karri wood—*Eucalyptus diversicolor*—and jarrah—*Eucalyptus marginata*—from Western Australia, suitable for joiners' work, furniture, sleepers, and piles. Black pine—*Podocarpus spicata*—red pine—*Dacydium cupressinum*—totasa—*Podocarpus totara*—kauri—*Dammara Australis*—which could be employed for housebuilding, furniture, cabinet work, pattern-making, and barrels, kauri being the most generally useful. Douglas fir—*Pseudolonga Douglasii*—black or swamp ash—*Fraxinus sambulifolia*—from Canada, both being strong and tough and cheap, the swamp ash having also a beautiful grain. Yellow wood — *Knysna* — stink wood—*Oreodaphne Bullata*—sneeze wood—*Pteroxylon utile*—from the Cape of Good Hope, the two former species suitable for furniture, building, and joiners' work, the latter, from its durability and freedom from attacks by insects, suitable for piles, posts, telegraph-poles, &c. Billian and serayah, from British North Borneo, the former suitable for beams, piles, and every purpose where durability is a necessity, and latter for furniture, veneers, &c. And lastly, padousk wood—*Pterocarpus Indiana*—from India, suitable for joinery, carriage work, and furniture. It grows in great abundance near the coast.

The Hon. Malcolm Frazer, of Western Australia, said that of karri and jarrah large quantities were in London at the present moment. Several hundred loads of 50 cubic feet per load may now be had at £7 a load.

Professor Macrom, of Canada, said that the reason that so few English people knew of Canadian timbers was the tendency on the part of trade to remain in fixed grooves.

The Douglas fir of Canada is fully equal to the white pine now employed, and when the latter becomes more scarce it will no doubt take its place.

The Douglas fir has the further merit of tapering very gradually, only 6in. in 90ft.; it can be supplied in England at £5 a load, and the black ash at the same price as elm or white pine. Mr. Cooper, of the Cape, said that the Umzumbit, for its great hardness and durability, was eminently suited for many purposes. Mr. Cooper then said there were other woods at the Cape which, instead of tapering 6in. in 90ft., became thicker as they grew higher. Mr. Alfred Dent, of Borneo, said that the Billian had great attractions for the English market. It grew in great profusion, was easy of access, hard and durable. Companies were wanted to undertake the supply of the timber on a large scale. It can be delivered alongside ship in Borneo at £3 10s. a load, a price which freight and other charges probably enhance some 50 per cent.

Mr. M. C. Davis, of Western Australia, owner of saw mills, gave it as his experience that piles made from jarrah and karri wood will last forty years without deterioration even between wind and water. Telegraph posts stand thirty years. The *teredo navalis* will not penetrate beyond the sap. Piles of the timber can be had 88ft. long and 52in. square, tapering to 40in.

The proceedings terminated with a vote of thanks—proposed by Sir P. Cunliffe Owen and seconded by Sir C. Hutton Gregory—to Mr. Edward Woods for his kindness in taking the chair at the meeting, and to Mr. Ransome for the assistance he had given in the comprehensive experiments which had been made, and which would be beneficial in bringing the importance of Colonial timber before the public.

At the close of the meeting Sir P. Cunliffe Owen requested that the information furnished that day should be embodied in a pamphlet, and published with other official publications of the Royal Commission of the Indian and Colonial Exhibition.

The following particulars respecting Jarrah timber have been supplied us since the Conference.

Jarrahdale timber station is situate on the west coast of Australia, and comprises a tract of land 250,000 acres in extent. A large trade has been worked up in this timber both in the Colonies and in India—the Governments of both countries having placed contracts for Jarrah timber to a considerable extent. The company owning this station have every appliance of the latest invention for tree-felling and cutting, and employ a large number of hands. There is a railway belonging to the company running between their station and Rockingham, the port of shipment—distance about twenty-six miles. They also have a small fleet of vessels—800 tons downwards—for the conveyance of timber to intercolonial ports. As regards the character of the wood, it is of straight growth, and yields solid timber 40ft. long by 2ft. square. In appearance it somewhat resembles mahogany, and, like that wood, is capable of a very high polish, and has enough figure to make it suitable for cabinetmakers' work. It is chiefly adapted for piles, sleepers, dock work, and shipbuilding, the peculiarity being its absolute resistance to the teredo and white ant, so that copper sheathing in shipbuilding is rendered unnecessary. The company has recently shipped a cargo to this market with encouraging results, the prices realised being at the rate of £7 per load. They have also a good exhibit at the Indian and Colonial Exhibition. The agents, M'Lean Brothers and Rigg, of 9 and 11, Fenchurch-avenue, E.C., are sanguine of its success in this country.

THE RAILWAY SERVANTS' CONGRESS.

At the Railway Servants' Congress held at Brighton last week, it is interesting to note that perhaps no subject of greater importance was discussed than that of continuous brakes. Mr. C. E. Stretton, of Leicester, vice-president of the Society, who took the chair in the absence of the president, Mr. P. S. Macliver, gave an able and very practical address in which he dwelt, as we have often done ourselves, on the unsatisfactory progress made by certain railway companies in equipping their trains with brakes complying with the Board of Trade conditions. These conditions were first issued in 1877, and yet at the 31st December, 1885, the date of the last brake return, there were only 21,000 vehicles out of 51,000, which, even to use the words of the return, appear to comply with the conditions. Reference was again made to the fact that, notwithstanding the terrible calamity at Penistone, when twenty-four persons were killed, and sixty-four injured, more than two years ago, the Manchester, Sheffield, and Lincolnshire Company are still using the same vacuum brake which then proved so incapable, and along with this company must be classed the London and North-Western, the Great Northern, and the South-Eastern Companies. It seems pretty clear that if a railway company, or rather, an individual like Sir Edward Watkin is not to be moved by the wholesale slaughter of those who pay to travel on his line, he is not likely to care for the views or criticisms of the Board of Trade or its inspectors; therefore legislation, in some form or other, which will compel the adoption of adequate safeguards is absolutely necessary.

According to the report of the general secretary at the Congress, Mr. Channing's Railway Regulation Bill, which was referred to a Select Committee just prior to the dissolution of the last Parliament, will be re-introduced next session, so that we may expect more powers will then be given to the Board of Trade to enforce provisions for safety, which everyone knows to be more necessary than many of those already insisted on. From the report of the proceedings, it is pretty clear that the railway servants intend to have a voice in settling this important question, and two resolutions were passed on the subject, showing the interest taken in it. It was moved by a delegate.

"That this Congress views with regret the unsatisfactory position of the brake question, and the comparatively small progress made by the companies in fitting their vehicles with brakes that comply with the conditions of the Board of Trade, and it deprecates the action of those companies who are fitting their vehicles with brakes that do not comply with the conditions of the Board of Trade."

It was also moved and carried:—

"That in order to discover what continuous brakes actually fulfilled the conditions imposed by the Board of Trade, this Congress should urge upon the Government to appoint a committee of experts to investigate and report upon the question."

In a leader on the subject of the Congress, our contemporary, the *Times*, remarked with truth: "Railway servants, peers, and the public at large, have never had any difficulty in making up their minds on the subject. Only one small class in the community remains undecided; unfortunately that alone has the power of acting upon a conclusion." On the subject of uniformity the *Times* further says, and with equal truth, "Everybody was long ago convinced that all trains should be fitted with one and the same kind of continuous brake. The British railway system is too closely connected, and rolling stock is too interchangeable for it to be safe to employ different brakes, if they were equally meritorious. Should one have to be selected experts and the public are sufficiently unanimous on the choice to be made." There was certainly remarkable unanimity in favour of the Westinghouse brake at the Railway Servants' Congress.

LAUNCHES AND TRIAL TRIPS.

On Wednesday, the 29th September, the Tyne Iron Shipbuilding Company launched a large steel screw steamer for the Australian trade, named the Port Augusta. Her principal dimensions are—Length over all, 360ft.; breadth, 38ft. 9in.; depth moulded, 28ft. 6in. The vessel has a long raking stem surmounted by a handsome figurehead, and is of finer form than usual, the entrance being unusually fine, and the run being easy and gradual, her estimated speed being 12 to 13 knots. The Port Augusta will be fitted with triple expansion engines by Messrs. Wigham, Richardson, and Co., of Walker-on-Tyne, and are calculated to indicate 2200-horse power. She is expected to make the run from the Channel to Adelaide, *viâ* the Cape of Good Hope, in thirty-nine days, and will have room for 750 emigrants. In a large deck-house aft is accommodation for a number of first-class passengers. The vessel has teak decks, and has been built under special survey to Lloyd's 100 A1 class, and to the requirements of the Admiralty for their list.

The steamer Saint Regulus, built by Messrs. Royden and Sons, Liverpool, went on trial on Saturday, 9th October. She is a vessel of the most modern type of cargo carriers, being 335 by 42 by 30, with a dead-weight capacity of 4800 tons at 24ft. draught, and is built entirely of steel to Lloyd's highest requirements. Water-ballast tanks are fitted to enable her to discharge a full cargo, say, at Marseilles, and steam to an English port in ballast trim. The engines are of the most modern type, specially designed and built by Messrs. Jack and Co. for accessibility in running and in overhauling. The cylinders are 25in., 41in., and 67in. diameter by 4ft. stroke, each working its own crank, and although the engines are unusually open, they occupy no more length in the ship than two-cylinder engines of equal power. The boilers, of which there are two, are double-ended, and constructed of steel, for a working pressure of 160 lb. per square inch. The Saint Regulus has been built for Messrs. Rankin, Gilmour, and Co., of Liverpool.

On Monday, the 11th inst., Messrs. Earle's Shipbuilding and Engineering Company launched from its yard at Hull a fine twin screw steamship, built of steel to the same scantlings as if of iron, for the Great Eastern Railway Company's passenger service between Harwich and Antwerp. She is the third steamer built by Earle's Company for the same owners, and although generally similar in design to her predecessors s.s. Norwich and s.s. Ipswich, she has several improvements and additions as required by the exigencies of the service. Her dimensions are 280ft. by 31ft. by 15ft., with long bridge, poop, and topgallant forecastle, leaving between these short open spaces for deck cargo. The whole of the first-class accommodation is arranged under the bridge and forward of the machinery space, the second-class under the poop, and the seamen below the main deck forward, the space under the forecastle being available for horses and cattle. The officers are berthed under the bridge abaft the first-class cabins. There are permanent berths, dining saloon, ladies' cabin, smoke room, lavatories, &c., in the most efficient style for 134 first-class passengers, and portable fittings for sixty-two additional passengers during the tourist season. Accommodation is also provided for fifty-six second-class passengers with comfortable state-rooms, &c. The whole of the passenger space, crew's quarters, and engine room is fitted with the electric light, and steam heating is provided throughout the ship. Trimming and assisting in keeping a suitable draught of water for speed will be effected by means of water ballast. Special attention has been given to the stiffening of the hull to reduce vibration as much as possible. The stern frame and propeller brackets are of cast steel, by Messrs. W. Jessop and Sons, Sheffield.

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

(*From our own Correspondent.*)

The quarterly meetings in Wolverhampton yesterday, and in Birmingham to-day—Thursday—have been held under circumstances calculated to inspire increased confidence in the closing quarter of the year. Traders were present in good numbers from all parts of the kingdom. Merchants from London, Liverpool, Manchester, and Bristol; and iron and steel masters from Cleveland, the West coast, South Yorkshire, and Derbyshire, Lancashire, South Wales, and other centres; and many came with the feeling that trade is putting on a better tone in the leading iron and steel districts. A more cheerful impression prevailed on the exchanges than has been seen for some time past.

Buyers from a distance found the Staffordshire ironmasters were firmer in price, alike as regards raw and manufactured iron, and that in most cases fresh contracts for forward delivery were not to be placed, except at some sort of rise from previous minimum rates.

The galvanising black sheet makers showed the firmest front alike on the Wolverhampton and Birmingham Exchanges. Most of these firms quoted an advance of 5s. per ton on the rates which regulated last previous business, and refused inquiries which were offered them on other terms. A few who are well placed quoted even 7s. 6d. to 10s. advance. The demand, however, was not large in those cases where makers stood out for the full rise, and in numbers of instances the order books have not as yet received much accession from the meetings. An increased business is, however, wholly likely in the ensuing two or three weeks, when buyers have sufficiently satisfied themselves concerning the exact state of the market. Doubles were generally quoted at £6 5s., and lattens at £7 to £7 5s. at maker's works. A few makers asked £6 10s. for doubles, and lattens in proportion.

The galvanised iron manufacturers are this week decidedly more favourably situated for work, and merchants' inquiries are larger. The increased prices demanded for black sheets has forced the galvanisers to endeavour to secure large lines of common sheets to cover their next quarter's wants, and under these circumstances prices of galvanised iron were to-day much stronger. Spelter has advanced 15s. per ton in the last fortnight or three weeks, and this further strengthens galvanisers' hands.

