SCREW PROPELLER EFFICIENCY.

By Professor A. G. Greenhill.

No. III.

III.—Investigation of the Effect of Fluid Friction.

(31) According to the experiments of Froude and others on fluid friction, the drag exerted by water flowing over a plane surface with uniform velocity v can be expressed by $f v^2$ per square foot, where f is some constant depending on the nature of the surface, but independent of the pressure.

Froude finds—"Trans. Inst. Naval Architects," vol. xix. 1878—that with a lb. as unit of force and a foot-second as unit of velocity, $f = {\cdot}004$ when only one surface of an ordinary propeller blade is taken into account, but this must be doubled, and we must put

$$f = {\cdot}008$$

when the fluid flows past both sides of the surface, as is the case with the blades of a propeller when the pitch is not large enough for a pronounced eddy or discontinuity to be formed at the back of the blades.

With the poundal as unit of force, we must put

$$f = {\cdot}008\, g \text{ or } {\cdot}256.$$

(32) Now referring to Fig. 8 for the propeller of uniform pitch, and supposing l the axial length of the blade, and θ the angle between the disc area and the line A B on the blade, the development of the section of the blade made by a co-axial cylinder of radius r, so that $c = 2\pi r$; then for an element of the blade A B of breadth $d\,r$, and therefore of area l cosec $\theta\, d\,r$, the frictional drag is

$$f l v^2 \operatorname{cosec} \theta\, d\,r$$
$$= f l u^2 \operatorname{cosec}^3 \theta\, d\,r,$$

since $v = u \operatorname{cosec} \theta$; and the axial component of this drag

$$= f l u^2 \operatorname{cosec}^2 \theta\, d\,r;$$

so that the total frictional drag of one blade obtained by integration is

$$= f l u^2 \int_{\frac{1}{2}a}^{\frac{1}{2}d} \operatorname{cosec}^2 \theta\, d\,r.$$

If there are b blades, and F denotes the frictional drag of the propeller,

$$\text{F} = b f l u^2 \int_{\frac{1}{2}a}^{\frac{1}{2}d} \operatorname{cosec}^2 \theta\, d\,r.$$

Now

$$\cot \theta = \frac{2\pi r}{p},$$

and, therefore,

$$\operatorname{cosec}^2 \theta = 1 + \frac{4\pi^2 r^2}{p^2};$$

so that

$$\text{F} = b f l u^2 \int_{\frac{1}{2}a}^{\frac{1}{2}d} \left(1 + \frac{4\pi^2 r^2}{p^2}\right) d\,r$$
$$= b f l u^2 \left\{ \tfrac{1}{2}(d - a) + \frac{\pi^2}{6\,p^2}(d^3 - a^3) \right\},$$
$$= b f l u^2 \left\{ \tfrac{1}{2}(d - a) + \frac{8}{3\,p^2}(\text{A}^2 - \text{B}^2)\frac{d^3 - a^3}{d^4 - a^4} \right\}.$$

This value of F must be subtracted from the former value of the thrust, in order to obtain the true thrust; so that now

$$\text{T} = 2\pi m(\text{A}^2 - \text{B}^2)\frac{u}{p^2}(n p - u)$$
$$- b f l u^2 \left\{ \tfrac{1}{2}(d - a) + \frac{8}{3\,p^2}(\text{A}^2 - \text{B}^2)\frac{d^3 - a^3}{d^4 - a^4} \right\},$$

which can be written in the form—

$$\text{T} = 2\pi m(\text{A}^2 - \text{B}^2)\frac{u}{p^2}\left\{ n p - (1 + k) u \right\}$$
$$- \tfrac{1}{2} b f l u^2 (d - a)$$

where

$$k = \frac{4}{3} b \frac{f}{m} \frac{l}{\pi} \frac{d^3 - a^3}{d^4 - a^4}$$

(33) Now suppose P is the pitch when for the speed u and thrust T, the revolutions have their minimum value N; then

$$\text{N P} = 2(1 + k)u,$$

and then the slip

$$s = \frac{1 + 2k}{2 + 2k}.$$

Then in order to keep up the thrust T at speed u with other corresponding values of n and p, we must have—

$$\frac{n p - (1 + k) u}{p^2} = \frac{(1 + k) u}{\text{P}^2}$$

$$\frac{p^2}{\text{P}^2} = \frac{n p}{(1 + k) u} - 1 = 2\frac{n p}{\text{N P}} - 1,$$

so that we have

$$\text{T} = 2\pi m(\text{A}^2 - \text{B}^2)\frac{u}{p^2}\left\{ n p - (1 + k) u \right\}(1 - h)$$

where

$$h = \frac{1}{2} b \frac{f}{m} \frac{l}{\pi} \frac{\text{P}^2}{1 + k} \frac{d - a}{\text{A}^2 - \text{B}^2};$$

So that the new value of T, with fluid friction taken into account, differs from the original value

(i.) In the presence of the factor $(1 - h)$.

(ii.) In having $n p - (1 + k) u$ as a factor instead of $n p - u$; and h and k are both small quantities, whose squares, &c., may practically be neglected.

(34) The value of L remains the same as before (6), so that now the efficiency

$$e = \frac{\text{T}\,u}{2\pi \text{L}\,n}$$
$$= (1 - h)\frac{u}{n p}\frac{n p - (1 + k) u}{n p - u}$$

which reduces to [illegible] as before, when h and k are made zero, by neglecting fluid friction.

Expressed in terms of the slip ratio s

$$e = (1 - h)(1 + k) \cdot \frac{(1 - s)\left(s - \frac{k}{1 + k}\right)}{s}$$

so that e, represented in Fig. 11, the curve connecting e the efficiency as ordinate, and s the slip ratio as abscissa, is a hyperbola.

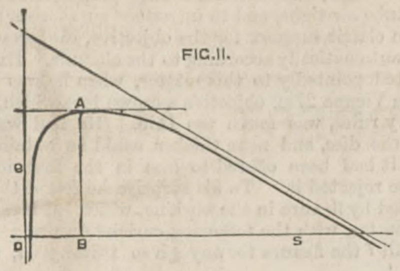


FIG. 11.

Written in the form

$$e = (1 - h)(1 + k)$$
$$\left\{\left(1 + \sqrt{\frac{k}{1 + k}}\right)^2 - \left(\sqrt{s} - \sqrt{\frac{k}{1 + k}} \cdot \frac{1}{\sqrt{s}}\right)^2\right\},$$

or, by elementary differentiation, we see that at the point A on the curve the efficiency is a maximum, and then

$$e = (1 - h)\left\{\sqrt{(1 + k)} + \sqrt{k}\right\}^2$$

when

$$s = \sqrt{\frac{k}{1 + k}} = \text{O B}.$$

For practical purposes, we can then put $s = \sqrt{k}$, since k is small.

By increasing d, the diameter of the propeller, h and k are diminished; so that the efficiency of the spiral elements like A B increased with the radius r of the cylinder on which they are traced; and the tips of the blades are the most efficient of a propeller when fluid friction is taken into account.

(35) In practice $\frac{a}{d}$, the ratio of the diameter of the boss to the diameter of the propeller, is a fraction such that $\frac{a^3}{d^3}$ and $\frac{a^4}{d^4}$ are insensible, so that we may put

$$k = \frac{4}{3} b \frac{f}{m} \frac{l}{\pi d}.$$

Now, according to Froude's experiments,

$$\frac{f}{m} = \frac{{\cdot}008\, g}{64} = {\cdot}004,$$

so that

$$\sqrt{\frac{f}{m}} = {\cdot}02;$$

and for a four-bladed screw, $b = 4$, and

$$k = {\cdot}004 \times \frac{16}{3} \frac{l}{\pi d}.$$

Suppose, for instance, the length of the propeller measured fore and aft is one-third of the circumference, then

$$l = \frac{1}{3}\pi d,$$
$$k = {\cdot}004 \times \frac{16}{9},$$

and

$$\sqrt{k} = {\cdot}02 \times \frac{4}{3}$$
$$= {\cdot}03 \text{ about},$$

so that the greatest efficiency is obtained when the slip is about 3 per cent., considerably less than what is usually given.

(36) An inspection of Fig. 11 shows that increasing the slip beyond the theoretically maximum efficient value does not diminish the efficiency so rapidly as diminishing the slip.

When the slip is a little more than 50 per cent., or $s = \frac{1}{2}$ nearly, then the revolutions are a minimum, even when fluid friction is taken into account; and for those revolutions, the speed of the vessel is such that the thrust of the propeller is about a maximum.

Strictly speaking, the revolutions are a minimum, or n is a minimum, when, as above, $n = \text{N}$, $p = \text{P}$, and

$$\text{N P} = 2(1 + k)u,$$

or,

$$s = 1 - \frac{u}{\text{N P}} = \frac{1 + 2k}{2 + 2k};$$

so that the percentage of slip

$$100\, s = 50\left(1 + \frac{k}{1 + k}\right),$$

a little more than 50, since k is small.

(37) Denoting as above by P the pitch corresponding to the minimum number of revolutions, then a diminution of pitch below P will require increased revolutions but diminished indicated horse-power to maintain the same speed, so that the efficiency rises in consequence of a diminution of pitch below P; but an increase of pitch above P will require increased revolutions and increased indicated horse-power to maintain the speed, and the efficiency drops rapidly below 50 per cent.

(38) An instance of this kind was recorded in The Engineer of May 7th and 14th, in connection with the Great Eastern, in her voyage from Milford Haven to Liverpool, when, with twenty-seven revolutions a minute, the speed of the screw $n p$ was measured to be about 12 knots—more nearly 11·7—the pitch of the propeller being 44ft.; but the speed of the vessel was only about $5\frac{1}{2}$ knots, implying about 53 per cent. of slip. This percentage of slip shows that the revolutions were nearly the minimum value N for the speed of $5\frac{1}{2}$ knots. But suppose the pitch of the propeller had been halved, and made 22ft. Then we should find that increasing the revolutions with this new pitch of 22ft. only about 25 per cent., and thus making the revolutions about 34 a minute, would produce the requisite thrust at the same speed of $5\frac{1}{2}$ knots, the slip being reduced to about 20 per cent., while the indicated horse-power required would be only about five-eighths of the indicated horse-power required previously with a pitch of 44ft., or the efficiency of the engines would be increased 60 per cent. This would be exact by leaving out of account fluid friction.

(39) Taking fluid friction into account, however, and supposing that 27 is the minimum value of the revolutions, so that

$$\text{N P} = 2(1 + k)u;$$

or

$$\frac{1}{2(1 + k)} = \frac{u}{\text{N P}} = 1 - s$$
$$= 1 - \frac{53}{100} = \frac{47}{100};$$

or

$$1 + k = \frac{50}{47},\quad k = \frac{3}{47} = {\cdot}0064;$$

very slightly different to the value of k given before.

Then for the new pitch p—

$$\frac{n p}{\text{N P}} = \tfrac{1}{2}\left(1 + \frac{p^2}{\text{P}^2}\right)$$
$$= \tfrac{5}{8};$$

or

$$\frac{n}{\text{N}} = \frac{5}{4} = 1{\cdot}25,$$

if

$$\frac{p}{\text{P}} = \tfrac{1}{2};$$

so that the revolutions must be increased 25 per cent. when the pitch is halved, and made 22ft.

(40) Then, E denoting the old efficiency and e the new—

$$\frac{e}{\text{E}} = \frac{\text{N P}}{n p}\ \frac{n p - (1 + k) u}{\text{N P} - (1 + k) u}\ \frac{\text{N P} - u}{n p - u};$$

which reduces with the above values to—

$$\frac{e}{\text{E}} = 1{\cdot}5 \text{ about};$$

so that the efficiency is increased about 50 per cent. by halving the pitch, even when the effect of fluid friction on the propeller is taken into account, in this numerical application to the s.s. Great Eastern. In order to predict the effect of diminishing the pitch at other speeds, it would be necessary to have a record of the number of revolutions of the engines at the different speeds with the present propeller.

(41) The pitch has hitherto been considered uniform in the investigation of the effect of fluid friction on the blades of the propeller. But when the pitch of the propeller increases from $\frac{u}{n}$ on the leading edge of a blade, in order to avoid shock on entrance, to any final pitch p, the investigation of the effect of fluid friction depends greatly on the rate of increase of the pitch, and requires special treatment in each case. We may, however, predict that the allowance to be made for the effect of fluid friction will not exceed the allowance we have already investigated in connection with propellers of uniform pitch.

THE ROYAL INSTITUTION.

TELESCOPIC OBJECTIVES AND MIRRORS.

On Friday evening, April 2nd, Mr. Howard Grubb, F.R.S., delivered a lecture at the Royal Institution upon "Telescopic Objectives and Mirrors: their Preparation and Testing." Dr. William Huggins, F.R.S., presided.

The lecturer said that time would not permit him to go into the history of the development of the methods of constructing telescopic objectives, but a few words on the history of optical glass manufacture were necessary. Dollond's discovery of the means of achromatising objectives rendered possible their construction of larger size, provided suitable material could be obtained, for his discovery rendered visible faults which had previously been masked. Many years then elapsed before Guinand, a persevering Swiss peasant, succeeded in producing good discs of glass of suitable dimensions. His secret he handed down in his own family to M. Feil, of Paris, one of his descendants, and also through M. Bontemps, who for a time was associated with Guinand's son, and afterwards accepted an invitation from Messrs. Chance, Bros., and Co., of Birmingham, to assist them in an endeavour to improve this branch of their manufacture. Only these two houses, so far as he knew, could make optical discs of large size.

The glass discs when received by the optician have to be tested. Sometimes, when received, they are roughly polished on both sides; sometimes they have but small facets polished on the edges. For telescopic lenses it is best to have them polished on both sides, to avoid the risk of having to throw a lens away, after much trouble and labour have been expended upon it. The points to be looked to are (1) air bubbles, specks, and mechanical impurities; (2) homogeneity; (3) annealing. The first of these can be seen by the eye. The test for homogeneity is somewhat equivalent to Foucault's test for the figure of concave mirrors. The disc of glass should either be ground and polished into a convex lens, or it should be placed in juxtaposition with a convex lens of similar or larger size, of known good quality; a small brilliant light is placed opposite one side of the lens, so that the conjugate focus is found on the other side at a convenient distance; a small gas flame will do as the source of light. When the image of the flame is thus brought upon the pupil of the eye by the lens, the lens should appear to be "full of light," but at the slightest movement to one side the lens should appear quite dark. If the eye be now slowly passed backwards and forwards between the positions showing light and darkness, any irregularity of density will be easily seen, but some experience is necessary. If any portion of the lens be of a different density to the general mass, that portion has a larger or shorter focus, revealed by luminosity, while the rest of the lens appears dark. He had sometimes succeeded in photographing such defects in the camera.

Annealing is tested by the polariscope, the discs of small size being examined through the facets, by means of a polarising plane and a Nichol's prism. Larger sizes, polished on the surfaces, can be more easily examined, and their defects become visible in the lantern polariscope. Mr. Grubb here projected upon the screen a polarised image of a badly annealed disc, which was traversed by a black cross, and by rings of colour near the circumference. He said that opticians never expected to get quite rid of the black cross, but that if any coloured rings appeared the glass was rejected.

The composition of the metallic mirrors of the present day differs but little from that used by Sir Isaac Newton. The best alloy is now made in the proportion of four chemical atoms of copper to one of tin. The curves of lenses have to be calculated for focus, and for the correction of the chromatic and spherical aberrations. In many published works full information is given as to the calculation of the curves; and, contrary to a general illusion, there is no difficulty or mystery about the matter. The calculation of the curves which satisfy the conditions of achromatism and desired focus is a most simple one, and can be performed in a few minutes by anyone having a slight algebraical knowledge, provided the refractive indices and dispersive power of the glass be known. Both Messrs. Chance and Messrs. Feil supply these data with their discs, quite sufficiently accurate for small-sized objectives, and he accepted their figures for any discs up to ten inches in diameter. When above that size, he obtained his data from personal measurements. The calculations of the curves for spherical aberration are very troublesome, but fortunately they may generally be neglected. Some years ago the Royal Society commissioned one of its members to draw up tables for the use of opticians, giving curves to satisfy all the conditions they required. The plan was abandoned because the surfaces produced by opticians are, in most cases, not truly spherical. Object glasses cannot be made on paper; the final corrections must be left to the optician, and not to the mathematician. A sensible difference in correction for spherical aberration can be made in half-an-hour's polishing. He would be willing to undertake to alter the curves of the crown or flint lens of any of his objectives, by a very large quantity, increasing one and decreasing the other, so as to still satisfy the conditions of achromatism, but introducing theoretically a large amount of positive or negative spherical aberration, and yet to make out of the altered lens an object glass perfectly corrected for spherical aberration, so far as ordinary sizes are concerned. Even for large sizes it is sometimes possible to make a better lens by deviating from the curves which give a true correction for spherical aberration, and correcting that aberration by "figuring." The work of making a lens is divided into (1) rough grinding, (2) fine grinding, (3) polishing, (4) centreing, (5) figuring and testing. In the rough grinding the discs are cemented to a holder, and ground with sand and water. For fine grinding the tools are of brass or iron; he preferred iron, except for very small sizes. The tools are grooved on the face, in the manner suggested by the late Mr. A. Ross, in order to allow the grinding material to properly distribute itself. If two spherical surfaces be rubbed together, or rubbed together with dry powder between, they will tend to keep spherical; but if wet powder be used, they will abrade more on the centre and edge than in the zone between. Mr. A. Ross designed the distributing grooves to meet the difficulty.

The particles of the grinding powder are either imbedded in the softer surface, or are rolling between the two surfaces, or are sliding between the two surfaces. The particles which become imbedded are the finer, and do little work; most of the work is done by those which slide; as the grinder is made of a softer material than the glass they partially adhere to the former, and are carried by it across the face of the latter. The best conditions for rapid grinding are—not too little emery, for then there will not be enough of abrading particles; not too much, for then the particles will roll on each other and tend to crush and disintegrate each other instead of abrading the glass; there should be just sufficient to form a single layer of particles between the grinder and the glass surface. Lenses less than 5in. or 6in. in diameter are usually ground by hand, and it is possible to grind by hand surfaces up to 12in. or even 15in., but the labour is severe; he was gradually reducing the size allotted to hand grinding; he found machine grinding to be more constant in its results. The machinery used is the same as for the subsequent polishing.

In fine grinding operations by hand the glass is usually cemented to a holder, having for smaller sizes three pieces of cork to which the lens is attached; this holder is screwed to a "spud" or nose on the top of a post screwed to the floor. The operator applies the proper quantity of moist emery, then works the grinder over the glass in a set of peculiar strokes, the amplitude and character of which he varies according to circumstances, at the same time that he changes his position round the post every few seconds. The grinder suffers abrasion as well as the glass, and the skill of the operator is shown by the facility with which he is able to bring the glass to the curve of the grinder without altering the curve or figure of the latter. A skilled operator can even take a lens of one curve and a grinder of, say, a deeper curve, and produce surfaces fitting together, and of shallower curves than either.

In the early stages of grinding, gauges of the paper radius, and cut out of sheet brass or sheet steel, are used for roughly testing the curves of the lenses. For more accurate purposes a spherometer is used. It is made in various forms, generally with three legs terminating in three hardened steel points, which lie on the glass, and a central screw with fine thread, the point of which can be brought down to bear on the centre of the glass; the versed sine of the curve for a chord equal to the diameter of circle formed by these points is measured, the radius of the curve can then be easily calculated. He did not find the points of the spherometer satisfactory for regular work, they are apt to get injured or worn, and on ground surfaces one or other of the feet may find its way into a deep pit in the lens. His spherometer, then exhibited, had three feet of about $\frac{1}{2}$in. each, which feet were hardened steel knife edges forming three portions of an entire circle. After its three curved feet are placed upon the lens, the screw with the micrometer head is turned till the point is felt to touch the surface of the glass; the scale and head can then be read off. The screw in the instrument has fifty threads to 1in., and the head is divided into 100 parts, so that each division is equal to $\frac{1}{5000}$in. With practice it will measure to one-tenth of this, or $\frac{1}{50000}$in., and by special precautions even perhaps $\frac{1}{100000}$in. or $\frac{1}{150000}$in., which he had found to be practically the limit of the accuracy of mechanical contact. To show the delicacy of the instrument, he brought its movable centre and its three feet to bear equally upon a curved glass surface; when then blown upon with air of the temperature of the theatre the spherometer would not move without sliding bodily on the glass. He then raised the spherometer by means of a string so as not to alter its temperature, and placed his hand for a moment on the centre of the glass; on replacing the spherometer a puff of air made it turn upon its central screw, because the latter rested upon the lump produced by the warmth of the hand upon the centre of the glass.

Flexure during polishing causes great difficulties, but even the thick pieces of glass used for lenses will bend with their own weight. He placed the spherometer upon a disc of glass of about $7\frac{1}{2}$in. diameter, and $\frac{3}{4}$in. thick, so that the instrument would not turn, the disc then resting upon three blocks near its periphery. He next placed a block under the centre of the disc and removed the three others. The spherometer would then spin round upon its central screw. The spherometer is too coarse an instrument to be of use in figuring objectives. For small sizes no special precautions are necessary to prevent the effects of flexure in grinding, but for all sizes over 4in. in diameter he used the equilibrated levers devised by his father, and utilised for the first time on a large scale in supporting the 6ft. mirror of Lord Rosse's telescope. He had also sometimes polished lenses while they were floating on mercury, but it was difficult to keep the discs sufficiently steady without introducing other chances of strain. Very large lenses, when placed in their cells, suffer flexure from weight alone, as they then are supported nowhere but at the edge; he therefore once proposed to make the telescope tube air-tight, and to introduce air at a slight pressure to form an elastic support for the objective, the pressure to be regulated automatically according to the altitude. His attention was directed pointedly to this matter, when he was obliged to use for the Vienna 27in. objective a crown lens which, according to ordinary rules, was much too thin. He had waited some years for the disc, and none thicker could be obtained at the time. If it had been offered to him in the first instance he would have rejected it. To his surprise he found that he was not troubled by flexure in the working, which led him to investigate the matter, with the following curious results.

If we call f the flexure for any given thickness t, and f' the flexure for any other thickness t', then $\frac{f}{f'} = \frac{t^2}{t'^2}$ for any given load or weight approximately. But as the weight increases directly as the thickness, the flexure of the discs due to their own weight, which is what is wanted to be known, will be about as $\frac{f}{f'} = \frac{t}{t'}$ In relation to the effect of this flexure on the image in any lens bent by its own weight, whatever part of its surface is made more or less convex or concave by the bending has a corresponding part bent in the opposite direction on the other surface, which tends to correct the error produced by the first surface. This is one reason why reflectors, which have not this second correcting surface, are so much more liable to show strain than refractors. If the lens were infinitely thin, moderate flexure would have no effect upon the image; the effect increases directly as the thickness. As the flexure decreases directly as the thickness, and the effect of that flexure increases directly as the thickness, it is clear that the effect of the flexure of any lens due to its own weight will be the same for all thicknesses. In other words, no advantage is gained by additional thickness. What has just been stated has nothing to do with the extra difficulty of supporting a thin lens during the grinding and polishing processes.

The speaker then dealt with the subject of the substances used for the face of the polisher. Cloth is sometimes used, sometimes pitch, and the French are said to employ paper. The ground surface of a lens consists of a multitude of hills and valleys. Cloth not only polishes the tops of these hills, but as it has a "nap," polishes them at the same time a little way down their sides; hence the lens seems to polish quickly with cloth, and looks well when the surface is in reality uneven. Pitch polishes down the tops of the hills, scarcely touching their sides, and with it polishing goes on for some hours without much perceptible advance, for the hills are being slowly shaved down; suddenly the remaining greyness disappears, and the surface is polished. He had not succeeded well with paper, which indeed was open to the same objections as cloth. Sir Isaac Newton was the first to use pitch for the polishing of lenses, and it seems to be the only known substance which will fulfil all the required conditions. The pitch used is not gas-tar pitch, but the natural bituminous substance which comes to England from Archangel. By continued boiling it can be made so hard that it cannot be scratched by the finger nail; yet if laid upon an uneven surface it will, in a few days or weeks, or months, subside and take the form of that surfacc, hence pitch has more of the qualities of a liquid than of a solid. The polishing tool is made by overlaying a metal or wooden prism formed to nearly the required curves by a set of squares of pitch, and while these are still warm pressing them against the glass, the form of which they immediately take. When it is desired to lessen the polishing abrasion in particular places it is done by modifying the sizes of the squares of pitch in particular zones with a knife and mallet.

The two best known polishing machines are those of the late Earl of Rosse and the late Mr. Lassell. Many years ago his (Mr. Grubb's) father devised a machine, figured and described in Nichol's "Physical Science." All these machines, notwithstanding the curves of motion, were liable to polish in rings, so in the latter he had made a modification to overcome the drawback. Here, by the aid of the electric lantern, he projected on the screen diagrams of the curves described by the various instruments. He also drew attention to a diagram representing a section of a lens of about eight inches aperture and one inch thick, magnified 100 times, to show the relative thickness of material abraded by the four processes. The quantity removed by rough grinding was represented by a band 25in. wide; the fine grinding by one $\frac{8}{10}$in. wide, the polishing by a line $\frac{1}{50}$in. wide, whilst the quantity removed by the figuring process could not be shown even on this scale, as it would then be represented by a line only $\frac{1}{10000}$in. thick. The approximate cost of the abrasion of a gramme of material by each of the four processes is:—Rough grinding, about 1d. per gramme; fine grinding, $7\frac{1}{2}$d. per gramme; polishing, 10s. per gramme; figuring, £48 per gramme.

The figuring process is that of correcting local errors in the surfaces, and the bringing of the surfaces to that form, whatever it may be, which will cause the rays falling on any part to be refracted in the right direction. It is an occasional but exceedingly rare thing for an objective to prove perfect on the first trial, but they usually gave such results when first tried that he considered them to be but three-fourths finished. The figuring consists of (1) The detection and localisation of faults; (2) the altering of the figures of the different surfaces to cure the faults. In the case of a 27in. objective of 34ft. focus, say that there is an error in the centre of one surface of about 6in. diameter, which causes the focus of that part to be $\frac{1}{10}$in. shorter than the rest. For the sake of simplicity, say that the surface is generally flat; the central 6in. of the surface therefore instead of being flat must be convex, and of over 1,032,000in. radius, about 17 miles. The versed sine of this curve, as measured by the spherometer, would be only about $\frac{1}{250000}$, 4 millionths of an inch, a quantity in his opinion mechanically unmeasurable. If the error had been spread over three instead of six inches, the versed sine would only be about $\frac{1}{1000000}$; probably its effect on the image would not then be appreciable, but a similar error near the edge of the objective certainly would be appreciable. No known mechanical arrangement is delicate enough to measure these quantities; optical devices are therefore necessary, and trials of the objective or mirror on a telescope are really the crucial test. The best object to employ is generally a star of the third or fourth magnitude; but as in this climate it frequently occurs that no such star is visible, a minute image of the sun reflected from a little polished ball, or even a thermometer bulb, will do. Small electric lamps, with their light condensed and thrown upon a polished ball, are useful.

For the localisation of errors, sets of diaphragms which leave exposed various zones on the surface, the *foci* of which can then be separately measured, are useful, but a really experienced eye does not need them. For concave surfaces Foucault's test, described in Dr. Draper's and other books, is useful; but is not available for convex surfaces, and only partially available for concave parabolic surfaces. The detection of one fault in an objective is easy, but usually many are superimposed; it would be impossible in one lecture to state all the methods of localising faults, but he would mention some that had never previously been made public. To detect faults of symmetry, revolve one lens on another, and watch the image; it can then generally be ascertained whether the fault is in the flint or crown lens. With some kinds of glass the curves necessary for satisfying the conditions of achromatism and spherical aberration are such that the crown becomes an equi-convex and the flint a nearly plano-concave of the same radius on the inside curve on either side of the crown. This form is a most convenient one for the localisation of surface errors in this manner. The lenses are first placed in juxtaposition and tested. Certain faults of figure are detected. Now calling the surfaces A B C D in the order in which the rays pass through them, place them again together with Canada balsam or castor oil between the surfaces B and C, forming what is called a cemented objective. If the fault be in either the A or D surface, no improvement is seen; if in B or C, the fault will be much reduced or modified. Now reverse the crown lens, cementing the surfaces A and C together. If the same fault still shows, it must be in either B or D; if it does not show, it will be in either A or C. From these two experiments the fault can be localised.

Sometimes a suspected error is so slight that it appears problematical whether an alteration would improve matters or not. He had devised methods, for use in some such cases, of temporarily altering the surface. If he suspects a certain zone on an objective to be too low, he passes his warm hand six or eight times round that particular zone. This usually raises the surface too much at first, but the observer at the eye end can watch the results as the effect passes off. To lower any part of the surface he paints on sulphuric ether with a camel's hair brush, blowing on it slightly; this gives as much cooling effect as necessary. The next point is the remedy. The lens is again put on the polishing machine, the pitch patches and the stroke are modified so as to tend to reduce the surface where desired. All thanks are due to Lord Rosse, Mr. Lassell, and Dr. De La Rue, for having published all about the figuring process which it is possible to communicate; but those who have succeeded in this work have had to strike out new lines for themselves, hardly one having attained notable success by following the instructions bequeathed by others. Some Continental workers are said to use small polishers and local touch in the figuring; the method is useful in removing gross quantities, but he would not employ it for the final perfecting of the surface. In working at the Vienna objective, it often happened that the figure was so nearly perfect that it was dangerous to carry on the polishing process for more than ten minutes between each trial, but then it was sometimes necessary to wait for a week before the atmosphere became steady enough to allow the trial to be made to determine whether the ten minutes' working had done harm or good. In a few days the work of weeks may sometimes be undone.

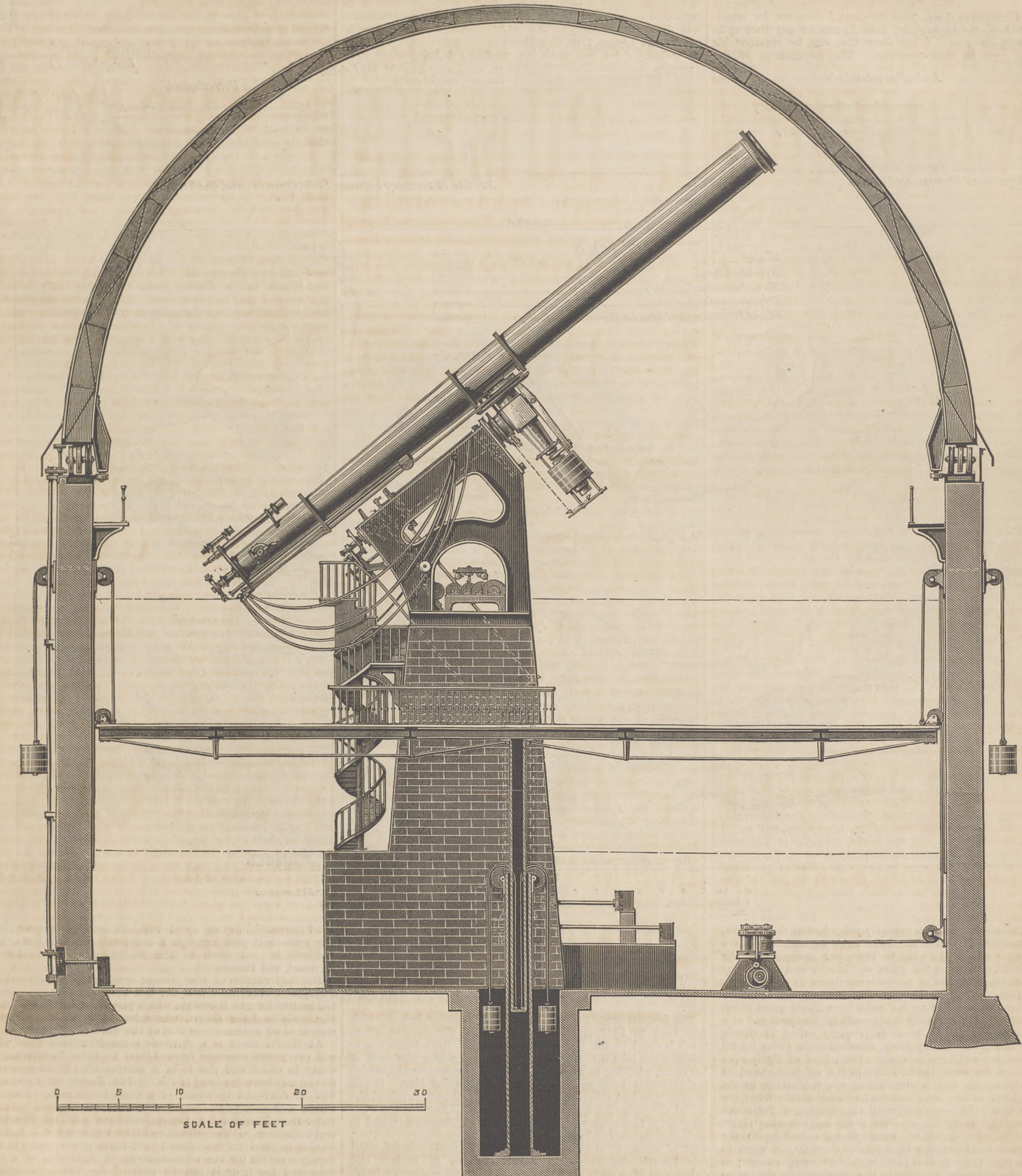
In making a new 28in. objective for the Royal Observatory at Greenwich, he intended to make provision for the reduction of these troubles. The greatest difficulties are the want of atmospheric homogeneity, because of varying hygroscopic and thermoscopic states, and sudden changes of temperature in the polishing room. The polisher must always be made of a hardness corresponding to the existing temperature. It takes about a day to form a polisher of large size, and if before the next day the temperature changes 10 deg. or 15 deg., as it often does, that polisher is useless, and a new one has to be made, and perhaps before it is completed another change of temperature occurs. To grapple with these difficulties he proposed to have the polishing chamber underground, and leading from it to have a tunnel formed about 350ft. long of highly-glazed sewer-pipes at the end of which tunnel is placed an artificial star illuminated by the electric light; on the other side of the polishing chamber is a shorter tunnel forming the tube of the telescope, terminating in a small chamber for the eye-pieces and the observer. About half-way in the long tunnel there will be a branch pipe connected to the air shaft of the fan which is used regularly for blowing the blacksmith's fire, and through this, when desired, a current of air can be sent to "wash it out," and mix up all currents of varying temperature and density. It may be found necessary even to keep this going during observations. By this arrangement he hoped to be able to have trials whenever required without waiting hours or days for a favourable moment.

