THE STRAINS ON CIRCULAR LOCK-GATES.

No. II.

By C. H. ROMANES.

IN my last paper it was shown that for iron gates, or for those constructed of timber under certain circumstances, the proper radius to adopt, and that which gives the minimum quantity of material with the assumed span equal to 80ft., is 43·52ft.; and the angle A O[1] B at the centre of the circle corresponding to this radius is about 66 deg. 58 min.—Fig. 2, p. 383. Where, however, the gates have to be constructed, from economic or other reasons, chiefly of Memel fir, a larger radius than this must be used, and which must be determined by considerations we shall describe.

In an account of the Avonmouth Dock,* Mr. J. B. Mackenzie has briefly described the construction of the lock-gates. It appears that although these gates were originally designed of wrought iron, the high price of that metal at the time of their construction in 1873 led to the adoption of timber—mainly pitch pine and Memel; the heel and mitre posts, however, are of oak, except in the case of the outer pair of gates which are of greenheart.† These gates when closed are cylindrical, or in the form of a continuous circular arc, with a span of 70ft.

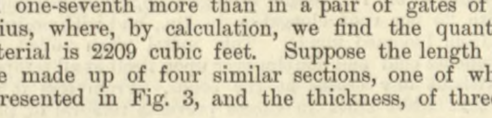
In determining the radius in gates of this sort we observe in the first place that the gate must be of uniform section throughout, because subjected to a uniform compression throughout, and as the length of the gate will be diminished under this pressure, the section must be uniform in order that the diminution of length may be proportionate on each side of the line of pressure, which should be made to coincide with the centre line of the gate as nearly as possible. Under these conditions the structure will maintain its circular form under pressure. Secondly, the thickness measured is in the direction of the radius. This thickness is determined by three factors. (1) The scantling of the timber, which can be obtained from the market suitable for making the heel-post in one piece, that being desirable, if not absolutely necessary. Should greenheart be the timber adopted for the heel-post, the thickness is by this condition limited to about 2ft. 8in. (2) The intensity of the pressure on the rib next the sill. (3) The bending stress, and thence the "working" at the joints produced by opening and shutting the gates. Thirdly, Memel fir being straight timber, it must be cut to the curve of the gate; and as the logs ordinarily in the market do not exceed 14in. square, the ribs of the gate must be built in sections. The fewer sections there are the fewer joints there will be, and therefore the fewer bolts and straps required. The last consideration renders it desirable that the thickness should be as great as the factors (1) and (2) admit of in order to give stiffness to the gate. Therefore it has now to be found whether 2ft. 8in. is sufficiently thick to give the area of section required by factor (3).

The resistance of Memel fir to crushing when dry is from 5000 to 6000 lb. on the square inch, but when wet it is not nearly so much. In the absence of experiments we will take it at about one-half of the above figures, or $1\frac{1}{4}$ tons on the square inch. The area of the cross section is $32 \times 12 = 384$ square inches; and $384 \times 1\frac{1}{4} = 480$ tons gives the total resistance of the cross section. Now, $\frac{480}{84} = 5{\cdot}71$ tons—this divisor, it will be shown further on, is the greatest pressure on a cross section of the rib next the 1ft. deep sill—so that this part of the gate would have sufficient section to bear nearly five and three-quarters times more pressure than it would ever be required to bear as long as the timber and bolts remained sound. Subject to these considerations, it appears that a radius of 58ft. is a suitable one to adopt for gates with a span of 80ft. With gates of 70ft. span for the Avonmouth Docks the backs when closed formed an arc with a radius of 50ft. In the case under consideration the length of the gate, measured on the curve from centre of heel post to centre of mitre post, 44·30ft., and the rise of the curve—from centre of mitre post to middle of the line joining heel posts—16ft. (see Fig. 4). By the equation previously obtained,

$$Q = m\,p\,r^2 \text{ arc sin. } \frac{c}{r}$$

Substituting the above value of the radius, and tabulating the values of the other symbols, as was done in the table in my first paper, we shall find the quantity of material in the gate to be 2559 cubic feet, or that with gates of 58ft. radius the net quantity of material is between one-sixth and one-seventh more than in a pair of gates of $43\frac{1}{2}$ft. radius, where, by calculation, we find the quantity of material is 2209 cubic feet. Suppose the length of the gate made up of four similar sections, one of which is represented in Fig. 3, and the thickness, of three logs.

Fig. 3.