Best thin sheets for stamping and working-up purposes, as also tin-plates of East Worcestershire make, were in fair call at steady prices.

Plates were without much improvement, and prices were unchanged at £6 10s. to £6 15s. for tank sorts; £7 10s. to £8 for common boiler qualities; and £9 to £10 for best makes. The competition from other districts particularly tells in this branch, with the result that it is very difficult to get any advance in prices.

The marked iron firms have made no alteration in quotations. They re-declared the £7 for marked bars, which has prevailed since the middle of April last, when Messrs. Noah Hingley, and Sons led off a 10s. reduction after bars had been standing at £7 10s. since February, 1883. For the Earl of Dudley's make the customary 12s. 6d. per ton nominal in addition to the £7 was quoted.

The amount of business which was done at the full price of £7 was very small, consumers declining to buy on such terms except where special qualities were needed for engineering and other special purposes. The bulk of the sales that the superior bar makers are effecting are for their second-class branded qualities, for which the quotation remains at £6. The "Mitre" iron of Messrs. Phillip Williams and Sons continues an exception to the brands of most other firms in that first qualities are quoted £6 15s., and second qualities £5 15s. B.B.H. bars of Messrs. John Bradley and Co. afford an exception at the other extreme in that much higher prices are quoted than by most of the other bar firms.

Round Oak iron stands for the new quarter at:—Bars, lowest quality, £7 12s. 6d.; single best, £9; double best, £9 10s.; and treble best, £12 10s.; strips and hoops and angle iron are:—Lowest quality, £8 2s. 6d.; single best, £9 10s.; double best, £11; and treble best, £13. His lordship's rivet and tee iron are:—Single best, £10; double best, £11 10s.; and treble best, £13 10s. Strips and hoops of $\frac{7}{8}$in. and 20 gauge become £9 2s. 6d., lowest quality; £10 10s. single best; £12 double best: and £14 treble best; while $\frac{3}{4}$in. becomes £10 2s. 6d., £11 10s., £13, and £15 respectively.

Bars ranging from £5 5s. down to £4 15s., and for hurdle qualities £4 12s. 6d., were in most demand, and these are the bar makers who are running their works with the least irregularity. Recently some encouraging merchant orders have come to hand, and they are very welcome. Hoops and strips are in pretty brisk request, at prices 2s. 6d. per ton stronger in some sales. Coopers' hoops were quoted £5 5s. to £5 10s.; export hoops, £5 10s. upwards; and gas-tube strip £4 15s. per ton to £4 17s. 6d. for narrow sizes.

The pig iron trade was very strong this afternoon, particularly as regards imported sorts. Some makers of Lincolnshire, Derbyshire, and Northampton pigs refused to accept contracts at prices other than those which are at the moment practically prohibitive. Other makers there are who quoted 39s. 6d. delivered for Lincolnshires; 35s. 6d. to 36s. for Northamptons; and 36s. to 37s. for Derbyshires.

The Thorncliffe—South Yorkshire—brand wss quoted at 47s. 6d., which was a prohibitive price. The amount of business which was done in imported pigs this afternoon was smaller than would have been the case if sellers had been less firm.

Local pigs were led off by the Lilleshall Iron Company, Shropshire, who re-declared last quarter's prices, namely, 50s. to 52s. 6d. for hot blast sorts, and 75s. for cold blast. Staffordshire all-mine makers quoted 52s. 6d. to 55s., and although the business done was small, their hands were strengthened by the advanced rates quoted for hematites. The Barrow Company, and other West Coast houses, quoted 52s. 6d. and 55s. delivered, according to the quality, while the Tredegar and certain other Welsh companies quoted 52s. 6d. for first qualities, and 43s. for No. 2. In actual business, however, some little concessions were made.

Staffordshire part-mine pigs were 35s., and common 27s. 6d. for forge, and 30s. to 32s. for foundry. The Apedale brand of North Staffordshire pigs were quoted at the prohibitive figure of 40s. delivered, but some common North Staffordshire brands were to be had at not much above 32s. 6d.

Coalowners were unable to give any good account of the state of trade, but they were more hopeful in anticipation of the future. Prices were without quotable change. The Earl of Dudley's official coal list, which has not been altered since October, 1882, has been withdrawn by his lordship's new manager, Mr. George Tylden Wright, since in the present state of trade it is no real guide to prices.

The tone of the North Staffordshire iron trade continues to improve week by week. Buyers, believing that the improvement has become permanent, are beginning to buy forward, and sellers at the same time are refusing to enter exceptional lots at current rates, but demand stronger prices. At the quarterly meeting of the members of the North Staffordshire Coal and Ironmasters' Association on Monday it was reported that the ironworks were working better time.

A meeting of the South Staffordshire Institute of Iron and Steel Works Managers was held on Saturday, when Mr. Harris opened a discussion on the paper read at the last meeting by Mr. T. Morris, F.G.S., of Warrington, entitled "The Influence of Oxygen on the Iron during the Puddling Process and its Effect in the Engineering Shop." He expressed himself pleased that Mr. Morris had made a straight hit at the erroneous idea which had been abroad for so many years, and which had not yet died out, that puddling was performed by men who rarely possessed a greater amount of skill than was necessary to use the spade. It was a fact that however iron left the hands of the puddler so it remained, and if the puddler, through want of skill or through carelessness, failed to do his duty, all the skill of the workmen in the other departments would never correct the error. The discussion was continued by Mr. Tucker, who demonstrated the presence of slag in the bars of iron which Mr. Morris exhibited as specimens free from that constituent, which had proved to have exceptional tensile qualities. Other members also spoke.

At the suggestion of a few of the leading wrought nail makers the operatives who are on strike have appealed to all the employers for an advance of 10 per cent. in wages. The few replies which have been received are by no means favourable to the request, and the men have accordingly determined to again approach the employers at their meeting at Birmingham to-day.

The Cradley Heath operative chain makers are seriously considering the question of demanding the 4s. list. They have entered on the tenth week of the strike, and apparently do not favour the idea of gaining a small benefit for such a big struggle. The agitators are hard at work endeavouring to accomplish their object, and probably the men will come to definite decision on Monday.

The Birmingham brassworkers, who number between 5000 and 6000 men, are beginning to agitate for an advance in wages. Repeated reductions have brought their remuneration down to a low point. The reason given by the masters for the low prices paid is said to be the severe foreign competition; but on behalf of the men it is stated that the competition from which their employers suffer most is local, and not foreign. As a consequence, the Executive Committee of the National Association of Amalgamated Brassworkers have issued a manifesto, declaring that steps will shortly be taken for an advance.

The Birmingham Industrial Exhibition, which will wind up on the 30th inst., is an unqualified success, the total attendance from the opening day until Tuesday last being 247,000.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The animation which characterised the iron market here last week has not been maintained, but makers seem to be holding to the slight advance they were able to put upon prices, and for the most part they are indifferent about committing themselves to further sales of any weight. There is still the doubtful aspect about any improvement in the market that it is more the reflection of a decreased production than of an increased comsumption of iron, and with so many furnaces out of blast, and the heavy stocks held both in store and in makers' hands, there is naturally a want of confidence in any possible material upward movement of the market; but notwithstanding all this there is an undoubted gradual strengthening of prices, which is so far acknowledged by buyers that they are prepared to pay higher prices than could have been got a few weeks back, and this applies both to pig and manufactured iron.

There was again a good average attendance on the Manchester iron market on Tuesday, and although there was a quieting down on the tolerably large buying going on last week, a fairly steady business was reported generally. Lancashire makers of pig iron are still getting a fair weight of orders, and are very firm at 37s. 6d., less $2\frac{1}{2}$, as their minimum both for forge and foundry qualities delivered equal to Manchester. In district brands quoted prices are firm at about 39s. 6d. to 40s. 6d., less $2\frac{1}{2}$, for No. 3 foundry Derbyshire, and 37s. 6d., less $2\frac{1}{2}$, for No. 3 foundry Lincolnshire delivered into the Manchester district. At the full prices the business done has been comparatively small, but at about 6d. under the above quoted figures sales of some weight have been made. Forge qualities, so far as district brands are concerned, still meet with only a very limited inquiry, and this is confined practically to Lincolnshire iron, with prices 1s. to 1s. 6d per ton below what makers are asking for foundry qualities. In outside brands Middlesbrough iron keeps very firm, with a hardening tendency. In Scotch iron, however, there is some underquoting by merchants, but I have not heard of sales of any great weight beyond those made last week.

Hematites still move off only in small parcels, but are firm at 51s. 6d. to 52s. 6d., less $2\frac{1}{2}$, for good No. 3 foundry qualities, delivered into this district.

A fairly good demand is being maintained in the manufactured iron trade, and the hardening of prices up to the basis of £5 per ton for bars delivered into the Manchester district is becoming more general. There are, however, still sellers at under this figure, and in other descriptions of finished iron prices have not got up very much. Hoops remain at £5 5s. to £5 7s. 6d., and sheets at £6 5s. to £6 7s. 6d. for singles, and £6 10s. to £6 12s. 6d. for doubles, delivered into the Manchester district.

The condition of the engineering trades still shows no appreciable improvement. The reports of the trades union societies connected with the engineering branches of industry present nothing encouraging as regards the immediate prospects of trade. The returns for the past month from the various branches of the Amalgamated Society of Engineers show no material change in the general condition of trade. There is some improvement in the Newcastle district, but this is largely attributable to the activity at the works of Sir William Armstrong, Mitchell, and Co., and appertains more to the construction of guns and munitions of war than to the development of ordinary trade requirements. As regards the general run of engineering work, the condition of trade remains stationary on the basis of only moderate employment that has been reported for so long past, and the number of out-of-work members on the books of the society receiving donation benefit remains practically unchanged. Here and there the returns vary from month to month, but the increase or the decrease, as the case may be, is so small that it does not affect the average for the country generally, and this remains at about 8 per cent. of the total members of the society in receipt of out-of-work support. The report of the Steam Engine Makers' Society records no improvement, but a slight increase in the number of unemployed members, which now average a little over $4\frac{1}{2}$ per cent. of the total membership in receipt of out-of-work support, and the reports from the various districts are still gloomy in tone as to the condition and prospects of trade generally.

At the opening meeting of the ensuing winter session of the Manchester Association of Engineers, held on Saturday, in addition to a very interesting address delivered by the president, Alderman W. H. Bailey, "On the First Iron Boat, and its Inventor, John Wilkinson, the Father of the Iron Trade," several questions of interest to engineers were brought out in the subsequent discussion. Mr. Daniel Adamson, C.E., pointed out that notwithstanding all the scientific progress which had been made up to the present time, there was still much want of knowledge with regard to the proper treatment of metals, and perhaps nowhere was there still so much "rule-of-thumb" as in the use of cast iron in the foundry. When they had guns that broke down, when they heard continually of lost ships and of boilers blowing up, he would ask them to take his view that there was no such thing as absolute accident; it was a combination of untoward conditions, and if all the circumstances could be clearly traced it would be found that there had been either ignorance, wilfulness, parsimony, or some perhaps excusable error of judgment which had led up to the disaster. In pure iron they had a most ductile material, and its proper treatment with alloy to meet different specified requirements, without introducing an element of danger, was really the essential knowledge that was needed. Passing on to the question of over-production, Mr. Adamson remarked that one of the greatest commercial problems we had before us had arisen out of the enormous means of production which had been brought into existence; the conclusion to which he arrived was that the making of things in such tremendous abundance must result in the shortening of the hours of labour, and in benefit not only to the workpeople but to the world at large. No doubt the landlord was going to suffer, and the whole question of the land would have to be taken in hand; the steamship had so altered the whole conditions of life by the readiness with which supplies of food and the products of the soil could be drawn from all parts of the world, that it must necessarily affect the conditions upon which the products of the soil could be raised in this country.

Another question touched upon at the meeting had reference to the desirability of something being done to protect the drawings and tracings prepared by engineering firms, and which are so often appropriated without any acknowledgment whatever after they have been supplied in response to inquiries for estimates and plans for certain specified work. The president, Mr. Bailey, mentioned several flagrant instances of downright dishonest appropriation of engineers' tracings and drawings, and urged that it was really requisite that some steps should be taken with the view if possible of obtaining some sort of copyright protection for such drawings. The discussion which ensued elicited a general concurrence of opinion that some means of affording protection to engineers in the manner suggested by the president ought to be sought for, the only difficulty being the method by which such protection could be obtained.