After stating that the general idea that the working of a plane mirror is more difficult than one with curves is not quite correct, the lecturer drew attention to a working model of a proposed observatory for Mount Hamilton in California. An engraving from Mr. Grubb's design for this observatory is given on page 23. A Mr. Lick has left a large sum of money for the erection of a monster observatory, which is already partly complete, and contains some excellent instruments of moderate size, the work already done with which favours the idea that the great 36in. refracting telescope about to be erected there will be placed under more favourable conditions for observations than any other large telescope in the world. The trustees of the Lick Observatory had invited him to design an instrument for the 36in. objective now in course of construction by Messrs. Clark, of America, the contract for the mounting not having yet been made, and in the model he had put his ideas into practical form. The conditions he laid down for himself in designing the observatory were that it should be possible for the observer single-handed to enter the equatorial room at any time, and that without using more physical exertion than is necessary for working the smallest sized telescope, or even a table microscope, he should be able to open the 70ft. dome, turn it round backwards and forwards, point the equatorial to any part of the heavens, revolving it in right ascension and declination to any extent, and finally, the most difficult of all, to bring his own person into a convenient position for observing. There is generally far more trouble in moving the observatory "chair" and placing it in proper position than in pointing the instrument itself. In this instrument the chair would require to be 25ft. high, and with its movable platform, ladder, balance weight, and so on, would weigh probably some tons. Even if very perfect arrangements were made for the working of this chair, the mere fact that the observer while attempting to make the most delicate observations is perched upon a small and very unprotected platform 25ft. above the floor, and in perfect darkness, tends to reduce his value as an observer to an extent only to be appreciated by those who have undergone the trial; personal comforts and discomforts have much to do with the value of observations.

He proposed that all the various motions should be effected by water power. Some water engines have no dead point, and having little *vis inertia* are easily stopped and started. He proposed to use four of them; one for the right ascension motion of the instrument, and one for the declination; one for revolving the dome, and one for raising or lowering the observer himself; but instead of having anything of the nature of a 25ft. chair or scaffold, he proposed to make the 70ft. floor of the observatory movable. It is balanced by counterpoise weights, and raised and lowered at will by the observer. Then the observer can, without any effect, raise and lower the whole

PROPOSED OBSERVATORY, MOUNT HAMILTON, CALIFORNIA.

For description see page 22.)



floor, carrying himself and twenty people if desired to whatever height is most convenient for observation, and wherever he is observing, he is conscious that he has a 70ft. floor to walk about upon, which even in perfect darkness he can do in safety. The valves and reversing gear of the water engines are actuated by a piece of mechanism, the motive power of which may be a heavy weight raised into position some time during the previous day by man or water power. By means of a simple electrical contrivance, this piece of machinery is under the complete control of the observer in whatever part of the room he may be, and he carries with him a commutator of a compact and convenient form with eight keys in four pairs, each pair giving forward or backward movements at will to the portion of the observatory appliances intended to be controlled. The shutter of the dome moves back horizontally; to open it it is but necessary to anchor it to a hook in the wall, and to move the dome in the opposite direction.

Supposing the telescope to be in a vertical position, and the observer at the eyepiece to accidentally start the machinery for raising the floor, it would be bad for him, so safety apparatus had been devised which, after the floor had been raised to a particular level, would cut off all the water power of the establishment. At the same time, a certain amount of intelligence in the operator has to be assumed.

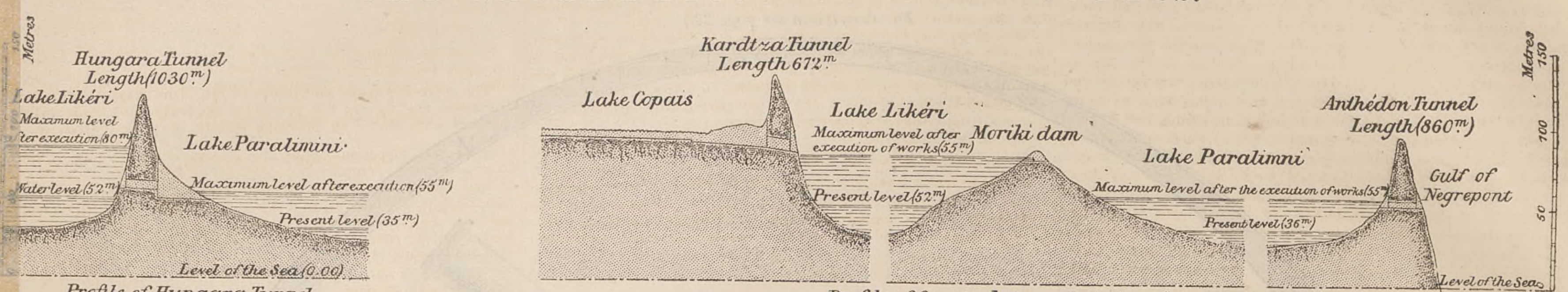
The remark had been made to him that by laying bare the particulars of his work, men would pick up his trade secrets. Up to the figuring, the processes were purely mechanical; but the last process was something beyond mechanical work. A person might spend a year or two watching every detail of the manufacture of large objectives, see every part of the process, and take notes, yet he could then no more expect to figure an objective himself than a man could expect to be able to paint a picture because he had been sitting in an artist's studio for the same time watching him at his work. The art can only be learnt by experience, and then only by particular persons. He agreed with an experienced amateur who said that nine years' hard work was necessary to acquire the experience. It is true that some large objectives are turned out by machinery; but what kind of an objective can be turned out by a machine left to inexperienced hands? At the risk of being accused of working by rule-of-thumb, he confessed that conditions often arose to meet which he seemed to know intuitively what ought to be done, what crank to lengthen, what tempering is required of the pitch square, yet would find it difficult to give a reason satisfactory even to himself; and over every new objective he had found some new set of conditions to be then met by newly devised arrangements. A well-known English astronomer once told him that he considered a large objective as much a work of art as a fine painting.

THE RECLAMATION OF LAKE COPAIS.

The people who take any interest in the doings of Greece regard it as a plucky little State, striving its utmost by warlike means and fierce language to assert its rights to be regarded as the descendant of the great Greece of old, doing what it can to be worthy of the traditions handed down from father to son through many centuries of gloom and deadly oppression from the days of Pericles, of Alexander, of Socrates, and the poets; but there are not many amongst even the greatest friends of Greece who regard it as being a land in which works of considerable engineering magnitude are being carried out, and yet there is no doubt that the little kingdom of the Hellenes is advancing to a place of some importance, not only in the minds of all true Philhellenes, but in the estimation of such men as know it within and round its shores.

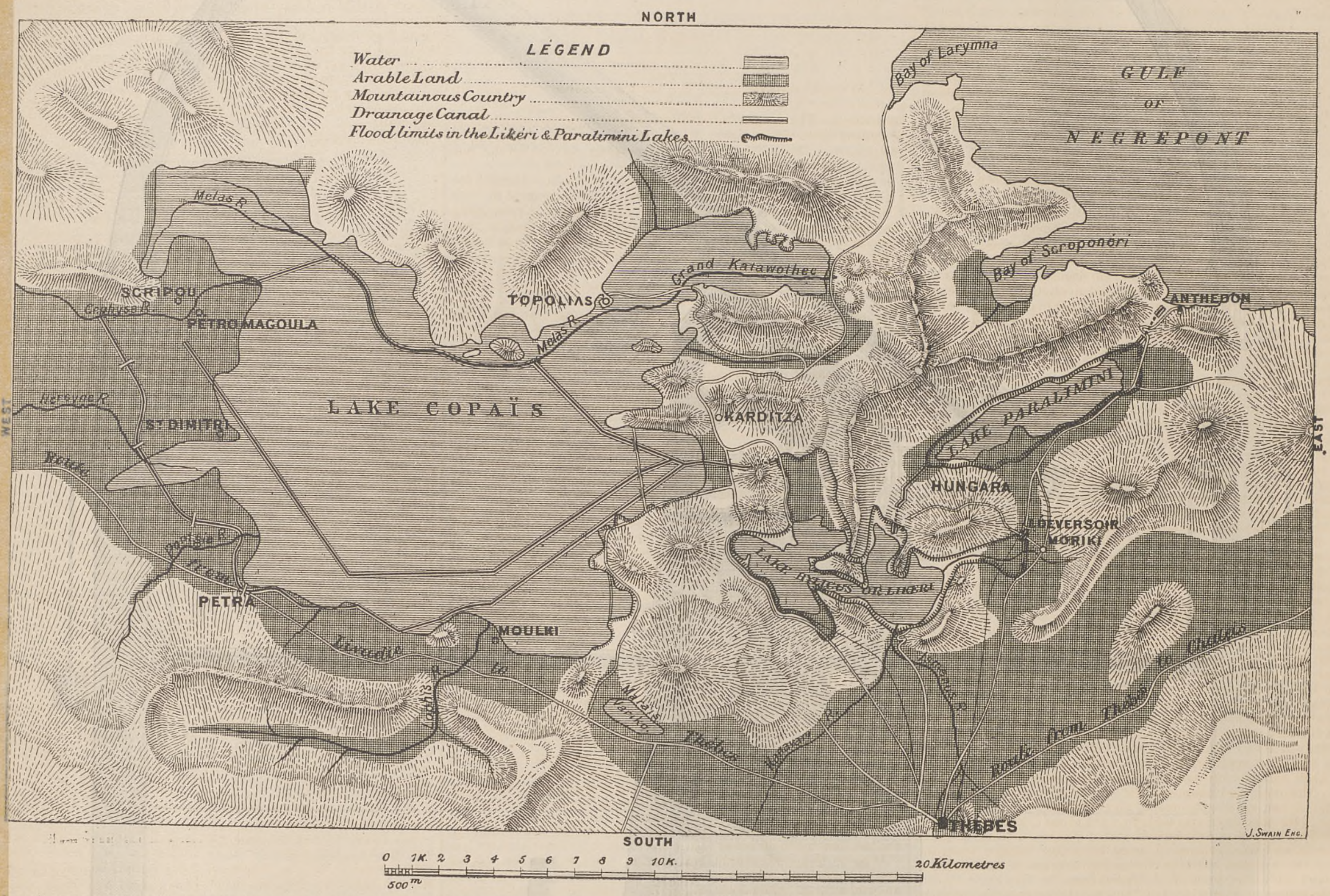
If our readers will for a moment consider that the population of the kingdom is under two and a-half millions, probably less than half that of Ireland, and that it already shows such signs of strong vitality, though really only sixty years old, as may be seen in its several railways; its mines and works at Laurium; its Corinth and Kalamaki Canal; its great work of reclamation of Lake Copais; its two fine engineering workshops in Piræus, those of Messrs. Vasiliades Brothers and of Messrs. MacDowall and Barbour; its arsenal and floating docks at Arrapi; its fleet of upwards of thirty first-class passenger and mail steamers; its tramway services both by steam and horses, and its harbour works at Piræus and elsewhere, they will at once see the modern Greeks do not merely sit down and hug themselves in the knowledge of the greatness of the Greeks of old, but are up and doing their best to place themselves in the front rank of the smaller nations who are eager to place themselves within touch of the greater nations from a commercial and scientific point of view. Of course they owe much to the fostering care of France and England, especially the former; but we contend that a nation which is capable of inaugurating so many works, even with much foreign friendly help within so few years of its freedom, rightly deserves our congratulations and deservedly claims some admiration. We have shown in a review of the work of placing new machinery on board the

THE RECLAMATION OF LAKE COPAIS.



Profile of Hungara Tunnel

Profile of Country between Lake Copais and the Sea



Greek mail steamer Thessalia, recently published in these pages, what the general condition of the Greek shipping interest is. We hope in a few weeks to be able to show our readers how the admirable work of joining the gulfs of Corinth and Athens by a canal is progressing; and at present we desire to place before them a few facts concerning the great work which has been conducted at the Lake of Copais, a few miles from Thebes, and which is rapidly, after many adversities, approaching completion.

The Lake of Copais, or, as it is properly called in Greek, "Copaiba," is a great marshy basin, situated some miles inland from the channel which runs between the island of Egripos, or Negripont, and the main land. It lies in the neighbourhood of Thebes and Livadia, and is situated at a considerable height above the level of the sea. Its waters accumulate from the watersheds from the north; from the mountains of Parnassus and Helicon; and from the overflow from neighbouring rivers during the winter or other wet seasons, collecting in the plain of Copais and forming a huge lake of some 60,000 acres in extent. In each October this plain is only a marshy swamp; in November the water-level begins to rise, attaining its maximum height in April, then falling until it has reached its normal condition of being a dismal swamp in October, only to rise again with unerring regularity in November. The water which rises during six months of the year disappears during five other months from two causes, viz., evaporation and the existence of "Katavothres." To the former of these causes is due the disappearance of a body of water of the whole area of the plain by about 5ft. in thickness, and to the latter that of a still larger quantity. It may be mentioned that the Katavothres are the geological fissures which exist all round the lake, but in the greatest number on the east side. Some of these Katavothres lead to the sea, and a very large number of them to the depths of the earth. It will be readily understood that this great stagnant inland lake is a fruitful cause of sickness and malaria to all who come within the range of its evil influences; and that during the months of July, August, September, and October, the ravages from the fever within a distance of 15 kilometres of its borders are very deadly. The soil of the plain under the water is of remarkable fertility, which it owes to the great quantity of organic matter which it contains, and would in a very short time repay the outlay required to dry it up, so that the promoters and movers in the scheme might expect to be reimbursed in a little time, while the sanitary effect on the country for miles round this present plague spot would be incalculable.

It is known that in the remote ages of antiquity the depth of water was much greater, and the evil effects from a health point of view were not nearly so serious; but things have changed greatly since then, and amongst many others volcanic causes have operated to raise the bed of the lake, with the effect of greatly augmenting its area, reducing its depth, and multiplying in an enormous degree its evil followings. It is evident from traces which have been found that the ancients made many attempts to rid themselves of this plague, but without any serious result, if we except the fact that the remains of the work have shown to the modern engineers the things they should avoid in many cases, and in many instances the work of the ancient has been of the utmost assistance to the modern engineer.

The first attempts to dry the lake made after modern methods date back to 1847, and were made by M. Sauvage, to whom much is owed as the pioneer of the work. His scheme was to overflow the lake through a tunnel pierced under the neck of Larymna, utilising to a large extent many ancient works, which had evidently been used for a somewhat similar plan. It will be seen that had this plan succeeded, it would have involved the loss of the water for agricultural purposes. After this the work was many times conceded by the Hellenic Government, and to various companies and individuals; but from one cause or another, want of money or of energy, all the schemes came to grief, until two French engineers—M. Revol, engineer of bridges and dykes, and M. Moulle, civil engineer—took the matter in hand, proposing to allow the waters to run away through lakes Likeri and Paralimini, making Likeri a reservoir for irrigation during the summer, which scheme was really the parent of the work in its present form.

In 1880 a concession was given to M. Vouro, who, with the aid of one of the great merchants of Athens, M. Scoulondis, succeeded in forming a company, mainly French, which was intrusted to the management of M. Saratte, but unfortunately just as this latter gentleman's projects were ripe for execution he was overtaken by premature death, and was succeeded in 1882 by a M. Pochet, engineer of bridges and dykes, on whose plans the work was advanced to a very large degree; but in 1884 the company, at whose head was M. Scoulondis, took the whole of the work under its immediate supervision, with a result upon which it cannot be too heartily congratulated. The difficulties of great unhealthiness and distance from any victualling centre were the greatest to be overcome.

The work now consisted of two parts: (1) The construction of canals proper; (2) the various lines of auxiliary canals, the function of which is to collect the water of the tributary rivers and the rain, and to lead these into the Bay of Karditya, from whence they should pass by the main canal and tunnel. There are three canals, which may be seen on reference to the accompanying map: (1) The great central canal, 34 kilometres in extent at present, which will follow the south bank of the lake; (2) the Melas canal, which will follow the north bank; and (3) the interior canal, which will collect the water from the lowest part of the interior of the marsh. These three canals will converge at Karditya, but the work of their construction cannot be vigorously pursued until the passage for the emission of the water at Karditya has been completed, that is to say, until the partial drying up of the lake has been accomplished. The water will pass through a canal and tunnel at Karditya, and will be led down to the sea through lakes Likeri (or Hylicus), and Paralimini.

The construction of the passage consists in the excavation of a deep and wide ditch or dyke, and the formation of a tunnel 672 metres long to Karditya, which passage will lead the waters of Copais to Lake Likeri, whose level will be raised from 52 metres to 80 metres above that of the sea.

At Moriki there is a *deversoir* some 50 metres wide which will carry the overflow from Likeri to Lake Paralimini, the water in which will rise from a normal level of 36 metres to 55 metres above the level of the Gulf of Negropont, to which it will be conveyed by means of a tunnel 860 metres long, and which will debouch at Anthedon. It will be seen that the water from Paralimini to the sea will have a fall of 55 metres, and according to the estimate of the engineers this fall will be able to yield no less than 12,000-horse-power, and will thus supply a reason for the establishment at Anthedon of a large industrial town; or it can be utilised for the generation of electricity which might be transmitted to a distance for the supply of light or power. This completes the whole scheme of drying lake Copais and rendering its present bed available for agricultural purposes, as well as of carrying away all the germs and causes of fever which now abound in the district; a work the importance of which can only be realised by those who have seen the marsh and the district which is to derive so great a benefit.

The works, however, are not completed by this much, for a tunnel upwards of 1000 metres in length, and at a height of 60 metres above the sea level, is being driven from Lake Likeri to Lake Paralimini, the fall of water through which will be utilised for the supply of power to hydraulic engines which shall be capable of raising 50 million cubic metres of water during the summer to Copais for the purpose of irrigating some 20,000 acres of its extent.

On Friday, June 11th, the Panhellenique Steam Navigation Co.'s steamer Thessalia, which had been specially chartered by M. Scoulondis and his associates in this great work, for the purpose of conveying a large party of gentlemen to witness the opening of the Karditya passage, left the Piræus, having on board M. Le Comte de Mony, the French Ambassador, General Vosseur, and some sixty other gentlemen, including of course M. Scoulondis. After a very enjoyable run of some seven or eight hours, during which the Thessalia and her new engines obtained the warm approbation of all on board, the narrow entrance at Chalcis into the Gulf of Negropont was reached, and the anchor dropped, for the Thessalia is too long to be taken through the narrow and dangerous channel—about 50ft. broad—which runs between the Island of Egripos, or Negropont, and the main land. The company therefore left the Thessalia, and made the passage of the narrow straits in a fleet of small boats under the guidance of Captain Nicola Sgourdaos, the commander of the Thessalia, embarking on board the Argolis, another of the Panhellenique steamers, which was in waiting at the other side of the narrow channel, to convey them to Anthedon. As soon as the Argolis got under way the French ambassador's presence was recognised by the French and Greek men-of-war at Chalcis with a salute of twenty-one guns. After about two hours' steaming, the Argolis dropped her passengers at Anthedon, from whence they were taken to Thebes in a number of carriages, and where they spent the night, going on the following day to inaugurate the opening of the Karditya passage and to inspect the whole of the works. The opening of the Karditya passage lowers the water in Copais to a very material extent, and will allow of the immediate cultivation of an area of from 10,000 to 12,000 acres, while the general healthiness of the district will be enormously improved, at the same time that the work of canal cutting can be proceeded with by the company under much more easy and favourable circumstances.

The *deversoir* at Moriki is well advanced, and will soon be finished. The tunnel to Anthedon is entirely pierced, and is completed to its full section for about one quarter of its length; it will be finished during this present year, and the tunnel of Hungara is pierced for a distance of 300 metres, so that it is clear that the most difficult part of the work is accomplished, and that probably next year the whole of this great undertaking will, after many disappointments and very great difficulties, be an accomplished fact.

LETTERS TO THE EDITOR.

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

LONG CARRIAGES WITH FLEXIBLE WHEEL BASE.

SIR,—I observe that in the interesting remarks in your issue of the 7th May relative to the New Cross railway accident, you say in reference to the long eight-wheeled carriages—42ft. over buffers—in use on the Metropolitan Railway, as a quotation apparently from Major-General Hutchinson's report—"When running round curves the sliding arrangement of the boxes has a tendency to become jammed." Further on in the paragraph it is stated—"All the Metropolitan stock has sliding axle boxes," &c. Perhaps it may interest your readers to know, that while it is perfectly true that all the carriages have, more or less, a "sliding arrangement" so far as the two inner pairs of wheels are concerned, yet in the case of the majority of the carriages supplied to the Metropolitan Railway during the time—from 1864 to 1872—when I had charge of the locomotive and carriage departments of that railway, I applied a "radial bar" arrangement to the two extreme, or leading and trailing, axles, by which the wheels are made to radiate—or approximately so—to the curve in place of merely "sliding" sidewise. By this means jamming is rendered impossible. I enclose a sketch showing the arrangement, which possibly you may think worth publishing as recording the earliest known application, namely, in 1866, of the principle of the Bissell radial arm to passenger carriages, at a time, too, when the means for giving flexibility to long vehicles were not as common as they are now. It will be observed that I used long swing links from the ends of the springs to control the radial action in place of the inclined planes peculiar to the Bissell truck. The links had the obvious advantage, amongst other features, of dispensing with the rubbing surfaces in the Bissell arrangement, which, as requiring frequent personal attention and oiling, were quite unsuitable for carriage or wagon stock.

I may mention, at the same time, that prior to adopting the radial bar arrangement, I applied Adams' radial axle box to the extreme pairs of wheels of one lot of carriages, in combination with the long swing links above named—of which I also enclose a sketch—which carriages have continued to run satisfactorily from that time to the present day. This was, as far as I am aware, the first application of the radial axle-box to carriages, although it had, of course, been applied to locomotives prior to that time. Although, as I have said, it worked well, yet I considered the radial bar an improvement, and therefore substituted it in all the later long carriages added to the stock during my charge, as avoiding a special axle-box of rather awkward form to make and apply, and also because it transferred the friction from the guiding and exposed surfaces of the radial boxes to the centre of motion at the united ends of the radial bars.

Contrivances of this kind may now-a-days be regarded as more or less superseded by the four or six-wheeled centre pin bogies now in use on several lines in this country, which were known to me at the time as being used in America, and of which I had then by me a working drawing, but which I hesitated to adopt because of the considerable extra weight it involves in comparison with the radial bar arrangement. That the latter arrangement has proved a complete success for all purposes of the Metropolitan Railway is evidenced by the fact to which you refer in the concluding sentence of your remarks on the subject, namely, "Considering the millions of times which these"—the Metropolitan—"carriages traverse sharp curves without derailment, we venture," &c. I may further mention that one of these long carriages with radial bars was tried, in 1872, by the London and South-Western Railway Company on the curved portions of their line in Portsmouth Dockyard, with the result that although the front and hind pair of wheels left the rails in attempting to run the carriage round the sharpest curve, namely 1½ chains radius, it travelled safely round curves of 3½ and 4 chains, on its way to the spot where it left the rails.

ROBT. H. BURNETT.

Victoria-street, Westminster.

[We have engraved Mr. Burnett's drawings on page 26.—ED. E.]

STEEL RAIL COMPETITION.

SIR,—Under the rubric "Railway Matters," in your esteemed journal of the 18th ult., I observe the remarks, which Mr. G. J. Snelus made to his workmen concerning the competition of other countries in steel rails. No doubt those were very excellent remarks, and it would be well if they were taken to heart by the workmen all over England. But may I venture to observe, with your permission, that even if the English workman became ever so frugal and thrifty, and accepted comparatively quite low wages, it could not in the case before us, and probably in others too, square the account with the foreigner, nor is it very likely that between now and better times the masters of science, unless it be that of political economy, will have been able to introduce such vast improvement as would be necessary to help to balance the account either.

We are handicapped by three factors, and consequently have to fight a very up-hill battle, not to say a word about the advantages the foreigner has in longer hours, smaller wages, equal prices of raw materials, and other small matters. For instance, in this country where protection is the rule, the price is sufficient to leave a tolerable margin, and £6 and above was the accepted price of a tender for rails for the Berg Märkisch Railway last week, whilst the market quotations are still higher. Such a price is not possible in England with free trade, but just this extra price obtained here enables the foreigner to hold out and compete with us outside his own country, and this without loss to himself, whilst we might profit nothing or be losers at the price the foreign maker might quote. Then the Government assists the industry of the country all in its power by reducing railway freights and charges on minerals, coal, and raw materials, which, again, our autocratic railway directors do not do, or if they condescend to listen they do not act until action becomes of little use; and lastly, the foreigner is not loaded with royalties on coal and ironstone, &c., as we are. If the masters, workmen, and science combined can invent anything to counterbalance the three dead weights I have mentioned, then I quite agree with Mr. Snelus that we should be able to hold our own against our competitors.

Whilst writing the above it has occurred forcibly to me, that if you, Sir, could see your way to publishing regularly the prices of metals, fuels, &c., in Germany, accompanied with trade notes and the like information, it might be useful to many of your readers, and afford them an opportunity of comparing and estimating the costs of production of competing articles.

U.

Rheinland, July 1st.

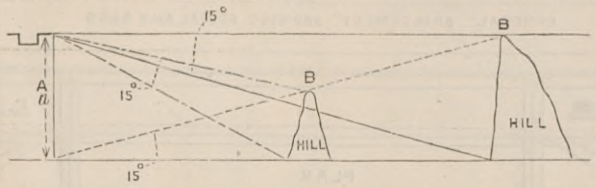
MILNES' WEEKLY PROBLEMS.

SIR,—In your last issue, page 507, is there not an omission of data? I subjoin sketch, showing how the hill in question may be any height, α and β being both equal to 15 deg.

T. R.

July 5th.

[There is not any omission of data, the problem stands as given. As regards the graphic solution, our correspondent forgets that an



engineer would read angles on the vertical circle continuously up or down from the horizon, the subtending angles appearing as differences. The height is therefore perfectly defined by the four projecting lines.—ED.]

THE COMING-DOWN OF FURNACE CROWNS.

SIR,—The experiments lately carried out with a new furnace for high-pressure marine boilers, as reported in a recent issue of THE ENGINEER, recalls to mind an excellent article which I read some time since upon the coming-down of furnace tops at sea in your valuable paper. I intended at that time to submit to you, and through you to the engineering world, an arrangement which would effectively prevent such a serious thing to occur to a boiler at all. Unfortunately for myself, embarrassment through want of employment prevented me at the time; but, although the same cause operates still, I will, now that attention is directed towards the furnace and its weakness, or rather the cause thereof, submit my cure, or, better still, prevention.

Now, Sir, as you truly pointed out in the article before referred to, the furnace top comes down by getting over-heated through an accumulation of sediment settling on the furnace inside the boiler. My plan consists in an arrangement of scrapers working inside the boiler directly on the furnace in such a way as to brush off and prevent anything settling thereon. Motion to be communicated by a shaft working through a stuffing-box in the end of the boiler or any other convenient place. Of course, anybody of experience in such matters will understand at once what I am driving at, so that I need not here trouble you with unnecessary details. I am certain such an arrangement would prevent any dirt held in suspension in the water settling on the furnace during the time the ship would be lying at rest in port for the purpose of coaling or taking in stores. It would also to a large extent prevent the formation of scale in a place where it is most likely to do the greatest harm. The thing is simple, effective in action, and easily wrought, and could be applied to existing boilers with very little expense.

240, Gallowgate, Glasgow, July 3rd.

MICHAEL SMITH.

STEEL RAILWAY COACHES.

SIR,—The Great Northern Railway Company of Ireland build their second-class carriages with divisions between each compartment, the upper part of each being composed of glass—that is to say, from about the level of a passenger's head to the roof of the carriage is glass instead of wood. This must strike anyone as being extremely dangerous in case of accident, and last week, in the catastrophe near Portadown, it was fully exemplified, a carriage of this description, second or third from the engine, having been smashed up entirely, nothing remaining except the frame, and axles, and wheels, while a composite coach, which was behind the tender, escaped with much less injury.

What I mainly wish to draw attention to is the use of glass in the compartment divisions. The use of such a material gives less chance to the unfortunate traveller in case of collision. Your South Melbourne correspondent's letter is worthy of notice, and an exchange of glass for steel in the construction of railway carriages would perhaps, prove beneficial all round.

July 6th.

SUBSCRIBER.

HARDCASTLE'S EMBOSSED PLATES.

SIR,—In your notice of my system of embossing plates in your issue of the 2nd inst. there is an error in the top line of the second column. The thickness of plate should be $\frac{5}{16}$in. instead of $\frac{5}{8}$in., as printed. In column 3, page 3, line second, the figures ought to read, "Two plates $\frac{17}{64}$in.," not $\frac{11}{64}$in. as printed. Two pressures are also named as requisite to emboss steel plates. In one case 70 tons, and in another 80 to 86 tons. Both are right, but it should be noted that the lower pressure is required for plates of Thomas and Gilchrist's basic manufacture, whilst the higher is for Siemens' open-hearth steel, the latter being harder than the former, and also requiring more time for the flow of metal.

30, Hyde-terrace, Leeds, July 5th.

R. A. HARDCASTLE.

STEAMERS' COOKING HEARTHS.

SIR,—I read in your issue of yesterday's date the article, "Flame Contact," a new departure in water heating, and near the end of it Mr. Fletcher states that some applications of this theory have been patented.

For your information I may state that it is no novelty to construct ships' cooking hearths with dependent rods or points formed on the hot plates, &c., with the object of abstracting the heat from the flame. Upwards of twenty years ago this principle was applied by the late Mr. Andrew Brown, of Liverpool.

Manager's Department,
Carron, Stirlingshire, N.B.,
July 3rd.

DAVID COWAN,
Manager for Carron Company.

FORTY-KNOT SHIPS.

SIR,—In my letter appearing in your issue for June 25th, I stated that by Reech's law, or the law of the late Mr. Froude, the resistance at corresponding speeds varied as the cube of the linear dimension. Mr. Hurst's interpretation of the same law is that the resistance of vessels increases as their bulk, not, however, at the same speed, but at a speed larger in the proportion of the square root of the increase of linear dimension. The two readings have precisely the same meaning.

Perhaps I might have been more explicit with the term "corresponding speeds," but it was certainly not meant to convey the impression that the larger ship would have a resistance the cube of that of the smaller ship, and at the same speed as the smaller ship.

I quite agree with Mr. Hurst when he says that if we take a boat four times that of another, we get sixty-four times the resistance, and that this resistance will be at a speed double that of the type ship. What I wished to point out, however, was that we cannot substitute horse-power for resistance. Before writing my last letter I had doubts as to the accuracy of the performance of Mr. Hurst's type ship. I refer to a speed of 21¾ knots with 470 I.H.P. I notice without surprise that he has amended this in his letter of your last issue to 20¾ knots with 695 I.H.P. My doubts arose partly through considering the performances of torpedo boats published in recent journals, among which were the following:—

Dimensions.	Speed.	I.H.P.
86ft. by 11ft.	18·3	405
87ft. by 10ft. 10in.	21·75	469
125ft. by 13ft.	19·5	650

The corrected speed and power of Mr. Hurst's type ship seriously increases the figures for power for the forty-knot ship, stated by himself and others in previous letters in your journal on this question.

E. H. PARKER.

Leven Shipyard, Dumbarton, June 7th.

SIR,—Will you kindly allow me to make the following rejoinder to your editorial remarks on my letter of 26th June in your issue of 2nd current:—(1) The drawing in the specifications of my patents Nos. 124 and 3576, of 1884, are meagre, as I have acknowledged in them is the case, in consequence of the limitation of size by the Patent-office rules. But they are in terms of these rules, and easily understood as your remarks show. (2) I do not claim in my patent No. 124, of 1884, that there is anything new in driving water astern of a vessel for the purpose of propulsion—or rather by that means of reaction in water of forcing a vessel through the water—because the paddle, the screw, and the jet system of H.M.S. Waterwitch and others, are all alike propulsion by reaction in water. But I do claim that the method of gaining cheap reactionary power invented by me, and shown in that patent, is beyond question entirely new.

Aware as I am of all the Waterwitch and other inventions and experiments here and abroad, I should much like to know what are "the very grave objections" which you say I have "not taken into consideration in any way," as I am above all other things an economist.

WILLIAM HARVEY.

London, July 5th.

THE PHYSICAL SOCIETY.

AT the meeting of the Physical Society, held June 26th, Prof. W. E. Ayrton, F.R.S., vice-president, in the chair, Mr. E. M. Langley was elected a member of the Society. The following communications were read:—

"On Certain Sources of Error in Connection with Experiments on Torsional Vibrations, by Mr. Herbert Tomlinson. During a long series of researches on the torsional elasticity and internal friction of metals, the author has come across the following sources of error in connection with torsional vibrations. In some of the earlier experiments, a horizontal brass bar was suspended by a wire and oscillated, the times of oscillation being observed by the ordinary lamp, mirror, and scale. The moment of inertia was varied by sliding two brass cylinders, suspended from the bar by fine wires, backwards and forwards along it. It was then found that, under certain conditions, the bar executed a few vibrations of rapidly decreasing amplitude, came to rest, and then commenced to swing again, the amplitude increasing to a maximum, again decreasing, and so on. This effect was finally traced to an approach to synchronism between the time of oscillation of the bar and that of the small cylinders about their axes of suspension, the absorption of energy being due to these being set in vibration. The effect entirely disappeared upon clamping the cylinders rigidly to the bar. On another occasion, however, the old phenomenon reappeared, and after much time spent in investigating it, was found to be due to a somewhat similar cause—a near approach to synchronism between the periods of torsional and pendulous vibrations. If the axis of the wire passed accurately through the centre of mass of the vibrator, this would not occur; but this condition it is practically impossible to fulfil. Another source of error lies in the fact that in a wire recently suspended the torsional vibration period will always be found to be slightly greater than when it has been suspended for some time and frequently oscillated.

"On a Mode of Driving Electric Tuning Forks," by Professor S. P. Thompson. It is invariably found that the frequency of an electrically maintained fork is continually changing. This great inconvenience the author believes to be due to the fact that the impulses are given to the prongs at a disadvantageous moment—namely, when they are at the extremities of their swings. It is desirable that the impulse should be given at the middle of the swing, and to effect this it is suggested that each fork should make and break the circuit of the magnet influencing the other one, and it was shown how the electrical connections could be made to effect this in a simple manner.

"A Further Note on the Formula of the Electro-magnet and of the Dynamo," by Professor S. P. Thompson. In a paper recently communicated by the author, it was shown that an expression given by Fröhlich for the intensity of magnetisation in terms of the magnetising force was nearly identical with one derivable from a simple law enunciated by Lamont. In a recent paper Frohlich has further developed this law, and in the present paper the author has extended Fröhlich's results, and has applied them to the various forms of dynamos.