In the coal trade there is about a steady business doing in the better classes of house fire coal, which is keeping collieries in most cases on pretty near full time; but for all other descriptions of fuel for iron making, steam, and trade requirements generally the demand continues very slow, and common round coals and engine fuel are more or less a drug in the market. As regards prices, an advance of 6d. per ton on best coals is being got at a large number of the Lancashire collieries, but common round coals, burgy, and slack are quite as low as ever. At the pit mouth best coal averages 8s. 6d. to 9s. per ton; seconds, 7s. to 7s. 6d.; common coal, 5s. to 5s. 6d.; burgy, 4s. 3d. to 4s. 9d.; best slack, 3s. 6d. to 4s.; and common, 2s. 6d. to 3s. per ton.

For shipment there is a moderately good trade doing, which is finding an outlet for some of the surplus supplies of common round coal, and if anything a shade better price is being got as compared with the excessively low figures ruling last month, 7s. per ton being now the average quoted figure for steam coal delivered at the high level, Liverpool, or the Garston Docks.

Barrow.—There is a still further improvement to note in the hematite pig iron trade of this district, and the demand all round is shown to be more and more satisfactory. It is also noteworthy that the demand is not confined to one particular quarter. There is a good request on home account, and there is also a good demand from America and the Colonies. Makers are well sold forward, and in some instances makers are too fully sold forward at late prices. An advance in quotations has been made, and holders are keeping back in anticipation of a further advance. Makers are now asking 44s. 6d. per ton net at makers' works, and forge and foundry No. 3 at 43s. 6d. to 44s., according to qualities. Stocks of iron have been considerably reduced, and they are likely to be still further diminished, as makers and holders generally have sold largely forward. The Barrow Hematite Steel Company has blown in another furnace, and has now eleven out of fourteen in blast. Messrs. Kirk Brothers and Co., of Workington, have re-lighted their blast furnace at the new yard, for the purpose of making their own special brand to work up finished iron at their rolling mills. The third furnace at Mossbay, Workington, has been put in blast. Up to recently at this place three out of the four furnaces were idle, and one temporarily stopped. During the month of September the shipments of steel rails and pig iron from Barrow to foreign ports amounted to 13,497 tons, being a few thousand tons over the preceding month. The demand for steel rails is well maintained, and the orders offering represent a large bulk of metal, but makers, who are all round well sold forward, are asking higher prices, especially for forward delivery. Business in West Cumberland a short time ago was done at £3 10s. per ton, and in Barrow at £3 12s. 6d., but the quotation is now £3 17s. 6d., being an advance of 5s. per ton in about six weeks. The trade in tin bars has fallen off almost altogether, and there is no hopes of any immediate improvement. There is also a poor trade doing in ship plates, and in merchant steel colonial and American contracts for rails are freely offered, and there is a prospect of an all-round good winter's trade in this department. Shipbuilders have secured one or two repairing orders, but they are only in receipt of a few inquiries for new work. Marine engineers are fairly employed, but the general engineering trade is quiet. Iron ore is in brisker demand at the advanced price of 9s. to 10s. per ton, according to quality. Shipping is still well employed.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Several correspondents have been inquiring as to local manufacturers of "Charlier" steel for horse shoes. It may save your readers some trouble if I state that after considerable inquiry I find that "Charlier" steel is manufactured by the Kelham Rolling Mill Company, and Messrs. Goodwin Brothers, of the Scottish Steel and File Works, Allen-street, both of Sheffield.

The Board of Trade returns for September show that iron and steel exports reached a value of £1,716,089, against £1,934,390 and £2,093,167 for the corresponding months of 1885 and 1884. It will thus be seen that there is a continuous decrease in the total values of exported iron and steel as compared with the corresponding months of the last two years. This decrease applies also to the nine months of the year, the respective values for the same periods being £16,388,229, £16,510,298, and £18,668,958. In the specialities directly affecting the Sheffield district the return is not so depressing, there being an increase, though slight, in hardware and cutlery—why cannot these two items be separated?—and a decided improvement in steel. In hardware and cutlery the values exported were, September, 1885, £252,159; 1886, £255,257; the values for the nine months were, to September, 1885, £2,102,818; to September, 1886, £2,128,235. The increasing markets are Germany, France, Spain and Canaries, Foreign West Indies, Brazil, Argentine Republic, British North America, and East Indies. The decreasing markets are Russia, Holland, United States, British Possessions in South Africa, and Australasia. The largest increase is shown by British North America, from £11,931 to £17,633; the largest decrease by British Possessions in South Africa, from £5423 to £3865, and Australasia, from £54,358 to £49,765.

Unwrought steel was exported to the value of £136,476, as compared with £91,201 for September of last year. France shows a slight increase, from £7043 to £7060; and the United States a very great advance, from £17,815 to £49,862; other countries, from £66,343 to £79,564. On the nine months the increase is greatly marked—from £738,837 for the first three quarters of 1885 to £975,621 for the corresponding period of 1886.

Steel rails again show a gratifying activity. Last month the value exported was £225,794, against £208,863 for September, 1885, though the values for the nine months show a large falling off. Sweden and Norway have increased from £282 to £19,331; the United States from £1153 to £21,261; Peru, from *nil* to £5987; and British North America from £53,713 to £66,473. Decreasing markets are Mexico, Brazil, Argentine Republic, from £24,062 to £14,753; British Possessions in South Africa, £2013 to £666; British East Indies, from £63,819 to £34,328.

The South and West Yorkshire collieries have sent to Hull during September 145,488 tons as compared with 137,568 tons for September of last year, showing an increase of 7920 tons. The exports to foreign countries from Hull show a total of 62,760 tons last month, against 66,882 tons for September of 1885. While there is a falling off in the export of the mineral to other European markets, no less than 23,251 tons were shipped to Russia from Hull last month, being an increase of 6564 tons on the weight sent there in September, 1885. Of the exports to Russia, 19,303 tons were sent to North Russia, and 3948 tons to South Russia. In the corresponding month of last year South Russia was blank in the returns.

A fatal boiler explosion occurred at the works of Messrs. J. H. Andrew and Co., Sheffield, on Friday. The boiler, a vertical one, of 15-horse power, had been in use for fourteen years, burst through the gable end of the building, and was carried bodily over a dam, falling at a distance of fifty yards from its original site. Two men were killed and three injured. The coroner has adjourned the inquest to admit of an examination and report by competent authorities.

A memorial, signed by a large number of miners, has been presented to the Right Hon. H. Matthews, Secretary of State for the Home Department, requesting him to send a legal representative from the Home-office to attend the adjourned inquest on the bodies of those killed at the explosion at Altofts. The miners set forth the importance of tracing the causes of such disasters, if possible, by way of preventing their recurrence in the future. They add that the inquiry into the Wharncliffe Silkstone calamity "left unsatisfied the public and mining opinions of this important district"—Barnsley.

During the extreme darkness of last week—three days particularly—the demand on the Sheffield Gas Company was so great that it outstripped the expectations and preparations of the engineer. On Saturday evening the gas suddenly lowered in large portions of the town and one of the thoroughfares went out altogether. On the previous Wednesday the quantity of gas supplied exceeded by 1,500,000 cubic feet the quantity supplied on the corresponding day of last year.

There has died during the week Mr. Thomas Heiffor, razor manufacturer, who had the army and navy contracts for many years. Mr. Heiffor was one of the oldest manufacturers in the town, and was famous as one of the pioneers of popular prices in razors. With another local firm he made a shilling razor a leading article—a really good article, too—and for years did an enormous business. The razor supplied to the soldiers and sailors is much cheaper than 1s. I have heard of it being supplied under 6d.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The spurt which has taken place in the price of Cleveland pig iron is, no doubt, very gratifying to the makers of that article, —indeed, for the moment, they seem perfectly satisfied with the prices they are obtaining, with their future prospects, and with themselves. They regard their experiment in restriction of output as a complete success, and the difficult problem of how to overcome trade depression as in their case completely solved.

Outside the fraternity of iron smelters there are, however, still some who shake their heads. These hesitating unbelievers ask whether a combination of competitors was ever yet successful for any considerable length of time, and especially in a Free-Trade country. They say that the benefit the ironmasters have obtained so far has been counterbalanced by increased cost of production, owing to their smaller output; that although an impetus has been given to buying, owing to a fear among consumers and merchants of higher prices, still consumption has not been increased, and that unless it is, a reaction must shortly set in; that already some moribund and expiring competition has been revivified by the artificial rise in values which has occurred, and the area of consumption hitherto occupied by Cleveland pig iron has already been seriously encroached upon by that from rival districts; finally, that the sorely tried and diminishing manufactured iron trade has received from the rise another severe blow, which has crippled it still more, and made it still less capable of continuing to consume.

These things the smelters cannot, or will not, see at the moment, so pleased are they at being able to sell at profit once again. But they will probably have to recognise them after a time; at least, if they do not, the present restriction of output will be an exception to all previous ones ever tried in Cleveland.

A peculiarity of the Cleveland pig iron trade, and one which has not often been dwelt upon, is that the producer of pig iron seldom takes any trouble to obtain customers among consumers, or to retain them for direct business when he has them. He does not concern himself to study or adapt himself to their peculiarities or their special requirements, but usually assumes an unduly independent attitude. If they want his iron they must take what it suits him to make, and the delivery and terms of payment must be what are convenient to him, and not to them. If the consumer wants a pig with rather less silicon or phosphorus than usual, the smelter will not adapt himself to the demand. He will prefer to take his chance of selling elsewhere, where simply g.m.b. is specified. If the consumer wants delivery over a considerable length of time, in order to cover a similar deferred contract of his own, the chances are the smelters will not sell at all beyond two or three months; or, if they do, they require a much higher price. If the consumer wants credit in proportion to what he allows to his customer, he has either to refund it altogether, or he has to pay an extra equal to about 7½ per cent. per annum interest.

The result of this want of an accommodating spirit between the producers and consumers of pig iron is, of course, the maintenance of an intermediate class of iron merchants, who abound in every consuming and producing centre. They do the work the smelters refuse to do; they hunt out consumers, keep an eye to their position, give them the delivery and the credit they want, and vary the brand as well as they can to suit their requirements. For this work they must, of course, be paid, and well paid. Having the consumers mainly in their hands, they sometimes—and, indeed, at most times—carry on the speculative operations known as "bulling" and "bearing," to the great annoyance of the smelters. The latter have, however, no one but themselves to blame. If they conducted their business direct, taking simply the same pains to push it as producers of other commodities do, the intermediate merchant class would not exist long, or, if they did, they would soon lose their present power.

The Cleveland ironmasters, notwithstanding their undoubted and long-continued suffering from the depression of trade, do not appear yet to have realised the causes thereof. Their one idea of relief when prices are unremunerative still is a combination among themselves as against buyers, in order to maintain or raise prices. The effect of such a rise on consumers everywhere they do not seem ever to contemplate. Their true and sound policy is that indicated by Mr. Oppenheimer, the British Consul-General at Frankfurt. He concludes a most able report on the trade between Germany and Great Britain in these words. He says:—"If English manufacturers would do their utmost to make themselves known in foreign countries, either by travellers thoroughly acquainted with the language of the country they visit, or by means of advertisements in the special paper devoted to each industry, they might easily open up new channels to these industries, and successfully struggle against and overcome the depression of trade and commerce."

The quarterly meeting of the Cleveland iron trade, held at Middlesbrough on Tuesday last, was well attended, several representatives of other districts being present. A report was current at an early stage of the proceedings to the effect that the market being held at the same time in Glasgow, was flat in tone, and certain merchants, anxious to cover previous sales, endeavoured to make capital out of this. They were, however, quite unsuccessful. Sellers exhibited great firmness, and succeeded not only in maintaining prices, but even in securing a decided advance. No. 3 g.m.b. was sold at 31s. 3d., 31s. 4½d., and even 31s. 6d. for prompt delivery. The first-named figure was freely offered by buyers, and considerable anxiety was manifested by them to contract ahead. This, however, sellers, being for the moment masters of the situation, refused to do at anything like current prices. Grey forge iron was sold at about 1s. per ton below No. 3, but the demand was much less than for foundry qualities. Connal's warrants were in somewhat more request. Buyers offered 31s. 6d. per ton for them, but without finding willing sellers. Shipments of pig iron continue very satisfactory, over 34,000 tons having been sent away since the 1st inst. Finished iron remains about the same. Makers are naturally unwilling to sell unless they can at all events obtain an advance in price sufficient to cover the rise in pig iron. Consumers will not as yet give this, and so few transactions are recorded.

Dr. Percy's statement last week to the effect that the ironmasters of the United States were importing 2,000,000 tons of Spanish hematite ore per annum has taken many people by surprise, as the quantity taken by them from the Bilbao district was always supposed to be extremely small. It is probable therefore that it is from the South of Spain that they get their supplies, especially as he announced that our Transatlantic cousins were at the present moment busily prospecting in that part of the Peninsula with a view to leasing whatever mining property they may there find to suit them.

As to the value of tempering in oil, it is curious how doctors differ. Mr. Adamson, President-elect of the Iron and Steel Institute, denounces the practice with characteristic warmth. He admits that a higher tensile strength is obtained, but says it is at the expense of ductility, and that a number of severe but unequal strains are probably set up by it, tending to facilitate or even commence rupture. On the other hand, Mr. Vickers, of Sheffield, who is certainly also a high authority, appears to hold a different opinion. He says that the important feature of oil tempering is not so much that it increases the ultimate tensile strength as that it raises the elastic limit, which is after all the great desideratum.

It must be, on the whole, comforting to Bessemer steel makers to find that they are not likely to be superseded, nor even to be materially affected by the Clap-Griffiths or fixed converters, which are being put down in several directions. It was conclusively proved last week that whatever can be done in the way of obtaining pure metal by the latter process, can be as well done by the ordinary converter, and more cheaply. It is somewhat curious, however, that this should not have been found out before; and even though the fact has now become fully established, there seems no reason to doubt that there is a good field for small fixed converters, when they form part of works devoted to rolling small sections, where large supplies of large ingots are not required, and where command of quality is absolutely essential.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The pig iron market, which was very strong last week, has been less so this week. An unsatisfactory Board of Trade report for September as to the exports of iron and steel had something to do with the less hopeful feeling on 'Change this week, but there is still a considerable amount of confidence evinced in the future of the market. The shipments of the past week exhibit an improvement over those that have been despatched for some time, amounting to 10,175 tons, as compared with 7645 in the preceding week, and 9250 in the same week of 1885. One furnace has been put in blast at Coltness, but one having been put out at Carron equalises the number, and there are now sixty-nine in operation compared with ninety at this date last year. It is expected that four of the eight that went out recently at Gartsherrie through an accident will be in blast again soon, the remaining four being kept out pending the strike of colliers in the employment of the firm for an increase of pay. The chances of much larger shipments of Scotch pigs—not hematite—going to the United States at present are somewhat reduced by an increase in the freight taking place at the same time as the advance in prices. In point of fact, the exports to both the United States and Canada have become smaller in amount than was anticipated. In the course of the week about 1900 tons of pigs were added to the stock in Messrs. Connal and Co.'s Glasgow stores.

Business was done in the warrant market on Friday at 41s. 3½d. cash. At Monday's market there was a fair inquiry at 41s. 6½d. to 41s. 5d. cash. Transactions took place on Tuesday at 41s. 5d. to 41s., improving to 41s. 4d. cash. Business took place on Wednesday at 41s. 3d. to 41s. 7½d. cash. To-day—Thursday—business took place at 41s. 9d. to 41s. 11½d. cash, there being a reaction at the close to 41s. 8d. cash.

The values of makers' pigs are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 46s. 6d.; No. 3, 43s. 6d.; Coltness, 51s. and 44s. 6d.; Langloan, 46s. and 43s. 6d.; Summerlee, 47s. 6d. and 42s. 6d.; Calder, 47s. and 43s.; Carnbroe, 43s. 6d. and 40s. 6d.; Clyde, 43s. 6d. and 40s.; Monkland, 43s. and 38s.; Govan, at Broomielaw, 43s. 6d. and 38s.; Shotts, at Leith, 45s. and 44s.; Carron, at Grangemouth, 46s. 6d. and 43s. 6d.; Glengarnock, at Ardrossan, 43s. 6d. and 40s. 6d.; Eglinton, 42s. and 38s.; Dalmellington, 42s. and 38s. 6d.

The arrivals of Middlesbrough pigs at Grangemouth for the week were 6660 tons, as compared with 8320 in the preceding week, and 7560 in the same week of 1885.

The Lanarkshire makers of malleable iron have raised the prices of common bars 2s. 6d. a ton, the quotations now ranging from £4 10s. to £5 5s.

Messrs. Hanna, Donald, and Wilson, engineers, Paisley, have received an order to construct a bridge for the East Indies. It will cross a river in ten spans of 76ft. each in length.

A few shipbuilding contracts have been placed in Clyde yards.

The past week's shipments of iron and steel manufactured goods from Glasgow embraced machinery to the value of £13,000; sewing machines in parts, £7963; steel goods, £7000; and general iron manufactures, £40,370.

Shipment of coals from Scotch ports in the past week have been rather more satisfactory in amount. At Glasgow, 29,336 tons were despatched; Greenock, 104; Ayr, 8163; Irvine, 1361; Troon, 5064; Burntisland, 19,192; Leith, 2348; Grangemouth, 12,606; Bo'ness, 5170; total 83,434 tons as compared with 78,452 in the corresponding week of 1885. Main and ell coals continue firm in price, recent advances being maintained, although upon these there has been no improvement. Splint coal is somewhat more plentiful as the ironmasters, who have damped out furnaces, are sending it into the market and competing with the coalmasters. The demand for steam coals is fair, but in few instances pressing.

A strike which recently took place among the ironstone miners of the Shotts Iron Company has terminated, an amicable arrangement having been made between that manager and the miners.

The colliers of the West of Scotland are still agitating for a second 6d. a day of an advance on their wages; but as their demand for the first 6d. is being resisted by the larger ironmasters, it is not considered that they have much chance of success. A largely-attended conference of the men was held a few days ago at Airdrie. It was reported that the whole of the colliers in the employment of the Messrs. Baird, at Bothwell, had been out on strike for several weeks, and it was agreed to send them relief at the rate of 10s. a week per man. A resolution was adopted to the effect that unless the 6d. advance should be conceded by Thursday of this week, "a policy of forcing the hands of the employers should be arranged.'

At a mass meeting of the Fifeshire miners, held at Dunfermline on Saturday, Mr. James Innes, the chairman, stated that throughout the Scotch mining districts already 23,000 men had joined the National Federation, and from that institution, he said, he looked for much. It was unanimously resolved to continue restriction of output, and deputation were appointed to wait on the employers to press for an advance of wages to the extent of 10 per cent. on the rates existing previous to the last reduction.

The tonnage of vessels arriving in the Clyde for the past nine months of the year is 975,216, against 1,052,734 in the same period of last year. The sailing tonage has been 1,199,097, as compared with 1,256,143 last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Two recent occurrences tend to encourage the opinion that an improvement is at hand. The first is the remarkable success of the Bute Dock Company in floating the 4 per cent. debentures. The stock amounting to £800,000 was not only cleared off at once, but the applications were eight times in excess of the amount! Cardiff alone applied for more than the amount. This is not only a striking proof of the skill and far-sightedness shown in maturing the scheme by Sir W. T. Lewis, but implies confidence in the future, and reveals the truth that there is plenty of money in the country only waiting for a good opportunity to be brought out.

The next occurrence is the opening of the Lady Windsor Colliery, the latest but one of the new deep sinkings. This is one of the Ocean Collieries, D. Davies being the principal shareholder, and is near the rising town of Pontypridd. The interest shown in the matter would not favour the view that the Welsh coal trade is hopelessly gone to the bad.

Apart from these things the encouragement is not strong. Prices keep low, and I am told of long contracts concluded at even lower prices than are quoted. The only coal maintaining its price is small steam. In respect of quantity house coal is improving in demand. This is but to be expected, and will soon affect Newport exports.

One is glad, in the midst of colliery depression, to hear of colliers doing something besides grumbling, especially when it takes the higher form of a grateful recognition for services rendered. At a gathering in Cardiff on Saturday Sir W. T. Lewis was presented with a testimonial and a cheque for 150,000 pennies, subscribed by 150,000 colliers, in hearty recognition of his great services in founding the Miners' Provident Fund. If this were the only deed of the worthy knight, instead of many, he would have written his mark in a large round hand over the history of his generation.

One of the valleys showing coal trade improvement is that of the Garw, where A. Hood and Co. are sinking to the deep, and where C. Evans, Heolgerrig, may soon be expected to follow. The Ffaldau Colliery has only lost four days for a long time. Brailhycymmer Company are beginning to sink at Darren, and Ellis and Evans, of Nanthir, are about beginning. Notices are out at South Dunraven. The large steam coal collieries, Merthyr and Aberdare Valleys, show little change yet for the better.

In the matter of Monmouthshire coals, which for a long time have affected our best steam coal trade, there is a movement afloat which will come before public notice in a few days. As I have long contended, the coalfield of the future, with its lower coals almost untouched, is that of Monmouthshire, and Taff Bargold and other valleys will form the New Rhondda. But railways have yet to be made. Two attempts have failed, a third is on the carpet, and the survey just completed. The connection will be with Cardiff, so a stout fight is certain, but as colliery owners and not railway people will be at the head, the chances of success are strong. This new enterprise will be the leading feature of the new year, and be engrossing. I can only now simply refer to it, and so will give details again.

The firm of D. Owen and Co., Cardiff, promise early next year to issue a history of the coal trade of Wales, which will have some novel features. Interwoven in it will be records of railway enterprise, from the queer trains, with sails, invented by Mackworth at Neath, to the start of the Taff Vale and the incoming of the Great Western. The chapter on the Taff Vale will be full of incidents, such as that in which the Iron King figured when shares were at 40, and he offered to give them away. This chapter is to be prefaced with a portrait and biography of Mr. Geo. Fisher; the Great Western chapter with portrait and biography of Sir Daniel Gooch. I shall refer to this national enterprise again, as a solid record of what is really wanted—a book to hand down the men and their commercial and mineral career.

Whispers of good news reach me. The Colonies are wanting rails; New South Wales to wit, with its rails for 400 miles, and more demands are coming in from home railways and collieries.

As I have previously stated, if anyone requires rails now is the time; they cannot be cheaper, but they can be dearer! And I note that Bilbao freights are gone up 1s. to 1s. 3d., which means dearer ore.

Tredegar works are improving. This week a furnace has been blown in, and will employ a large number of hands. At Blaina, too, the blast furnace works have been re-started. So trade in iron and steel is manifestly looking up.

The tin-plate trade is much better, men are inclined to make concessions, and buyers to give better prices. In the Swansea district things are much more hopeful; New York took 1000 tons of tin-plates last week and Baltimore 1050 tons. The total shipment during the week was 30,423 boxes; over 140,000 boxes were in stock a fortnight ago. Now they have lessened perceptibly, and buyers are eager in putting in orders.

Offers of 13s. Bessemer steels and cokes are common, but makers want more. Ordinary quotations are 13s. 3d. to 13s. 6d., but some makers of best brands are actually refusing business at these figures. If the closed works remain closed business will become good. There are no two opinions about this.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

The improvement in some branches of the iron trade reported last week is sustained, as far as quantity of work at the mills is concerned; but even yet this has not caused any perceptible rise in prices, though it has helped to steady them. Sellers are, therefore, not now so willing to book orders for forward delivery or take them in large quantities as formerly. The reports from most of the neighbouring markets are still encouraging, with the exception of Belgium, and in Silesia there is a good demand and some speculation in pig iron. Plates are also being called for, and the Laura-Hütte, according to Breslau despatches, has booked orders for plates for several vessels from the Vulcan Company at Stettin. It is looked upon as probable that prices in general will shortly take an upward turn, though it is possible that the keen competition may tend to keep them down in some special branches. In Rheinland-Westphalia great efforts are being made to get more of the native ores of the Siegerland and Nassau into the Westphalian markets against the Spanish ores; but still, for the moment, it appears the latter can be delivered at Ruhrort cheaper than the former, though they are but a few hours distant, and the others have to make a longish sea and river voyage, and the railways help all they can by reducing freights on native ores to a minimum. In quality there is not much difference. The prices of native ores range from 7 for red and brown up to 10·50 M. p.t. for roasted steel stone. Forge pig is in pretty good request at 39 to 42 M. p.t., as the mills and forges are running full time on fine sheets, bars, and girders. Spiegel costs 45 to 46; Bessemer, 42 to 43; basic, 37 to 38; and Luxemburg pig, 28 to 29 M. p.t.; foundry pig, 45 to 53 M. p.t. for the three sorts. Some of the rolling mills keep extra busy on bars, plates, and girders, as the building season is now near an end, and merchants wish to replenish their dwindled stocks before winter sets in. All that is at present required is higher prices. Wire rod mills are also better employed, chiefly on steel quality for export. Steel rails are as lifeless as ever; good bars and girders can be bought at 91 to 97, with concessions on large orders; angles at 100 to 105, hoops at 100 to 105, boiler-plates at 139 to 142, and heavy sorts at 130 to 132, thin sheets at 123, in Bessemer steel at 142·50 to 145, wire rods at 97 to 100 in iron, and 95 to 100 in steel; rivet iron at 115 to 130; wire nails, 125 to 135; rivets, 152 to 160; drawn wire 112, and in steel 115; steel rails, 120 to 125; sleepers, 122 to 130 M. p.t.; wheels and axles, 315 to 320; steel tires, 220 to 235 the set. The constructive works are still labouring under a deficiency of orders, and if more work does not shortly come in, which, however, is not expected, more hands will have to be discharged. If anything, the wagon builders seem to have the best prospect at present. Zinc is dull, and the same may be said of coke and coal, excepting for house purposes, and the quoted market prices of all three remain unchanged.