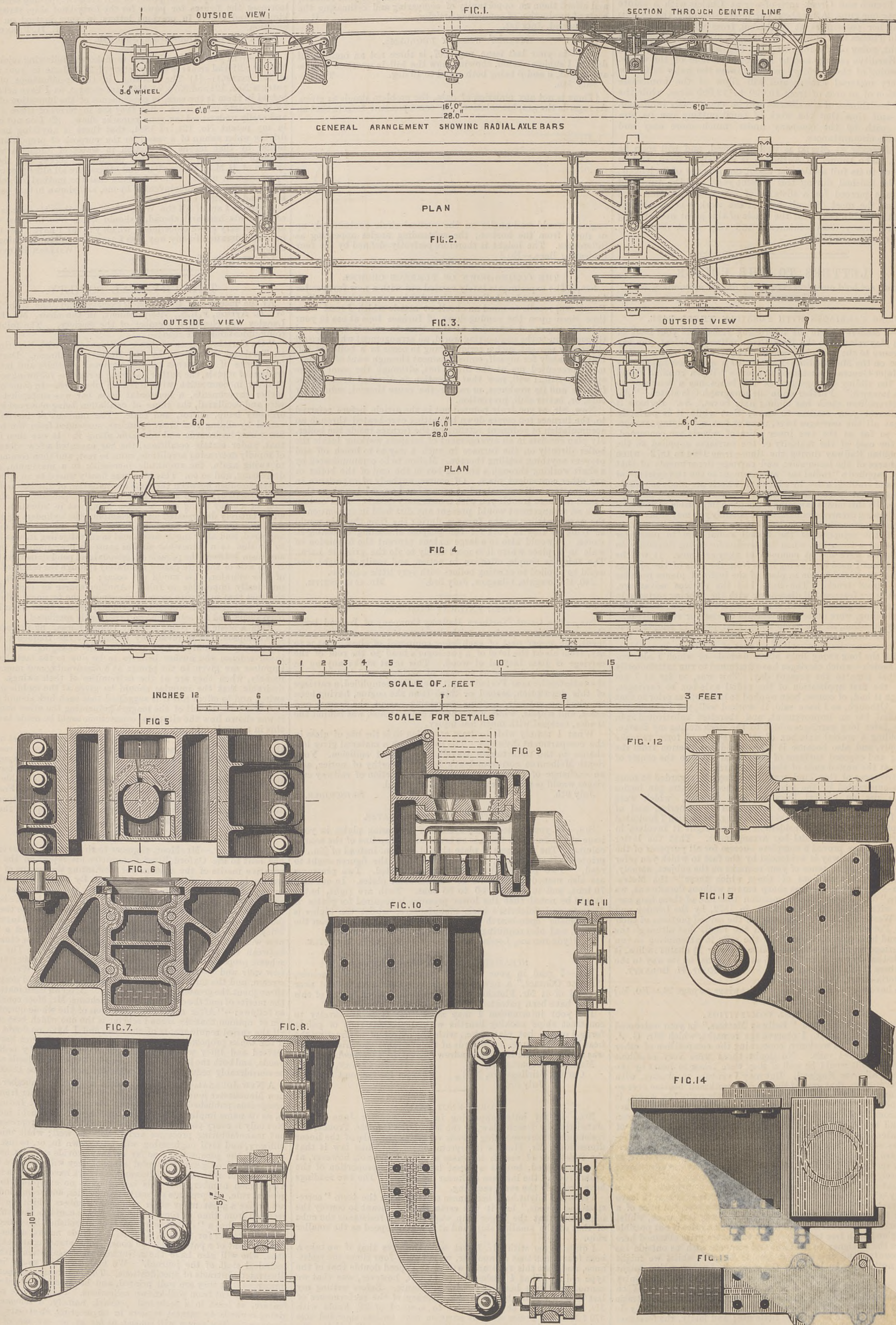
IFFLEY LOCK.—Mr. Moor, engineer to the Thames Conservators, has sent to the Oxford River Committee his report on the comparative merits of the schemes for facilitating the escape of flood waters in the neighbourhood of Iffley. By the first or original scheme it is proposed to remove the lock and the weir at Iffley and the weir on the Weir's Mill stream, and to dredge the bed of the river between Oxford and Iffley to a depth sufficient for the purposes of navigation. By the second scheme it is proposed to rebuild Iffley lock on the Berkshire side of the river, to construct a large new weir in the main channel, and to remove the narrow causeway between the Isis Tavern and the existing overfall. The third scheme proposes to leave the lock and weir at Iffley as they are; a new weir and overfall would be constructed on the Weir's Mill stream, and the mill stream itself would be widened and deepened throughout the greater part of its course. After an examination of the merits of and the objections to each scheme, Mr. Moor concludes as follows:—"After careful consideration of the whole question I am of opinion that the second scheme is the one which best meets all the varied requirements of the case, and I have no doubt that if the works proposed by it were carried out the district between Oxford and Iffley would be freed from inundation by ordinary floods, and both the level and duration of extraordinary floods would be considerably reduced." The estimated cost would be £8500.

A NEW JOURNAL.—We have received a specimen number of a new Manchester journal, entitled *Industries*. We gather from the prospectus published on the inside of the wrapper that *Industries* is, as its name implies, intended to cover a very large field indeed. Not only is every possible phase of engineering to be represented, but manufacturing processes and details as well; while mining, military, and civil engineering will be thrown in, or, to use the words of the prospectus, "so far as they provide subjects having an industrial or generally useful aspect," they will "receive their due share of attention." Allowances always have to be made for a specimen number, and this before us is no exception to the general rule. It presents no startling novelties, and seems, indeed, not unlike a great many other specimen numbers which we have received from time to time. The prospectus contains the familiar statement that a "department has been established in connection with *Industries* for patents, designs, and trade marks, under the management of a patent agent of considerable standing and experience, who will also have the advantage of consultation with the technical staff of the journal." We find, too, the usual list of illustrated abstracts of specifications. The engravings are not too numerous, but they are well printed, and have been selected with much judgment from well-known collections. There is one novel feature, at least in a technical journal, namely, a scheme for giving rewards to earnest readers in engineering, electricity, and chemistry. The prizes will consist, as far as we can see, of free patents for inventions produced by the successful competitors.

RADIAL ROLLING STOCK, METROPOLITAN RAILWAY.

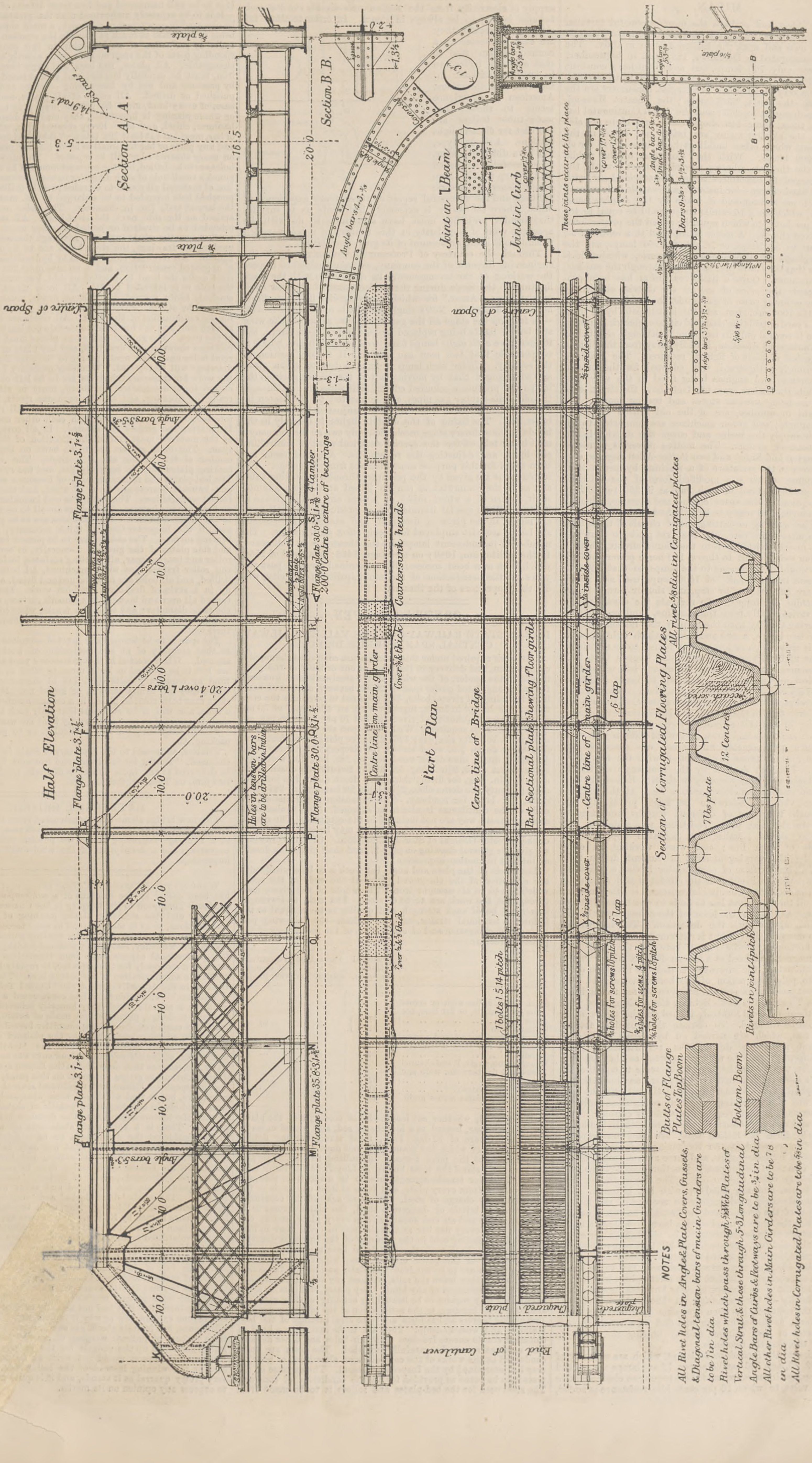
MR. ROBERT H. BURNETT, ENGINEER.

(*For description see page 25.*)



CONTRACTS OPEN—GIRDERS FOR THE SUKKUR BRIDGE.

(For description see page 28.)



CENTRAL STATION ELECTRIC LIGHTING IN MILAN.

One of the oldest, and perhaps the most successful installations of distributed electric light is that of the Societa Generale Italiana, who own and work the Edison system in Italy. The station was inaugurated in December, 1882, and in September, 1883, numbered only 700 lamps, but now furnishes a constant service for 8000 incandescent and 79 arc lamps, which are distributed over a very large area. The largest consumers are the three theatres—the Scala, 2566 lamps; the Theatro Mansoni, 371; the Filo-drammatico, 263; and the Hotel Continental has 473; besides these, some 140 shops, cafés, and clubs are also lighted, and the electric mains are being laid down in the principal streets where other buildings have been wired for an additional 1000 lamps. With the exception of the public lighting and the theatres, where a special contract is made, the price now charged to consumers is, by the ampère hour, with an additional fixed charge—for instance, a 16-candle Edison lamp would cost 35f. per annum, and if taken by the ampère hour, 5½c. per hour, which for a 16-candle lamp would be equal to 4c., or about ⅜d. per hour, to which must be added the proportional part of the fixed charge. A meter is supplied at a rental of 5s. per annum up to 50 lamps, or 7s. 6d. for 100 lamps, and the lamps are replaced at the company's expense, without it is clearly shown that they have been destroyed through the carelessness of the consumer. Quite a little revolution has been produced as regards the price of gas in the district electrically lighted. The ordinary price of gas is 36c. the cubic centimetre, or about 7s. the 1000 cubic feet, and this is still paid by all those who are even a yard outside the charmed circle of electrical supply.

The station is central only in name, and although selected as the most advantageous situation, is really away from the district where the greatest amount of light is required. The building, which was formerly a theatre, is well adapted for the present work, the dynamos and engines being fixed in the very deep basement, while the boilers are a few feet above the street level, the upper floors being used as stores and testing rooms. The dynamos, eight in number, are of the old Edison type, with horizontal magnets; and seven machines are connected to the feeders which supply the mains and cover the district in the well-known network system. The motive power is furnished by six Armington and Sims' and two Porter-Allen engines, each connected direct to the armature of a machine by means of an Oldham coupling, which is a modified form of the old Hook joint. The uniform speed of each engine is 350 revolutions, with the exception of the spare engine and dynamo, which is kept slowly moving and ready to be switched in should occasion demand. The starting or cutting out of circuit of these large machines requires some care. In the first place, to start it is necessary to insert resistance into the shunt circuit, which is done by a plug switch; but to throw 150-horse power into the main circuit would be dangerous to the lamps, so that the current is first sent into a "bank" of 1000 lamps used as a resistance, which are cut out step by step, and similar care is taken when a machine is stopped. To regulate the electro-motive force which varies greatly from time to time, hand regulation is employed during the day with the help of the Edison tell-tale, consisting of two lamps, a red and white, which light up when the current is either high or low, and is found to be sufficient; but when the night service is on, as it may happen that 2000 lamps are turned out at once, an attendant has to carefully watch the electric regulator and be ready to insert resistance into the field magnet circuit by moving a wheel connected by a shaft and bevel gear to the various commutators. The principal difficulty to overcome in the system of distribution employed is the equalising of the electro-motive force at the ends of the feeders, which are tubes laid down on the old Edison plan without the return galvanometer wire which was described and illustrated in The Engineer in connection with the new three-wire system. The plan devised by the company's electrician, Mr. J. W. Lieb, who was formerly with Mr. Edison, is very ingenious, and enables the electro-motive force at the extreme ends of the various feeders to be kept practically the same, although they are of different lengths and area of conductor. In the first place, resistance was added to each conductor, so as to equalise the potential approximately at the ends of each line; and when working, in order to provide for the varying amount of current drawn from each feeder, a peculiar form of commutator having a guillotine-shaped contact piece is inserted in the circuit of each conductor. By moving the contact piece suitable resistance is either inserted or cut out; all the attendant has to do is to watch the different ampère meters, and move the lever of the commutator to the number which agrees with the deflection. The instrument employed to measure the current is extremely simple, and consists of a horizontal needle swung between the poles of a permanent magnet, and fixed at a known distance above one of the naked conductors, the current deflecting the needle in opposition to the polarising action of the horseshoe magnet. By far the largest amount of current is drawn off for the lighting of the Scala Theatre, the stage lighting alone taking over 1000 lights. If these were all suddenly turned on the lights in the district would be dimmed. To obviate this auxiliary feeders have been run, which are turned on by means of a commutator and resistance during the performance. These feeders still form part of the network system, as they are connected at the theatre to the mains, but serve to equalise the pressure in a most efficient manner, and afford an illustration of what is perhaps not the most economical, but still the only practicable way of maintaining a constant potential in a district where the amount of light required is suddenly doubled.

The flow and return conductors, which are both imbedded in the same old form of Edison tube, are laid underground throughout the system, both for the mains and feeders. The supply is drawn from the mains, and these are connected to the feeders by means of the ordinary junction boxes, which each contain a safety catch or cut-out. The feeder boxes have expansion joints, and are filled up with hot bitumen. The insulation is extremely good, mainly on account of the favourable character of the ground, and no trouble has been experienced, nor has the underground service been interrupted at all. The cut-outs are an improvement on the old Edison form, but still have the disadvantage attending all lead plugs when the current is great, in that to guard against accidental melting due to the heating effect of the current, the area has to be much larger than is necessary. In fact these safety plugs will protect the cable against a bad short circuit, but nothing else. The original difficulty of the expansion of the lead, also of local heating at the contacts, has been overcome by giving the latter an arched form, as shown in plan and end view on the accompanying sketch in next column, and by uniting the metal to two copper strips at the two ends.

In addition to the incandescent lamps, which are severally of 16, 8, 10, 32, 50, and 100-candle power, 79 arc lamps are worked in derivation, two in series; most of these require an electro-motive force of 45 volts, to which 10 per cent. idle resistance is added, constituting a total loss of current which is extremely low for a combined arc and incandescent system of lighting. The constant supply of electricity from the station necessitates the Babcock tubular boilers to be always in steam. In order to allow for cleaning and repairs, they are each connected to a common steam pipe so that any one boiler can be stopped without interfering with the others. American experience seems to show that water-tube boilers are the best for electric light stations. A similar type, but by a different maker, is successfully employed at Antwerp for the Compagnie Generale's electric lighting, and the successful report of three years' experience at Milan, where the water is extremely bad, leads us to surmise that insular prejudice must have something to do with the apparent want of popularity in this country of a boiler which recommends itself on account of its great portability.

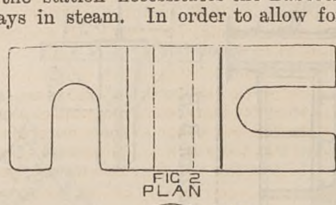


FIG 2
PLAN

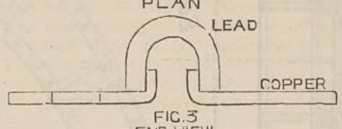


FIG. 3
END VIEW

Through the courtesy of Professor G. Columba, who is the engineering director of the company, we were enabled to inspect the working of the arrangements in connection with the stage lighting of the Scala during the performance of the new spectacular piece "Amor," for which many special lighting effects have been designed. Not a single gaslight is used in this theatre—in fact, on the stage all the gas fittings are removed, the wing and border lights being replaced by 16-candle Edison lamps, the former have each eight lamps fixed to a vertical board, which is so portable that two men can suspend it to any portion of the scenery. Under each lamp is fixed a red or green glass, and so arranged that by moving a rod the globes encircle the lamps and produce a coloured effect. The wires are run through the old india-rubber gas pipes, and connected to the batten by a hollow conical joint, which is quickly adjusted by means of a brass nut. The fixing of the electric lights is entirely in the hands of the ordinary stage mechanics, only two of the company's men being told off for the special electrical work of controlling the lights and adjusting the resistances. A special room has been fitted for this purpose some distance from the stage. The instructions are given by the prompter through a speaking-tube, and as all the commutators can be joined at will to a common shaft, a turn of a wheel raises or lowers any of the groups of lights. All the special illumination is produced by small hand arc lamps, in the place of limelight, and nineteen 1000-candle arc lamps are also employed for scenic effect on the stage. The number of incandescent lamps in the theatre is as follows:—In the auditorium, 1080; on the stage, 1486; or a total of 2566, which have now been successfully maintained for the past two years to the satisfaction of the municipality of the city, who are the proprietors of the theatre.

CONTRACTS OPEN.

INDIAN STATE RAILWAYS—INDUS VALLEY RAILWAY, CENTRAL SPAN, SUKKUR BRIDGE.

The work required under this specification comprises the supply, construction, and delivery in England, at one or more of the ports named in the tender, of the whole of the steelwork and ironwork for one triangulated girder span of 200ft. between centres of bearings, including all rivets, bolts, &c., required to complete the erection of the bridge in India, together with an allowance of 50 per cent. on the net quantity of rivets, and of 10 per cent. on the net quantity of bolts required. With each span are to be supplied:—ninety-five bolts for sleepers; 1263 ditto for planking of footways; fifty-three dozen ⅝in. wood screws for sleepers; fifty-three dozen ½in. ditto ditto; nine dozen wood screws, 2in. long for footways; seven dozen ditto, 2½in. long, for ditto; twenty-one dozen coach screws, 1½in. long, for ditto; thirty-two dozen ditto, 2in. long, for ditto; twenty-one dozen ditto, 2½in. long, for hand-rails; 945 dozen ditto, 2in. long, for roadway. The expansion apparatus on the ends of the cantilevers is also to be supplied. The timber work and permanent way are not included in the contract. The span is shown on three sheets of drawings, which may be seen at the office of the Director-General of Stores, India-office. Of these drawings we give the general drawing on page 27, and shall give some details of interest in another impression.

The whole of the plate and angle bar work is to be of steel, with the exception of the chequered plates at the ends of the span, which are to be of wrought iron. The whole of the rivets used throughout the work are to be of steel. The steel and wrought iron must be of such strength and quality as to be equal to the following tensional strains, and to indicate the following percentages of elongation and of contraction of the tested area at the point of fracture:—

	Tensional strains per sq. in.	Percentage of contraction.	Percentage of elongation in 8in.
	tons.		
Steel plates, either with or across the grain, angle, or flat bars, not less than	27 }	30	20
Or more than	31 }		
Wrought iron, round and square bars, and flat bars under 6in. wide	24	20	—
Wrought iron, angle, T, and channel bars and flat bars 6in. wide and upwards	22	15	—
Wrought iron plates	21	10	—
Wrought iron plates across grain.	18	5	—

Strips of steel, whether cut lengthwise or crosswise of the plate, bar, or angle bar, heated to a low cherry red, and cooled in water at a temperature of 82deg. Fah., must stand bending double round a curve of which the diameter is not more than three times the thickness of the piece tested. In addition to this, angle and flat bars must stand the tests known at Lloyd's as the ram's horn tests. Tests for tensile strength are to be made from side and end shearings from every plate, and from at least one angle or flat bar from every charge of steel. To guard against the occasional acceptance of brittle or dangerous steel, the manufacturer is to preserve a side and an end shearing from every plate, and an end shearing from every flat bar and angle bar, in order that it may be tested by bending cold in the presence of the Inspector-General or his deputy. Each such shearing is to bear a stamped number corresponding to the plate or bar from which it was taken. The test pieces are to be cut from the plates and bars in the condition in which they leave the rolls, without any subsequent annealing or other treatment of any kind. Any plates, flat bars, or angle bars which may require to be heated for bending must be carefully annealed after bending, to the satisfaction of the inspector-general. The nuckle bearers and saddles are to be steel castings of the best material and workmanship. They are to be cast with a head of sufficient size to ensure freedom from air-holes and other defects. The castings are to be carefully annealed. The tests are to be conducted at the works of the contractor or elsewhere, or both, as may be determined by the Inspector-General. The expense of the tests is to be borne as provided for in the conditions of contract. The steel used for the bed-plates and rollers is to be made from ingots of Bessemer steel cast from pigs of the best description for the purpose by manufacturers approved of by the Inspector-General. It is to be well hammered and free from defects of every kind.

It is to be expressly understood that the greatest accuracy is to be observed in every part of the work, a main object of the designs being to facilitate as much as possible the erection of the girders in India by perfection of workmanship in this country. All corresponding parts of the span must be made exactly similar and interchangeable. All plates, flat bars, and angle bars, both steel and iron, must be carefully levelled and straightened—the angle bars by pressure and not by hammering—before and after they are punched or drilled. All edges of all plates, and the ends of all bars, of every kind, must be planed dead true to the dimensions, or where planing is impossible, they must be dressed off fair with hammer, chisel, and file. Every sheared edge, whether of a plate or bar, must have at least ⅛in. taken off it by machine or by the chisel, and any plate or bar too small to leave ⅛in. for planing or chipping on every sheared edge will be rejected. Throughout the work all holes are to be drilled, but the contractor may, if he think proper, first punch a small hole of such diameter in each case as to leave at least ⅛in. of material all round to be subsequently drilled out; thus, the punched hole intended to be enlarged to 1in. must not exceed, at the largest end, ¾in. in diameter. The holes are to be slightly arrised on the side next the rivet head. All steel or ironwork intended to be rivetted or bolted together must be absolutely in contact over the whole surface. Although the word rivets may be used on the drawings, the rivet holes are to be made to the sizes figured. All rivetting is to be done by hydraulic or steam machines of approved construction, and in no case must the diameter of the rivet under the head be more than $\frac{1}{32}$in. less than the diameter of the hole it is intended to fill. All loose rivets and rivets with cracked, badly formed, or deficient heads, must be cut out and replaced by others. Rivets must also be cut out when required for the examination of the work. All rivets are to be cup-headed at each end, and the heads are to contain not less than 1½ diameters of the rivet. The gussets and cover plates must be shaped to the full sizes shown on the drawings, and any plate or bar in which the rivet holes have been made nearer to the edge than shown on the drawings will be rejected. Wherever necessary for the division of the work for transport the rivets are to be left out, but the holes, except those hereinafter mentioned, must in all cases be made ready for rivetting, and all the requisite rivets, including 50 per cent. extra, must be sent with the work. All rivet holes at the intersections of the diagonals with each other are to be drilled in India after the girders are erected. In all cover plates the fibre of the material must run in the direction of the length of the span. The main girders are to be built on the blocks, with a camber of 4in. in the arc of a circle. The underside of all bearing plates must be perfectly flat, and the rivets countersunk. The bed-plates and rollers are to be of Bessemer steel. The saddles and knuckle bearers are to be of steel, and the truck frames of forged wrought iron. The bed-plates and knuckles are to be planed on both top and bottom. The rollers are all to be turned accurately to the same diameter. The knuckles are to be planed and bored, and, if the Inspector-General think necessary, ground to a true bearing surface. The saddles are to be planed to take the bearing and side plates of the girders. Generally, in connection with the roller and bearing gear, all meeting surfaces, including the sides of the roller frames, are to be machined, all bolt holes are to be drilled, and all bolts are to be turned and fitted, and the whole got up in a style of first-class machine work. The rollers are to be turned all over and brought to a smooth surface, and accurately to the same diameter; and the roller trucks, when complete, must run straight and easily on a planed surface of sufficient length to test their truth.

The span is to be temporarily erected complete in every respect, so that accuracy of fit and perfection of workmanship may be assured. When erected in the contractor's yard all the holes which are left to be rivetted in India must be filled at one and the same time by temporary bolts $\frac{1}{32}$in. less in diameter than the holes which they fill, firmly screwed or keyed up. It will not be sufficient that bolts shall be placed in a certain number of holes only at a time, nor will it be sufficient that only such a number of bolts shall be inserted as may temporarily hold the work together.

The specification gives full particulars as to painting, marking, packing, &c.

Tenders, addressed to the Secretary of State for India in Council, endorsed, "Tender for Steelwork and Ironwork for Bridges," must be delivered at the India Office, Whitehall, London, S.W., before two p.m. on Tuesday, the 20th inst.

BATTERSEA BRIDGE.

The new bridge about to be constructed from the designs of Sir Joseph Bazalgette over the Thames at Battersea, forms the subject of a two-page engraving which we publish this week. Further engravings and a description of the whole will appear in future impressions.

Warping the Meaning of Patent Specifications.—Attention has been called in the columns of a contemporary by Professor Sylvanus Thompson to the warping in the Chancery Courts of the language and the straining of the meaning of words in patent specifications, so as to make it read in some forced sense in favour of a patentee who is backed up by wealthy supporters. He says: "This evil tendency, fostered by eminent leading counsel and by a few professional experts, who lend themselves to this mode of securing a monopoly for the patentee, is rapidly bringing into discredit the administration of the patent laws. The writer instances the case in the Appeal Court of the 'United Telephone Company *v.* Bassano.' The defendants had constructed a telephone transmitter in a manner which they honestly believed to be different, not only in design, principle, and mode of action, but even in the materials employed, from the transmitter invented by Edison, the American, whose patent is held by the plaintiff company. There had been some question whether the 'tension-regulator' or mechanism of the defendants' instruments was or was not substantially the same as that described in the Edison specification. Lord Justice Cotton, in giving judgment on this point, made the following statement:—'Edison had mentioned several sorts of tension-regulators, but in that which had been ultimately preferred there were fixed blocks and suspended pencils of carbon which acted by varying the tension according to the distance between the carbon points.' That is a very clear statement of what the learned judge considered the defendants to have infringed. But now comes the extraordinary fact that not only is this passage not quoted from the Edison specification, but there is absolutely nothing in the Edison specification even to support it. 'Fixed blocks and suspended pencils of carbon,' 'distance between the carbon points,' are not suggested and never were suggested by Edison. The words 'fixed blocks' and 'suspended pencils' are never mentioned by Edison. Nay, even the substance 'carbon' is never once named by Edison. The nearest approach to all this in the Edison document is tufts of silk fibre covered with plumbago, or with volatilised metals, and lamp-black contained within a case. That a High Court of Justice can be so influenced by eminent advocates as to be able to warp and strain tufts of metallised silk and cases full of lamp-black into 'fixed blocks and suspended pencils of carbon,' and then to add that 'it was not the duty of the Court to point out the exact particular of the construction to which the infringement was due,' is one of those things which would be incredible if it had not actually occurred yesterday. But can anyone explain how or why it is that not only in suits about telephones, but in suits about gas engines and electric lights, the same process of judicial warping of patents has gone on?" Mr. Imray has taken up the cudgels for the judges, and argues that Professor Thompson would not write as he has written had he been on the winning instead of the losing side. This is really a very pretty quarrel as it stands, and it is quite unnecessary for us to express any opinion on its merits.

RAILWAY MATTERS.

A DAILY paper of the 5th inst. announced that on the Richmond Railway on the 4th inst. "the excessive heat caused the railway points to expand to such an extent that they had to be dissected before the trains could run into the station."

THE Official returns for 1885 state that the number of cases in which trains on the German Railways arrived late at their final destination was 20,303. This represents about ·88 per cent. of the total number of trains, and the result shows improved punctuality as compared with 1884, when the rate was 1·08 per cent.

A PROPOSAL is on foot for the erection of a great central railway station for Leeds, to be used by all the railway companies running into Leeds. The proposal is to pull down the Wellington—Midland—station, and to acquire and clear away most of the property between the Queen's Hotel and the Great Northern Hotel, and on the site thus available to construct a new station twice as large as all the present stations combined.

THE Rhode Island Locomotive Works Company, United States, has designed, under Messrs. Bentley and Knight, an electric locomotive, weighing 21·4 tons, and running on six 68in. drivers, two large motors being placed between the end and the centre drivers, and communicating motion to all by friction gear. The electric locomotive is supposed to be 670-horse power at full speed, the motors having an electric capacity of 500,000 watts.

AN official report on the Local Chamber of Commerce at Frankfürt-on-Main indicates the heavy expenditure which that city is now incurring and the benefits accruing. The new railway station is being built at an expense of £1,500,000, while the improvement of the navigation of the river Main will allow vessels of 1000 tons burden to ascend as far as Frankfürt itself. Thus the city will have vastly increased facilites for both land and water traffic which cannot fail to exercise considerable influence upon the extension of its commerce.

THE *Railroad Gazette* says:—Few even yet realise the extent to which our own Pacific coast has become the rival of the rest of the United States in supplying Europe with wheat. In the five months ending with May last the exports from San Francisco and Portland, Ore., compare as follows with those from all Atlantic ports:—Pacific ports, 13,291,687; Atlantic ports, 13,916,770; total, 27,208,457; per cent. from Pacific, 48·8. The pacific coast, however, exports but little flour, comparatively, while the Atlantic ports exported the equivalent of 12,214,426 bushels in flour this and 18,627,970 last year.

THE fatal railway accident last week near Portadown seems to have given rise to some curious suggestions as to the cause, but from the evidence given at the coroner's inquest it would appear that the line was in the hands of the packers, was not finished, and that the sleepers were barely supported by ballast, and were not embedded, but only lay on the surface. It further appears that the bit of line near the place of derailment—a curve—had moved or been moved inwards, which would not be the result either of the pushing of the engine or of the elongation by heat of the rails too tightly laid end to end. The coroner's jury gave an open verdict.

THE first of the daily through trains on the Canadian Pacific Railway, whose arrival at its destination has already been reported, made the journey from Montreal to Port Moody "on time" and without the slightest mishap. It left the St. Lawrence seaport on Monday, June 28th, about 8 p.m., and reached the Pacific terminus early on Sunday last—quicker by some twenty hours than the usual railway journey between New York and San Francisco. Under present circumstances, 136 hours are considered necessary for the journey; but when the Canadian Pacific is in proper working order the distance—2898 miles—is expected to be done easily in 120 hours.

M. ARMENGAUD has proposed, in a communication to the French Association of Civil Engineers, a system of communication which consists in placing a telephone in each compartment in such a manner that any unusual noise or struggle can be detected in the guard's brake. He also suggests that a bell might be made ring by telephonic action, so that no doubt would attend the transmission of any cries. The *Bulletin de la Ceramique* states that this combination is about to be tried upon the *Chemin de fer du Nord* with the concurrence of M. Banderali rolling-stock engineer, and of M. Berthon, director of the *Société Générale des Téléphones*. Doubts are, however, expressed as to the practicability of the scheme in its present form.

THE number of persons employed on the German railways—normal gauge—in the business year 1884-85 was 278,583, against 269,832 in the preceding year. The general management absorbed 14,890, the management of the lines 99,029, and the carrying department 164,664 persons. The repairing shops employed 49,913 officials and workpeople. The officials and railway servants received M. 302,639,046 in 1885—M. 290,951,975 in 1883-84—equal to M. 1086 per man, against M. 1078 the year before. The employés in the workshops received M. 48,279,294 in 1885—M. 46,079,219 in 1883-84—equal to M. 967, against M. 964 per man the previous year. The Prussian State railways employed in the year 1884-85 an average of officials and servants of 187,495; in 1883-84, 169,181; and in the workshops, 1885, 35,508; in 1883-84, 31,910.

THE works for the widening of the South-Eastern Railway Company's bridge across the Thames at Charing Cross are so far advanced that the Middlesex side of the river has been reached, the works having been commenced on the Surrey side. When completed the bridge will be widened to the extent of 48ft., admitting of the laying down of four additional lines of rails. Messrs. J. Cochrane and Sons, of Westminster, are the contractors. The widening of the bridge has necessitated the removal of the Charing Cross Swimming Bath, which was moored immediately to the west of the bridge. The undertaking includes the enlargement of the Charing Cross station by widening it to a considerable extent on the west side. This, it is said, involves the removal of the recently erected Avenue Theatre, together with the demolition of a large number of houses on the east side of Craven-street.

A VIENNA correspondent writes that on the 1st inst. the Berlin and Stuttgart express came into collision with the Bamberg mail train at Rottendorf, on the line from Wuerzburg to Kissingen. Seventeen passengers were killed, and in addition a large number of passengers were injured, some dangerously. The collision occurred on a steep incline. Neither of the drivers had any idea of the approaching casualty, for at the spot where their trains met there is a curve and some buildings impede the view. When it was seen that a collision was imminent, there was no longer time to lessen the force of the concussion by slackening speed, and the engines ran into each other. The carriages were forced one upon another far above the height of the telegraph wires, and the line for a considerable distance presented a terrible spectacle of ruin. The German railways are considered, as a rule, remarkably exempt from accidents, but slow speeds seem to be no preventive.