The Belgian iron convention has not been of long duration. The combination was abused by some of the parties, through there being no legal control over them, who undersold plates in the Bruxelles market, and now the prices have lost their former firmness. The demand has gone back, and the formal dissolution of the syndicate may be at once looked for. Prices, though, are kept up *pro formâ*. In France the market is still firm, though the price of 150f. for merchants' bars did not last long, and the ironmasters are wisely now keeping the prices at a natural level, instead of attempting to keep them up at a forced height.

On the 4th inst. one of Krupp's monster guns was shipped at Antwerp for Italy, destined, as it is believed, for arming one of the new cupola forts at Spezzia. The gun has a 40 cm. bore, a length of 14 m., and weighs without breech pieces 118,000 k., and with them 121,000 k. It was brought to the loading place on one of Krupp's own wagons, which is 23 m. long, and runs upon sixteen pairs of wheels.

It is gratifying to hear from local sources here that the manufacturers of brass locks at Wolverhampton have regained their former lost ground and are now able to undersell the Germans in this article in the English markets, which has been brought about, it is said, by the English manufacturers having introduced new machinery for the purpose. This will doubtless encourage manufacturers in other branches to do likewise, and so beat off not only the German but the American competition.

On the occasion of the return of the first of the German Lloyd's steamers from the East, the following paragraph made the round of the daily papers:—"The astonishing success which has attended the subsidised N. G. Ll. steamers is reported from all quarters. The shares of the company have suddenly risen from 105 to 112 per cent.; the superabundance of cargo for the return voyage exceeded all expectations, for it appears as if New York goods for China were destined to be carried by these vessels. The N. G. Ll. is on the high road to entirely run the old companies off the line, which till now have had all the carrying to the East in their own hands." For English readers comment on the above would be superfluous, unless it were perhaps to sympathise with the unfortunate old P. and O. and the Messageries Maritimes Companies, which are so soon to become things of the past.

The following simple, efficacious, and well proved method is recommended for restoring burnt cast steel, so-called, to its original good quality and usefulness:—It consists in heating slowly and carefully to avoid sudden flashing up of three parts of pure colophany—black resin—and two parts of good boiled linseed oil, stirring quietly all the time of melting, which produces a dark brown syrupy mass, and then introducing to it the burnt cast steel whilst red hot. By repeating the operation the quality of the steel will be improved.

Eels in the East London Company's Water Mains.—Great complaint is being made of the stoppage and of the pollution of the water in the mains of the East London Water Company by dead eels, some of which were of several pounds weight. Eels have for some time been found in this company's mains, and it is said to be the result of the giving way of a filter bed about three years ago, which let fish into the pure water basin.

AMERICAN NOTES.

(From our own Correspondent.)

New York, Oct. 2nd.

As compared to a week ago prices are slightly higher in several classes of goods. Textile products are quotably higher on account of the advance in wool and its scarcity, and because of the movement on the part of manufacturers to buy largely for future requirements. Merchant bar, plate, skelp, and tank iron are slightly higher for early deliveries, but for late deliveries are selling at the prices of two weeks ago. Standard brands of foundry and forge iron are more difficult to get owing to two reasons—first, to the heavy demand, which has pretty well cleaned up the market; and secondly, to the fact that several large producers are refusing to sell their early winter production at present prices. The bar iron makers are commanding the market at 1 dol. 80c. to 1 dol. 90c. for refined bars. Nails have fallen off in demand, but are still 2 dols. 10c. at tide water, and 2 dols. in the interior. Old rails have advanced 50c. per ton in the week, and 500 tons of double-heads sold yesterday, to be delivered at Philadelphia, at 22 dols. 35c. English tees are selling at 21 dols. 50c. and 22 dols. Holders of American rails are asking 22 dols. 50c. for them, delivered at New York and Philadelphia. Steel blooms have been cut out of the market by the 26 dol. quotation. There are a number of inquiries in hand for large lots of bridge iron, steel rails, wrought iron pipe, and heavy plate iron. To-day's lowest steel rail quotations are 34 dols. at mill. Two Western Pennsylvania mills took orders this week for 13,000 tons, and two Eastern mills are in negotiation to-day for mid-winter deliveries for the trunk lines, for which 34 dols. 50c. is asked. American bar and plate iron makers could use large quantities of old rails, but are purchasing only for immediate needs on account of the high prices. It is questionable whether as favourable trade and industrial conditions have existed for many years. While demand is strong, and productive capacity fully sufficient for the legitimate requirements, there is no dangerous tendency to artificial prices, or to over-production. Buyers are assured that when they need material they can obtain it, and that they do not intend to crowd prices up upon themselves. A great many wells are being bored in Western Pennsylvania and Eastern Ohio for natural gas, and the wrought iron pipe makers are offered contracts for pipe to be delivered in February and March. Building activity continues unabated. The building contracts for the past month figure up five million dollars in amount.

NEW COMPANIES.

The following companies have just been registered:—

Aberavon Tin-plate Company, Limited.

This company proposes to purchase the right and interests of Richard Morgan Lloyd, of Morriston, Glamorgan, under a lease dated 20th ult., from Thomas Jenkins, formerly of Brynhyfryd, Aberavon, but now of Groes, Margam, County of Glamorgan. It was registered on the 1st inst. with a capital of £5000, in £10 shares, for the purpose of manufacturing and dealing in bar iron, steel, terne, and tin plates. The subscribers are:—

	Shares.
John Powell, Llanelly, ironfounder	1
*R. Morgan Lloyd, Aberavon, manager of tin-plate works	1
John Jones, Aberavon, draper	1
H. Morris, 4, Eliot hill, Blackheath	1
*H. J. Millner, 7, Laurence Pountney-hill, secretary of a company	1
*A. Taylor, 7, Laurence Pountney-hill, iron merchant	1
J. Fisher, Swansea, accountant	1

The number of directors is not to be less than three nor more than five; qualification, 10 shares; the first are the subscribers denoted by an asterisk. Mr. R. M. Lloyd is appointed managing director at a salary of £300, with an additional £35 to cover house rent, and will also be entitled to 5 per cent. on the profits remaining after payment of £10 per cent. dividend.

Fleetwood Salt Company, Limited.

This company proposes to acquire and work brine, mines of salt, rock-salt, and other minerals, brine shafts and springs, in Great Britain or elsewhere. It was registered on the 4th inst. with a capital of £50,000, in £10 shares. The subscribers are:—

	Shares.
J. Wethered, Clifton, Bristol, colliery proprietor	50
C. Thomas, Soapworks, Bristol	50
H. Rawcliffe, Chorley, Lancashire, brewer	50
W. Cochrane, M.E., Gosforth, Northumberland	50
F. H. Gossage, Soapworks, Widnes	50
T. S. Timmis, Soapworks, Widnes	50
A. W. Chalmers, 5, Fenwick-street, Liverpool, chartered accountant	50

The number of directors is not to be less than three; qualification, 25 shares.

Fielding Brothers, Limited.

This is the conversion to a company of the business of wholesale, retail, and manufacturing watch and clock maker, goldsmith, silversmith, and jeweller, carried on by Thomas Fielding, trading in London as Fielding Brothers, and in particular to acquire that branch of the said business known as the London Watch Club's Association. It was registered on the 30th ult. with a capital of £60,000, in £1 shares, with the following as first subscribers:—

	Shares.
Thomas Fielding, 43, Lombard-street, watchmaker	50
S. Newman, 20, Ridgway-road, Thornton Heath, book-keeper	1
A. O. R. Scarlett, 4, Scipio-street, Peckham, accountant	1
F. Langham, 2, Calcutta-road, Tilbury, watchmaker	1
J. J. Harris, Almington-street, Hornsey-road	1
A. Fielding, Thorold-road, Ilford, spinster	10
Henry de Jersey, 168, Buckingham Palace-road	1

The number of directors is not to be less than three nor more than seven; qualification, £100 in shares or stock; the subscribers are to appoint the first and act *ad interim*. After £10 per cent. per annum dividend has been paid to the shareholders, each ordinary director will be entitled to £3 3s. in respect of every meeting attended. Mr. T. Fielding is appointed managing director at a salary of £200 per annum, and a commission equal to £25 per cent. of the net profits in excess of sufficient to pay £10 per cent. dividend.

Gyrnos Tin-plate Company, Limited.

This company was registered on the 5th inst. with a capital of £18,000, divided into 60 shares of £300 each, to purchase the Gyrnos Tin Works, in the parish of Languick, Glamorgan, as from the 29th ult. The subscribers are:—

	Shares.
John Player, Clydach, Glamorgan, tin-plate manufacturer	1
C. E. Peel, Swansea, merchant	1
W. H. Player, Swansea, tin-plate manufacturer	1
R. E. Bell, Swansea, works manager	1
H. M. Peel, Swansea, merchant	1
F. Player, Neath, works manager	1
R. Powell Morgan, Swansea, solicitor	1

The number of directors is not to be less than three nor more than five; the company in general meeting will determine remuneration.

Halkyn Hall Mineral Company, Limited.

This company proposes to acquire and work the Halkyn Hall mines, parish of Halkyn, Flint. It was registered on the 6th inst. with a capital of £10,000, in £1 shares, with the following as first subscribers:—

	Shares.
A. Crompton, Rusholme-road, Manchester, licensed victualler	100
W. Gilbert, 77, Bloomsbury-road, Manchester, broker	100
W. Cross, Rusholme-road, Manchester, commission agent	50
*R. G. Curr, 5, Nelson-street, Manchester, chemical manufacturer	50
*J. Woolcock, M.E., Bootle, Liverpool	100
T. Shaw, 377, Stockport-road, Manchester, builder	50
*J. E. Chapman, Stockport-road, Manchester, licensed victualler	25

The number of directors is not to be less than three nor more than seven; the first are the subscribers denoted by an asterisk; qualification, 20 fully-paid shares; remuneration, £100 per annum.

J. P. Jackson and Co., Limited.

This is the conversion to a company of the business of engineer and sundriesman to the wine, spirit, and aërated water trades, carried on by John Perkins Jackson, at Liverpool. It was registered on the 6th inst. with a capital of £20,000, in £5 shares. The subscribers are:—

	Shares.
*J. P. Jackson, Waterloo, Liverpool, engineer	50
E. Pershouse, Waterloo, Liverpool, manager	50
*C. Willmer, Birkenhead	20
*H. A. Steer, Rhyl, wine merchant	20
John Lyon, 1a, Lord Nelson-street, Liverpool, mineral water manufacturer	1
J. Lambie, 83, Hamilton-street, Birkenhead, wine merchant	1
J. Relf, 40, Duke-street, Liverpool, wine merchant	1

The number of directors is not to be less than three nor more than seven; the first are the subscribers denoted by an asterisk; qualification, 20 shares. The company in general meeting will appoint the remuneration of the board. Mr. J. P. Jackson is appointed managing director upon terms specified in an unregistered agreement.

Canadian (Queensland) Gold Mining Company, Limited.

This company proposes to carry on mining operations in Australia, or elsewhere, and also the business of a mining, milling, smelting, and trading company in all branches. It was registered on the 30th ult. with a capital of £70,000, in £1 shares, with the following as first subscribers:—

	Shares.
A. Brogden, J.P., 9, Victoria-chambers, West	1
R. Walker, J.P., Leathamhill, Glasgow	1
J. Shaw Kennedy, J.P., D.L., 1, South Eaton-place	1
J. H. Mace, Brodrick-road, Upper Tooting	1
F. Richard, 8, Queen's-road, Dalston	1
F. W. Bridges, 120, Cloudesley-road, N., clerk	1
W. J. Lavington, Dashwood House, New Broad-street, secretary to a company	1

The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification for subsequent directors, 100 shares. The remuneration of the board is to be at the rate of £200 per annum for the chairman, and £100 per annum in respect of each director, with an additional sum equal to 5 per cent. of the net profits available for dividend or bonus after 10 per cent. has been paid.

Transylvanian Gold Mining Company, Limited.