UNDER a new mail acceleration scheme, the completion of which was announced at a meeting of the Aberdeen Town Council on Monday, great advantages will accrue to passengers travelling between London and the North of Scotland. The mail service to the North *viâ* Aberdeen has been accelerated four hours, and the London papers will now be delivered in Keith, Elgin, &c., at a correspondingly earlier hour. Passengers, papers, and letters will reach the county town of Banff at 6.25 a.m., instead of 10.20 as formerly. In connection with the opening of the new railway along the Banff and Morayshire coasts simultaneously with the new mail service, an arrangement has been arrived at between the Highland and Great Northern Railways which will enable passengers from London and other places to travel with the option of three routes *viâ* Aberdeen to Inverness and the north, returning *viâ* Dunkeld on the Highland line at the same price as was formerly charged for a ticket without the privilege of changing the return route.

NOTES AND MEMORANDA.

IN London 2617 births, and 1222 deaths were registered during the week ending, July 3rd. The annual death rate per 1000 from all causes, which had been 16·1 and 14·9 in the two previous weeks, rose to 15·4.

LAST week 2437 births and 1258 deaths were registered in London. Allowing for increase of population, the births were 244 and the deaths 228 below the average numbers in the corrsponding weeks of the last ten years. The annual death-rate, which had been 14·9 and 15·4 in the two previous weeks, further rose to 15·8.

AT a recent meeting of the Stockholm Academy of Sciences a paper was read on the new elementary body germanium, and some of its combinations, by Professor L. Fr. Nilsson. The researches of Professors Nilsson and Petterson, made at the request of Professor Winkler, the discoverer of germanium, show that his suggestion that germanium might possibly be identical with Mendelejeff's ekasilicium is quite correct, and in accordance with the facts.

FOR the purpose of illustrating a paper read at the Royal Institution, William Anderson, M. Inst. C.E., showed two similar cylinders of wrought bar iron suspended in water and balanced. He removed one and substituted another in its place made of the same bar as its fellow cylinder, but forced, while red hot, into a mould by a pressure of sixty tons per square inch and allowed to cool under that pressure; the two cylinders balanced showing the specific gravity to be the same.

AT a recent meeting of the Paris Academy of Sciences a paper was read on the "Commission on Weights and Measures," by M. E. Grimaux. Some unpublished documents are printed, showing the action taken by the Commission on behalf of Lavoisier, at that time under arrest as a farmer-general. From one of these documents it appears that, in consequence of said action, the illustrious names of Laplace, Delambre, Borda, and others were themselves removed from the Commission on the 3rd Nivose of the second year of the Republic—December 26th, 1793.

IN illustration of the diffusion of gases, Mr. W. Anderson recently gave some good examples through porous media of inconceivable fineness. When two gases, such as hydrogen and air, are separated by a porous medium they immediately begin to pass into each other, and the lighter gas passes through more quickly than the heavier. He showed a glass tube, the upper end of which was closed by a thin slice of cork, the lower end dipped into a basin of water. The tube was filled with hydrogen, which is about 14½ times lighter than air; consequently it left the tube through the cork more quickly than the air could enter in by the same means, and the result was a partial vacuum in the tube, and a column of water drawn up, proving that the cells of cork are eminently pervious to gases. The pores in the cell walls appear, however, to be too minute to permit the passage of liquids.

IN his recent lecture on "Cork," Mr. W. Anderson said: "In this strong upright glass tube I have, at the top, a piece of india-rubber, immediately below it a piece of wood, and below that a cork; the wood and the cork are loaded with metal sinkers to reduce their buoyancy. The tube is full of water and is connected to a force-pump by means of which I can impose a pressure of over 1000 lb. per square inch. The image of the tube is now thrown on the screen and the pressure is being applied. You see at once the cork is beginning to shrink in all directions, and now its volume is so reduced that it is incapable of floating, and sinks down to the bottom of the tube. The india-rubber is absolutely unaffected, the wood does contract a little, but not sufficiently to be visible to you or to cause it to sink. I open a stop-cock and relieve the pressure; you see that the cork instantly expands, its buoyancy is restored, and it floats again. By alternately applying and taking off the pressure I can produce the familiar effect so well known in the toy called 'the bottle imps.' It is this singular property which gives to cork its value as a means of closing the mouths of bottles. Its elasticity has not only a very considerable range, but it is very persistent. Thus in the better kind of corks used in bottling champagne and other effervescing wines you are all familiar with the extent to which the corks expand the instant they escape from the bottles. I have measured this expansion, and find it to amount to an increase of volume of 75 per cent., even after the corks have been kept in a state of compression in the bottles for ten years. If the cork be steeped in hot water, the volume continues to increase till it attains nearly three times that which it occupied in the neck of the bottle."

AT the recent meeting of the American Society of Mechanical Engineers in Chicago, a paper was read by Mr. Wilfred Lewis, of Philadelphia, on "Experiments on the Transmission of Power by Belting." Among the conclusions reached from these experiments are the following: That the co-efficient of friction may vary under practical working conditions from 25 per cent. to 100 per cent.; that its value depends upon the nature and condition of the leather, the velocity of sliding, temperature and pressure; that an excessive amount of slip has a tendency to become greater and greater, until the belt finally leaves the pulley; that a belt will seldom remain upon a pulley when the slip exceeds 20 per cent.; that excessive slipping dries out the leather and leads toward the condition of minimum adhesion; that raw hide has a greater adhesion than tanned leather, giving a co-efficient of 100 per cent. at the moderate slip of 5ft. per minute; that a velocity of sliding equal to ·01 of the belt speed is not excessive; that the co-efficients in general use are rather below the average results obtained; that the sum of the tensions is not constant but increases with the load to the maximum extent of about 33 per cent. with vertical belts and indefinitely with horizontal belts; that, as the economy of belt transmission depends principally upon journal friction and slip, it is important to make the belt speed as high as possible within the limits of 5000ft. or 6000ft. per minute; that quarter-twist belts should be avoided; that it is preferable in all cases, from considerations of economy in wear on belt and power consumed, to use an intermediate guide pulley, so placed that the belt may run in either direction, and that the introduction of guide and carrying pulleys adds to the internal resistances an amount proportional to the friction of their journals.

IT has been shown by Lord Rayleigh and others that the velocity (U) with which a group of waves is propagated in any medium may be calculated by the formula $U = V\left(1 - \frac{d \log. V}{d \log. \lambda}\right)$ where V is the wave velocity, and λ the wave length. It has also been observed by Lord Rayleigh that the fronts of the waves reflected by the revolving mirror in Foucault's experiment are inclined one to another, and in consequence must rotate with an angular velocity $\frac{dV}{d\lambda}\alpha$, where α is the angle between two successive wave planes of similar phase. When $dV/d\lambda$ is positive—the usual case—the direction of rotation is such that the following wave plane rotates towards the position of the preceding. Writing to a contemporary on this subject, Mr. J. Willard Gibbs calls attention to the fact that, while the individual wave rotates, the wave normal of the group remains unchanged, or in other words, that if we fix our attention on a point moving with the group, therefore with the velocity U, the successive wave planes, as they pass through that point, have all the same orientation. This follows immediately from the two formulæ quoted above. For the interval of time between the arrival of two successive wave planes of similar phase at the moving point is evidently $\lambda/(V - U)$, which reduces by the first formula to $d\lambda/dV$. In this time the second of the wave planes, having the angular velocity $\alpha dV/d\lambda$, will rotate through an angle α towards the position of the first wave plane. But α is the angle between the two planes. The second plane therefore in passing the moving point will have exactly the same orientation which the first had. This consideration greatly simplifies the theory of Foucault's experiment, and makes it evident, he thinks, that the results of all such experiments depend upon the value of U, and not upon that of V.

MISCELLANEA.

IT is reported that Messrs. Caird and Co., of Greenock, expect to receive an order from the Peninsular and Oriental Company for 15,000 tons of new shipping.

THE Atlantic Giant Powder Works, near Brakesville, New Jersey, exploded a few days ago, destroying the whole of the buildings and producing a concussion which was felt twenty miles away. Ten persons were killed and twelve others were injured.

THE Paris Municipality have resolved, by 54 votes to 3, that the foreigners engaged in constructing the Metropolitan Railway should be limited to 10 per cent. of the number employed; and, by 34 votes to 10, that the machinery should be exclusively French.

THE progress report for 1885 of the Railways of New South Wales shows a considerable falling off in the net return on the capital expended. The decrease, as compared with 1884, is 83 per cent. The total mileage opened for traffic at the close of 1885 was 4732 miles.

THE United States Congress will, it is believed, vote 3,000,000 dols. this session towards the enlargement of the American Navy by the building of two armoured ships, of 6000 tons each, three cruisers of from 3500 to 5000 tons each, four torpedo boats, and one torpedo cruiser.

A GERMAN zinc combination has been formed, and will endeavour to enforce reduction in the production of zinc. The zinc industry has for a long time suffered from depression—though not like the iron and steel industries—but it is supposed that it will now, in all probability, receive a decided impetus.

A MEETING of the South Staffordshire Mines Drainage Commissioners was held in Wolverhampton on Wednesday, when a resolution was passed calling upon all the mineowners to make a return of the minerals raised by them in the half-year just ended for the purposes of levying a surface drainage rate.

A PRETTY little suburban village named Wayne, on the main line of the Pennsylvania Railroad, will, it is reported, after next week, be lighted with electric lamps. An electric light plant has been constructed at a cost of £5000, which will supply all the houses with incandescent lamps and furnish the streets as well with light.

IT appears from a notification in the official *Pekin Gazette* that the Chinese Commissioners allow that the dismissal of the foreign engineers from the Keelung coal mines—a step that was taken from motives of economy "on account of the largeness of the salaries and miscellaneous expenses"—was a mistake, the subsequent inefficiency of the working having caused a loss greater than the amount saved by dispensing with foreign assistance.

THE *Pioneer* states that the explorations for coal conducted by Dr. Warth in the salt range in the Punjaub have proved so satisfactory, that the Government is now arranging for the practical working of the seams. Dr. Warth estimates that over one million tons are underlying the Plateau at Dundote. The coal is not of the first quality. It contains iron pyrites and is very friable; but it believed that it will be very useful for the North-Western railways.

EFFORTS are to be made to deepen the Sandy Hook entrance to New York harbour, so as to afford a channel 30ft. deep at low water, enabling the largest steamers to cross the bar at all states of the tide. The Senate has voted 1,000,000 dols. towards the expense of beginning the work, which it is expected will take three years to comple. A series of permanent improvements is contemplated, planned by General Newton, who has been in charge of the improvements in the Hell Gate entrance.

ENGINEERS pronounce the project of tapping the Niagara river by means of a canal and bringing the water to Lockport to be practicable, and have declared that not elsewhere within the known world are there such natural advantages for the creation of a gigantic water power, and that it can be delivered at Lockport to the extent of 300,000-horse power, if so much shall be wanted, at a minimum of expense. Lake Erie and all the great upper lakes would be the millpond for this power—Niagara river the head race, and Lake Ontario its tail race.

AT the monthly Board meeting of the directors of the Suez Canal Company, held yesterday, M. de Lesseps stated that the authorisation given at the beginning of the year for vessels provided with the proper electric lights to continue their passage through the Suez Canal by night has been productive of very good results, as the traffic has thus been sensibly relieved. The postal steamers of the Peninsular and Oriental Company, which have adopted the system of electric lighting, now pass through the canal in twenty hours, whereas the average time spent by these vessels in getting through the canal before night navigation was permitted was thirty hours.

MR. DAVID VAN NOSTRAND, the well-known scientific and military publisher of Murray and Warren Streets, New York, died on June 14th, at his residence, 23, West Twentieth-street. He came of an old New York family, and was born in 1811. He was connected nearly all his life with the book trade, and enjoyed the acquaintance and friendship of a great many leading scholars and writers, especially those engaged in scientific work. His establishment has long been a resort of naval and military men. Mr. Van Nostrand was a prominent member of the Union League and Century Clubs, and of the St. Nicholas and Holland Societies. He was twice married, but leaves no children. His second wife survives him.

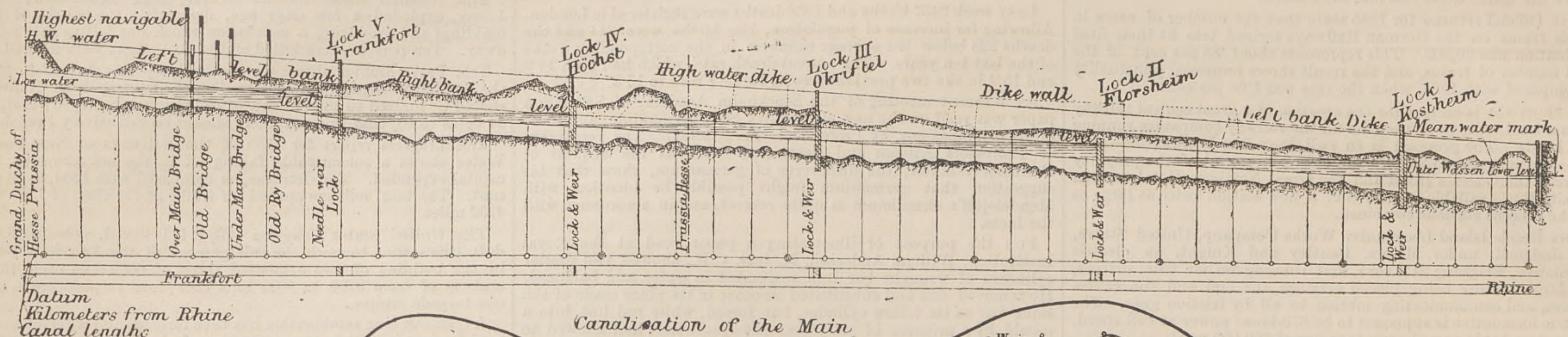
A TRIAL recently took place of the fixed steam fire engine constructed by Messrs. Merryweather and Sons for the Colonial and India Exhibition. The buildings are protected by upwards of seventy hydrants on the water company's main, the pressure in which, however, is insufficient for fire purposes, sometimes falling to 10 lb. per square inch. The engine pumps directly into the main, producing a pressure of 100 lb. per square inch. The Inventions Exhibition was protected by portable fire engines, but this year General Festing preferred to have the pump connected to the main, though, in case of a burst in the pipe, delivery outlets are provided on the pump for the attachment of a hose. The engine is of the Greenwich type, and capable of delivering 700 to 800 gallons per minute.

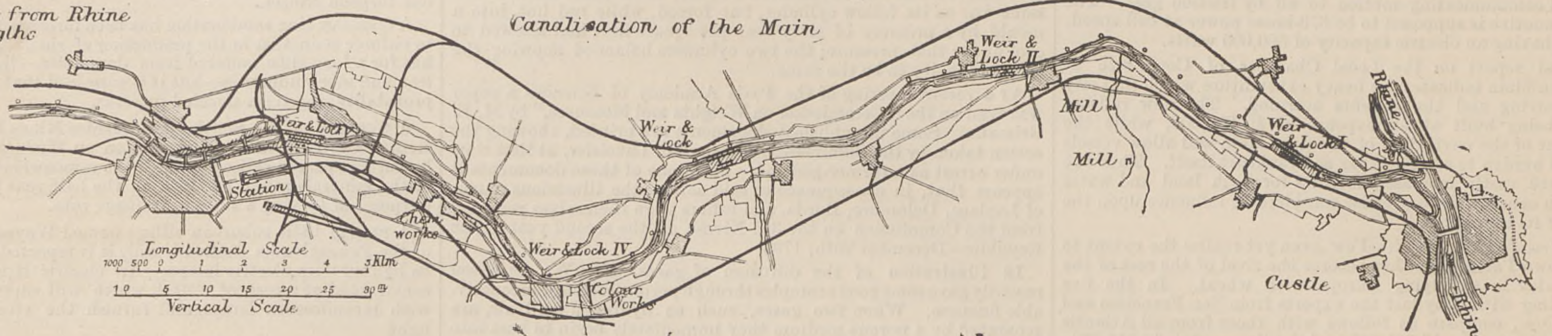
IT is said that Messrs. Siemens Brothers have been manufacturing incandescent lamps whose glasses are filled with hydrogen. It had been remarked before that glow-lamps in which the inner glass wall had been rendered brown could be cleaned by filling them with hydrogen and then exposing both the carbon filament and glass to a high temperature. These lamps are said never to become brown at all, and to last longer. They can be used with higher electro-motive forces, and consequently under conditions considerably more favourable to economy, without diminishing their wear. It is thought that many evils that are found in the vacuous glow-lamps now in use will disappear when the carbon filament is in an atmosphere of a gas exerting considerable pressure, but not acting chemically upon it.

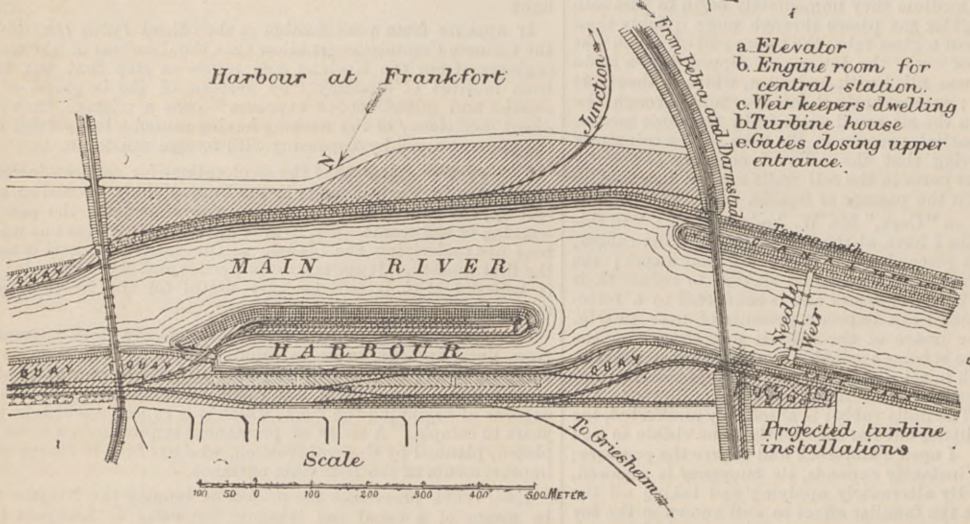
CAPTAIN W. J. L. WHARTON, hydrographer to the Admiralty, has recently issued his report for 1885. It gives a detailed account of the work performed. Nine vessels were engaged abroad. In these ships seventy-one officers and 598 men were occupied in the work. The paper states in detail the operations performed on the coasts of the United Kingdom, at Newfoundland, and the Gulf and River of St. Lawrence, by the steamer Gulnare; in the West Indies, by H.M.S. Sparrowhawk; at Gibraltar and in the channels of Sicily and Malta, by H.M.S. Sylvia; in the Gulf of Aden, the Red Sea, Wetta Passage, and Port Darwin, by H.M.S. Myrmidon; at Malta, in the Red Sea, at Diego Garcia, and on the coast of China, by H.M.S. Rambler; in the Eastern Archipelago, by H.M.S. Flying Fish; at Queensland, by the Colonial gunboat Paluma; on the north-west coast of Australia, by the Meda; and off New Guinea, by H.M.S. Lark.

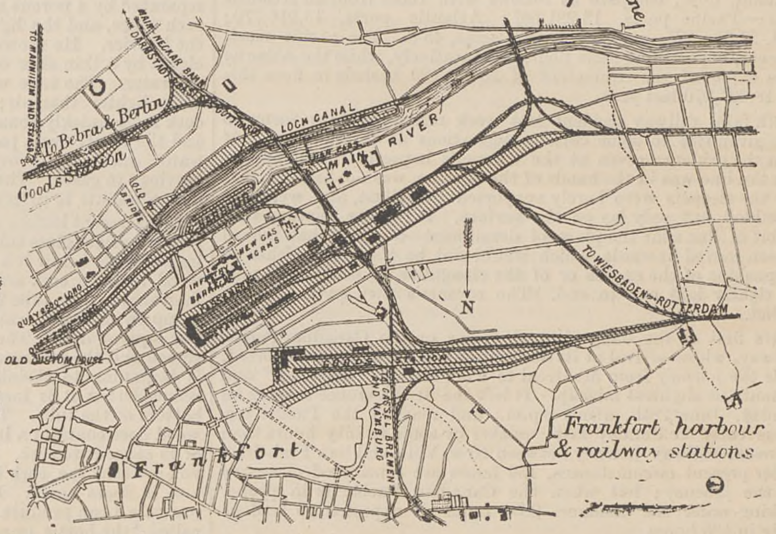
INLAND NAVIGATION ON THE CONTINENT.

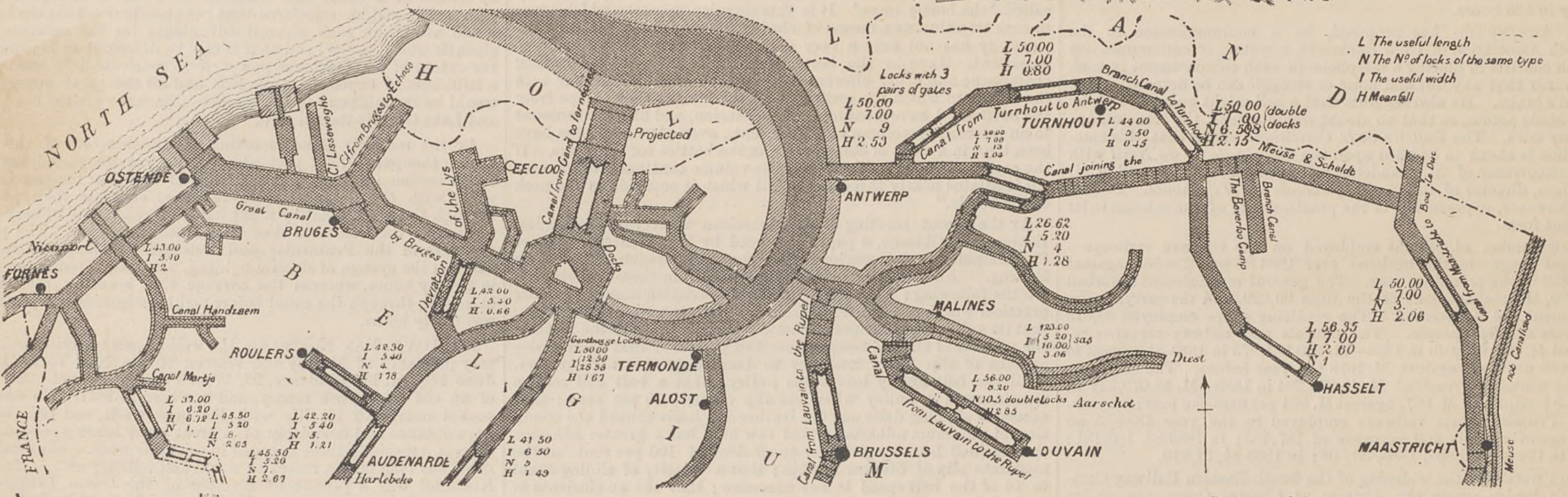
(For description see page 33.)

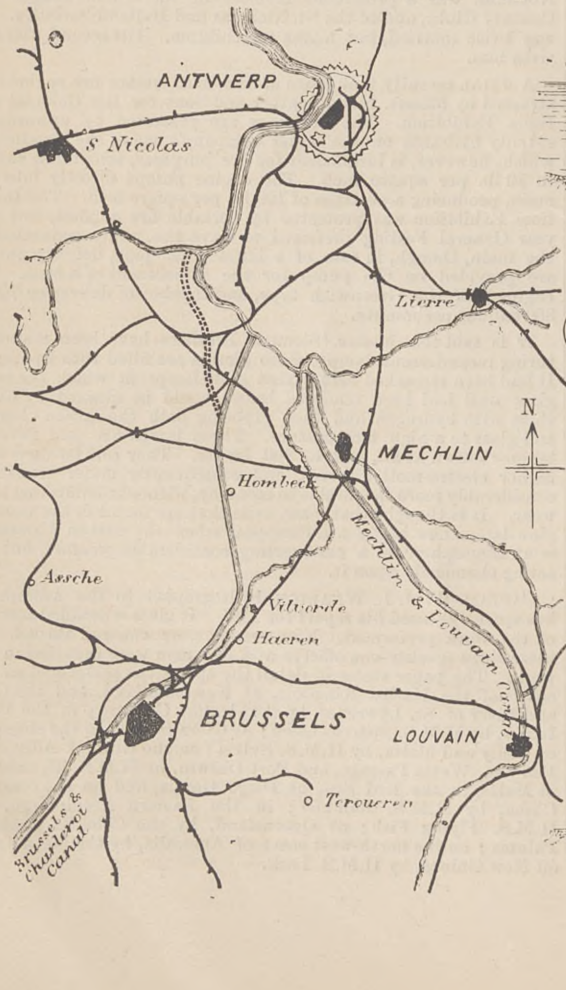


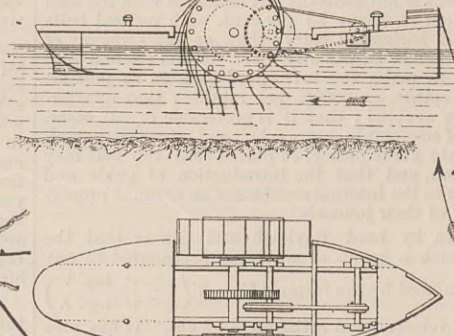


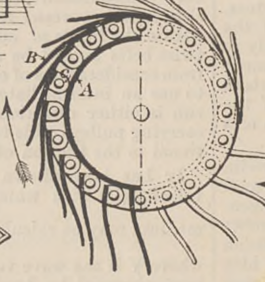


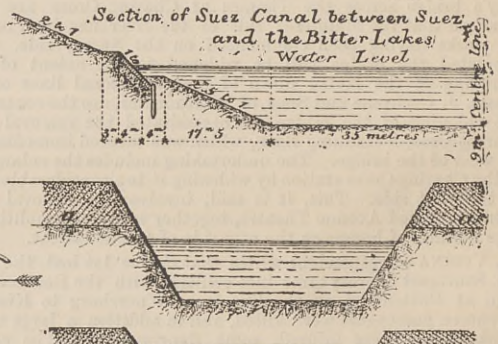


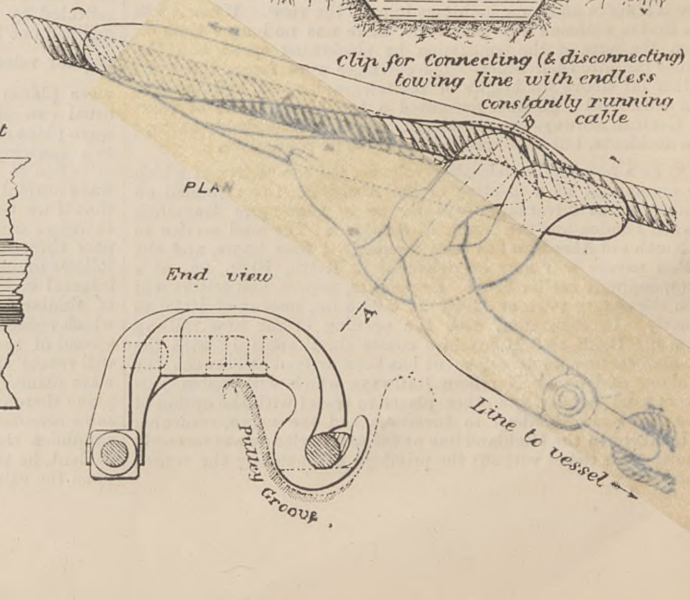


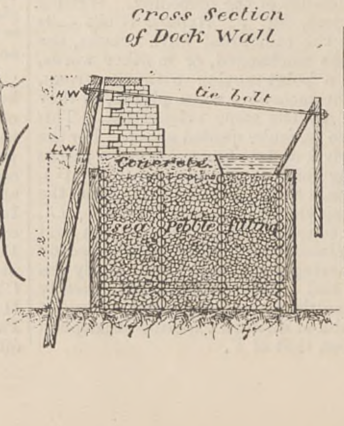


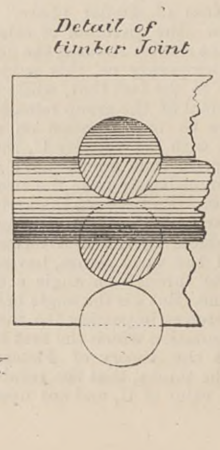












FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame BOYVEAU, *Rue de la Banque.*
BERLIN.—ASHER and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. GEROLD and Co., *Booksellers.*
LEIPSIC.—A. TWIETMEYER, *Bookseller.*
NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

PUBLISHER'S NOTICE.

*** *With this week's number is issued as a Supplement, a Two-Page Engraving of the New Battersea Bridge. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

CONTENTS.

THE ENGINEER, July 9th, 1886. PAGE

TO CORRESPONDENTS.

Registered Telegraphic Address—"ENGINEER NEWSPAPER, LONDON."

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

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

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

J. S. AND G. B.—*No.*

W. W. (Lead Pipe and Sheet Manufacture).—*A communication awaits the application of this correspondent.*

J. P. H. (Penge).—*If you will define what you mean by the word "blow," we will answer your question. We cannot answer it until you do. If you cannot define it, then you may rest assured that no one can answer your question.*

A. G. H.—*If the three given points are equidistant from a fourth, then it is possible to draw a circle which will touch them all, by taking the distance from the fourth point to any one of the three as a radius. Your question is like many others, incomplete.*

A LONG SUBSCRIBER.—*The greatest safe speed for a cast iron fly-wheel is about 3000ft. per minute, or, say, 80 revolutions per minute for a wheel 12ft. in diameter. This velocity is, however, often exceeded, but fly-wheels burst now and then because it is exceeded.*

BOILER.—*Your scheme is only a simple modification of a marine boiler tried years ago in the United States Navy. It steamed about as well as the ordinary boiler, but the tubes could not be kept tight even when worked with distilled water. There is a certain diameter of tube inside which water can be worked. This appears to be about 3in. for short and 4in. for moderately long tubes—say 3ft. for the first and 8ft. for the second. Smaller tubes than this will choke up, no matter what precautions are taken. This is experience, not theory.*

INJECTORS AT SEA.

(*To the Editor of The Engineer.*)

SIR,—I shall be much obliged to any reader who has had experience with injectors for feeding marine boilers, if they will tell me whether they will work or not. I am told that they become choked up with salt, drawing as they do from the sea, in place of a donkey. There must be some objection of this kind to their use, or else they would be found at sea.

AQUARIUS.

Ryde, July 7th.

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THE ENGINEER.

JULY 9, 1886.

HIGH-SPEED MARINE ENGINES.

A VERY excellent paper on high-speed steam engines was read by Messrs. Marshall and Weighton, on the 21st of April, before the North-East Coast Institution of Engineers and Shipbuilders. All the papers read before this Society hitherto, with perhaps a partial exception here and there, have been extremely practical and full of valuable information, and the paper in question is no exception to the general rule. Its authors have written as practical men for practical men, and the result has been quite successful. The paper does not profess to deal with that familiar class of little engines which run at a tremendous number of revolutions, but with marine engines of very considerable dimensions, in which a speed of 130 revolutions per minute is regarded as abnormally high. Its authors advocate the extension to the mercantile marine of methods of design and construction which have greatly reduced weight in the Navy. But they do not propose to push matters as far in this respect in merchant as in war vessels. Messrs. Marshall and Weighton take the weight of propelling machinery, including boilers, water, and all fittings, at per indicated horse-power; in the mercantile marine, 480 lb.; in the Royal Navy, 360 lb.; in special engines for light draught war vessels, 280 lb.; in the Polyphemus, 205 lb.; locomotives, 140 lb.; torpedo boats, 60 lb.; ordinary marine boilers, including water, 196 lb.; locomotive boilers, with water, 60 lb.; and they then proceed to consider the conditions, which are very complex, which determine the ratio of $\frac{\text{power}}{\text{weight}}$, or $\frac{P}{W}$, and a table is given showing how the weight of machinery is affected by the number of times the steam is expanded. Thus, for example, let the number of expansions be 0, the piston area 1, the steam used 1, and the total weight equal 100, then, with a sevenfold expansion, the piston area will be 2·47, the weight of steam used will be ·3528, and the total weight, including water in the boilers, will be 48·17. If we augment the expansion to 12, then the consumption of steam will be ·3091, the piston area, 3·710; and the whole weight, 51·6. From this it will be seen that as we augment initial pressures and ratios of expansion the whole weight of the propelling machinery must increase. Furthermore, we may point out that the consumption of steam stated here is deduced from calculation, and there is no doubt but that in practice it will be higher than the figures given for the larger measures of expansion, because the cooling area of metal in the engine is augmented, and so are the differences in the maximum and minimum ranges of temperature. But more steam would mean a larger boiler, and the weight would augment with the rise in the pressure and number of expansions more rapidly than Mr. Marshall has assumed.

One peculiarity of the use of very high pressures is that slide valves cannot be used. The power required to work them is enormous, and the surfaces rapidly wear out and become leaky. Consequently piston valves are employed of necessity, and these are of very large dimensions and great weight. If the number of revolutions were small, this would not matter much; but at high speeds just the same difficulties are encountered in dealing with these piston valves as those which crop up with the pistons and other reciprocating parts. Momentum and inertia come into play. In the case of the main pistons, these can be combatted by compression and lead, as ably set forth by Mr. Arthur Rigg in a recent impression of this journal. Messrs. Marshall and Weighton are the first to deal with the problems presented by the inertia and momentum of piston valves, and point out very properly that these do not admit of being fought by compression, for sufficiently obvious reasons; and they give diagrams of crank-shaft strains and moments, obtained by experiment and calculation with piston valves weighing respectively 500 lb. and 1500 lb., and they deduce the following formulæ—

$$S = \frac{R^2 \sqrt{W}}{50} \text{ and } S_1 = \frac{R \sqrt{W}}{2 \cdot 54};$$

where S = maximum resistance of one valve in pounds at beginning of stroke, S_1 = mean resistance of valve in pounds during the whole stroke, R = revolutions per minute, and W = weight of valve and rod in pounds. Thus it will be seen that the stresses augment as the square of the number of revolutions, and as the square roots of the weights. Consequently, at comparatively moderate speeds, it would be almost impossible to make valve gear which would stand the strains to which it would be submitted.