This company proposes to acquire a mineral property known as the mines of Vulkoj, near Zalathna, in Transylvania, in the kingdom of Hungary. It was registered on the 6th inst. with a capital of £120,000, in £1 shares. An unregistered agreement of the 30th ult. between Messrs. Adrien Hemipel and Sultet de Frontin of one part, and D. Elliott (for the company) of the other part, regulates the purchase. The subscribers are:—

	Shares.
*H. Currie, J.P., 88, St. James-street, S.W.	200
*Colonel G. B. Malleson, 27, West Cromwell-road	200
*Henry A. Greig, 2, Crosby-square, member of Lloyd's	200
*R. H. Twigg, C.E., 4, Victoria-street, S.W.	200
G. Strauss, jun., 12, Hansell-street, E.C., merchant	1
A. H. Sayle, 14, Denmark-street	1
W. Skinner, 283, Strand, contractor	1

The number of permanent directors is not to exceed seven, nor to be less than four; qualification, £200 of the nominal share capital. The first four subscribers, and Mr. Adrien Heimpel, of Beziers, France, are the first directors. Mr. Heimpel is appointed managing director at a salary of £800 per annum, and will serve on the board without further remuneration. The remuneration of the permanent directors will be £650 per annum, of which the chairman is to receive £200, and each other director £150, and a further sum equal to 5 per cent. on the paid-up capital when 15 per cent. dividend is paid. The directors will also receive travelling and other expenses properly and necessarily expended by them.

London-Scottish Plate-glass Insurance Company, Limited.

Registered on the 6th inst. with a capital of £20,000, in £1 shares, to transact plate and other glass insurance business. The subscribers are:—

	Shares.
*H. Fitch, 30, Bury-street, E.C., wholesale stationer	50
*J. Hill, 100, Queen Victoria-street, E.C., wholesale ironmonger	50
*W. S. Parker, 10, King William-street, secretary to a company	100
*J. E. Walford, 73, Knightrider-street, builder	50
*D. Young, 213, Clapham-road, auctioneer, &c.	50
A. W. Orwin, 15, Weymouth-street, Portland-place, physician and surgeon	100
A. T. Hobman, 239, New-cross-road, contractor	50

The number of directors is not to be less than three nor more than seven; the first are the subscribers denoted by an asterisk, and Mr. Henry Bragg; qualification for subsequent directors, 100 shares.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

5th October, 1886.

12,613. Bottle Stoppers, &c., T. Sugden and T. Taylor, Oldham.
12,614. Joint for Coupling Tubes, F. A. Williams, Wolverhampton.
12,615. Carding Machines, &c., W. Cunningham, Glasgow.
12,616. Breech-loading Fire-arms, A. Crerar.—(*A. W. Savage, United States.*)
12,617. Telegraphs, H. J. Allison.—(*The Writing Telegraph Company, Incorporated, United States.*)
12,618. Venting Casks, T. P. Richards and J. Davies, Liverpool.
12,619. Double Link Coupling for Railways, C. J. Howe, Sunderland.
12,620. Screw Curtain Hook, G. Peake, Crewe.
12,621. Stoppers for Bottles, A. Philburn and A. Moors, Ashton-under-Lyne.
12,622. Manufacture of Stencil Plates, J. Hall, Leeds.
12,623. Electric Safety Lamps in Mines, M. Settle, Manchester.
12,624. Field Service Canteen, G. T. Plunkett, London.
12,625. Pipe Cases, W. A. Peirce, London.
12,626. Water for Steam Boilers, W. G. and C. W. G. Little, Rotherham.
12,627. Lap Machines for Cleaning Cotton Fibre, W. Taylor, Manchester.
12,628. Pruning Apparatus for Trees, J. Gordon, London.
12,629. Self-acting Brake for Perambulators, W. H. Moody, Freemantle.
12,630. Metallic Zinc, W. S. Squire and S. C. Cuthbert, London.
12,631. Couplings for Signal Rods, F. A. Williams, Wolverhampton.
12,632. Transmitting Electro-magnetic Energy, J. M. V. Kent, London.
12,633. Mortise Lock, K. O. Peez, London.
12,634. Compound Engines, W. A. Young, Glasgow.
12,635. Fastening for Leather Razor Strops, W. W. Pellett, London.
12,636. Detectors for Marsh Gas, B. J. B. Mills.—(*N. W. Perry, United States.*)
12,637. Lawn Tennis Racquets, A. Shaw and A. Shrewsbury, London.
12,638. Telescope Ladder for Domestic Purposes, J. Kelly, London.
12,639. Fitting the Dark Slide to Photographic Cameras, F. Miall, London.
12,640. Gas Engines for Heating Water, H. Sutcliffe, Halifax.
12,641. Share Plates for Ploughs, F. R. Booth, Sheffield.
12,642. Stoppering Aerated Liquid Bottles, J. Stones, London.
12,643. Linen Buttons, J. Koch, London.
12,644. Stopping Bottles, W. Ball, London.
12,645. Operating Sewing Machines by Hand, J. Pendlebury, London.
12,646. Draught in Boiler Furnaces, W. Shaw and J. Cran, Glasgow.
12,647. Boots, W. Duncan and A. Black, Glasgow.
12,648. Preventing Ships from Sinking, J. A. Benninger, London.
12,649. Self-extinguishing Candles, D. G. Martens, London.
12,650. Self-holding Toasting Fork, L. J. Whitgreave, Sheffield.
12,651. Electric Safety Lamps, &c., J. W. Swan, London.
12,652. Oxidising Oils, A. and L. Q. Brin, London.
12,653. Steering Mechanism of a Toboggan Carriage, J. S. Brown and A. Vickers, London.
12,654. Vermin Traps, C. Walker and W. Allsopp, London.
12,655. Cooking Stoves, W. P. Thompson.—(*L. S. Browning, Newfoundland.*)
12,656. Batteries, A. J. Boult.—(*H. B. Cox, United States.*)
12,657. Wire Nail Machines, T. Fowler and T. B. de Forest, London.
12,658. Barrels, A. J. Boult.—(*W. T. Vale, Canada.*)
12,659. Watches, &c., F. Leman, London.
12,660. Automatic Car Couplers, A. J. Boult.—(*J. D. Ripson and R. Watson, Canada.*)
12,661. Thill Couplings, W. H. and H. E. Hannan, L. Miller, and M. L. Wright, London.
12,662. Checking the Length of Time Cabs, &c., are on Hire, W. Hutchinson, London.
12,663. Grooved Pulleys, R. Macpherson and M. Immisch, London.
12,664. Polishing Grain, Berries, and Seed, G. Hartlaub, London.
12,665. Gaining Power on the Shafts and Axles of Steam Engines, &c., F. I. Nibbs, London.
12,666. Velocipedes, H. Thresher, London.
12,667. Stopping and Re-starting Tramway Cars, &c., W. Newell, London.
12,668. Coupling of Wires for Fencing, &c., W. J. P. Walker and W. P. Walker, South Norwood.
12,669. Trotting Sulky, C. F. Stillman, London.
12,670. Castrating Instrument, A. M. Clark.—(*J. Trullinger, United States.*)
12,671. Device for Chalking Billiard Cues, J. Brown, London.
12,672. Steam Engines, J. J. Morrison, J. W. Judy, N. T. Hicks, and J. B. Harris, London.
12,673. Boxes and Hubs of Wheels, A. W. Lane and A. McCrimmon, London.
12,674. Screw Propellers, C. P. Wetherill, London.
12,675. Forging by Hydraulic Pressure, W. D. Allen, London.
12,676. Railway Car Couplers, &c., I. Cornwall.—(*G. Mitchell, Canada.*)
12,677. Bows for Archery Practice, H. F. Coombs.—(*H. Whiteside, Canada.*)
12,678. Carpet Beating or Cleaning Machines, J. Smithers, Kingston-on-Thames.
12,679. Drying Grain, &c., A. Kreps, London.
12,680. Railway or Tramway Wheels, O. Imray.—(*J. G. Hill, United States.*)
12,681. Clearing Hides, &c., from Lime, E. P. Nesbit, London.
12,682. Protection of Flame, F. B. Hanbury, Maidstone.
12,683. Automatic Musical Wind Instruments, E. Edwards.—(*O. Meinhardt, Germany.*)
12,684. Metallic Alloys, A. Gutensohn and J. W Bushe, London.
12,685. Gas Lamps, A. H. Hearington, London.
12,686. Magazine Fire-arms, E. A. Salvator, London.
12,687. Closing or Stoppering Bottles, W. B. Fitch, London.
12,688. Bottles, &c., W. B. Fitch, London.
12,689. Worm Gearing for Hoisting Purposes, W. H. Harfield, London.
12,690. Belt Fasteners, I. Dorel and E. Crumière, London.
12,691. Mechanism for Applying Motive-power, G. F Redfern.—(*W. McCalman, Victoria.*)
12,692. Malleable Iron and Steel, H. W. Bessemer London.
12,693. Fluid Meters, E. B. Donkin, London.
12,694. Hand-grinding Apparatus for Lithographic Stones, R. Koch, London.
12,695. Spinning Tops, J. Pascall, London.
12,696. Perfecting Printing Machine, P. O. de Clermont, London.
12,697. Steam Boilers, H. H. Lake.—(*W. E. Kelly, United States.*)
12,698. Heating Apparatus, W. E. Thursfield, London.
12,699. Stoppers for Bottles, &c., H. H. Lake.—(*The Deverall Manufacturing Company, United States.*)

6th October, 1886.

12,700. Machines for Coating Photographic Plates, B. J. Edwards, London.
12,701. Light Reaping Machine, S. Johnson, Ilford.
12,702. Hanging and Opening Casement Windows, E. Booth, Leeds.
12,703. Harness and Saddle Crupper Docks, F. H. Cottrell, Bristol.
12,704. Healds for Weaving Looms, C. Longbottom, Bradford.
12,705. Opening and Cleaning Cotton, &c., J., R., and J. Greenhalgh, Manchester.
12,706. Weighing Machines, F. C. Lynde, Manchester.
12,707. Attaching Railway Chairs to Metallic Sleepers, H. J. Harman, London.
12,708. Constructing, &c., Port Lights to Iron or Steel Vessels, C. J. Howe, Sunderland.
12,709. Gas Lamps and Burners, J. M. and J. Lamb, London.
12,710. Treatment of Grey Cotton, &c., T. Pickles, Manchester.
12,711. Water and Fluid Meter, J. Sanders and H Thomas, Longton.
12,712. Treatment of Gums for Varnish, W. R. Hodgkinson and A. Wingham, London.
12,713. Bedsteads, &c., I. Chorlton and G. L. Scott, Manchester.
12,714. Hydro-carbon Lamps, F. R. Baker, Birmingham.
12,715. Ferrule Stop Valve for Water, W. H. Foster, Halifax.
12,716. Window Blind Furniture, J. Campbell, Dundee.
12,717. Fixing Cork Rings in Necks of Bottles, J. Tiffen, Carlisle.
12,718. Multiple Gripping Clip, T. Dykes, Glasgow.
12,719. Retailing of Spirits, &c., J. Livingstone and J. McHardy, Dollar, N.B.
12,720. Producing Silicious Copper, C. Heusler London.
12,721. Movable Glass Measures, J. Worthington, Blackpoool.
12,722. Mixing Dried Air with Petroleum, J. A. Walker, London.
12,723. Actuating Healds in Looms, J. Ingham, W. Sagar, W. Simpson, and N. Coates, London.
12,724. Supplying Tar Fuel to Furnaces, J. T. Key, Sheffield.
12,725. Shields for Protecting Vessels, W. Rawson, Halifax.
12,726. Button Fasteners for Boots, &c., W. Stuart, Leeds.
12,727. Pumping Water from Mines, C. Blagburn, London.
12,728. Tools Actuated by a Reciprocating Motion of the Hands, A. Tatham, London.
12,729. Treating, &c., Tin and other Mineral Ores, G. M. Edwards, London.
12,730. Dry Gas Meters, J. L. Cloudsley, London.
12,731. Cigarettes, A. Parmelin, London.
12,732. Safety Advertising Purse, L. de Wyttenbach, London.
12,733. Mullers for Heating Liquids, &c., J. Kerfoot, London.
12,734. Pocket-knives, A. Weck, London.
12,735. Beds or Berths, F. H. Street and C. Ellis, London.
12,736. Treating Wheat Germ and Broken Wheat, R. Smith, London.
12,737. Cinder-sifter and Deliverer, D. Johnson, London.
12,738. Reflector, J. Walsh, London.
12,739. Blind and other Cords, S. Grafton, London.
12,740. Testing Vision for Colours, C. S. Jeaffreson, Newcastle-on-Tyne, and W. Curry and J. F. Pickard, London.
12,741. Rendering the Coating of Fuses Incombustible, G. J. Smith, London.
12,742. Metallic Harness for Looms, A. Dufour, London.
12,743. Applying "Doctors" for Roller Printing, J. Wilkinson and H. Bateson, London.
12,744. Boots or Shoes, J. Horner, London.
12,745. Martin Anchor, H. Martin, London.
12,746. Lift, P. G. Backman, London.
12,747. Regulating and Varying the Supply of Actuating Fluid to the Cylinders of Steam, &c., Engines, G. F. Alder, London.
12,748. Devices employed for Carrying out a certain Novel Recreational Game, W. Stobbs and E. L. White, London.
12,749. Chimney Pots for Preventing Down Draughts in Chimneys, J. Morris, London.
12,750. Articulated Shoe Sole for Orthopædic Purposes, E. Edwards.—(*A. E. Bruyge, France.*)
12,751. Loading Vessels with Coal, &c., Sir W. T. Lewis, Aberdare, and C. L. Hunter, Roath.
12,752. Loading Coal, &c., into Vessels, Sir W. T. Lewis, Aberdare, and C. L. Hunter, Roath.
12,753. Racquets for Lawn Tennis, &c., W. Phillips, London.
12,754. Collar Studs, G. T. Newling, London.
12,755. Instantaneous Shutter for Photographic Cameras, J. Leisk, Glasgow.
12,756. Distribution of Electric Energy, R. Dick and R. Kennedy, Glasgow.
12,757. Preparing Cod Liver Oil, R. de Bruce Trotter, Glasgow.
12,758. Water Softening Apparatus, A. Black, jun., London.
12,759. Locks for Double-barrelled Guns, L. W. Müller, London.