Reductions in the weight of machinery which will exert a given pressure, including in the word "machinery" the boiler, must depend on the efficiency of the latter. "It goes without saying," writes Mr. Marshall, "that forced draught is capable of very largely augmenting the power without adding very much to the weight. Indeed, the enormous increase of the ratio $\frac{P}{W}$ which has taken place of late years has been due almost entirely to the application of this principle." And he goes on to show how, by the aid of a plenum of 2in. to 2½in. in a stokehole, the weight of machinery may be reduced 26 per cent. It is a noteworthy fact, that neither in this paper itself nor in the discussion which followed it, was much consideration given to very important points as far as the mercantile marine is concerned. In 1881 Mr. Marshall virtually claimed that each ton of dead weight saved in a steamer represented a profit of £10 per annum for the steamer; and of course, if it could be shown that this was really the case, and that there were no induced disadvantages, the use of light engines and boilers and forced draught would be practically forced on the steamship owner. But however true it might be that £10 per ton per annum could be saved by reducing weight in 1881, when freights were high, it does not follow that £10 could be saved now, or anything like £10. But beyond this, it has to be borne in mind that light engines cost a great deal more than heavy engines for the same power. Thus, instead of the cast iron condensers used in the mercantile marine now, condensers of rolled sheet brass or gun-metal would have to be employed. Again, the use of forced combustion in boilers entails very serious difficulties. Experience has demonstrated that there is not now, even in her Majesty's Navy, a single ship which can be run at full speed with forced draught and closed stokeholes for more than about four hours; and that it could be used continuously for a voyage, say, across the Atlantic, much less during a voyage to India or Australia, is simply preposterous. We do not, be it understood, refer here to the employment of what we may term moderate forced draught—say, something equivalent to half an inch of water; but this is really little more than could be had by adding to the height of a chimney and making better use of windsails. Besides, forced draught, properly so called, always means waste of fuel. Messrs. Marshall and Weighton combat this view, and give the following figures, taken from a paper by Mr. Sennett, for vessels in the Navy:—The Mersey burns 2·48 lb., the Scout 2·6 lb., the Rodney 2·2 lb., the Howe, 2·16 lb., and the Caroline 2·54 lb. per indicated horse-power; but Mr. Marshall has not given the consumption when working without forced draught, which is considerably less, and he does give a table which shows that the evaporation with a locomotive type of boiler was extremely small. Thus with an air pressure of 3·54in., the total water evaporated was only 6·96 lb. per pound of coal from and at 212 deg. The best Nixon's navigation, with 2in. of water pressure, only evaporated 8·56 lb., and it could not well be otherwise, seeing that the products of combustion escaped at as much as 1200 deg. It may be said that if the boiler was larger then the economy of fuel would be greater. No doubt it would, but the weight of the boiler would be augmented, and the very advantage which forced draught is intended to confer would be lost. The whole weight to be carried includes engine, water, and coal, and if we reduce the boiler we augment the coal, and obviously this is false economy in the highest degree. The entire question of light machinery in the mercantile marine is very complicated. The present cost of such machinery must be very high, and the result arrived at may be got better in another way. Thus, Mr. Adamson, in the course of the second day's discussion, said, "The question was, could high-speed engines be made at the same cost as the ordinary compound engine weighing, with boilers, say, 300 tons? If they altered that into a high-speed engine, they would perhaps save 100 tons. Was it worth while, for the sake of saving that amount of weight, to put the high-speed engines into a vessel instead of the other? He could alter the design of an ordinary vessel carrying, say, 4000 tons, to enable her to take an additional 100 tons, for about £300, by slightly increasing the dimensions, while he should fancy that the high-speed engines would cost ten times that amount in excess of ordinary engines." This is excellent common sense. In speaking or writing about marine engines, men continually forget, not only that the whole question is one of money, but that the money can be spent in various ways to secure a given object. The high-speed engine is a much more complex and many-jointed machine than the ordinary compound engine. If it is to be properly looked after and kept in order, more engineers must be carried than are carried now. The average engine-room staff of a cargo boat are chief, second, and third engineers, and the donkey man, who takes the chief's watch. The ship makes a run of, say, eighteen days across the Atlantic. The boilers have to be opened up and cleaned; all the glands have to be packed; the connecting rods taken down, and both big and little ends let together; stern tube seen to; valves examined, and a dozen other things to be done; and the engineer is happy if he is allowed three days to do all this in, and that without the help of a shore gang. Mr. Marshall gives diagrams of high-speed engines at the end of his paper. One glance at them is enough to show that no engines of the class could be properly looked after by a staff of three engineers. The extra cost of packing and lubrication alone would be a serious item in these hard times, and if we add the additional cost of fuel, and the rapid wear and tear of tubes and uptakes to the other expenses, it will be seen that the advantages derived from a saving of weight are illusory. No true analogy really exists between the engines used in the Navy and those in the mercantile marine. It is just as logical to say that what is good in the one service must also be good in the other, as it is to assert that because a locomotive does its work admirably on a railroad, an engine modelled on similar lines must be just the thing for marine purposes.

It is curious that in all these discussions so little is said about the power and coal wasted by friction and badly-made propellers. It has long been known that of every 1000 indicated horse-power developed in a steamer not more than 450 to 500 are utilised in driving her. Here is an enormous margin which no one attacks, and yet events occur almost daily which show that something, much or little, might be done. Thus, for example, Mr. Nichol, one of the speakers, in the discussion related an experience which he had had. A ship was built on the Tyne to go at 14 knots, with fifty-five revolutions per minute. The propeller was designed, and rejected as being too small by the superintendent engineer to the company for which the ship was built. On the trial trip the ship would only make forty-nine revolutions per minute, when the bearings heated, and a very unsatisfactory voyage as to speed was made. The cause was sought for and found in the undue proportions of the propeller. 10in. were cut off the top of each blade, and the engines then made fifty-five revolutions without heating, and with the most satisfactory results. In the case, again, of the s.s. John O. Scott, the propeller was very heavy and the consumption 15 tons a day. The propeller was reduced in diameter and area, and the ship then went at the same speed, making ten revolutions more per minute, and the consumption fell to 13 tons a day. There is, our readers may rest assured, no special isolated virtue resident in expansion, or high speed, or lightness, or forced draught. Each of these things has its advantages and disadvantages, and the skill of the engineer is shown not by advocating any one of these as a panacea for all the ills shipowners are heirs to, but by so combining the best features of all that a satisfactory result may be reached; and the engineer ought to know that the value of the result will always be estimated by the shipowners in terms of pounds, shillings, and pence, and on no other basis.

ENGINEERING ACCIDENTS.

Engineers have very largely contributed to the happiness of mankind, but it must be admitted that they have also introduced elements and agencies which have caused much misery and suffering, both of mind and body. In the seventeenth century no one was killed by boiler explosions, and Mr. Huskisson was the first man slain by a railway accident properly so called. Some thousands of individuals have been killed, mangled, or maimed by machinery which would have had no existence but for the engineer; and it might be argued with some show of reason that the members of our profession have not been as careful to obviate disasters as they have been to attain the objects they have had in view. The answer to such a line of attack is, of course, that when mischief is done, it is the result of accident; but it is worth while to consider whether this is true or not—whether disasters following on the labours of the engineer are or not unavoidable, and whether there really is such a thing as an engineering accident. First, let us clearly define what the word "accident" means. If we turn to the dictionary, we find "Accident, an unexpected event, chance." In other words, it means the occurrence of something unforeseen—something that is not and cannot be anticipated; something which, although it may be brought about by man's agency, has not been purposely brought about. There are, however, two sides to this question. Many so-called accidents are events which might have been anticipated and avoided, while others could not possibly have been anticipated. The latter are, however, comparatively small in number; and a very considerable proportion of the events called "accidents" are not in any proper sense of the word accidents at all. Take for example the Stepney boiler explosion, and the catastrophe which happened last week near Portadown, in Ireland. In the first case the boiler would not have exploded if the owner had ascertained by proper examination that the shell was extensively corroded. In the latter, so far as can be gathered from the evidence at present available, the train ran off the rails because the sleepers lay loose on a thin bed of ballast, and were not packed or secured in any way. These catastrophes obviously resulted because the indispensable conditions of safety were not present. It may be said that ignorance lay at the root of the matter in both cases. Neither the owner of the boiler nor the gangers who repaired the road, were aware of the consequences which must ensue on the line of action which they adopted. This may be quite true. Indeed, we will go further and admit that nearly all the so-called accidents result from ignorance; but this will not help us much to prevent them, because the ignorance which leads to an accident is very often wilful. There can be no doubt that a very great number of accidents is strictly preventible, while others are nothing of the kind; and it is to the former that we desire to direct attention. When a ship is caught in a gale of wind and is wrecked on a lee shore, that may be regarded as an accident. If a horse takes fright at a heap of stones by the roadside, runs away and upsets the carriage behind him, killing its occupants, that is no doubt, in the dictionary sense, strictly an unavoidable accident. But we venture to add that accidents of this kind are not engineering accidents, and that in one word there ought to be hardly any engineering accidents. Every possible contingency can either be guarded against now, or means can be devised to guard against it in future. More care, more forethought, and a greater exercise of skill and invention than has yet been brought into the service, would almost eradicate engineering accidents from the world.

A great deal has already been done in this direction; much remains to be accomplished. Some years ago many deaths and maimings occurred every year by the fracture of railway tires. No amount of examination could detect hidden flaws buried in the substance of the metal. But Mr. Mansel, and other engineers working with the same object, succeeded in devising systems of making and fixing tires which rendered such "accidents" impossible. The old tire depended for its security on its continuity. If the tire broke in any place it left the wheel, and the carriage left the rail, and there was a smash. But the modern tire does not depend on continuity for its efficiency. The modern tire may be broken right through in several places, and still it will do its duty and cling to the wheel. Derailments occur now and then through the breakage of crank axles. It may yet be found possible to build engines which will not be derailed even if the crank axle does break. This end has been very nearly attained even now; for although a large number of crank axles break every year, few passengers are killed or wounded by their failure. The introduction of the block system and efficient continuous brakes have in like manner done a great deal to make railway travelling safer than it was in times past. It will be found that what is true of railway working is true of almost everything with which the engineer has to do, and that engineering accidents may in nearly all cases be classed as strictly preventible. The engineer deals with the forces, so called, of nature, but he does not deal with any uncontrollable force. He could not deal with an uncontrollable force. To do that is left for such geniuses as Mr. Keely. It is quite true that the forces of nature are stupendous; but man cannot do anything with them in the stupendous phase. He can only take a very little bit of each, and use it just as far as he can control it—no more. The energy which is, in a sense, stored up in a great powder magazine is no doubt very great; but if a man can only get a thimble full of powder out of the magazine he cannot do much mischief with that. But it must not be forgotten that the force does not wear out or change, while the means by which it is controlled does, and the escape of natural forces from the condition of servitude into which the engineer has brought them is always due, not to the inherent power of the slave, but to the wearing out of his fetters. A steam boiler can be made when new to resist a given pressure—say 150lb. on the square inch—and its powers of doing mischief are so far limited. It is nothing to the purpose that the power of steam is in the abstract unlimited. So long as the boiler is well designed, well made, and in good order, the force of so much steam as the boiler represents when at work is quite under control. If, however, the boiler is suffered to waste away and become weak, then an explosion will take place; but the explosion is not due to the irresistible force of steam, as some persons think, but to the circumstance that the boiler, originally strong enough, has become too weak for the work it had to perform.

From what we have said it should be clear that so-called engineering accidents result not from the uncontrolled forces of nature, such as that which operate when a ship is driven ashore, but from neglect in some shape or form either to maintain in their integrity the power of the agency by which we control so much of a natural force as we have been able to utilise, or to provide means by which the loss of integrity of the controlling agency may be rendered innocuous. The first is accurately illustrated by a steam boiler. When that boiler is at work there are so many thousand foot-tons of energy locked up in it, which, if the shell plates or flues give way, will be let loose in a moment to do fearful mischief. The strength of the boiler-plates is the agency by which we control the force of the steam. If the plates are allowed to become too weak by corrosion there is an explosion; but this explosion is not an accident, but the result of negligence, ignorance, or parsimony. Mansel's tire is an apt illustration of the second proposition. The agency with which we control centrifugal and other forces operating on and in the tire is its strength. It is possible that we may be deceived as to this, and therefore we bring in a second contingent agent to combat centrifugal force if the tire should fail because of some weakness which we cannot discern. If there were no possible means either of making sure that all tires were sound, or that their failure would not result in the derailment of a train, then when a tire did break that would be strictly an accident. Happily it may be said that the list of dangerous failures of parts of machines is rapidly growing less and less. Improved methods of construction, better materials, design, and workmanship, all tend day by day to eliminate true accidents, and induce sensible, competent engineers to regard with more and more doubt theories intended to relegate catastrophes to the category of unpreventible. In nine cases out of ten it will be found that the so-called accident, instead of being the result of chance, has really been brought about by simple agencies having nothing occult about them. When a crane chain breaks, and some men are killed, we may rest assured that it did not break by "accident," but just because it was too weak for its work; and that had proper precautions been observed it would not have been too weak. The number of railway accidents which occur is very small. Almost the only one of any importance which now takes place happens when both lines being fouled by the breakdown of a train on one line, another proceeding in the opposite direction, and close by at the time, runs into the wreck and is thrown off the road. We do not suppose that a period will come when no one will be killed, or even injured, by the productions of engineers; but we venture to hope that the number of deaths and injuries may be made much less than it is now; and we are supported in this belief by the fact that already great strides have been made toward that desirable goal.

SPANISH PIG IRON.

Spain, as a producer of pig iron on any scale sufficient to allow of her selling to other countries, is so comparatively young that the references to her in Sir I. Lowthian Bell's recent work on "Iron and Steel" are few. But some facts transpiring this year show that Spanish pig iron is becoming our competitor in the markets of the world. There is now being shipped from Bilbao pig iron to the amount of from 10,000 to 15,000 tons monthly on the average. A part of this is sent to other Spanish ports—a part to the United States, and the remainder to Italy and Germany. That exportation will grow there is no doubt. It is based on the fact that at last the Spaniards have found out that it is better for them to smelt the ore in Spain, and sell in the shape of crude iron, than to sell the ore to be smelted elsewhere; and there can be no doubt that the wages paid at the Spanish smelting works are very small in comparison with those paid at British blast furnaces. This was to have been expected, because the wages in Spain are low, and because the new industry of iron smelting had its rate of wages regulated, not by that known in other countries in the industry, but by that in other industries in the locality of the works. Sir I. L. Bell tells of one smelting establishment in Spain where the "head keeper of the furnaces was paid 4s. 4d. for his day's work, and assistants and slagmen from 2s. 2d. to 2s. 10d." There were many women at work also, and the average earnings of the workpeople, all told, were under 2s. per day, or less than half the rate paid in England. With cheap labour, and with abundant ore on the spot, it is to be expected that the Spanish crude iron trade will grow even with the difficulty that there is in regard to fuel. Spain imports her coke mainly from the north-east of England; and thus it is that she is only a competitor with us under unequal circumstances. Cleveland or Wales import her ores if they want to make hematite iron; but she needs to import our coke if she wishes to melt her own ores; and the freight of the coke is higher than that of the ore. Still there can be no doubt that Spain will endeavour, and that very naturally, to utilise her ores on her own soil, though under the great deficiency in regard to fuel to which we have referred; and it is probable that the United States and Italy will be the countries in which we shall find her opposition the strongest—the latter because of its proximity, and the former because it needs iron of a certain quality, and has been in the habit of drawing its supply in part from Spain in the shape of ore. Thus we shall find that Spain will increase as a nation smelting iron and exporting it, and that increase may be in part at the expense of our smelters, though the loss will be counterbalanced in part by the gain that the coke makers here will have.

THE STEEL-RAIL TRADE.

It is to steelmasters matter of importance that there are just now reports of large orders to be placed in the rail and sleeper line, which should afford improvement upon the present condition. The news from Pekin concerning the last postponement of the Chinese railway construction business is not gratifying. Yet considering the determined attempts which capitalists and steelmasters in other parts of the world, particularly Germany and America, were making to get the work, and bearing in mind the low rates at which the continentals are now becoming accustomed to accept foreign contracts, it was not so much a matter of concern as otherwise would be the case. The intelligence is, too, modified to some extent by the explanation vouchsafed by the Marquis Tseng. This distinguished member of the Chinese Empire, speaking in Lancashire, a few days ago, lent no countenance to one of the statements from Pekin that the building of the line would be delayed until the Chinese were themselves in a position to manufacture the materials needed in its construction. His Excellency rather seeks to impress upon English manufacturers and capitalists that the delay is mainly due to the prejudice which still exists in the Celestial Empire against this development of Western ideas. He clearly enough sees that the introduction of railways into China, when such an event takes place, will produce an enormous increase in the commerce of the country. But he points out that though the Imperial Government fully recognise the necessity of taking such a step, it would be a mistake to think that any considerable extent of railway is likely to be laid down in the near future. If, however, our railmakers are to be deprived of the Chinese work, there are happily other big international schemes under development that should afford their mills good work in the near future. It is greatly to be hoped that prices will take an upward turn before long, and there are evidences in this direction.

GRUSON'S SHIELD AT SPEZIA.

On June 22nd last, at St. Maria Bay, Spezia, experiments with the Grüson shield were continued. A French steel projectile was fired at this shield, which had already received three blows from Krupp steel projectiles, fired from the 100-ton B.L. gun. The behaviour of the French steel resembled that of the German, *i.e.*, the projectile broke up. The shield is thought to be capable of bearing a fifth blow. We hope to give details shortly.

PRIVATE BILL LEGISLATION.

Of the total number of Private Bills introduced for the late Session, 97 have passed through all the stages and received the Royal Assent; 32 have been withdrawn, or have lapsed; 8 have been rejected in Committee, or thrown out by non-compliance with Standing Orders; and 53 have been put off for three months, or suspended under the new Order, under which they may be taken up again in the next Session, at the point at which they were interrupted by the Dissolution of Parliament.

The measures which have received the Royal Assent are:—Accrington, Clitheroe, and Sabden Railway; Alliance British and Foreign Life and Fire Assurance Company; Ardrossan Gas and Water; Ardrossan Harbour; Ashton-under-Lyne Improvement; Ballymena and Portglenone, Ballymena and Larne Railways, and Ballymena and Ahoghill Tramways; Barry Dock and Railways; Beaconsfield, Uxbridge, and Harrow Railway (Abandonment); Bexley Heath Railway; Bray and Enniskerry Light Railway; Bridlington Gas; Brighton and Dyke Railway; Brighton Corporation (Loans, &c.); Brighton, Rottingdean, and Newhaven Direct Railway; Bristol Corporation (Docks); Bristol (Totterdown Bridge); Brooke's Divorce; Burgess Hill Water; Bute Docks (Cardiff) Further Powers; Bute Docks (Cardiff) Transfer; Caledonian Railway; Cambridge University and Town Water; Cleator and Workington Junction Railway (No. 1); Commercial Union Assurance Company; Cricklewood, Kilburn, and Harrow-road Tramways; Dore and Chinley Railway: Dublin, Wicklow and Wexford Railway; East and West India Dock Company; East and West Yorkshire Union Railways; Eastbourne, Seaford, and Newhaven Railway; East London Water; Edinburgh University Buildings Extension; Falkirk Drainage; Folkestone, Sandgate, and Hythe Tramways; Forth Bridge Railway; Girvan and Portpatrick Junction Railway; Glasgow and South-Western Railway; Glasgow Bridges, &c.; Great Northern Railway (Ireland); Great Western Railway; Guildford Corporation; Harrow and Stanmore Railway; Highgate and Kilburn Open Spaces; Hull, Barnsley, and West Riding Junction Railway and Dock; Kirkcaldy and Dysart Water; Lambeth Water; Lanarkshire and Ayrshire Railway; Leamington Corporation; Lee River Purification; Leeds Hydraulic Power Company; Listowel and Ballybunion Railway; Liverpool Corporation; Liverpool United Gas; London and South-Western Railway; London, Brighton, and South Coast Railway; London, Chatham, and Dover Railway; London, Tilbury and Southend Railway; Lord Walsingham's Estate; Loughborough Local Board; Manchester Ship Canal; Marple Local Board Gas; Metropolitan Board of Works; Metropolitan Markets; Midland Great Western Railway of Ireland; Midland Railway; Morecambe Tramways; Mountain Ash Local Board (Gas, Water, &c.); Newport (Monmouthshire) Gas; North London Tramways; Nottingham Suburban Railway; Nuneaton Gas; Oldham Corporation; Oswestry and Llangynog Railway; Pewsey and Salisbury Railway; Rhondda and Swansea Bay Railway; Ripon Corporation; Rowley Regis and Blackheath Gas; Scinde, Punjaub, and Delhi Railway Company; Scottish Union and National Insurance Company; Shrewsbury Hospital, Sheffield; Sidmouth Water; Sligo and Bundoran Tramway (Release of Deposit) (changed from "West of Ireland Steam Tramways (abandonment of Sligo and Bundoran Tramway)"); Solihull Gas; Southampton Docks; South Hampshire Railway and Pier; South Shields Gas; Southwark and Vauxhall Water; Stapenhill Bridge; Swansea Harbour; Taff Vale Railway; Tendring Hundred Water; Torquay Harbour and District; Tyne Improvement; Uxbridge and Rickmansworth Railway; Wallasey Tramways West Riding (Police Superannuation); Westropp's Divorce; Wrexham Gas, The Bills withdrawn or lapsed were these:—Argyll Ship Canal; Bexhill Direct Railway; Bank of South Australia; Bedford and Peterborough Railway; Birmingham Central Tramways; Chesterfield, Hasland, North Birmingham Tramways and Omnibus Company; Wingfield and District Tramways; Charterhouse; Cleator and Workington Junction Railway; Cranbrook and Paddock Wood Railway; Easton and Church Hope Railway; Eastern and Midlands Railway; Gravesend and Northfleet Docks and Railways; Horse Guards Avenue; Lancashire County Justices; Liverpool, Southport, and Preston Junction Railway; London, Chatham, and Dover and London, Brighton, and South Coast Railway Companies; Lloyd's; Metropolitan Street Improvement Act Amendment; Marple Gas; Neath Harbour; North-Eastern Railway; Oulton Church; Pontypridd, Caerphilly, and Newport Railway; Peabody Trust; South-Eastern Railway; South Kensington and Marble Arch Subways; Stratford-upon-Avon, Towcester, and Midland Junction Railway; Swansea Bridges; Tees Conservancy; West London Electric Lighting; Whitehaven Harbour and Docks.

The schemes rejected as not proven, or for non-compliance with the Standing Orders, were:—The Felixstowe, Ipswich, and Midland Railway; Felixstowe Railway and Docks; Liverpool and Birkenhead Subway; Leicester Corporation Water; Leicester Extension; Lincolnshire Marshes and East Coast Railway; South Maplethorpe and Willoughby Railway; Skegness and St. Leonard's Tramway.

Following the precedent established in 1880, Parliament passed a special order suspending, for resumption in the next Session, the following Bills which had reached various stages short of third reading in both Houses:—Ardrossan Harbour, Barnet District Gas and Water, Barry and Cadoxton Gas and Water, Belfast Main Drainage, Bridgewater Railway, Carlisle Corporation, Chatham and Brompton Tramways; Exeter, Teign Valley, and Chagford Railway; Halifax High Level, and North and South Junction Railway; Hampstead Heath Enlargement, Hillhead and Kelvinside (Annexation to Glasgow), Ionian Bank, Kensington Vestry, Kingstown and Kingsbridge Junction Railway, Leeds Compressed Air Power Company, London Street Tramways Extensions, Lynton Railway; Manchester, Bury, Rochdale, and Oldham Steam Tramways; Manchester, Sheffield, and Lincolnshire Railway; Mersey Railway, Metropolitan Railway, Midland and South-Western Junction Railway, Midland and South-Western Junction Railway (No. 2), Moore-street Market and North Dublin City Improvement, Muswell Hill Estate and Railways, Nelson Local Board, North London Tramways, North Metropolitan Tramways, North Pembrokeshire and Fishguard Railway, Ormskirk Railway; Plymouth, Devonport, and District Tramways; Portsmouth and Hayling Railway, Rhymney Railway, River Suck Drainage, Rotherham and Bawtry Railway (Extension of Time), Salford Corporation; Seacombe, Hoylake, and Deeside Railway, Southend Local Board, Warehousemen and Clerks' Schools.

INLAND NAVIGATION.

CANALS, so long relegated to the background, appear now in a fair way of coming to the front again, additional interest having been lent to the subject by the passing of the Manchester Ship Canal Bill, and by the subsequent permission to pay interest out of capital. At a congress on inland navigation, held last summer in Brussels, the Belgian Minister of Agriculture, Industry, and Public Works, observed that canals had been too long neglected, and that public attention was now being turned to them, not with that impetuosity which, fifty years ago, created an immense iron network, but with a wise maturity which augured well for their future. In a paper on the eventual prospects of the canal, M. Van Drunen, one of the secretaries of the congress, and engineer to the Société Générale des Chemins de fer Economiques, came to the conclusion that the true transport arrangements of a country should include both railways and canals, each taking its share of the traffic according to its aptitude, to the great advantage of trade and manufacture. The canal would not take from the railway either passengers or goods sent by *grande vitesse* in small quantities, while the water transports would comprise substances forwarded in large quantities at low tariffs, and on which the profit is insignificant. The canal would thus free the railway from a clog upon its action, and enable it the better to organise its fast passenger service to its own profit and the public advantage. Reduction in the cost of transport is the remedy suggested for the present stagnation in trade, it being indispensable that the transport of raw materials be cheapened both for industry and agriculture. Ship canals only enable the capital of a country to engage in commercial operations, because capital is not so easily displaced for commerce as it is for industry. A canal system of moderate section should be supplemented by a few ship canals of sufficient depth, where the probable traffic warranted the outlay.

The economical side of the question was well brought out by Mr. Daniel Adamson, who energetically pleaded the cause of the Manchester Ship Canal, and others in a similar case. Cotton imported from India to London cost less for ship transit, over 4000 miles, than by railway from London to Manchester, a distance of 200 miles; and manufactured goods, sent by through rate from Manchester to Bombay, paid 12s. 6d. for the 40 miles by rail to Liverpool, and only 10s. for the remaining 4000 miles. Water carriage was the carriage of the future for heavy and not necessarily fast traffic; and the legitimate province of the railways, with their handmaids the telegraph and telephone, was for quick speed and light weight. The railways should be content to carry passengers, 14 to the ton, at 14d. per mile, rather than minerals and other heavy goods at 1d. per ton per mile, including the loading and unloading. Mr. E. Leader Williams, C.E., engineer for the Manchester Ship Canal, wished it to be put on record that it was he who first suggested the idea of lifting vessels vertically by hydraulic power, having argued that, if there had been no difficulty with a vertical, there need be none with a horizontal water joint. The late Mr. Mulvaney, formerly Commissioner for Public Works in Ireland, insisted on the advisability of taking the sea as far into the interior of a country as possible; and the Antwerp delegate complimented the English for carrying out public works by private enterprise instead of courting the favour of Government.

Three important ship canals, the Suez Canal, the Cronstadt and Petersburg navigation, and the canalised River Main between Maintz and Frankfort, to be opened on 1st October next, formed the subject of several interesting communications. M. Dirks, engineer to the Dutch Waterstaat, and member of the Suez Canal International Committee, gave the results of the inquiry that had been conducted as to the deepening and widening of the canal, the captains having, on an average, voted for a width of 85 metres and the pilots for 76 metres, with a depth, respectively, of 3ft. and 3½ft. under the keel; while four captains estimated the speed that could be attained under the improved circumstances at 8 knots an hour, one at 9, two at 10, and two sailing full speed. The Committee had unanimously declared for enlarging the existing canal, with a provisional depth of 8½ metres, and a final depth of 9 metres. This would permit of a speed of 8 knots an hour, so that steamers could pass through in a single day, or half the time now required. For protecting the banks, masonry facing was recommended—shown by the accompanying section of the canal between Suez and the Bitter Lakes—resting on a *risberme*, or horizontal portion, of sufficient width to constitute a solid base, carried up to a height of about 1 metre above, and continued to 2 metres below, low-water mark of ordinary spring tides. (See half section of canal on page 30.)

Commander di Gioia, delegate of the Italian Government, and also a member of the Suez Canal International Committee, considered that planting the banks down to the water's edge constituted the best and most economical protection. The action of the waves was felt 2 metres below the water line, and not more than 1 metre above it, so that the banks must be protected for a vertical height of 3 metres.

M. Tcharnomsky, engineer, of St. Petersburg, gave some particulars of the Cronstadt and Petersburg ship canal, 28 kilom. or 17 miles long, generally 84 metres or 275ft. wide, and 22ft. deep, which cost £1,200,000, and will, by saving the transhipment of goods, prevent a loss of about £800,000 per annum on a traffic of 2,700,000 tons. The Goutonieff dock, 365 metres long by 214 metres wide, and the two supplementary docks, have a total area of 174 hectares, or 430 acres. The foundations of the quay walls, laid in treacherous ground, consist of caissons, formed of fir logs, about 10½in. in diameter, and filled with sea pebbles, on which is a layer, about 3ft. high, of concrete, carrying the granite-faced masonry, in accordance with the cross section on page 30, but laid in steps, and varying in height with the bottom. The logs are halved at the joints, as shown by the detail, also on page 30, and are braced together by half logs and tie bolts. The timber is always under water, so that it is not liable to decay; and there are no teredos in the Baltic.

Herr Düsing, engineer-in-chief for the canalisation of the Main between Maintz and Frankfort, contributed some information concerning that work, which is being carried out by the Prussian Government at a cost of £275,000, and will permit the largest vessels—1000 tons burden—that navigate the Rhine to get up to Frankfort. The depth of the Main will be increased from 0·9 metre to 2 metres, while the locks, &c., are being constructed for an ultimate depth of 2½ metres. The distance to be regulated is 36 kilom., or 22 miles; and the total fall is 10 metres, or 33ft. There are five weirs with locks, dividing the length into five reaches. The needle weirs are in the middle of the stream, the masonry sill being at low-water level, excepting the central opening, where it is 0·6 metre lower, to allow boats to pass freely when the weir is down. The locks on the left bank are 80 metres, or 262ft. long by 10½ metres, or 34ft. wide; and the raft passes on the right bank are 12 metres, or 39ft. wide, the shoot having an inclination of 1 in 200. On page 30 are plan and longitudinal section of the Main canalisation, together with a plan of the Frankfort harbour and railway communications in connection with it, and an enlarged plan of the harbour itself. Particulars of the works at Frankfort were added by Herr Stahl, delegated by the Municipality in the absence of Mr. Lindley, engineer-in-chief. The works, which were begun in 1884, and are to be completed at the end of the present year, are being carried out by the Frankfort Municipality at a cost of £200,000. The harbour of refuge, 570 by 70 metres = 1870 × 230ft. and 2·8 metres = 9ft. deep, on the right bank, is formed and protected by an outer dam parallel with the shore line, and will also be fitted out for loading and unloading goods. Besides this harbour of ten acres area, which will be capable of receiving fifty of the largest Rhine boats (of 1000 tons), the commercial harbour on both sides of the river, between the Main-Neckar Railway and the State Railway bridges, will have an area of thirty acres. There will also be 5 kilom., or 3 miles of quay, above the Main-Neckar Railway bridge along the reach of the river dammed by the Frankfort weir. Sidings will run from the goods stations all along the quays, so as to facilitate the direct transfer of goods from water to rail and *vice versâ*. It is intended to erect hydraulic cranes and lifts supplied from a central hydraulic station, utilising the fall of 2·7 metres = 8ft. 10in. at the needle weir to drive turbines giving out from 280 to 500-horse power.

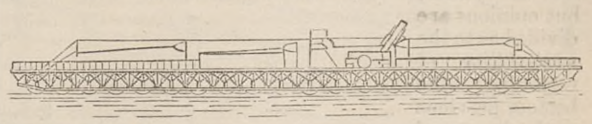
M. de Saint-Hubert, of Namur, advocated the making of canal locks as uniform as possible, so that the Governments of adjacent countries might agree upon a system of through working, as was the case on railways. He also expressed the opinion that the service should not be interrupted during the night, and to this end he would utilise the fall of water over the weirs to generate electric current for lighting the locks and shores. He gave an outline of his scheme for connecting all the large rivers of Central Europe, the Elbe, the Rhine, the Danube, the Oder, and the Weser, thus forming one vast system of waterways, connecting the North, Black, and Baltic Seas, and making Berlin and Vienna sea ports. There would be a length of 1000 kilom., or 621 miles of canal to cut, at an estimated cost of £11,000,000, requiring a capital of £14,025,000; but he estimates the traffic at 2,400,000 tons per kilometre (0·62 mile). Taking only half of this to begin with, and putting the dues at half a kreutzer per kilometre, there would be an immediate revenue of £600,000, yielding more than 5 per cent. on the capital.

In the diagram on page 30, showing all the navigable waterways in the North of Belgium, the canals are represented by straight and the rivers by curved lines. The cross-hatched band is in proportion to the minimum depth of water, while the increase of depth due to tides or floods is shown by a wider band single-hatched. The positions of the locks are shown by transverse lines. The locks of normal type are drawn within the bands to a scale of 0·0004m. per metre, their dimensions being given by a small table adjoining each, in which L represents the useful length, *l* the useful width, N the number of locks of the same type, and H the mean fall. The total fall is measured to low-water mark in waterways connected with tidal rivers. The cumulative lengths are given in kilometres (1 kilom. = 0·62 mile) near the locks. The map also on p. 30 shows the water communications between Antwerp, Brussels, Mechlin, and Louvain, and also the projected canal from the existing Willebroeck Canal to the Scheldt at the mouth of the Rupel. Even now a small steamer trades weekly between London and Brussels; but the Cercle des Installations Maritimes has been formed to promote the scheme of making Brussels a seaport, by deepening the Willebroeck Canal, and giving it a new outlet into deep water, as shown by the dotted lines. The canal connecting Louvain with the Rupel by Mechlin was authorised by Marie Therèse, in 1750; but the work was so badly executed that more expense was incurred than would have made a new canal. It has been improved from time to time, but still does not answer to the requirements; and Louvain, like Brussels, is agitating for its ship canal.

The quays of the Ghent docks, which were visited, have two lines of way in front, and four behind the warehouses, which are to have cellars and an upper storey. The hydraulic principle has been chosen for the travelling cranes, which will run on the first line of way. These additional works are estimated to cost 12,000,000f. or £480,000, which has already been raised by loan. There is a scheme for making Bruges a seaport, by cutting a ship canal to the nearest point on the coast, a distance of 7½ miles, and making a deep sea harbour enclosed by piers at Heyst, and docks at Bruges. An English company offered to carry out the work for a 99 years' concession, if the Belgian Government would guarantee 3 per cent. on the outlay.

During the deliberations on the technical portion of the programme of questions, M. Casse gave it as his opinion that in cutting a canal, the *débris* should be put on the banks in as direct a manner and with as little intermediate mechanism as possible; and he described an excavator that he had devised for effecting this object. It consists of a hollow jib, movable along the bottom by chains and pulleys, carrying at one end a revolving cutter, giving blows like those of a pickaxe, and at the other an exhausting fan. The *débris* are drawn through the hollow jib and delivered by tubes on to the banks, with a great saving in cost.

M. A. Huet, of Delft, advocated the making of canals according to the lower of the two sections shown on page 30, instead of according to that usually adopted, *a*, *a*, being the original level of the ground in both cases. His reason is that, although the relative height of the bottom is greater, and therefore not so advantageous, much less land is required to receive the earth excavated, and consequently the expense is considerably reduced. He also gave particulars of his water locomotive, shown by the accompanying sketches, by means of which he feels warranted, by trials on a small scale, in expecting as great speed on the water as is now attained on railways. The vessel's keel



is fitted with plain drums of sheet zinc, steel, or iron, caused to revolve at great speed by a pitch chain and belt from the pulley of a motor. The speed is to be increased by immersing a greater number of drums, or more of their surface, or by increasing the speed of the motor. In support of his project, M. Huet cited the experiments made by M. Bazin at Paris in 1874, when discs made to revolve at great velocity presented the remarkable phenomenon of a ricochet motion directly they touched the surface of the water.

Among the models exhibited was one of Bateman's paddle steamers, shown by plan, elevation, and detail of paddle wheel on page 30, in which the floats are hinged, and fall down so as to leave the water easily, only assuming a position normal to the periphery of the paddle-wheel at the moment of taking the water.

Sig. J. Rigoni contributed a paper dealing with the various methods of traction on canals, in which he referred to the system of towing vessels by an endless cable, constantly running, supported on pulleys in the tops of posts, placed on the banks in a somewhat inclined position towards the stream. The advantages of this system are—high speed, regularity of traffic, optional starting and stopping, prevention of injuring the banks, and great economy in a canal where the traffic is great. The cost of installation is put at between 6000f. to 7000f. per kilometre, and the working expenses at about 1000f. per kilometre per annum. The most important part of the system is the clip, shown by the sketch on page 30, by means of which the bargeman can connect or disconnect his towing line at pleasure. It consists of a portion almost tubular, embracing the running cable, which enters by an opening longitudinally helicoidal. On an appendage laterally curved to the tubular portion is a lever, mounted on a hinge and working horizontally like an excentric. This lever, when pulled smartly by the tow line from the barge, acts by the end opposite to the running cable, so as to twist and tighten it against the tubular portion. The lever is capable of assuming three different positions, corresponding with three different actions for gripping, sliding along without gripping, and releasing entirely.

THE ATHUS IRON AND STEEL WORKS.

No. IV.

(*Continued from page* 60, *vol.* lxi.)

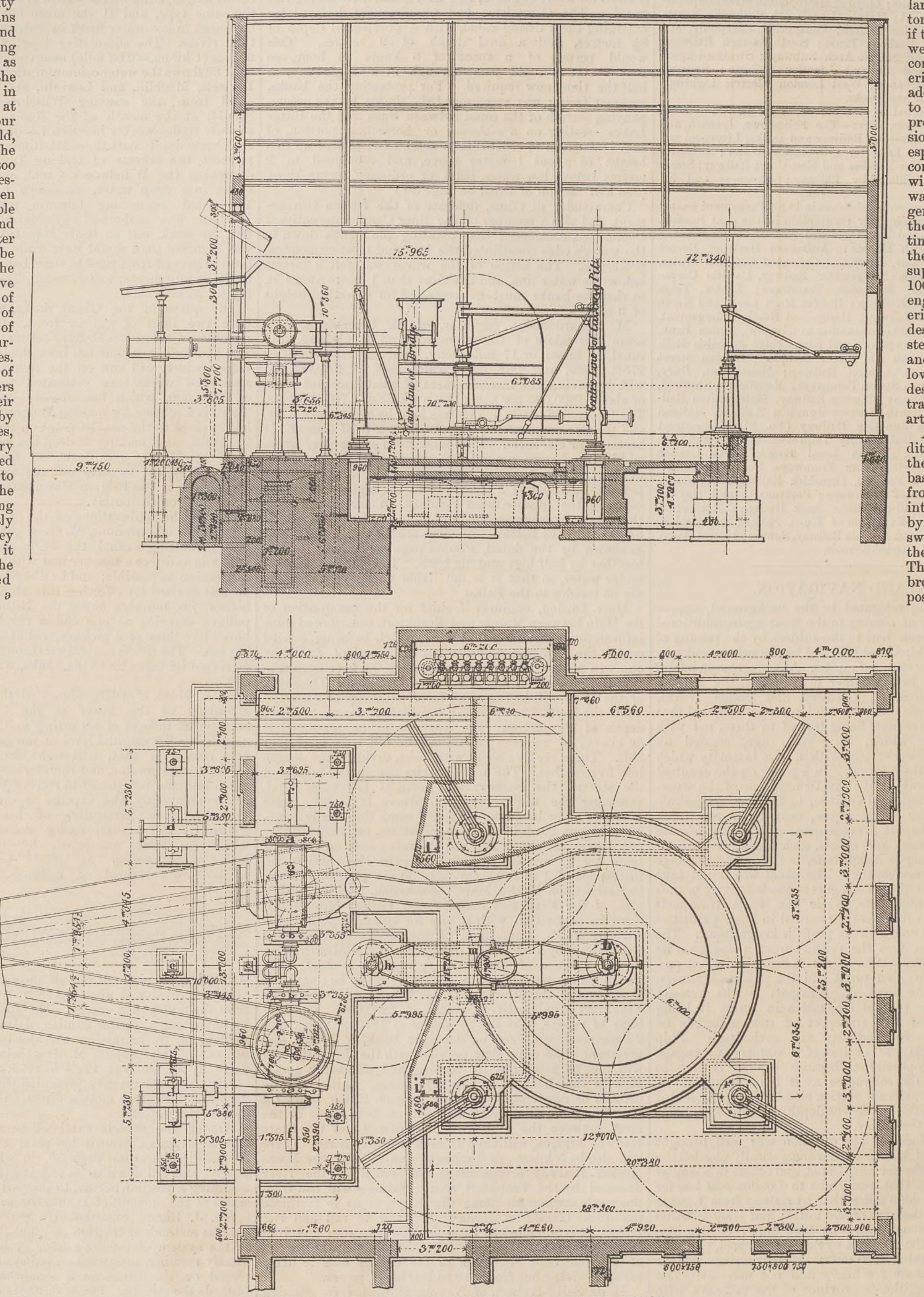
Steel Works Casting House.—In a paper on the Holley arrangement of Bessemer steel works adapted to the basic process, M. Greiner reminded the Liége engineers of this great difference between acid and basic converters; that the latter are subject to chemical wasting in addition to mechanical wear, so that they do not last, on an average, for more than sixty blows. As no means have yet been found to make the lining stand longer, and as the re-lining of the converter, while in position, requires at least twenty-four hours, and would, therefore, keep the works standing too long, it becomes necessary to choose between putting down a double converter plant, and making the converter removable, so as to be quickly replaced. The latter alternative shows a saving of 30 per cent. in cost of construction, and of 20 per cent. in current labour expenses. Instead, however, of lifting the converters bodily, with their rings or belts, by travelling cranes, which must be very powerful, and carried at a great height, to say nothing of the difficulty of dropping the converter exactly into position, Holley preferred that it should slip out of the belt while inverted being received by a carriage and lowered by a hydraulic lift to the casting house floor, and then run along rails to the lining repair department. Any dividing of the converter into sections to reduce the load on the lift is out of the question, on account of the loss of time that would ensue from making the several joints; but opinions are divided as to the advisability of removing the bottom previous to the descent of the converter. If the bottom is removed, there is a joint to make while the converter is in position; whereas, if it is kept on, the centre line of the converter trunnions must be carried at a level of 3ft. higher, and the hydraulic press must have just so much more travel.

The method adopted at Athus is to have three converters, two in use and one under repair, and to remove the bottom before lowering the converter. A front view of the converter was given on page 59; and the engravings above show vertical and horizontal sections through the spacious casting house, while those on the opposite page give details of the converter and its carriage, under the supposition that the former is lowered with the bottom. Fig. 1 shows the converter received mouth downwards on its carriage, and lowered from its belt; and Fig. 2 the re-lined converter again placed in position, the dotted lines of each figure indicating the respective complementary positions. All that is necessary to release the converter from its ring, when the carriage is brought under it in the press, is to knock out the cotters of twelve bolts, a horizontal section through one of which is shown in Fig. 1A. Figs. 3 and 4 give transverse and longitudinal sections through the converter, the last-named view being partly in elevation. The travel of the hydraulic lift is $3\frac{1}{2}$ metres, or 11ft. 6in., and the diameter of the rod 27 centimetres, or $10\frac{1}{2}$in. The weight of the converter empty is about 10 tons, and the press was tested in action with a load of 100 tons. To prevent injury to the press from a possible spilling of the charge, the platform is sunk a few inches below the floor level, and covered with a layer of sand. Reference to the plan will show that the centre lines o the converters are parallel, while the lines of way leading to the repair shop are convergent. To meet this discrepancy helicoidal guides are fitted to the inside of the converter standards, so that the requisite twist is given to the lift platform. The converter standards, as designed by Holley, were found too weak; accordingly the Cockerill Co. strengthened them, while at the same time introducing a hole, like that in its steam-hammer frames, for the sake of lightness. The vertical section of casting house shows the position of the ladle, from which the molten pig iron, after its weight has been taken by a weigh-bridge, flows from the tap hole into the down-turned converter, the smaller ladle for the molten spiegeleisen occupying the same position while being tipped. The lime additions are thrown with a shovel into the converter while in its upright position, from a bridge at a higher level outside the casting house.

Basic converters are generally made with concentric mouths, so as to pour alternately from either side, in order to counteract the unequal wear of the lining, and also to favour the falling inside of the metal blown upwards by the blast. These advantages, however, are more apparent in theory than in practice; and at Athus the usual form of excentric-mouth Bessemer converter has been retained, which is capable of holding more metal. Indeed, a far larger charge than 10 tons might be blown, if the rest of the plant were designed in accordance. The Cockerill Company has added a safety valve to each converter for preventing an explosion in the passages—especially when the converter is turned with its mouth downwards—due to the generation of gas from the tar used to agglutinate the dolomite of the lining. The blast is supplied by a vertical 1000-H.P. blowing engine, of the Cockerill Company's latest design, with inverted steam cylinder above and air cylinder below, which will be described and illustrated in a subsequent article.

After the lime additions and the blow, the charge of molten basic steel is tipped from the converter into the ladle carried by the transfer crane, swung round under the converter mouth. This crane is then brought into such a position that its horizontal jib lies in the same straight line with that of the central casting crane. The ladle is then transferred to the central crane by being drawn on to the horizontal jib of the latter by a horizontal hydraulic press, as shown by the sections of casting house. The central crane, 10 tons nominal, but tested to 25 tons, has a lift of $2\frac{1}{2}$ metres, or 8ft. 2in., and is capable of making a complete revolution in the casting pit, which is 14 metres, or 46ft. in diameter, and 1·2 metre, or 4ft. deep.

Of the four ingot cranes shown in the horizontal section only three have as yet been erected. Two are 5 tons nominal; and the other — that nearest the distribution platform, seen in the plan—has a power of 10 tons nominal, because it is required to lift the ladle on to its support for cleaning and repairs. In accordance with Holley's arrangement, all the cranes are hydraulic; they are also guided at the top in the girders carrying the roof, instead of being counterweighted, an arrangement which reduces the load and friction, thus lessening the expenditure of water under pressure. The hydraulic pressure for the cranes, for tipping the converters by a rack and pinion, and for drawing along the ladle full of molten pig iron from the blast furnaces or cupolas, is supplied by two horizontal steam pumping engines, made by the Cockerill Company, each capable of yielding 2 cubic metres, or 440 gallons of water at a pressure of 20 atmospheres, or 300 lb. per square inch. The eight levers for working the valves of the water under pressure, and also of the blast for the converters,



VERTICAL AND HORIZONTAL SECTIONS OF CASTING HOUSE.

Reference to Plan of Casting House.—

a a, Spur Pinions for Tipping Converters. *b b*, Pipes Leading Blast to Converters. *d d*, Hydraulic Cylinders for Tipping Converters. *e e*, Columns Supporting Converter Bridge. , Converter Standards. *g g*, (Dotted circles) Lifts for Converters. *h h*, Transfer and Casting Cranes. *i i*, Ingot Cranes. *l l*, Columns of Bridge for Molten Pig Iron. *m*, Bearer for Horizontal Jibs of Transfer and Casting Cranes.

NORDENFELT GUN TRIALS.

A SERIES of firing trials was carried out with Nordenfelt guns at Dartford on Tuesday last, July 5th. The following experiments formed the programme:—(1) A single-barrel gun on field carriage fired 80 steel bullets in 30 sec. (2) A five-barrel rifle calibre gun fired 100 rounds in 13 sec, and afterwards 265 rounds in 30 sec. (3) A ten-barrel rifle calibre gun fired 200 rounds in 13 sec., and 400 in 31 sec. Some drill was carried out with a detachment of the Central London Rangers, and afterwards with one of the Grenadier Guards, under Captain Lloyd. Firing and moving were performed with great rapidity. Three men of the 10th Hussars, under Major Wilson, worked Lord Charles Beresford's two-wheel carriage with five-barrel Nordenfelt gun, moving rapidly and firing both with horses in and out of the carriage. With the exception of the springs being rather too much affected by the firing, this was very satisfactory.

Next, some firing was carried out with quick-firing guns for penetration, when the 1in. gun projectile, at sixty yards, perforated an iron plate 1in. thick. A $1\frac{1}{2}$in. projectile from a 2-pounder gun perforated two 1in. plates, and penetrated a third sufficiently deep to bulge the back. A 6-pounder projectile perforated five 1in. plates. The quick-firing guns were also tested for speed. The $1\frac{1}{2}$in. gun, on naval carriage, fired six rounds in 17 sec.; the 3-pounder, on field non-recoil carriage, fired six rounds in $14\frac{1}{2}$ sec.; the 6-pounder, on a recoil carriage, fired six rounds in 14 sec.

Lastly, a mountain gun equipment was shown. A good account of the trials was given in the *Times*, but Mr. Nordenfelt considers that justice was not done to him by the statement that his guns are not yet adapted for land service, 200 machine guns being in course of manufacture, or already turned out, for the Army.

As many of our readers know, machine gun, including quick-firing ones, which can hardly be distinctly separated from them, form mainly three groups—(1) those of rifle musket calibre for sweeping down infantry in the field or repelling boarders at sea; (2) guns of about an inch calibre, firing steel bullets with sufficient power to stop torpedo boats; (3) quick-firing guns, for playing on the unarmoured parts of ships.

LAUNCHES AND TRIAL TRIPS.

THE s.s. Eldorado, built and engined by Earle's Shipbuilding and Engineering Company for Messrs. Thomas Wilson, Sons, and Co., of Hull, was taken on her official trial trip on the 29th ultimo. This vessel has been constructed and equipped in the remarkably short time of four and a-half months, in order to take her place on the Norwegian passenger station, in lieu of the vessel of the same name, now called the Sfaktirea, and sold to the Greek Government for a fast cruiser at the beginning of the year, as recently mentioned by us. Her engines are triple-compound, three-crank, having cylinders 28in., 43in., and 70in. diameter by 39in. stroke, supplied with steam of 150 lb. pressure by two large steel, cylindrical, tubular boilers, each fitted with four of Fox's patent corrugated furnaces and Henderson's patent self-cleaning fire-bars. The ship was taken on the measured mile off Withernsea, and the result of a number of runs with and against the tide gave a mean speed of 14·9 knots, the machinery working most satisfactorily the whole of the day. On her return to port she was handed over to the owners, and will sail on her maiden voyage to Bergen on July 6th, for which trip a full complement of passengers has already been booked.

On Friday, 2nd inst., the steam yacht Fire Fay was tried for speed in her cruising trim on the measured knot at Skelmorlie, with her full equipment and 40 tons of coal on board ready for sea. The Fire Fay has been built for Mr. J. W. Clayton, of Hampton-on-Thames, by Messrs. Lobnitz and Co., Renfrew. The following are her dimensions:—Length between perpendiculars on water-line, 170ft.; breadth moulded, 22ft.; depth, 12ft. 6in. She is fitted with a set of Lobnitz's triple expansion engines, the intermediate cylinder being annular, and these indicate 630-horse power, with 128 revolutions, and 150 lb. steam pressure in the boiler. The latter is double-ended, and has four furnaces. The speed guaranteed by the builders was 13 knots per hour. The trial gave a mean speed of 14·1 knots per hour. The amount of coal consumed when running 14 knots was, we are informed, 9 cwt. per hour, with 630 indicated horse-power, and we are further informed that progressive speed trials showed that when running at a speed of 13 knots, and indicating 500 horse-power, the consumption was 7 cwt. of coal per hour, or 1·568 lb. per 1-horse power per hour, and with a speed of 11 knots, 320 indicated horse-power, it was reduced to 5 cwt. of coal per hour. The Fire Fay leaves this week for a cruise in Norwegian waters.

Messrs. William Simons and Co. have launched at Renfrew a twin-screw single-ladder dredger, called the Dolphin, and built for the Crown Agents for the Colonies. The Dolphin is fitted with compound surface-condensing engines and mild steel boiler of 220 indicated horse-power, having a single bucket ladder working through a well in the centre of the vessel, which can dredge the vessel's own flotation to 33ft. depth of water. It lifts 240 tons of free soil per hour. This dredger has been built under the direction of Sir John Coode, C.E., and Mr. William Mathews, assisted by Mr. Wilson Wingate, inspecting engineer, and Mr. W. N. Bain, resident engineer, and is the third vessel built by this firm for the Crown Agents, and in a few days will proceed to the West Indies.

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

(*From our own Correspondent.*)

THIS is the week of the quarterly meetings. They were held in Wolverhampton yesterday—Wednesday—and in Birmingham this—Thursday—afternoon. They drew together a good attendance of iron and steel masters, export merchants and factors, colliery proprietors, and agents engaged in the sale of pig iron and steel from various parts of the kingdom. But the general elections were largely discussed to the disadvantage of business. Alike the Wolverhampton and the Birmingham markets had the appearance of a predominance of sellers over buyers in all departments, and no surprise was expressed that the sales made should have been of light account.

Best finished iron was re-announced at last quarter's prices—namely, £7 for bars and £8 10s. for sheets and plates. This was the rate fixed at the beginning of May last, when a reduction of 10s. per ton occurred. For their second qualities these same best houses were freely quoting £6 for bars and £7 10s. for sheets, with other sorts in proportion. Makers stated that, rather than further reduce the price of first qualities, they would close their works.

Messrs. William Barrows and Sons quote for the new quarter:—Bars, round, square, and flat, £7; best bars, suitable for chain-making and other purposes, £8 10s.; double best, suitable for superior chain, bars, and the like, £9 10s.; plating bars, £7 10s.; best angle, tee, and rivet iron, £9; and double best, £10. Boiler-plates the firm quote £8 10s., £9 10s., £10 10s., and £14 10s., according to quality; and sheets, £8 10s. for 20 gauge; £10 for 24 gauge; and £11 10s. for 27 gauge. Hoops they quote £7 10s.; best, £9; and wide strips £8 10s.

Messrs. John Bradley and Co., who, by reason of the exceptional character of their iron, are able to command more money than any other house in the trade, price all bars above $\frac{5}{8}$in. £9 10s., which is £2 10s. above the price of the other marked bar firms. Hoops they quote £8 10s., which is £1 per ton advance on other firms, and sheets and plates £10, which is £1 10s. more than other best makers are asking. Rounds and squares up to $\frac{5}{8}$in. are quoted at £8, an advance upon the terms of other firms of £1 per ton.

The New British Iron Company occupies a somewhat exceptional position as follows:—Best Corngreaves bars, £6 5s.; composite bars, £8 15s.; best Corngreaves rods, £6; best Corngreaves plates, £7 15s.; tank plates, £7; best Corngreaves angles, £6 15s.; best Corngreaves tees, £6 15s.; and best Corngreaves hoops, £6 15s. per ton.

Mitre iron, rolled by Philip Williams and Sons, of the Wednesbury Oak Works, is a uniform 5s. per ton less than the make of other list houses. Bars of $\frac{5}{8}$in. round or square, or $\frac{1}{2}$in. to $\frac{7}{16}$in. round or square, and flats 1in. by $\frac{5}{8}$in., or $\frac{1}{2}$in., are £6 15s., as against £7 by other firms. Strips from $1\frac{1}{2}$in. to 6in. broad £7 5s., and angles and plating also £7 5s. Sheets of 20 w.g. are £7 15s.; 24 g., £8 10s.; and 26 g., £9 10s. Wednesbury Oak branded qualities are quoted at £1 per ton less than Mitre.

It is noteworthy that in 1873 Staffordshire marked bars, which are this week freely quoted at £7, were strong at £16 per ton.

The medium and common bar makers received a moderate amount of business this week, and so, too, did the strip and hoop makers. Export merchants are fair customers in this line, and orders are also being received direct from Australia, South Africa, South America, India, and other markets. Prices in this department varied from £5 10s. down to £5, and even £4 15s., for bars, and £4 17s. 6d. to £5 for gas strip, and £5 5s. to £5 10s. for common hoops. Superior hoops were 15s. to £1 additional. Bedstead strips were £6 10s. to £7. Compared with the prices ruling at the January quarterly meeting, common bars, hoops, and strips showed a reduction of 5s. per ton.

Sheets for use by galvanisers were slightly firmer in price, by reason of the little better tone which characterised the galvanised trade. This improvement arose out of more satisfactory reports to hand from the antipodes and the Southern States of America of the condition of the wool and other produce markets. Values have recovered. At present, however, the galvanisers and the black sheet makers are at only part production, and some of them are very slack. Prices are varied, and although £5 15s. remains the nominal minimum for singles, and £6 for doubles, it is admitted that sales are taking place at less. Lattens are quoted £6 15s. to £7. Current prices are a drop on those of last January by 10s. per ton.

Orders for sheets, bars, and hoops, are still being placed by some local purchasers in outside districts at prices less than those which local makers can accept. Sheets up to 16 gauge are being ordered by local middlemen from North of England works for delivery in the Thames at £5 15s. per ton. But the quality of the Northern sheets is admittedly not equal to the Staffordshire make. North Staffordshire bars are being delivered in London at £5 10s. to £5 15s. per ton. Large sized sheets, rolled for special purposes, have just been brought from Warrington delivered into this district at £3 per ton less than the buyer would have had to give to Staffordshire makers. The work was, however, of a special sort. Tank and safe plates are coming into this district from the North of England at prices much under those of the native makers. They are mainly common qualities, a class of trade which Staffordshire plate makers do not profess to cultivate. Safe plates are arriving at £5 15s. per ton and upwards, while for superior sorts from native makers safe firms are paying prices up to £9.

All-mine pigs have been re-declared this week for the new quarter without alteration for Shropshire and Staffordshire sorts, upon the nominal basis of 52s. 6d. to 55s. for hot-blast pigs, and 75s. to 80s. for cold-blast. Very few transactions, however, took place at these figures, and the general selling price of hot-blast was 50s. Cold-blast held its own very fairly. Common pigs were 5s. down on last January prices. Part-mine pigs were 35s. to 40s., and on to 42s. 6d., common foundry 30s. to 32s. 6d., and common forge, 27s. 6d. to 30s. Willingsworth make was quoted 32s. 6d.

The number of furnaces now blowing in South Staffordshire and East Worcestershire is returned at 29. The firms who are doing most are Mr. Alfred Hickman, who is blowing four furnaces out of six built, the Earl of Dudley, the New British Iron Company, and Messrs. Roberts and Co., each of whom is blowing three.

Inquiries were to-day—Thursday—upon the market for lots of Lincolnshire, South Yorkshire, Derbyshire, Leicestershire, and Northampton pigs. Buyers, however, were very chary in the matter of price, and sellers had to accept low terms. Derbyshires mostly remain at 34s. to 35s. delivered to railway stations in this district; Northamptons, 33s. to 34s.; Lincolnshires, 38s. to 38s. 6d.; and Thorncliffe, South Yorkshire, pigs, 47s. to 47s. 6d., without business. This is a drop on the quarterly meeting six months ago of 4s. to 5s. per ton on Derbyshires and Northamptons, and 3s. to 3s. 6d. on Lincolnshires.

Hematites changed hands, but only in moderate quantities. Cumberland firms, such as the Barrow and Carnforth Companies, quoted 52s. 6d. delivered, and for Ulverstone brand as much as 53s. 6d. was asked. Yet some of the best South Wales descriptions were freely offered at 50s., with 41s. 6d. for second qualities. These Welsh hematite prices are a fall on January last of 4s. on No. 1 and 2s. on forge sorts, while the Cumberland quotations are a drop of only 1s. 6d. per ton.

At Birmingham to-day—Thursday—the Galvanised Iron Trade Association declared prices up 5s., because of the largely increased colonial, South American, and Cape demand, and the rise in spelter. Orders are much more numerous. Black sheets, &c., also firmer, though prices were not quotably changed. Steel was offered in great variety, at £4 5s. to £4 10s. for blooms and billets, and £5 10s. for Staffordshire bars.

There was little that was encouraging in the reports of the North Staffordshire iron and coalmasters at their quarterly meeting at Stoke-on-Trent on Monday. The excessive heat of the weather seems to have had the effect of curtailing production at the forges, with the consequent reduced output of pigs. Prices showed no improvement. Not much business was transacted at the meeting, but it was hoped that the inquiries which were made would result in increased trade.

A pleasing incident took place at Dudley on Saturday, when, in the presence of a large gathering, Mr. E. Fisher-Smith, the retiring agent of the Earl of Dudley, was presented with a service of plate, which had been subscribed for by the heads of the departments. Mr. Smith is retiring after a service of forty-eight years with the noble house of Ward and Dudley. Mr. Fisher-Smith introduced Mr. Tylden Wright, his successor, who in a short address said that as coal would not grow again they must look out for fresh fields of enterprise, and he suggested that they might try and find more beyond the fault at Himley.

Some of the heavier branches of the metalliferous trades outside iron and steel manufacture are pretty favourably situated, heavy ironwork for structural purposes, machinery castings, and railway-making materials being in fair demand. Engineers are better engaged on export than on home orders, and light ironfounders are steadily employed on cheap castings for South Africa and India.

Galvanised edge-tool makers, wire netting firms, and some other manufacturers, heartily welcome the improvement in the Australian markets.

The bicycle and tricycle machine industry is very brisk at date, and the chief shops are running from six in the morning until ten at night. Export orders are being filed in heavy lots for Germany, Italy, France, Spain, and other continental markets, together with the Australian colonies, India, and even some of the Chinese markets.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business in the iron trade of this district, if it does not get actually any worse, still makes no progress towards improvement, and there has again been very little doing during the past week. There are a few inquiries stirring in the market, but in most cases buyers base these on prices so excessively low that business is not always practicable, notwithstanding that sellers still show a disposition to entertain anything in the shape of a reasonable offer. The most discouraging feature is the continued absence of anything in the future to indicate any prospect of improvement, and the complete failure of low prices to bring forward trade. The prospect before makers, both in pig and finished iron, is the very unsatisfactory one of a continued struggling on to keep works going at unremunerative prices, and a reduction of the output is gradually forcing itself upon producers as the only remedy for the present ruinous competition in the market.

The Manchester iron market on Tuesday was again more or less unsettled by the excitement of the parliamentary elections, and presented no special feature so far as business was concerned. Nominally quoted rates are without alteration. For Lancashire pig iron makers' quotations remain at about 37s. to 37s. 6d., less $2\frac{1}{2}$ per cent., for forge and foundry delivered equal to Manchester, but at these figures they are doing practically little or nothing, and where an occasional order of any moment is booked they have to meet buyers with some concession. District brands vary so much in price that it is difficult to quote any fixed current market rate. Some brands are to be got as low as 34s. to 34s. 6d., less $2\frac{1}{2}$ per cent., for forge and foundry qualities delivered equal to Manchester, whilst for others makers quote 36s. to 36s. 6d., less $2\frac{1}{2}$ per cent., delivered here as their minimum figures, but even at the lowest prices there is little or nothing doing. Outside brands offering here remain about steady as regards quoted rates, but buyers who have orders of any weight to place have no difficulty in finding sellers at under current market rates, and the best named brands of Middlesbrough foundry are to be got at about 38s. net cash, delivered equal to Manchester.

For hematite there is still only a very slow demand, and prices remain extremely low. Local-made hematites are quoted at about 49s., less $2\frac{1}{2}$ per cent., for No. 3 foundry qualities delivered equal to Manchester, but they could be got at 1s. per ton under this figure, and good Cumberland qualities at about 50s. to 51s. per ton delivered here.

In the manufactured iron trade there is still only a very small weight of business coming forward, and in some cases buyers and sellers seem rather disposed to hold back until after the quarterly meetings, although it is difficult to understand what possible change these are at all likely to bring forward. There is nothing to justify any anticipation of improvement, and it is scarcely probable that prices will come any lower. Although here and there bar iron is to be got through merchants at under makers' prices, generally there seems to be a determined stand at £4 17s. 6d. as the very minimum basis of quoted rates for either Lancashire or Staffordshire bars delivered into this district. In hoops and sheets rather more business is in some cases reported to be stirring, but no better prices are obtained; hoops delivered into the Manchester district can be got readily at £5 7s. 6d., and good qualities of sheets at £6 10s. per ton.

The condition of the engineering trades continues very unsatisfactory. It is true the returns of the trades union societies show a continued slightly decreasing number of unemployed. This month's report of the Steam Engine Makers' Society is again of a slightly improved tone, and there was a further reduction in the number of unemployed, which, as compared with the returns for March, shows a decrease of about two per cent., and there are not now more than about $3\frac{1}{2}$ per cent. of the members actually in receipt of out-of-work donation. There is, however, still no perceptible improvement in the actual condition of trade, which at the best is only returned as moderate, and although the number of unemployed continues to decrease; the returns as to the actual amount of wages paid in this district show that the men are actually earning much less, which is an indication that in a large number of cases they are only being kept on short time. The increase of activity in some classes of work which is usual at this season of the year may, of course, fully account for an extra number of men getting into employment, but the information I get from reliable sources shows no improvement whatever in the leading branches of the engineering trade in this district; tool-makers seem to be the best employed, but they are, as a rule, only moderately supplied with work, and apart from special work, other departments are only very indifferently employed, with the weight of new work coming forward still very small.

Messrs. W. Collier and Co., of Salford, who have in hand an order for a complete set of tools for the manufacture of cotton machinery, have introduced several improvements, which they are now carrying out in this class of special machine tools. Amongst these they are introducing an entirely new tool for drilling carding engine cylinders. In the present tools for this class of work the drills are actuated by spur gearing, which necessitates one-half of the drills being driven in one direction, and the other half in a reverse direction. In Messrs. Collier's new drilling machine the spur gearing is dispensed with, and the drills are all driven in one direction by means of an archimedean screw. This arrangement possesses the further advantage that a new drill can be put into any of the spindles without stopping the machine, and different lengths of drills can be used. This tool is being constructed for drilling twenty holes at once, and is adjustable for cylinders from 24in. up to 50in. diameter, and a motion is attached to each drill spindle to make it entirely independent. Another improved tool is a lathe for turning the outside surfaces of licker-in or leader rollers for carding engines, which is so arranged that it is adapted for turning two rollers at once from 7in. to 10in. diameter and in length up to 50in. This tool consists of a strong double bed with double fast-and-loose headstocks, and suitable clutch-box gearing. There are two separate sliding carriages, each fitted with a compound rest, arranged to carry two tools, so that two rollers, with two tools operating upon them, may be turned at the same time, although they may be of different lengths and diameters. This, of course, is a tool which might be applied for any purpose where two rollers or shafts have to be turned at once.

In the coal trade the demand all through continues extremely dull, and except where collieries are putting down into stock, it is only with very great difficulty they are kept going about five days a week. There is no actually quoted change in list prices, but to effect sales very low figures are taken, and there is a general want of firmness when concessions upon current market rates can bring forward business. At the pit mouth best coals average about 8s. to 8s. 6d.; seconds, 6s. 6d. to 7s.; common coals, 4s. 9d. to 5s. 3d.; burgy, 4s. 3d. to 4s. 9d.; and slack from 3s. for ordinary qualities to 3s. 9d. and 4s. per ton for the better sorts.

For shipment there is only a very poor demand, and steam coal can be bought without difficulty at about 6s. 6d. per ton delivered at the high level, Liverpool, or the Garston Docks.

Barrow.—There is a better tone in the hematite pig iron trade, and the market is more cheerful. A large tonnage of iron is being disposed of, and deliveries show a marked increase. The inquiry for Bessemer qualities of pig iron is steadily maintained, and makers are in receipt of contracts which will keep their furnaces in blast for a few months to come, at the present rate of production. There is a steady consumption of Bessemer iron by makers of steel, who in their turn are well employed both in the steel rail and tin-plate bar trade. The output of iron in this district may roughly be estimated at 27,000 tons per week. One or two of the largest works in the district are stopped altogether, while others have a large proportion of their furnaces out of blast. Stocks are not so large as they have been, and makers' delivery engagements are considerable, not only in reference to home but to continental and foreign orders. Prices show no change, and parcels of mixed Bessemer iron are offered at 42s. per ton net at makers' works, with No. 3 forge and foundry iron at 41s. per ton upwards. The steel trade is only brisk in the two chief departments already referred to. Shipbuilders are short of work, and no orders of any moment are offering. The yards of builders look more bare than they have done for many years. Engineers and ironfounders are also very short of orders. Iron ore finds a poor market, and large banks are stored in various parts of the district. Coal and coke are in steady request at late rates.

The high level bridge at Barrow has now been opened to the public, but owing to some hitch between the railway company and the tramway company a small portion of the tram line remains unfinished, which, when completed, would open out the tram route from the centre of the town to and from Ramsden Dock, It is expected the difficulty will soon be arranged.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

MR. MUNDELLA, during the course of his electioneering campaign for the Brightside division of Sheffield, dealt one evening with questions of trade and commerce. The most important item in his speech was the announcement that the treaty with Spain was likely to be sanctioned by the Cortes, and would come into operation on the 16th inst. The unfair manner in which British goods, and particularly the products of Sheffield, have been handicapped in the Spanish markets has alone been a serious cause of complaint, and the local Chambers of Commerce, as well as the Cutlers' Company, have used all their influence to get England put upon what is known as "the most-favoured-nation" treatment. In the case of Sheffield alone it is believed that our trade can be more than doubled if equitable terms are afforded by Spain. At present, French and German goods are largely taken in preference to British-made articles, and little doubt is felt that with a fair tariff most of the trade with Spain can be recovered from continental competition. While this prospect is exceedingly gratifying, it must be admitted that the outlook in the United States is not so promising. There was considerable hope that the tariff duties would have been reduced this session, but it is now felt that very little probability of another reduction can be entertained this year.