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12,760. Holding Tressels, &c., More Securely, A. Edmondson, J. B. Moorhouse, and T. A. Proctor, Skipton-in-Craven.
12,761. Looms for Weaving Crimped Fabrics, T. Mason, Bradford.
12,762. Packing Manufactured Tobacco, J. Howson, London.
12,763. Preventing Snarling in the Winding of Yarn, C. A. Byrom, T. Schofield, and T. Lyon, Manchester.
12,764. Trap for Waste Water Outlets, W. R. Harris, Manchester.
12,765. Spreading Waterproof Materials, &c., or Fabrics, R. K. Birley, Manchester.

12,766. Wire Belts for Screens, &c., N. Greening, Manchester.
12,767. Casting Nails, T. Francis, H. Makepeace, and W. Wand, Birmingham.
12,768. Knot used in the Manufacture of Fishing Nets, A. J. Allan, Glasgow.
12,769. Retorts, W. Burns, Leith.
12,770. Galvanic Batteries, W. H. Munns.—(*H. Merzbach and S. O. Eisele, Germany.*)
12,771. Nail-holder, W. H. Munns.—(*H. Merzbach and S. O. Eisele, Germany.*)
12,772. Obtaining Manure from Distillers' Spent Wash, W. S. Squire, London.
12,773. Candle Shade Holders, D. Patterson and H. Russell, Glasgow.
12,774. Grinding Paint, &c., T. F. Hind and R. Lund, London.
12,775. Perambulators, H. J. Lawson, Coventry.
12,776. Detection and Prevention of the Alteration of the Amounts and Figures on Cheques, &c., E. G. Whitehead, New Malden.
12,777. Delivery Box for Cigarettes, &c., H. K. Bromhead, London.
12,778. Generating Electric Currents, S. F. Walker, Cardiff.
12,779. Regulator and Portable Battery, J. B. Medland, London.
12,780. Bottles and Stoppers, O. Sumner, Oldham.
12,781. Mills for Triturating, &c., Materials for Paper-making, &c., T. Routledge.—(*A. Abadie, France.*)
12,782. Pianofortes, G. Green and C. and G. P. Savage, London.
12,783. Tipping Billiard Cues, G. R. Holding, London.
12,784. Tooth Brushes, E. A. Stretton, London.
12,785. Miniature Gig for Children, J. Simpson and S. T. Fawcett, London.
12,786. Telephones, W. Wheatley and W. P. O'Reilly, London.
12,787. Wheels, E. C. F. Otto, London.
12,788. Umbrellas and Parasols, R. W. Thomas and P. C. Smith, London.
12,789. Tooth and similar Brushes, I. E. Clifford, London.
12,790. Smokers' Wind and Rain Light, F. Childerstone, London.
12,791. Stoppering Bottles, W. Flatau and A. D. Turner, London.
12,792. Machine Guns, T. Nordenfelt, London.
12,793. Ornamental Pottery Ware, H. L. Doulton and W. P. Rix, London.
12,794. Muzzle for Horses, M. B. Parrington, London.
12,795. Attachment for Tobacco Pipes, &c., L. F. D. Saget, London.
12,796. Shut-off Valves or Cocks, D. J. Morgan, London.
12,797. Tobacco Pipes, A. M. Clark.—(*J. B. Roux, France.*)
12,798. Regulating the Flow of Gas and Air, W. J. Sawyer, London.
12,799. Oxidising Oils, &c., C. Schill and C. Seilacher, London.

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12,800. Drawing Compasses, W. J. Harris and H. T. Parr, Walsall.
12,801. Heating and Illuminating Gases, H. Kenyon, Manchester.
12,802. Syphon-boxes, J. Edwards, Wednesbury.
12,803. Bottles, J. H. Batty, Manchester.
12,804. Tins and Moulds for Buns, &c., J. and H. Smith, Sheffield.
12,805. Baths, E. Dummer, London.
12,806. Slide Rules, G. Bousfield, London.
12,807. Folding Paper, L. McFarlane, St. Mary Cray.
12,808. Gas Fires, Stoves, or Furnaces, F. W. Hart, London.
12,809. Flyers for Slubbing, &c., Machines, J. W. Scott and J. Carr, London.
12,810. Marking Chemical, &c., Bottles, W. Lane, London.
12,811. Convertible Velocipedes, A. C. Downing, London.
12,812. Delivery of Warp from Beams, T. Mason, London.
12,813. Cure of Ingrowing Toe-nails, J. Beauchamp, London.
12,814. Taking-up Motion for Looms, J. Mason and J. Jump, London.
12,815. Working Signals and Switches, J. Ford, London.
12,816. Lifting Ships, E. Beyerhaus, London.
12,817. Gas Injectors, A. C. Henderson.—(*V. Morel, France.*)
12,818. Secondary Batteries, W. W. Beaumont, London.
12,819. Self-closing Valve Unions, J. G. Redgrave, Birmingham.
12,820. Coverings for the Head, E. Bluck and H. F. Ihlee, London.
12,821. Velocipedes, A. Gibson, London.
12,822. Loom for Weaving Elastic Fabrics, G. F. Redfern.—(*P. Leperre, Belgium.*)
12,823. Fastening for Shoe Ties and Boot Laces, T. Hooper and S. G. Moore, London.
12,824. Window Fastenings, J. Pollock, London.
12,825. Globular or other Steam Engines, T. Mudd, Liverpool.
12,826. Eyelets, E. A. Jahncke and H. W. Herbst, London.
12,827. Oscillating Stand, A. J. Eli and E. Blewitt, London.
12,828. Gas-heated Smoothing Irons, W. Beecroft, London.
12,829. Preparing Ingredients for Treating Sewage, &c., G. W. Bremner, London.
12,830. Operating Sewing Machines, G. Freeman, London.
12,831. Attaching the Shoes of Beasts of Burden to their Hoofs, C. Colombati, London.
12,832. Driving Screw Piles, F. Hilton, London.
12,833. Subjecting the Person to the Action of Electric Currents, A. Loiseau and O. Pierrard, London.
12,834. Velvet Plush, E. Edwards.—(*P. M. J. Byssautier, France.*)
12,835. Alloys of Iron, A. T. D. Berrington, London.
12,836. Eyelets, S. H. Keeling, London.
12,837. Rolling and Shaping Metal Cylinders or Tubes, J. A and J. Hopkinson, London.
12,838. Mounting Guns in Batteries or Forts, T. Hitt, London.
12,839. Axle Pulleys, &c., R. Clayton and W. Branford, London.
12,840. Synchronising Clocks, C. E. Hoefling, London.
12,841. Deep Sea Sounding, J. G. Jones, London.
12,842. Propelling Mechanism for Ships and Vessels, R. T. Turnbull.—(*I. Plimmer, New Zealand.*)
12,843. Steering Mechanism for Ships and other Vessels, R. T. Turnbull.—(*I. Plimmer, New Zealand.*)
12,844. Ladies' Dress Adjusters, A. C. Herts, London.
12,845. Ornamentation of Hats, &c., S. P. Howard, London.

9th October, 1886.

12,846. Combing Bristles, W. S. Yates, Halifax.
12,847. Cigars, &c., J. Jackson and F. Sunderland, Birmingham.
12,848. Obtaining Soundings from a Moving Vessel, J. Joly, Dublin.
12,849. Automatic Vented Shives, J. Lockwood, Manchester.
12,850. Treatment of Sewage by Clarification, &c., F. P. Perkins, Exeter.
12,851. Wheels for Perambulators, &c., W. J. Rae, Grimsbury.
12,852. Umbrellas, J. G. Kincaid, Glasgow.
12,853. Card Tables, L. Collman, London.
12,854. Coupling of Wagons, W. B. Maxfield and J. W. Hancock, Leicester.
12,855. Lock Nut, J. Dangerfield, Birmingham.
12,856. Bedsteads with Attachment for Spring Mattresses, G. and E. Woods, Liverpool.
12,857. Securing Screws or Nails to Brackets, &c., H. Munslow, Birmingham.
12,858. Calculating Machines, S. Tate, London.
12,859. Meter, &c., F. W. Dick, Glasgow.
12,860. Screws, A. Muir and J. Humphrys, London.
12,861. Treatment of Fume in Lead Works, J. Warwick, Newcastle-on-Tyne.
12,862. Rotary Engines or Motors, W. P. Thompson.—(*W. K. Austin, United States.*)
12,863. Sleepers and Chairs for Railways, J. M. and C. While, Darlington.
12,864. Dynamo-electric Machines, W. H. Munns.—(*H. Merzbach and S. O. Eisele, Germany.*)
12,865. Gas Producers, R. Grant, Glasgow.
12,866. Miners' Lamps, J. Gilchrist and D. Ballardie, Glasgow.
12,867. Measuring Intensity of Colour in Transparent Bodies, J. W. Lovibond, Salisbury.
12,868. Glass Bottles, &c., W. Breffit, London.
12,869. Pocket Fowling Pieces, J. T. Cooper, Birmingham.
12,870. Brakes for Wheeled Vehicles, M. M. de Budai, London.
12,871. Stretching Trousers, &c., A. Schwabacher, London.
12,872. Toy, J. D. Gay, London.
12,873. Novel Advertising Medium, E. J. James, London.
12,874. Movable Bridge for Connecting the Platforms of Railway Stations, &c., T. Stanford, London.
12,875. Mechanical Puzzle, &c., J. and N. R. Hepworth, Leeds.
12,876. Jewellery, J. Cook, Birmingham.
12,877. Candlesticks, F. Bosshardt.—(*J. T. Warburton, New Zealand.*)
12,878. Rotary Heel Tips, G. Furness, London.
12,879. Drapers' Busts and Bodies, A. W. and G. B. Childs, London.
12,880. Armatures of Dynamo-electric Machinery, &c., R. E. B. Crompton, London.
12,881. Hand Slotting or Shaping Machine, R. Dick, London.
12,882. Lock Nuts for Screw Bolts, R. Marshall and G. H. A. Thunder, London.
12,883. Caloric Engines, M. Nobiling, London.
12,884. Movable Arms, &c., for Folding Seat of a Victoria Phaeton, &c., W. Rixom, Barnes.
12,885. Sewing Machine, H. Sommerfeld, London.
12,886. Cutting the Pile in Looms for Weaving Double Fabrics, E. Greaves, Bradford.
12,887. Belt Pulleys or Drums, A. B. Perkins, Bradford.
12,888. Rotary Engines, L. Zechmeister and P. J. Weber, London.
12,889. Chimneys and Chimney Tops or Caps, H. S. Obbard, London.
12,890. Preparing Food from Cereals, J. Low, London.
12,891. Suction Tube for Feeding, &c., Bottles, R. K. Boyle, London.
12,892. Carriage Fire-escapes, C. H. Averberg, London.
12,893. Sewing Machines, W. Beecroft, London.
12,894. Self-sustaining Lifts, A. Attwood and T. W. Barber, London.
12,895. Tools for Forming the Necks of Bottles, F. Foster, London.
12,896. Putting Tension on Skins of Banjos, &c., T. Robson, Kingston-on-Thames.
12,897. Stoppers for Bottles, Jars, &c., W. Shepherd, London.
12,898. Material for Packing, I. Steinhart, London.
12,899. Hydraulic Lifts, T. P. Ford, jun., London.
12,900. Scoring Pasteboards, &c., H. Gardner.—(*J. Scherbel and T. Remus, Germany.*)
12,901. Velocipedes, H. Laming, London.
12,902. Smoothing Irons, W. Tully, London.
12,903. Type Writers, S. A. Grant, London.
12,904. Handle Bars of Velocipedes, E. Redman, London.
12,905. Bells for Velocipedes, E. Redman, London.
12,906. Holding Sacks while Filling, W. P. English, London.
12,907. Obtaining Heat for Generating Steam, A. and L. Q. Brin, London.
12,908. Naphthol & Naphthylamine-Monosulphonic Acids, G. Pitt.—(*L. Cassella and Co., Germany.*)

11th October, 1886.