The elections are largely absorbing attention, and interfering very seriously with business in the country districts. Travellers who in their regular course would have been visiting many of the eastern counties, have not gone on their journeys, it being felt that they would have had their labour for their pains. In the towns work has not been so seriously interfered with, as the artisans, having long suffered from want of employment, are not so foolish as to neglect it for the temporary excitement of a general election. Still it will be a great relief to business houses when the turmoil is over.

There has been but a moderate business this year at the seaside resorts and other watering places. The general elections have interfered with the holidays, and many of the leading pleasure places which would, under ordinary circumstances, have been filled during the present fine weather, are now much emptier than usual, the result being that hotel proprietors, restaurant keepers, and lodging-house people are not encouraged to replenish their stocks of cutlery, plated ware, and hardware goods generally.

Although the Scotch trade remains fairly good the demand for Ireland is excessively light. Local houses continue to receive letters in which the Irish merchants complain bitterly of the evil effects of political agitation on business. The leading firm in Cork, writing to a well-known Sheffield house, states that since May business has been extremely bad, and they did not think they should ever see such times. "The gentry we do business with," add the firm, "are really the spending classes of the community, but owing to the utter demoralisation and the thorough disregard of any obligation, are deprived of their means. Though they want goods they are honest enough to do without them, as they cannot pay what they owe." The same writers say: "The most honourable people completely fail to meet their liabilities, and this cannot end in anything but utter ruin. It is hard to believe, but it is the case, and money cannot be recovered from those who owe it at present; the people have been taught so many ways to avoid their obligations. English merchants must be the sufferers when you look at the immense amount of credit they give in Ireland."

The fine summer weather which has at length set in has enabled the farmers to get their hay in in good condition, but they complain that except in favoured districts the crops will be light, and wherever one travels the root crops and spring sown cereals are seen to be suffering from want of rain. The improvement in the demand for cutlery and other goods from the United States is maintained, but is mainly in the hands of the leading houses. The colonial markets are very fair, and good orders have been received, particularly from India and Australia. Continental trade is dull in nearly all directions.

In the iron trade the make of pig, light as it is, shows further probability of a reduction, and additional notices are being given to furnace hands preparatory to damping out. From the hematite districts more encouraging reports are received. For steel rails competition gets increasingly keen; in spite of the lowness of present quotations, it looks as if bottom has not yet been touched.

House coal continues to be in very poor request. Silkstones are now making 7s. 6d. to 8s. 6d. at the pits, but other qualities can be obtained at about 6s. per ton. There is a better tone, however, in steam coal, which has been rather brisker during the last six months.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE quarterly meeting of the Cleveland iron trade was held at Middlesbrough on Tuesday last, and was thinly attended. The Consett Iron Company exhibited some fine specimens of Siemens steel ship and boiler-plates of their own manufacture, otherwise there was nothing special to mark it as a quarter day. The unfavourable returns for June have had a depressing effect on the market, and neither buyers nor sellers showed any anxiety to do business. Only a few sales were made, but it cannot be said prices were any worse than on the previous Tuesday. The majority of the merchants quoted 29s. 4½d. per ton for prompt delivery of No. 3 g.m.b., and in isolated cases 1½d. per ton less was taken. For delivery to the end of the third quarter some consumers offer 29s. 6d. to 30s. per ton for No. 3, but sales are few and far between. Makers do not care to accept these prices, and are keeping out of the market at present.

Warrants are 29s. 6d. to 29s. 9d. per ton, but there is little business done in them.

The stock of Cleveland pig iron in Messrs. Connal's store at Middlesbrough amounted on Monday last to 258,852 tons, the increase for the week being 3976 tons. At Glasgow the increase for last week was 2716 tons, the quantity in store being 782,382 tons.

There is no new feature to report with regard to the finished iron trade. Orders are as scarce as ever, and prices are unaltered. Steel manufacturers are busy. Heavy sections of steel rails can be bought at £3 12s. 6d. per ton, and steel plates at £6 per ton—on trucks at makers' works, cash 10th, less 2½ per cent.

The Cleveland ironmasters' statistics for June were issued on the 5th inst. They show that only 94 furnaces are at work, out of 156 built in the district. The total make of pig iron of all kinds in the whole district during the month amounted to 202,131 tons, a decrease of 8918 tons when compared with May. The stocks show a considerable increase. The total quantity held in the whole district on June 30th amounted to 689,185 tons, being an increase of 19,413 tons for the month. The shipments for June were only 63,903 tons, being 7134 tons less than in May, 1886, and 13,166 tons less than in June last year. The principal items in last month's shipments were as follows:—Scotland, 29,859 tons; Germany, 6230 tons; Wales, 4740 tons; Holland, 3335 tons; Belgium, 2365 tons; Norway and Sweden, 2320 tons; Italy, 2133 tons; and America, 2083 tons. The quantity of manufactured iron and steel shipped last month was 34,386 tons, being 8434 tons less than in May.

Messrs. Dorman, Long, and Co., of Britannia and West Marsh Ironworks, Middlesbrough, commenced a few days since to erect two Siemens-Martin furnaces for the manufacture of steel.

On Saturday last the Consett Iron Company gave its men fourteen days' notice, and at the end of that time the workmen will be re-engaged, subject to a day's notice to cease work.

The net average selling price of Northumberland coal for March, April, and May, 1886, was 4s. 7·31d. per ton, being a decrease of ·69d. upon the standard average selling price of 4s. 8d. Under the sliding scale arrangement, there will be no alteration in the present rate of wages for underground workmen and banksmen.

The dispute between the Stockton and Middlesbrough Water Board and their contractors, Messrs. Walter Scott and Co., as to the difficulties which have arisen during the execution of the contract for the Hury reservoir is not yet settled. A special meeting of the Board was held on the 28th ult., to discuss the recommendations of the engineer, Mr. Mansergh, relative thereto. The main questions to be decided were two, viz., first, to what extent, if at all, the contractors' claim for £4131 for extra work already done should be allowed; and secondly, to what extent, if at all, the schedule of prices attached to the contract should be modified for that portion of the work which still remains to be done. After some discussion, a resolution was passed to the following effect, viz.: "That Mr. Mansergh be empowered to readjust the schedule of prices for the work remaining to be done on the basis recommended and explained by him; that the clerk to the Board be instructed to take care that the rearrangement be so worded as not to void the existing agreement and bond; and that the schedule as modified be applicable to any extension of the trench which may hereafter appear necessary."

There is a tendency to alter the method of winning salt on the banks of the Tees, in accordance with experience gained since the industry commenced some years ago. The bore holes hitherto put down have been made by Beaumont's diamond drill. Two of the salt companies are now contemplating the employment of the method which has been so successful in America and elsewhere for making oil wells. The system has also, it is said, been adopted in the United States for brine, but so far it is a new application as regards England. The plan of putting one tube inside another, the annulus being for the introduction of fresh water, and the inner tube for the suction of brine, is also now found not to be the best possible. The salt is thereby taken firstly and mainly at the lower end of the tube, and when it is cleared away the end of the tube becomes broken or bent for want of lateral support, and by reason of the distortion of the strata, which generally ensues. It is found better to have a single tube of wrought iron or steel for suction of the brine and another similar tube some distance off for the introduction of fresh water. By this means the salt is drawn from a more extended area, and the danger of damage to the tubes is not so great. Besides, if either of the single tubes break, there is not necessarily any stoppage or inconvenience.

The Belgians are competing with the North of Engand in bridge work and other material in a somewhat unpleasant manner. A short time since a steamer arrived in the Tees from Antwerp with 600 tons on board for India. It was immediately unloaded and transferred to a large export vessel about to sail for Bombay. A quantity of material used in and about mines, such as girders, rails, locomotives, winding engines, pulleys, wire ropes, and so forth, for the production of which the North of England is eminently suited, is now going to Spain from Belgium and Germany, and English producers are not even invited to quote. The reason for this is that the Spanish import duties favour those countries, to the disadvantage of this country. The Belgian bridge and girder work appears, in finish and in quality of material used, much inferior to the English, but cheapness, arising from less duty, settles the question in nine cases out of ten. It is hoped that the new Anglo-Spanish commercial treaty will come into operation by the end of July; but there is strong opposition from certain Spanish interests, and many doubt that it will be carried out at all even now. Señor Sagasta, the Prime Minister, is, however, an able man of broad ideas and strong will, and does not share the unreasoning anti-English feeling so prevalent in the peninsular. It is much to be hoped he will prevail. If he does, it should do something to help us to better times in the iron trade. England, with fair-play, should be able to defy competition in her own specialities in Spain at all events.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE excitement of the elections has been very great in Scotland this week, and has naturally distracted attention from business. For this and other reasons the iron market has been inactive, and the quotations of pigs have declined from the slight improvement established towards the close of last week. Fewer inquiries have been received, and the amount of transactions is pronounced unsatisfactory. The shipments of pig iron from Scotch ports in the past week were small, being 6424 tons, as compared with 5694 in the preceding week, and 7410 in the corresponding week of 1885. Early in the week there was some interruption at the ironworks in consequence of the colliers being idle discussing the reduction of wages; but otherwise there is no material change in the amount of production. The continued addition to stocks here and in Cleveland has a most depressing effect.

Business was done in the Glasgow warrant market on Friday up to 39s. cash. On Monday the quotation declined to 38s. 9½d. A further decline occurred on Tuesday to 38s. 7½d., closing at 38s. 8d. cash. On Wednesday transactions occurred at 38s. 7d. to 38s. 8d. cash. To-day—Thursday—the market was quiet, with business up to 38s. 9½d., closing with buyers at a penny less.

For makers' shipping iron the demand is limited, and the quotations are without much change, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 43s.; No. 3, 41s.; Coltness, 46s. 6d. and 43s.; Langloan, 43s. and 41s.; Summerlee, 45s. 6d. and 41s.; Calder, 46s. and 41s.; Carnbroe, 42s. and 39s. 6d.; Clyde, 42s. 6d. and 39s. 6d.; Monkland, 39s. 6d. and 36s.; Quarter, 39s. 6d. and 35s. 6d.; Govan, at Broomielaw, 39s. 6d. and 36s.; Shotts, at Leith, 44s. and 43s.; Carron, at Grangemouth, 47s. 6d. and 44s. 6d.; Kinneil, at Bo'ness, 43s. and 42s.; Glengarnock, at Ardrossan, 42s. 6d. and 39s. 6d.; Eglinton, 39s. 3d. and 36s. 3d.; Dalmellington, 40s. 6d. and 38s.

One or two steel-making firms now complain of a scarcity of orders, and all appear dissatisfied with the present low prices.

The shipments of iron and steel manufactured goods from Glasgow in the past week embraced machinery to the value of £2672; locomotives, £8638, mostly for Bombay; sewing machines, £3500; a steamer shipped in pieces for China, £2610; steel goods, £7550; and general iron manufactures, £30,500.

In the shipping department of the coal trade there has been more activity in the past week, and the aggregate quantity sent away from the different ports is considerably larger than in the corresponding week of 1885. At Glasgow 29,444 tons were shipped; Greenock, 2421; Ayr, 7487; Irvine, 2219; Troon, 6531; Burntisland, 18,486; Leith, 4136; Grangemouth, 15,642; Bo'ness, 11,188. The continued low prices make coalmasters very anxious to sell as much as possible, the return on individual quantities being so small. As yet there is no difficulty in obtaining supplies to meet every demand, although the colliers in some localities are endeavouring to curtail the output.

Since last week the reduction of miners' wages has become much more general. At the ironmasters' as well as at the salemasters' pits, the reduction is being effected, and a large proportion of the miners were idle in the early part of the week. The leaders of the men are, however, evidently convinced that resistance is hopeless. Were it resorted to in the case of the ironmasters' pits, a lock-out would certainly be the consequence, as at most of the works there are large stocks of pig iron that would supply the market for a considerable time.

Returns are now available of the foreign shipping trade of the Clyde during the first half of the present year. The arrivals embraced 713 vessels, with an aggregate tonnage of 628,919, as against 785 vessels, and 674,004 tons in the first six months of 1885. The sailings included 752 ships, of 756,554 tons, compared with 827, of 807,785 tons in the corresponding period.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

I HAVE just seen a good proof of the excellence of the steel rail make of Wales. At Talgarth they are now relaying on the Mid-Wales, taking up a rail made at Dowlais in 1870 and turning it. As regards wear, it would have lasted a good deal longer but for the indentations underneath. Sixteen years is a good life for a rail, and it shows that one great item of expense in railway management is considerably lessened. Not only is the period of renewals lengthened, but the number of platelayers reduced to a minimum. Yet steel rails at £3 10s. do not command a free sale. The only cargo of any importance this week has been 1200 tons to Montreal. There is a slightly freer demand from home railways, and Malta and Bordeaux figure a little for bar iron.

The principal demand at the steel works continues to be steel bar for tin-plate, and Dowlais and Cyfarthfa appear to have their share. There is also a little doing in steel sleepers, but so far to an inconsiderable extent. This is not surprising when it is seen what a quantity of "pickled" sleepers the leading railways have in stock, and which must be used before the question of steel sleepers is practically brought before directors.

The Rhymney Iron Company shows favourably by last audit, considering the bad times that have prevailed so long; but though a dividend might have been returned, the directors wisely refrain. The prospect of one next quarter is now fairly assured. Mr. Benjamin Robert Jones has retired from the management of Rhymney on account of ill-health, and will probably be replaced by Mr. Trump.

I note that Mr. Roberts, the oldest roll turner at Dowlais, is dead. Under Mr. Menelaus he executed some important contracts in the early days of steel making.

Little notice has been paid to the death of Mr. Edward Williams, of Middlesbrough, one of the most scientific and energetic of ironmasters. I understand that his biography is in the hands of Major Jones, of Cardiff, the American Consul, who had special opportunities for knowing the characteristics of the successful Welshman. Mr. Jenkins, of Consett was, like Mr. Williams, one of the "boys" of Mr. Menelaus, at Dowlais.

The accumulation on railway sidings of coal trucks is prodigious. Last week the coal export from Cardiff was 50,000 tons less than an ordinary average twelve months ago, and at all the ports there is a serious falling off. I find that nearly all the large steam coal collieries are in the same state of slackness. Cyfarthfa for the last six months has only worked 2½ days per week, and lately one day is the rule. Plymouth keeps on as well as the best. Merthyr Vale, Harris Navigation, and the leading collieries in the Aberdare Valley are all slack, and though prices are reduced to their lowest figure buyers keep aloof. Men who have grown grey in the coal trade say that they have never known trade so bad, and until the general industries of the country are more active it is useless to look for improvement.

Pitwood is fairly brisk at 15s.

The advance in tin-plate is maintained, and makers are firm in resisting attempts to bring down quotations. It was thought that when tin stopped in its rapid movement upward, tin-plate would show signs of falling again. Fortunately, this is not the case, and a large make is going on at satisfactory figures. The chief demand is for ordinary coke plate, and wasters especially are in request. Bessemer and Siemens with special sizes are also inquired after.

I am sorry to record a falling-off in patent fuel. From Cardiff especially the return last week showed badly.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE iron business has this week been very sluggish. In bars, sellers are more numerous than buyers. The girder trade is very bad, although a great deal of building is going on in the large towns, where girders are in good request, but the prices have been long unremunerative, and are still going back, in spite of the above demand. For boiler plates there has been a regular sale, and the prices have kept up to those fixed by the Convention. The wire mills complain of no demand from abroad, consequently offers are the rule and prices in favour of the buyers. The demand for steel rails is becoming less and less, and as old orders are worked off there are none to replace them, but still in the near future there are certain small lots which will be given out for native railways, but for orders for abroad no good news is stirring, and, indeed, it is not at all likely that the works here will accept orders at M. 68 to 70 per ton, as is reported has been done in England lately. The locomotive and wagon factories have booked some small native orders, and more are shortly expected to be given out. In general they are all to a moderate extent employed on old orders. The machine and boiler shops and foundries all require more work to keep them any way employed full time. The prices of the various sorts of iron and steel rails remain the same as given in the last report; the same as regards coal and coke; wrought iron rails, M. 80·50 to 94. It is reported here that a works near Naples will shortly be in a position to make 100,000 tons of steel rails per annum.

The production of pig iron in Germany—including Luxemburg—in the month of May, 1886, was 282,236 m.t., 138,997 tons of which was forge pig and spiegeleisen, 37,614 m.t. Bessemer, 76,487 tons basic, and 27,038 foundry pig. The production in May, 1885, amounted to 318,606 m.t. From January 1st to the end of May, 1866, there were produced 1,427,572 tons, against 1,561,400 for the same period last year.

The first of the subsidised steamers, the Stettin, built by the Vulcan Shipbuilding and Engineering Company at Stettin, for the North German Lloyd Company at Bremen, has just completed her six hours' trial run at sea. Her average speed is reported to have been 12·77 knots, whilst the guaranteed speed was to have been 12½ knots, her maximum speed having reached 13¼ knots. She will now take her station at Bremen preparatory to the opening of the regular service between Germany and Australia and Japan. In connection with this event a paragraph has appeared in a commercial organ which, whilst apologising for its introduction here, it may not be uninteresting to communicate. It runs as follows:—"The approaching opening of the German steamship line to Australia and the East is causing in business circles in London a very marked feeling of anxiety. Even whilst the German competition up to this was carried on under such difficult conditions, the English export trade to Australia had begun to find out what a dangerous rival it had in Germany, but now the situation is likely to become more and more unfavourable to English enterprise, because the attractions of German ports for over-sea goods will be sure to become greater as soon as the German line is opened. It is a fact that those in England who are most capable of giving an opinion, and whose interests are most affected, are beginning to doubt whether London will much longer be able to maintain the monopoly it has hitherto enjoyed as an entrepôt for the rest of the world. The transit and entrepôt business of London has declined 10 per cent. within the last five months, the greater part of which has been transferred to the German North Sea ports."

The copper producers here are agitating for a duty on the raw material and on copper and brass scrap which now enters free of duty. But in consideration of the large quantity of worked-up material which is made and afterwards exported, it is scarcely probable that the Government will entertain the proposition, especially as the metal workers are getting up a counter agitation. It appears that 15,698 tons of raw material were imported last year, whilst 15,406 tons of metal wares were exported. In this connection it may be mentioned that the metal workers' official organ declares that the German metal wares are quite shouldering out the English even in what used to be reckoned upon as our own markets abroad and in our Colonies, and that to maintain the situation every effort must be made and advantage sought, which a duty on the raw material would at once cripple.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, June 26th.

ALTHOUGH the improvement in our commercial world is slow, it is undoubtedly steady and sure. There is no longer any apprehension of serious trouble, and consequently trade is increasing in all our large industrial centres. Yet it cannot be said that there has been any sensible advance in prices, and the high-water marks on the Stock Exchange in the great cities of the United States have shown pretty favourably with the water marks of the same time last year. There is neither a swell nor a shrinkage in our markets. We are in a state of expectancy, and only keep floating until we see a little farther ahead. The knowing ones seem to anticipate higher prices during the next two or three weeks; but while working with a certain degree of satisfaction, they hold their purses very tight, and are slow in giving any large orders. Withal, there seems to be plenty of money ready for investment in railroad bonds at advancing prices. Our crops promise to be good both in quantity and quality, and this will have the tendency of increasing exports and checking gold shipments, thereby leaving us with a large surplus for next year, which will make our home values cheaper still. There is hardly any fear that the present Congress will have anything to do with the tariff or the currency, and this source of anxiety exists only in the most nervous minds. Builders are hard at work. The working men are mostly satisfied, and everything points to a fairly prosperous season in this interest. In the real estate line there is a great deal doing in a private way, which means in a more or less speculative way.

Lumber dealers have met with strong opposition to the movement set on foot and agitated for some time, to the effect of forming lumber exchanges in all the great cities of the United States, and especially New York city. The opponents of this movement claim that honesty reigns everywhere among lumber manufacturers and dealers generally. The two camps are pretty equally divided at present. One is anxious to have a protective guard, and the other wishes to move about freely and independently. They are both seemingly exultant, and their business is booming. First-class lots of walnut, ash, cherry, and poplar are in fair demand. Oak is gobbled up in no time by dealers, and they cry for more. It is only now that our Eastern cities are feeling the effects of the slack season which we have just traversed. Boston seems to be fairly supplied just now with all kinds of lumber. The arrivals last week include six cargoes of 2066 pieces, some being ordered and the remainder for yard purposes. In Chicago, building timber is in good demand. Lake arrivals are numerous; cargoes chiefly of basswood, birch, and maple. Hardwood lumber and timber amount to nearly 4,000,000ft. each week. The Gulf Coast cypress is growing in favour. The beer brewers of the West have discovered the durability of it, which makes it very valuable to them for vat purposes.

The iron trade is receiving some impetus just now, as numbers of railroads are in course of extension all over the United States. Our exports are lagging, and exporters say the foreign markets are plethoric with supplies, and they predict a dark outlook for some time to come. In Philadelphia the equilibrium is re-established, and although large buyers are still a little sluggish and cautious, their nervousness has entirely disappeared. Business all around is getting steady, with a fair prospect of booming up pretty soon.

NEW COMPANIES.

THE following companies have just been registered:—

Aireside Steel and Iron Company, Limited.

This company proposes to take over the property and effects of the Aireside Hematite Iron Company upon terms of an agreement of 28th May. It was registered on the 26th ult. with a capital of £125,000, in £10 shares. The purchase consideration is £61,124 10s. 3d., payable £41,124 10s. 3d. cash, and the balance in fully-paid shares. The subscribers are:—

	Shares.
*Joseph Ledger, Keswick, ironmaster	1
*L. Cooper, Kirkstall, Leeds, ironmaster	1
*C. J. Valentine, M.P., Workington, ironmaster	1
*W. Scott, Newcastle, contractor	1
R. Wigram, Leeds, engineer	1
W. Dughton, Workington, engineer	1
A. R. Hill, Leeds, ironfounder	1

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

Australasian Ice and Cold Storage Company, Limited.

This company purposes to erect factories in Australia, New Zealand, or elsewhere, for the manufacture of ice and ærated waters and beverages, and to establish cold stores for the preservation and freezing of perishable articles of food. It was registered on the 29th ult. with a capital of £100,000, in £5 shares, with the following as first subscribers:—

	Shares.
C. M. Fabre, 79, Mark-lane, wine merchant	1
S. Coombs, 11, Wincott-street, Kennington-road, engineer	1
E. T. Read, 80, Lombard-street	1
C. E. Pakeman, 7, Ferncliff-road, Dalston, clerk	1
A. Sintzewick, St. John's College House, Highgate	1
Isaac Fuller, 8, Old Jewry	1
J. A. Codd, 11, Queen Victoria-street	1

The number of directors is not to be less than three nor more than seven, resident in England, and not less than two nor more than three, resident in each colony. In pursuance of an agreement of the 1st ult., the Ice Factory Construction Company, Limited, have the right to appoint two duly qualified persons as directors, and subject thereto the names of the first directors will be determined by the subscribers, every shareholder being qualified; remuneration, £100 per annum to each member of the London board, with an additional £10 each for every 1 per cent. dividend in excess of 8 per cent. per annum upon the paid-up capital. The London board will appoint the remuneration of the Colonial directors.

Ball's Patent Dredger Company, Limited.

Upon terms of an agreement of the 27th of May, this company proposes to acquire and work various letters patent granted to Charles Julius Ball for dredging apparatus and appliances. It was registered on the 26th ult. with a capital of £14,000, in £20 shares. The purchase consideration is £2000 cash, 550 fully-paid B shares, and 50 per cent. of the net profits until a further sum of £5000 has been paid to the vendor. The subscribers are:—

	Shares.
J. R. Ellerman, 10, Moorgate-street, chartered accountant	1
J. A. Postans, 69, Lombard-street, secretary to a company	1
*F. J. Browne, C.E., Ealing Dean	1
W. M. Douell, 2, Lawn road, East Dulwich	1
*E. M. Wright, 69, Lombard-street, merchant	1
*C. Ball, C.E., Marsonette-street, St. Leonards	1
V. P. Jenkins, 16, Leadenhall-street, solicitor	1

The number of directors is not to be less than three nor more than seven; qualification, five shares; the first are the subscribers denoted by an asterisk, and Mr. J. Jackson; the company in general meeting will determine remuneration.

Charles Nelson and Company, Limited.

This company was constituted by deed of settlement on the 27th of April, and was registered on the 28th ult. as a limited company with a capital of £100,000, divided into 200 preference and 200 ordinary shares of £100 each. It proposes to carry on business as lime burners, cement manufacturers, brick and tile manufacturers, quarry owners, stone merchants, and paviors. 500 shares are taken up, and upon 204 the full amount is paid up, and upon the remaining 296 shares £80 per share has been paid. The members are:—

	Shares.
G. H. Nelson, The Lawn, Warwick, manufacturer	}
E. M. Nelson, Ealing, manufacturer	} 200
*T. P. Blyth, Rugby, cement manufacturer	}
T. P. Blyth, Rugby, cement manufacturer	148
*W. W. Blackstone, 40, Camden-square, cement manufacturer	148
F. J. Roberts, 164, Sutherland-gardens, W., barrister	1
J. Blackstone, 6, Albert-terrace, Regent's Park, surgeon	1
G. Nelson, The Lawn, Warwick, manufacturer	1
C. M. Nelson, Rugby	1

The number of directors is not to exceed seven; qualification, £500 of nominal capital. The first directors are the subscribers denoted by an asterisk. The remuneration of each managing director will be £500 per annum, and of the ordinary directors such sum as the company in general meeting may determine.

Cycloidal Screw Propeller Company, Limited.

Upon terms of an agreement of the 18th ult. this company proposes to acquire certain British and foreign patent rights granted to George Edward Vaughan and William Charles Hallett for improvements in screw propellers. It was registered on the 25th ult. with a capital of £20,000, in £10 shares, whereof 1100 are 7 per cent. cumulative preference shares. The purchase consideration is as follows:—£3000 in fully-paid ordinary shares to Lord Alfred Paget, and £3000 in cash and £6000 in fully-paid ordinary shares to Mr. Hallett. The subscribers are:—

	Shares.
*T. H. Bryant, Juniper Hall, near Dorking	30
*M. B. Lucas, 18, Penywern-road, South Kensington	30
*Captain V. O. Inglefield, R.N., 107, Victoria-street	30
*W. C. Houstoun, 8, Grosvenor-mansions	30
E. F. Mogg, Lebanon-gardens, Wandsworth	1
F. J. Fox, 123, Loughborough-road, Brixton	1
R. G. Fuller, 19, Devonshire-terrace, Notting-hill-gate	1

The number of directors is not to be less than three nor more than six; qualification, thirty shares; the remuneration of the board is not to exceed £300 per annum, or be less than £150 per annum, and a further sum of £20 per annum for each director for every 1 per cent. dividend in excess of 10 per cent.

Dixon, Horsburgh, and Co., Limited.

This company proposes to acquire the business formerly carried on by the Mendip Paper Mills Company in the out parish of St. Cuthbert, in Wells, and the parish of Wokey, Somerset. It was registered on the 24th ult. with a capital of £30,000, in £500 shares. The subscribers are:—

	Shares.
*Joseph Dixon, Oughty Bridge, Sheffield, paper manufacturer	8
George Dixon, Bruntliffe, land agent, &c.	4
*R. Horsburgh, South Darenth, Kent, paper manufacturer	8
J. Horsburgh, Cullompton, Devon, paper manufacturer	2
*G. Johnston, 71, Hayter-road, Brixton, paper manufacturer	5
W. Liddle, C.E., 55, Blundell-street, Caledonian-road, N.	1
G. Liddle, Newton Colliery, Glasgow, colliery manager	1

The number of directors is not to be less than three nor more than five; the first are the subscribers denoted by an asterisk, and John Dixon, of Scholecroft, Brincliffe, Leeds; the qualification for future directors will be £2000 in shares; the company in general meeting will determine remuneration.

Elizabeth Tin Mine, Limited.

This company proposes to acquire and work a mineral property situate in the parish of St. Blazey, Cornwall. It was registered on the 29th ult. with a capital of £25,000, in £1 shares. The subscribers are:—

	Shares.
*F. W. Summers, 5, Homerton-road, Hackney	1
E. Carter, 52, Finsbury-pavement, secretary	1
S. Bleach, 24, White-street, printer	1
T. H. T. Rogers, 3 and 4, Great Winchester-street, solicitor	1
G. P. T. Chave, 3 and 4, Great Winchester-street, solicitor	1
C. Bennett, M.E., 6, St. Stephen's-avenue, Shepherd's-bush	1
W. Scott, 3, Broad-street-buildings, accountant	1

The number of directors is not to be less than three nor more than five; the first are Messrs. Simeon C. Hadley, C. H. De Mortimer-MacIntosh, and F. W. Summers; remuneration, £1 1s. to each director for every meeting attended, and 10 per cent. of the balance of net profits remaining after payment of 10 per cent. dividend.

Horsehay Company, Limited.

This company proposes to operate upon and to work or manufacture ores, minerals, and metals of all description, and for such purposes to acquire the business and assets of the Coalbrookdale Company, Limited, of Horsehay, Salop. It was registered on the 24th ult. with a capital of £100,000, in £1 shares, with the following as first subscribers:—

	Shares.
E. D. Reynolds, 3, Clement's-lane, merchant	1
H. Carter, 3, Clement's-lane, merchant	1
T. Abercrombie Welton, 5, Moorgate-street, chartered accountant	1
H. J. Millner, 7, Laurence Pountney-hill, secretary to a company	1
Alexander Taylor, 7, Laurence Pountney-hill, merchant	1
W. Carter, 122, Cannon-street, iron merchant	1
Robert Turner Rohde, 40, Threadneedle-street, banker	1

The number of directors is not to be less than three nor more than seven; the first are Messrs. Frederick Monks, Warrington, Lancashire; Wm. Gregory Norris, of Coalbrookdale; E. Lovell Squire, of Coalbrookdale; H. Charles Simpson, the present manager of the Horsehay Works; and T. Abercrombie Welton; qualification, 250 shares; the company in general meeting will determine remuneration.

Hampton Plains Syndicate, Limited.

This syndicate proposes, with a view to the early formation of a large land and colonisation association, to acquire 1,340,000 acres of land in Hampton Plains, Western Australia, and an Act from the Australian Government authorising the construction of a railway from Hampton Plains to Esperance Bay, with or without a Government subvention in land or otherwise. Also to acquire land lying between Hampton Plains and Esperance Bay and in Western Australia. It was registered on the 29th ult. with a capital of £20,000, in £100 shares. The subscribers are:—

	Shares.
Colonel J. T. North, Eltham	2
T. E. Goddard, St. Michael's-alley, Cornhill	1
A. S. Dimsdale, 1, Acacia-road, Wood-green	1
W. C. Petmon, 5, Dorville-road, Lee	1
H. Chaplin, 19, Lincoln's-inn-fields	1
F. J. Smith, Island Cottage, Chiswick	1
G. Bush, C.E., Gracechurch-street	1

Registered without special articles.

Samuel Kidd and Co., Limited.

This company proposes to take over and carry on the business of millers and corn, flour, and grain merchants, carried on by S. Kidd and Co., at Isleworth, Middlesex, and also the businesses of White, Wright, and Co., of New Crane Mills, Shadwell, and of Richard Wright and Sons, of 37, Mark-lane-chambers. It was registered on the 24th ult. with a capital of £150,000, in £100 shares. The subscribers are:—

	Shares.
*W. Podger, Isleworth Mill, miller	1
*H. R. Perry, Isleworth, miller	1
*Wm. White, jun., New Crane Mills, Shadwell, miller	1
*A. R. Wright, 37, Mark-lane-chambers, flour merchant	1
*C. Sherriff, 43, Church-street, Isleworth, miller	1
W. Regester, Lawn Lodge, Isleworth	1
Robert Perry, Isleworth Mills, miller	1

The number of directors is to be five; qualification, £5000 of share capital; the first are the subscribers denoted by an asterisk. Messrs. H. R. Perry, Wm. White, and A. R. Wright are appointed managing directors for ten years, and will each be entitled to £1000 per annum for salary. Mr. C. Sherriff is appointed director and salesman for a like period at a salary of £600 per annum. Mr. Wm. Podger is appointed chairman. The directors will also be entitled to travelling and other expenses and to one-third of the surplus profits remaining after payment of 5 per cent. per annum upon the preference shares, and 10 per cent. per annum upon the ordinary shares.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—J. A. Smith, chief engineer, to the Alacrity; J. G. Stevens, engineer, to the Alacrity; E. J. Taylor, assistant engineer, to the Camperdown; H. Cook, chief engineer, to the Acorn; W. H. Gulliver, staff engineer, to the Orlando; G. Harding, chief engineer, to the Icarus; and F. Wain, acting assistant engineer, to the Jumna.

THE SCHOOL OF ELECTRICAL ENGINEERING.—The School of Electrical Engineering in Princes-street, Hanover-square, which is under the management of Mr. W. Lant Carpenter, D.Sc., has for some years been widely known through the success of those who have been educated in it. For several years it has attracted numerous students from abroad, and recently a curious proof of the appreciation in which it is held by past students was shown by the translation into Italian by one of them, and the publication in *Elettricita*, of the descriptive *brochure* of the school published under Dr. Carpenter.

SOCIETY OF ARTS.—The hundred and thirty-second annual meeting of the Society of Arts was held on Wednesday, June 30th, at the Society's House in the Adelphi. The annual report was read by the secretary, and contained the usual summary of the proceedings of the session of the Society just concluded. Seventy-six meetings were held, at which papers had been read and discussed, or lectures delivered. The total number of members of the Society is now 3657; the financial condition of the Society is prosperous, the revenue of the past year having amounted to £13,450, against an expenditure of £12,000, with an excess of assets over liabilities of £13,000. A ballot was taken for the new council, and resulted in the re-election of H.R.H. the Prince of Wales as president, and the following, amongst others, as vice-presidents:—H.R.H. the Duke of Edinburgh, K.G., H.R.H. Prince Albert Victor of Wales, K.G., the Duke of Abercorn, C.B., the Duke of Manchester, K.P., Lord Alfred S. Churchill, and Lord Sudeley. Twelve ordinary members of council and two treasurers were also elected, and Mr. H. Trueman Wood as secretary.

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.

29th June, 1886.