12,909. Setting Doffing Combs for Carding Engines, F. Mills, Heywood.
12,910. Bicycles, &c., H. Pipe, London.
12,911. Furniture Castors, J. Crowther and W. Dollin, Manchester.
12,912. Gas Motors, D. Clerk, Glasgow.
12,913. Form of Reading Glasses, F. Howchin, Liverpool.
12,914. Boiler for Heating Public Buildings, W. Whitehead, Gateshead-on-Tyne, and A. Emley, Newcastle-upon-Tyne.
12,915. Button Fasteners, S. M. Taylor, Sutton Coldfield.
12,916. Removing the Pressure of Steam on the Valves of Steam Engines, J. D. Smith, Woolstone.
12,917. Connecting Knife Bars to Heels in Mowing and Reaping Machines, T. Stirrup, Liverpool.
12,918. Looms, W. Bagshaw, Batley.
12,919. Valve, &c., H. Roberts and H. Roberts, Skipton-in-Craven.
12,920. Heating and Cooking by Steam, C. E. Saunders, Heavitree.
12,921. Binding the Loose Ends of Mattresses, &c., W. Stuncke, London, and R. W. James, Brockley.
12,922. Lawn Tennis Marker, J. McHardy and R. Brand, Dollar, N.B.
12,923. Lawn Tennis Poles, &c., J. McHardy and R. Brand, Dollar, N.B.
12,924. Built-up Cranks, J. S. Fairfax, London.
12,925. Horseshoes and Nails, E. Dejean and E. Rochester, London.
12,926. Holding Pens, &c., for Writing, &c., W. M. Sloman, London.
12,927. Snaps and Catches for Jewellery, &c., L. C. Dettmer, London.
12,928. Converting Alternate Rotary Motion into Continuous Rotary Motion, J. Radcliffe, East Retford.
12,929. Edging, &c., Sheet Metal, D. Smith, jun., London.
12,930. Soorkee Mill, C. Sheppard, London.
12,931. Combined Umbrella and Walking Stick, J. E. Bonnevaux and P. Verrier, London.
12,932. Combined Hat Brush, Hat Reviver, and Clothes Brush, W. A. Roadknight, London.
12,933. Water Heater, J. Knowlson, London.
12,934. Date Indicator, C. Lund, London.
12,935. Band Pulleys, A. T. Booth, London.
12,936. Cable Tramways, E. Pritchard, London.
12,937. Brakes, F. Tentschert and F. W. Minck, London.
12,938. Shooting Planes, J. H. Mullen, London.
12,939. Expanding Portmanteaus, &c., J. H. Mullen, London.
12,940. Stand for Holding Cards, &c., C. Dibdin, London.
12,941. Gauges for Controlling the Pressure of Gas, A. A. Joy, London.
12,942. Bending Plates, J. Platt and J. Fielding, London.
12,943. Scouring Several Pieces of Woollen Goods Simultaneously, A. J. Boult.—(*M. Guizard, Spain.*)

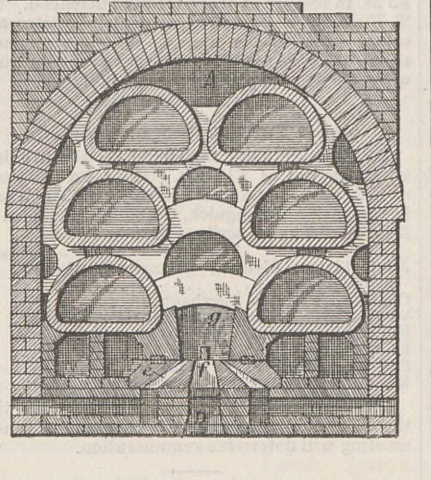
SELECTED AMERICAN PATENTS.

(From the United States' Patent Office official Gazette.)

346,301. Gas Retort Furnace, *George A. McIlhenny, Washington, D.C.—Filed April 30th, 1885.*

Claim.—The combination of a retort oven or chamber, A, fire pot C, flue D, and mixing chamber *g*, provided with hot air inlets *e* and gas outlets *f*, and upright dividing blocks L, of less width than the outlets and placed centrally thereover, whereby the gases are thrown equally toward the air inlets at each side.

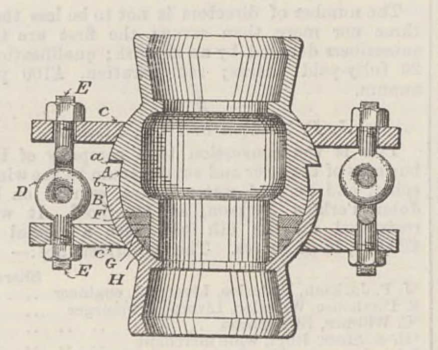
346,301



346,478. Ball and Socket Joint for Water and Gas Pipes, *Alba L. Holmes, Grand Haven, Mich.—Filed April 16th, 1886.*

Claim.—(1) In a pipe coupling, the ball and socket section A and B, having enlarged adjacent portions, one fitting within the other, and of greater diameter than the outer ends thereof, and the plates C, formed separate from the said sections, and having central openings fitting the outer surfaces of the enlarged portions of the coupling sections, said plates having a space between them to admit of their proper adjustment, combined with bolts and nuts for securing the said plates and sections in place, substantially as set forth. (2) In a pipe-coupling, the combination, with the ball and socket sections A and B, having enlarged adjacent portions, one fitting within the other, of greater diameter than the outer ends thereof, and having also the shoulders *a* and *b*, with a space between them, of the separated plates C, fitting the said enlarged portions of the said sections, and the interlinked jointed bolts and their nuts for holding said section and plates in place, substantially as set forth. (3) In a pipe-coupling, the combination, with the ball and socket sections, of a packing consisting of a wooden gasket, a hard metal ring, and an intermediate ring or gasket of soft metal, substantially as set forth.

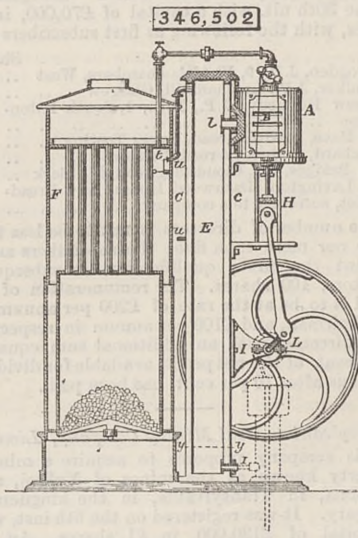
346,478



346,502. Low-pressure Engine, *Addison V. Sanford, Elmira, N.Y.—Filed January 18th, 1886.*

Claim.—(1) The combination of the boiler, the upright condenser isolated from and supported erect independently of the boiler, and the engine secured to the condenser at the side farthest from the boiler and supported thereby, substantially as described and shown. (2) In a low-pressure engine, the combination, with the condenser and driving shaft of the engine, of a pump having its suction pipe connected with said condenser, a crank mounted loosely on the driving shaft, the piston rod of the pump connected with said crank, a clutch between the crank and shaft, and adapted to fasten said parts together when turned in one direction, and to release the same when turned in the opposite direction, and a hand crank for turning the aforesaid crank independently of the shaft, all constructed and combined to permit of exhausting the condenser before starting the engine, substantially as set forth.

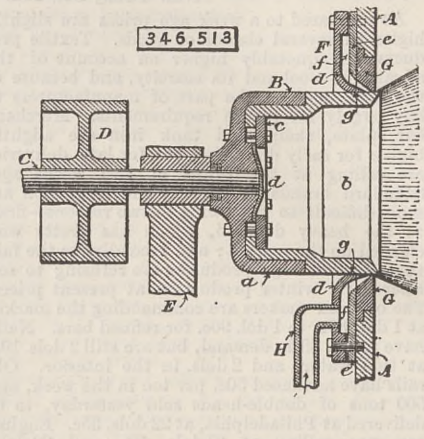
346,502



346,513. Attrition Mill, *Thomas L. Sturtevant, Framingham, Mass.—Filed March 6th, 1886.*

Claim.—(1) In a grinding mill, the combination, with the mill casing and a rotary head, of an annular chamber surrounding the latter and provided with an unobstructed delivery orifice, through which water or air may be discharged into the mill around the said head, substantially as set forth. (2) In combination with the mill casing and a rotary head, a stationary annular chamber surrounding said head and provided with a delivery orifice, through which water or air may be discharged into the mill about the said head, and a pipe leading from the source of supply to said chamber, substantially as set forth. (3) In a grinding mill, the combination of a mill casing and a rotary head with an annular chamber surrounding the same, and provided with a V-shaped annular delivery orifice, which is obliquely disposed and in close proximity to the periphery of said head, substantially as set forth. (4) In a grinding mill, the combination of a mill casing and a rotary head with flat disc *e*, collar G, having an inner bevelled face, and disc d^1, having a flange G, which presents an inclined face to said bevelled face of said collar, the said discs inclosing a space *f*, and forming an annular air or water chamber surrounding said head and provided with a V-shaped orifice, substantially as set forth.

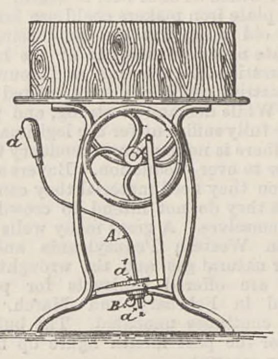
346,513



346,562. Treadle Attachment, *James L. Randolph, Martinsburg, W., Va.—Filed September 5th, 1884.*

Claim.—(1) In combination with the ordinary treadle of a sewing machine, a removable lever attached to the treadle in such manner that by the reciprocation of the upper end of the lever the treadle is rocked in its pivot bearings. (2) The described lever, consisting of the handle A, with bearing face a^1, projecting end a^2, and thumb-screw B, as described.

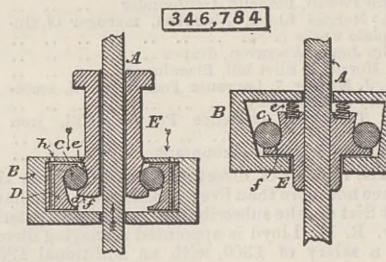
346,562



346,784. Clutch, *Arthur L. Stanford, Waukegan, Ill. Filed January 25th, 1886.*

Claim.—(1) In a friction clutch apparatus, the combination, of a fixed standard or support, a lifting bar, a moving clutch box, and a friction plate extending beyond the clutch box, and having at its outer extremity a lug or flange adapted to rest upon the standard or support in the release of the clutch, substantially as set forth. (2) In a friction clutch apparatus, the combination of a fixed standard or support, a lifting bar, a moving clutch-box containing a friction roll, and a friction plate extending beyond the clutch box, and having at its outer extremity a lug or flange, adapted to rest upon the standard or support in the release of the clutch, and having its inner end within the clutch box curved to operate in connection with said friction roll, substantially as set forth. (3) The combination, in a friction clutch box, of a removable and adjustable backing plate and adjusting devices, substantially as and for the purpose set forth. (4) In a friction clutch, the combination of a clutch box, friction roll, friction plate, spring, and lifting bar, substantially as set forth. (5) A friction clutch consisting of the clutch box, a friction roll or rolls working against a diverging surface upon one side of the bar to be operated upon, and having at the other side a bearing plate F, and bar G, said plate and bar being pivotally attached, substantially as set forth.

346,784



346,954. Permutation Padlock, *George F. Seiser, Worthville, Ky.—Filed May 26th, 1886.*

Claim.—In a permutation padlock, the combination of a case having a removable cap plate, a rigid post I^1, carried thereby, an arbor journalled in the cap plate, the rigid and loose tumblers carried by the arbor, and having the notches in their peripheries, a staple having the notched legs, and a spring I, formed of a single piece of metal and secured at its middle to the post I^1, and having the outwardly bent portions I^2, for the free passage therethrough of one leg of the staple, and the independent arms I^3, extending outwardly from both sides of the post and fitted around and bearing against the periphery of the loose tumblers, to prevent the latter from rotating loosely on the arbor by frictional contact between said arms of the spring and the tumblers, substantially as described.

346,954