8494. REFINING MINERAL OILS, R. Tervet, Glasgow.
8495. VELOCIPEDES, E. H. Hodgkinson, London.
8496. COMPOSITION for GLOSSING LINEN, J. Dawson, Manchester.
8497. UTILISING ELECTRICITY, A. F. St. George, Surrey.
8498. CHAIRS, B. J. Bing, Paris.
8499. DRIVING in MULES, T. L. Daltry, Manchester.
8500. TAKING the WEIGHT of the HORSES in STARTING TRAMCARS, &c., by LEVER, T. Charlton, near Newcastle-on Tyne.
8501. PORTABLE GALVANIC BATTERIES, W. L. Gates, London.
8502. FURNACE BARS, T. Norman and H. S. Motteram, Sheffield.
8503. IMPROVING the HUMAN COMPLEXION, C. H. Ashdown, St. Albans.
8504. FASTENINGS for SHUTTERS, S. Bott and C. Homer, Birmingham.
8505. SWITCHES, C. M. Dorman, Manchester.
8506. PRESSES for RACQUETS, &c., B. T. Ffinch, Sind.
8507. VELOCIPEDES, W. Phillips, London.
8508. STOPPERS for BOTTLES, R. E. Phillips.—(*M. Dauroy, France.*)
8509. DISINFECTANTS, A. Boake and F. G. A. Roberts, Stratford.
8510. INDESTRUCTIBLE WICKS for LAMPS, G. Asher and J. Buttress, Birmingham.
8511. AUTOMATIC DISENGAGING GEAR for ELEVATORS, &c., G. Hudson, Sunderland.
8512. VEHICLE, W. Eaves, Birmingham.
8513. MANUFACTURE of CARBON FILAMENTS, W. Maxwell Fulham.
8514. FASTENINGS for BELTS, J. Whitehead, Newcastle-on-Tyne.
8515. BALL BEARINGS for VELOCIPEDES, J. Dring and H. J. Pausey, London.
8516. SEWING, L. Muther, London.
8517. BARBED WIRE, F. B. W. Malet, South Kensington.
8518. METAL BARS or FRAMES, G. J. Atkins, London.
8519. STEAM ENGINES, J. S. Raworth, London.
8520. COPYING-PRESSES, J. McAuliffe, Greenwich.
8521. IMPROVED MATERIAL for NECKTIES, &c., J. Frankel and L. Fisher, London.
8522. SEWING MACHINES, A. Anderson.—(*The Singer Manufacturing Company, United States.*)
8523. SURFACE CONDENSERS, A. Myall.—(*J. McIntyre, United States.*)
8524. PIANOS, W. Simkins, London.
8525. EFFECTING the PROPULSION of the HUMAN BODY in WATER, G. G. M. Hardingham, London.
8526. APPARATUS for the MANUFACTURE of GLASS BOTTLES, &c., J. R. Windmill, Middlesex.
8527. SADDLES for VELOCIPEDES, A. J. Eli, London.
8528. IMPROVEMENTS in DETERGENTS and DYES, C. P. Andersen, London.
8529. SPRINGLESS DOOR LATCH, J. W. Radford, London.
8530. APPARATUS for RAISING WEIGHTS, W. L. Wise.—(*V. Popp, France.*)
8531. MANUFACTURE of ALUMINIUM, F. I. R. Seaver.—(*E. C. Kleiner-Fiertz, Switzerland.*)
8532. ROLLER GRINDING MILLS, R. Morrell, London.
8533. STEAM GENERATORS, &c., H. E. Newton.—(*R. A. Chesebrough, United States.*)
8534. STAND for BEAM SCALES, &c., W. B. Avery, London.
8535. WEIGHING MACHINES, &c., W. B. Avery, London.
8536. KITCHEN, &c., SALT, S. S. Bromhead.—(*A. Munetrez, Paris.*)
8537. LUMP SUGAR, J. Schwartz, Chislehurst.
8538. PIANOFORTE ACTIONS, J. Delerue, London.
8539. SELF-WINDING CLOCKS, J. G. Lorrain, London.
8540. CIGARS, &c., A. G. Goodes, London.
8541. CALCULATING APPARATUS, J. V. Charpantier, London.
8542. ELECTROLYTIC TREATMENT, E. Fürst, London.
8543. GAS LAMPS, A. J. Boult.—(*A. Hanniet, Belgium.*)
8544. MACHINERY for MAKING CAKES, &c., J. A. Baker, W. K. Baker, and G. S. Baker, London.
8545. COMBINED COOKING and HEATING STOVES, Q. S. Backus, London.
8546. RAILWAY SIGNALS, F. Stitzel and C. Weinedel, London.
8547. BOOTS, SHOES, &c., G. Rate, London.
8548. FURNACES, H. H. Lake.—(*G. E. Benninghoff and C. F. Jewell, United States.*)
8549. UTILISING GAS VAPOURS, H. H. Lake.—(*G. E. Benninghoff, United States.*)
8550. MAIL BAGS, H. H. Lake.—(*L. W. Freeman, United States.*)
8551. HORSESHOES, H. H. Lake.—(*Improved Horseshoe Company, United States.*)
8552. CLOCKS, H. H. Lake.—(*The New Haven Clock Company, United States.*)
8553. MUSICAL INSTRUMENTS, B. Fleck, London.
8554. BEARINGS for DRAWING ROLLERS of SPINNING FRAMES, &c., J. Booth, London.
8555. APPARATUS for USE in LEARNING to PLAY the PIANOFORTE, &c., H. H. Lake.—(*A. K. Virgil, United States.*)

30th June, 1886.

8556. BIT for BORING HOLES, A. Paice, Ryde.
8557. WEAVERS' SHUTTLES, J. Waddington, Bradford.
8558. WATER-CLOSET BASINS, T. W. Twyford, Longport.
8559. POTTERS' LATHES, J. R. Pratt, Longport.
8560. LOUVRE BRICK VENTILATOR, G. A. Barlow, Stoke-on-Trent.
8561. STOPPERS or CAPS for TOBACCO-PIPES, J. Storer, Glasgow.
8562. SILOS, R. H. Fraser, Glasgow.
8563. PACKAGES, BOXES, &c., R. H. Fraser, Glasgow.
8564. ELECTROLYTIC PRODUCTION of ALUMINIUM, Baron de Overbeck.—(*H. de Grousilliers, Germany.*)
8565. FLUSHING WATER-CLOSETS, G. Oulton, Liverpool.
8566. THERMOMETERS, A. Haddow, Edinburgh.
8567. SHOES for HORSES, &c., J. Grant and W. Wilson, Sheffield.
8568. TIPPING WAGONS, &c., R. Wadsworth, Halifax.
8569. CHRONOGRAPHS, W. H. Douglas, Birmingham.
8570. AUTOMATIC NON-CONDENSING EXHAUST STEAM TRANSMITTER and REGENERATOR, J. C. Revill, Nottingham.
8571. VELOCIPEDES, E. P. Howe, London.
8572. PLATES for RETAINING or SECURING ARTIFICIAL TEETH by ATMOSPHERIC SUCTION, A. P. Patterson, London.
8573. PORTABLE ELECTRIC BATTERIES, J. T. Armstrong, London.
8574. STRETCHING TROUSERS, H. G. Southwell, London.
8575. DISTRIBUTING MANURE, W. Davidson, Glasgow.
8576. HUTCH-AXLE LUBRICATING APPARATUS, R. Armstrong, Glasgow.
8577. COMBINED GUIDE and REST to KNIFE CLEANING MACHINERY, N. Hodgson, sen., and G. Litting, Hertfordshire.
8578. WATERPROOF MATERIAL, J. C. Mewburn.—(*C. H. B. F. Müller, Germany.*)
8579. FILE for DOCUMENTS, W. P. Thompson.—(*F. Heilbrunn, United States.*)
8580. FILES for LETTERS, &c., W. P. Thompson.—(*W. A. Cooke, jun., and C. S. Cooke, United States.*)
8581. TELEGRAPHIC or other CYPHER CODES, F. Paln, Liverpool.
8582. TANNING, A. J. Boult.—(*Count V. de Nydprück, Belgium.*)
8583. APPARATUS for CONSUMING SMOKE, &c., A. J. Boult.—(*S. Bond, Turkey.*)
8584. APPLYING a FLUSH of WATER to WATER-CLOSETS, F. Botting, London.

8585. EXPANDING, &c., CUTTERS of BORING BARS, J. Whyatt, London.
8586. APPARATUS for DRIVING PUNKAHS, J. Wetter.—(*C. Steiner, Argentine Republic.*)
8587. WHEELS of BICYLES, &c., H. S. Halford, London.
8588. MECHANISM of ELECTRIC ARC LAMPS, F. C. Phillips and H. E. Harrison, London.
8589. GAS STOVES for COOKING, W. H. Williams and J. Jacobs, London.
8590. HAT LEATHERS, J. Eaton, London.
8591. MEASURING WATER UNDER PRESSURE, C. S. Bilham.
8592. PERMANENT WAYS, G. Cowdery and E. R. Thomas, London.
8593. TREATING PAPER for FLOOR COVERINGS, J. Luke, London.
8594. SEPARATING LIQUID from SOLID SUBSTANCES, H. T. Breidahl, London.
8595. ELECTRICITY for SIGNALLING, &c., R. C. Ritson, London.

1st July, 1886.

8596. KNEE JOINTS, S. Richardson, Bangor.
8597. CONCENTRIC ARGAND BURNERS, The Ross Patent Lighting Company, Dublin.
8598. IRON PIANOFORTE FRAMES, W. J. Reeve, Birmingham.
8599. GENERATING CARBONIC ACID GAS, J. Mangnall and W. Bratby, Blackley.
8600. GAS HOLDERS, J. Mangnall and W. Bratby, Blackley.
8601. FLOWER HOLDER for COATS, B. H. Joseph, Birmingham.
8602. MANUFACTURE of BICHROMATE of AMMONIA, J. Park, Glasgow.
8603. BOWLS, F. W. Garrard, Ipswich.
8604. SELF-ADJUSTING RAILWAY CHAIR, W. Jackson, Middlesbrough.
8605. WASHING MACHINES, J. F. and G. E. Wright, Birmingham.
8606. WIND-POWER WHEEL, W. Johnson, Shetland.
8607. SHARPENING the CUTTERS, &c., of REAPING, &c., MACHINES, R. McGregor, Manchester.
8608. ELECTRIC SAFETY LAMPS for MINES, M. Settle, Manchester.
8609. TRANSIT BETWEEN TWO POINTS, H. W. Pugh and H. F. Solaini, Liverpool.
8610. HOUSEMAIDS' BOX and CINDER-SIFTER, J. Collin and H. Paine, Southwick.
8611. GEARING of BICYCLES, R. W. Thompson, Newcastle-on-Tyne.
8612. ROLLER GRAIN-GRINDING MILLS, Sir B. Samuelson, Bart., and C. Steckl, Banbury.
8613. INDICATING DISTANCE RUN by MACHINERY, J. and M. Blair, Liverpool.
8614. SHIPS' SIDE LIGHTS, &c., W. Mullan, Liverpool.
8615. SOAP FRAMES, P. Gill, Liverpool.
8616. GALVANOMETER, O. F. Jonsson, Liverpool.
8617. FRICTION COUPLING, O. F. Jonsson, Liverpool.
8618. GEAR WHEEL with COGS CUT in SOLID WOOD SEGMENTS, O. F. Jonsson, Liverpool.
8619. FIRE-EXTINGUISHING, W. M. Glenister, Hastings, and J. C. Merryweather, London.
8620. THERMO-ELECTRIC BATTERIES, G. E. Dorman, Stafford.
8621. CLEANING PULP CAVITIES of TEETH, J. Law, Edinburgh.
8622. ADVERTISING, F. G. Howarth, Liverpool.
8623. SELF-LOCKING CLAMP, J. J. Royle.—(*A. M. Gardner and Co., U.S.*)
8624. CHIMNEY-POTS, J. Bennison, London.
8625. GAS-BURNERS, W. G. Appleford, Birmingham.
8626. CENTRIFUGAL DRYING MACHINES, W. Horsfield, London.
8627. HORSESHOES, E. Dejean, London.
8628. INCREASING the ELASTIC FORCE of VAPOUR, J. Murrie, Glasgow.
8629. OPENING BOTTLES, W. H. Lloyd, jun., London.
8630. PREVENTING INCRUSTATION, F. B. Dœring, London.
8631. INCUBATORS, H. F. Perry.—(*F. Biven, U.S.*)
8632. SECURING RAILWAY CHAIRS, J. H. and W. Tozer, London.
8633. FASTENINGS for SECURING CORKS, J. and A. W. Maconochie, London.
8634. MACHINERY for FORMING WIRE STAPLES, &c., A. Brehmer, London.
8635. METALLIC TUBES, H. J. Haddan.—(*E. K. Coas, F. S. Andrews, and A. H. Sawtelle, United States.*)
8636. OIL BLEACHING APPARATUS, &c., P. J. Davies, London.
8637. HOLDING CARRIAGE WINDOWS, C. G. Gümpel, London.
8638. NAIL CUTTERS, D. Gestetner, London.
8639. DRIVING SEWING MACHINES, G. F. Beutner and A. A. Lateulère, London.
8640. KNITTED UNDER VESTS, J. S. Wells, London.
8641. COUPLING DEVICES for LOCOMOTIVES and TENDERS, A. Selkirk, United States.
8642. PRINTING MACHINES, H. H. Lake.—(*H. C. Hall, United States.*)
8643. FIREPLACES, H. Heim, London.
8644. CINDER SIEVE for PAILS, J. O. Spong and W. J. Sage, London.
8645. TREATING COFFEE to PRESERVE the AROMA, H. W. Hart, London.
8646. INDUCING the FLOW of LARGE VOLUMES of AIR, G. Seagrave, London.
8647. SAFETY HAIR PINS, J. H. Lee, London.
8648. MANUFACTURE of STOPPERS for BOTTLES, J. J. Varley, London.
8649. TOOLS for the MANUFACTURE of BOTTLES, J. J. Varley, London.
8650. BOTTLES for AERATED LIQUIDS, J. J. Varley, London.
8651. PISTONS, &c., W. C. Spurr and H. E. Smith, London.
8652. BRACES, G. F. Redfern.—(*C. Bernardon, France.*)
8653. ADVERTISING APPARATUS, P. Robinson, London.
8654. POCKET PHOTOGRAPHIC CAMERA, E. M. and G. H. Knight, Halifax.
8655. APPARATUS for BORING ROCK, J. A. McKean, London.

2nd July, 1886.

8656. FOLDING HEADS of CARRIAGES, J. Rock, Leamington.
8657. BREAK-DOWN GUNS, F. Beesley, London.
8658. RECEPTACLE for LIQUIDS, W. Hallam and J. Scott, Manchester.
8659. CLEANING KNIVES, &c., E. Appleton, Manchester.
8660. WATER GAS GENERATOR, B. H. Thwaite, Liverpool.
8661. CHAIN CLIPS for STENTERING, &c., MACHINES, A. C. Adams, Glasgow.
8662. ORNAMENTAL MOUNTS for BEDSTEADS, T. Causnett and R. Leadley, Birmingham.
8663. WATER WASTE PREVENTING APPARATUS, M. Syer and W. R. Clark, London.
8664. RISING and FALLING of a LID or COVER ATTACHED to the DRAWERS of a POSTAL and DOCUMENT CABINET, W. Holder, Dublin.
8665. SAFETY LOCKED DOOR CHAIN, W. H. Baraclough, Birmingham.
8666. TAPS for CHAMPAGNE, N. S. Heeley and I. A. Allaway, Birmingham.
8667. HOT-WATER HEATING APPARATUS, J. and N. Blezard, Padiham.
8668. EDGES or FLANGES of BAKING DISHES, H. Lisle, Wolverhampton.
8669. ADJUSTABLE SPECTACLE ORTHOPTIC for RIFLE SHOOTING, J. Rogers, Truro.
8670. REFLECTING LIGHT through COLOURED GLASS, &c., E. Townshend and T. H. Thompson, Birmingham.
8671. PAPER-BAG DARK-SLIDE, C. R. King, Maidenhead.
8672. RACK PULLEYS for BLINDS, J. Wilson, Glasgow.
8673. BOATS, W. V. Shaw, Glasgow.
8674. PERAMBULATORS, &c., C. R. Gorman and C. J. Fletcher, Birmingham.
8675. APERTURE-SIGHTING APPARATUS, H. P. Miller, London.
8676. MOUTHPIECE for HORIZONTAL BRICK-MAKING MACHINES, W. Temple, Newcastle-on-Tyne.
8677. BOTTLES, &c., J. C. Arnall and H. M. Ashley, Ferrybridge.
8678. PRESERVING WATCH-KEYS from DUST, A. B. Wilkins, London.
8679. DRYING APPARATUS, W. A. F. Wieghorst, London.
8680. LIQUID METERS, G. Teideman, London.
8681. INDIA-RUBBER for ERASING PENCIL MARKS, L. Wolff, London.
8682. REDUCING and CRUSHING MINERALS, P. R. Shill, London.
8683. CONNECTING SLEEVE LINKS, A. W. Agnew, London.
8684. BUTTONS, W. Burt, London.
8685. GLASS SIGNS, &c., E. Glükher and F. Rose, Halifax.
8686. MECHANICAL TELEPHONES, F. E. MacMahon, London.
8687. LAMP BURNERS, A. J. Boult.—(*W. H. Harvey, Canada.*)
8688. ARMATURES for ELECTRIC GENERATORS, G. T. Tugwell, London.
8689. NURSERY BOOTS, &c., H. Exton and A. T. Bridgewater, London.
8690. STAY-BINDINGS, &c., I. and C. Lunn, London.
8691. MECHANICAL TELEPHONES, &c., W. E. Lea, Liverpool.
8692. BASSINETTE PERAMBULATOR BODY with FLAT STICK, T. Rowe, London.
8693. NEW ELECTROLYTE in SECONDARY CELLS, W. J. Starkey-Barber-Starkey, Bridgnorth.
8694. GUN CARRIAGES, R. H. Hughes, London.
8695. MACHINERY for TURNING POTTERY WARE, J. Plant, Hanley.
8696. CLOSING DRESS STAND, E. Gems, London.
8697. PREVENTION of SEWER GAS in DWELLINGS, S. A. Johnson, London.
8698. CONDENSING STEAM, W. P. Green and T. W. Duffy, London.
8699. WOOD-WORKERS' CRAMP, R. Melhuish, London.
8700. PREPARING WEDDING CAKES, &c., H. W. Hart, London.
8701. SHIELD GRAFTING, R. E. Bénard, London.
8702. LINE FASTENER, J. J. and T. I. Day, London.
8703. AUTOMATIC WEIGHING MACHINES, J. Hart and J. L. Sampson, London.
8704. PORTABLE FIRE-ESCAPE, A. Crux, London.
8705. LOCOMOTIVE for SINGLE RAIL ELEVATED RAILWAYS, F. B. Behr.—(*A. Mallet, France.*)
8706. FEEDING APPARATUS for FIBRE CLEANING MACHINES, A. H. Death, London.
8707. ARMOUR PLATING of VESSELS, E. C. G. Thomas.—(*H. S. Thomas, India.*)
8708. STRANDING MACHINES, J. Stephens and A. Smith, London.
8709. MANTLES for LIGHTING, A. Paget, London.
8710. WHEELS, T. R. Crampton, London.
8711. AMMUNITION, J. Richards, London.
8712. SHIRTS, C. E. Towell, London.
8713. TILES, M. H. Blanchard, London.

3rd July, 1886.

8714. BRACES, G. Walker.—(*W. Greenshields, New Zealand.*)
8715. DRIVING BELT, R. Binnall, Rochdale.
8716. SECURING SPRINGS, W. D. Wilkinson, Birmingham.
8717. SOAP, A. Macqueen, Tunbridge Wells.
8718. NEEDLES, G. O. Schulz, London.
8719. PUMPING ENGINES, H., J. S., and H. B. Watson, Newcastle.
8720. PERMANENT WAY, T. B. Wilson, Manchester.
8721. PRINTING MACHINES, G. Newsum, Bradford.
8722. SECURING TYPE, G. A. Page, F. T. Schmidt, and R. C. Douglas, Bradford.
8723. PHOSPHATES, E. Solvay, London.
8724. DRIVING WHEELS, G. Hookham, London.
8725. PIGMENTS, J. M. Bennett, Glasgow.
8726. NAVIGABLE VESSELS, W. Forbes, Glasgow.
8727. MINCING MEAT, J. Coppard, London.
8728. PLACING TUBES upon SPINDLES, E. Jagger, London.
8729. OIL CANS, T. Caldwell, London.
8730. COMPENSATION BALANCE WHEELS, P. A. Newton.—(*C. A. Paillard, Switzerland.*)
8731. STOVES, E. Abate, London.
8732. WARP MACHINE, W. Tatham and J. Hancock, London.
8733. PREPARING TRANSPARENCIES, W. Jones and R. C. Powell, London.
8734. PREPARING TRANSPARENCIES, W. Jones and R. C. Powell, London.
8735. LAMPS, E. A. and F. S. Rippingille, London.
8736. A DETONATING FIRE ALARM, C. J. D. Opperman, London.
8737. GAUGING WIRE, W. Walton, Manchester.
8738. CASKS, H. W. Deacon and R. A. Price, London.
8739. ELECTRICAL SIGNALLING APPARATUS, H. H. Lake.—(*L. Sellner, Austria.*)
8740. HEATING WATER, G. Boegler, London.
8741. WINDOWS for RAILWAY CARRIAGES, B. Tettweiler, London.
8742. SELF-SUPPLYING BRUSHES, D. D. Macpherson, London.
8743. COMPRESSED AIR LOCOMOTIVES, A. A. E. G. de V. de Cumptich, London.
8744. STIRRUPS, G. F. Redfern.—(*F. Musany, France.*)
8745. STOP MOTION for DRAWING MACHINES, R. Priebsch, London.
8746. GAS LAMPS, F. Hochuli.—(*T. Schaeffer, France.*)
8747. PRESERVATIVE PAINT, J. Aniello, J. Kennedy, and J. P. Halket, London.
8748. MEASURING the DISTANCES of OBJECTS, W. Farquharson, London.
8749. TESTING WIRE, H. Bradwell, London.
8750. CHECKING RECOIL in ORDNANCE, J. Vavasseur, London.
8751. SELF-WINDING CLOCKS, J. G. Lorrain, London.

5th July, 1886.

8752. LEATHER BANDS for HATS, F. W. Cheetham and J. Hague, Manchester.
8753. FASTENER for MACHINE BANDS, &c., H. P. Trueman, Birmingham.
8754. GROOVED MATRICE for the PARING of HAT CURLS, S. and D. Wilde, Hyde.
8755. BOILER FURNACES, &c., P. H. Sadler, Birmingham.
8756. PARAFFINE WAX, R. Tervet and F. Alison, Glasgow.
8757. BONNETS for SAFETY LAMPS, J. Cooke, Birmingham.
8758. ELECTRIC ARC LAMPS, L. Hanson, Halifax.
8759. LIGHTING and EXTINGUISHING GAS LAMPS, W. Pollard, Halifax.
8760. SHOCK-DEADENING APPARATUS, R. Wotherspoon, Liverpool.
8761. ARTIFICIAL FUEL, W. C. and A. A. Haigh, Manchester.
8762. MASTICS for MAKING JOINTS, H. and W. Budiner, Paris.
8763. WOOD-TURNING MACHINE, S. Ingham, W. Illingworth, and J. W. Haywood, Leeds.
8764. MARKING FABRICS, &c., J. and R. J. Foot, London.
8765. FITTINGS for CONVERTIBLE SASHES, &c., R. Adams, London.
8766. OPENERS and SCUTCHERS, J. W. Makant and P. Parkinson, London.
8767. SUPPORTING HURDLES, &c., J. P. Bradley and W. T. Gidney, London.
8768. TAKING SOUNDINGS at SEA, H. P. Sherlock, London.
8769. FOLDING and PORTABLE LEG REST, G. E. Holland, London.
8770. LADIES' DRESS IMPROVERS, E. C. Vickers, London.
8771. LOOMS for WEAVING PILE FABRICS, J. Wade, London.
8772. LEVER BOTTLE OPENER, C. L. Bemrose, London.
8773. STIRRING, MIXING, &c., APPARATUS, E. Quack, London.
8774. OMNIBUSES, &c., J. Offord, London.
8775. COLLAPSIBLE HOODS for VEHICLES, E. Grimshaw, London.
8776. TROUSER STRETCHERS, E. G. Sims and R. H. Bishop, London.
8777. LUBRICATORS, F. Trier.—(*M. Schneider, Germany.*)
8778. ELEVATOR, T. J. Denne, London.
8779. APPLIANCE for GENTLEMEN'S SCARVES, F. Temple-Allen, London.
8780. SAFETY APPLIANCE for RIFLE RANGES, G. H. Gordon, London.
8781. MACHINES for CLEANING INTESTINES, H. J. Haddan.—*J. Cunning, U.S.*)
8782. SPANNERS, W. Martin, London.
8783. PLAYING GAMES of SKILL, G. Premi, London.
8784. ENVELOPE, E. H. Hale, London.
8785. OBSTETRIC BINDER, M. Orchard, London.
8786. DYNAMO-ELECTRICAL MACHINES, &c., S. H. Tacy, London.
8787. CENTRIFUGAL PUMPS, G. Yellott, Baltimore.
8788. OPENING, &c., ELECTRIC CIRCUITS, H. H. Lake.—(*R. Snyers, Belgium.*)
8789. SHOES and BOOTS, E. R. Lanonier et Cie., London.

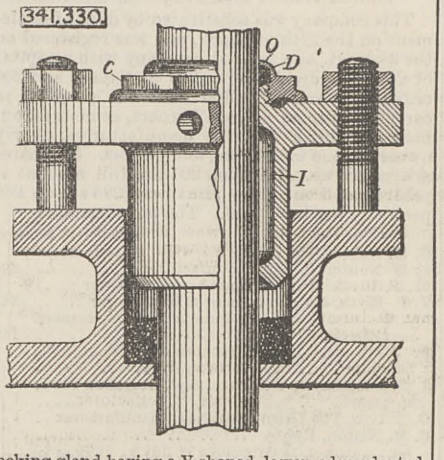
SELECTED AMERICAN PATENTS.

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

341,330. STUFFING BOX GLAND, *Joseph D. Hobbs, Joliet, Ill.—Filed February 17th, 1886.*

Claim.—(1) In combination, a packing box, a piston rod, and the packing gland having a V-shaped lower edge, and on oil chamber between said gland and the piston rod, substantially as described. (2) The combination, with the packing box and the piston, of a

341,330

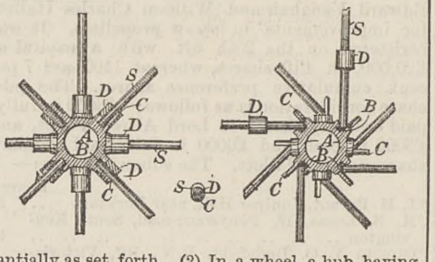


packing gland having a V-shaped lower edge adapted to compress the packing, an oil chamber I, and a nut C, at its upper end, having a packing chamber D, and packing O, contained therein, substantially as described.

341,462. WHEEL, *William W. Dunn, Peoria, Ill.—Filed December 7th, 1885.*

Claim.—(1) The combination, in a wheel, of the rim R, having sockets M, the hub A, having shallow sockets B and radial projections C, the spokes S, adapted to enter said sockets, and the ferrules D, substantially as set forth. (2) In a wheel, a hub having the radial projections C, in combination with spokes S and ferrules D, adapted to encircle said projections and spokes, as described, for the purpose specified.

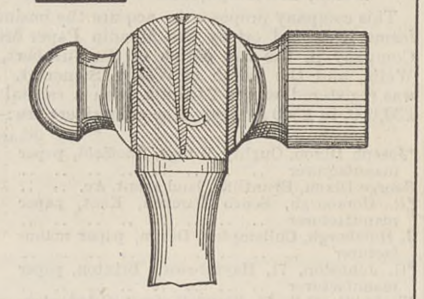
341,462



341,474. HAMMER, *Christopher J. Grellner, St. Louis, Mo.—Filed December 21st, 1885.*

Claim.—(1) The combination of the hammer, handle, perforated wedge made in one piece, and retaining nail or member adapted to enter the perforation in the wedge and to be turned outward at its lower end through the perforation in the wood of the handle, as shown and described. (2) The combination of the hammer, handle, wedge having a perforation, ribs strengthening the perforated portions of said wedge, and the nail or retaining member adapted to enter the

341,474

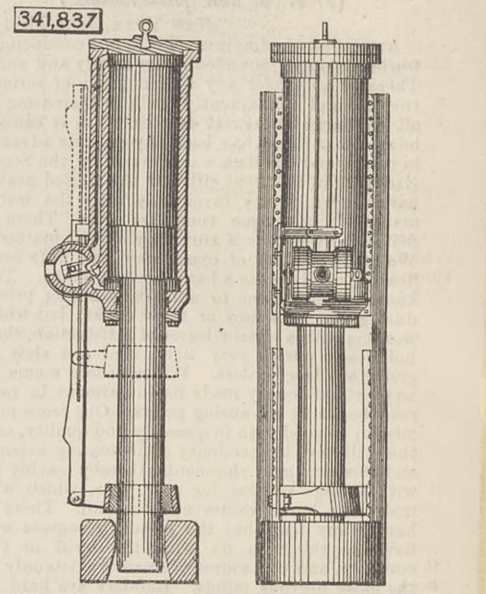


perforation in the wedge and to be turned outward at its lower end into the wood of the handle, as described. (3) The combination of the hammer, handle, perforated wedge, tapering ribs strengthening the perforated portions of said wedge, and retaining nail or member, the perforation turning outward through side of the wedge to form an incline, that acts to turn up the lower end of the nail or retaining member into the wood of the handle, as described.

341,837. STEAM PILE-DRIVER, *Augustus J. Dupuis, Detroit, Mich.—Filed October 26th, 1885.*

Claim.—(1) A steam pile-driver provided with steam ports leading to both ends of the cylinder, and an exhaust communicating with both steam ports, a valve chamber, a rotary valve within the same, a double crank on the stem of the valve, and a side bar operated by the plunger, and having cams which actuate said cranks, substantially as described. (2) A steam pile-driver having a rotary valve, a double crank on the stem of said valve, a slide bar having cams which actuate said cranks, and a collar connecting said slide bar to the plunger, the parts being combined substantially as described. (3) A steam pile-driver having a rotary valve, a double crank mounted on the stem of the valve, a slide bar actuating said crank, a collar connecting said bar to the plunger, and projections on the collar engaging with guides on the uprights, substantially as described. (4) In a steam pile-driver, the combination, with a rotary valve and a slide bar operating said valve, of a collar connecting said bar with the plunger, and a second two-part collar fitted within a recess in the plunger and embraced by the outer collar, substantially as described. (5) In a steam pile-driver, the combination, with the steam cylinder and a ferrule for supporting the head of the pile, of uprights connecting the two guides upon said uprights, a collar having projections engaging with said guides,

341,837

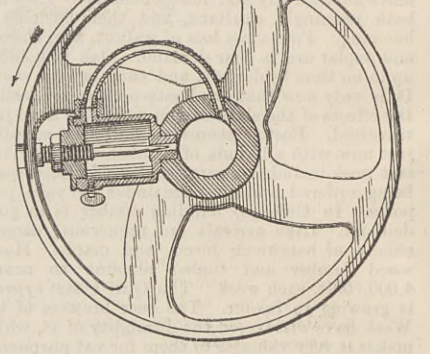


a plunger carrying the collar, a slide bar connected with the latter, and a rotary valve operated by cams on said rod, substantially as described.

341,738. LOOSE PULLEY OILER, *Charles W. Eckerson, Creston, Iowa.—Filed October 14th, 1885.*

Claim.—(1) The combination, with a pulley, of an oil cup connected to the hub thereof, and having air passage communicating with the bearing of the axle, an adjustable needle working in said air passage, and a curved feed-pipe connected with the top of the oil cup, and having its discharge end communicating with an opening in the hub of the pulley, substantially

341,738

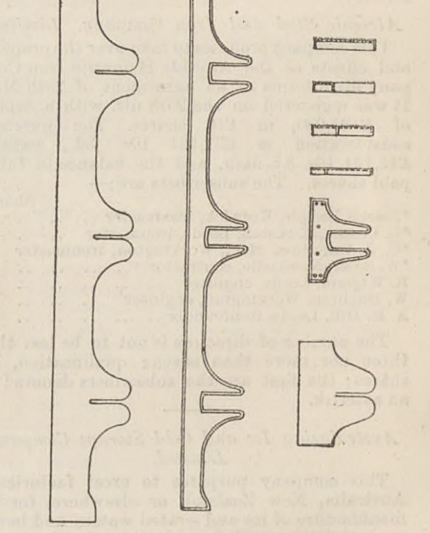


as described. (2) The combination, with a loose pulley, of an oil cup connected with the hub thereof, a needle for regulating the admission of air to said cup, and a feed-pipe connecting the top of the cup with the hub of the pulley, substantially as and for the purposes specified.

341,802. HORN PLATE FOR CAR AND LOCOMOTIVE FRAMES, *Samson Fox, Harrogate, County of York, England.—Filed January 19th, 1886.*

Claim.—(1) The mode or process of manufacturing frame or horn plates for rolling stock, which consists in first cutting a suitable plate to approximately the form of the intended frame or horn plate, afterward heating the said plate, then pressing or forcing it by means of a male die into and through a female die,

341,802

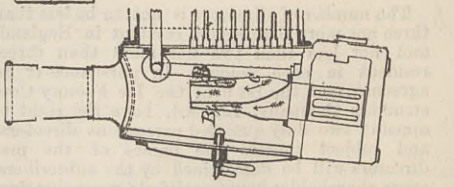


thereby imparting to it the desired form and flanging it, and afterward causing it to be held between pressers or holders to prevent warping or buckling, substantially as described. (2) As a new article of manufacture, a flanged frame or horn plate for rolling stock, formed of a single plate by pressing or stamping, substantially as described.

341,865. BLAST-PIPE FOR LOCOMOTIVE ENGINES, *Henry Adams, London, and William Adams, Nine Elms, County of Surrey, England.—Filed December 14th, 1885.*

Claim.—In an engine, the combination, with the boiler flues, of a curved blast-pipe with its enlarged

341,865



opening C in front of the forward ends of the lower boiler tubes, surrounded at its top by an annular steam discharge orifice B, substantially as and for the purpose set forth.

NEW BATTERSEA BRIDGE.

SIR JOSEPH BAZALGETTE, M.I.C.E., ENGINEER.