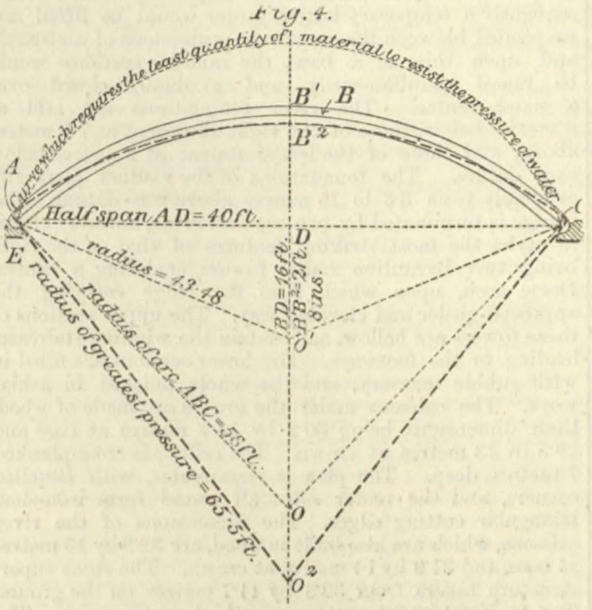
That each section of the gate can be formed out of 13in. logs may be shown as follows:—The length of the gate is 44·3ft. Since the mitre and heel posts will be made of other material than Memel, deduct for the mitre post 1ft. 6in.; for part of heel post, 6in.—that is 2ft.; add for three vertical posts at 13in. each—3ft. 3in. This makes for the total deduction from the length of the gate 5·25ft. Then $44{\cdot}3 - 5{\cdot}25 = 39{\cdot}05$ft.; and as there are four divisions, this gives $9\frac{3}{4}$ft. for the length of each division. The thickness of the gate being 2ft. 8in., is made up of three logs; the net thickness of the latter will consequently be $\frac{32}{3} = 10{\cdot}66$in. each. Let the radius of the arc A B, Fig. 3, equal to r, and the half span A C equal to d. Then the offset

$$CD = r - \sqrt{(r^2 - d^2)}$$
$$= 58 - \sqrt{(3364 - 22{\cdot}56)} = {\cdot}20\text{ft.} = 2{\cdot}4\text{in.}$$

Add this to the net thickness of each of the logs; then $10{\cdot}66 + 2{\cdot}4 = 13{\cdot}06$in. Hence the ribs of the gate can be formed out of 13in. logs.

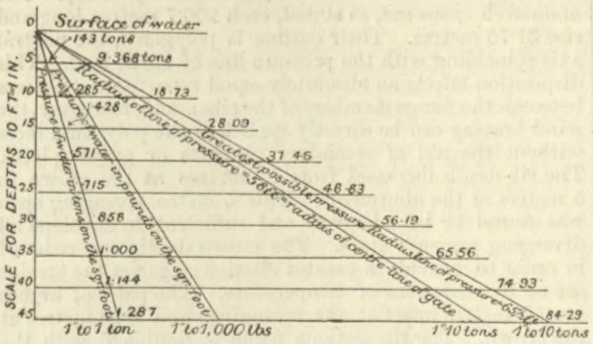
Having fixed the radius and thickness of the gate, it is required to find the line of maximum pressure. It has already been shown that the pressure on every cross section is $p \times r$, therefore the pressure increases with the radius. The greatest radius that any curve which is drawn within the thickness of the gates between the bearing points can have, is that of a circle which passes through the extreme bearing points K and L in the hollow quoins and is a tangent at the point B^2 in the

Fig. 4.



mitre post, Fig. 4. This radius is $65\frac{1}{2}$ft. Therefore, K B^2 L is the limiting position of the line of maximum pressure. In constructing a pair of lock gates, the object is usually to make the line of pressure under full head of water coincide with the centre line of the gate. But in calculating pressure, that along the line of maximum pressure should be taken and provided for in order to give greater security.

The weight of a cubic foot of sea-water is about 64 lb., the weight of fresh water is between 63 lb. and 64 lb. We shall here take the weight of sea-water for our calculations. The pressure on a square foot at a depth of 45ft. will therefore be 2880 lb. = 1·287 tons. The pressure on each cross section of the gate perpendicular to the line of pressure being equal $p\,r$ at 45ft. below the surface, and for 1ft. of depth it will be $1{\cdot}287 \times 65\frac{1}{2} = 84{\cdot}29$ tons for the line of maximum pressure, or $1{\cdot}287 \times 58 = 74{\cdot}5$ tons, when the line of pressure coincides with the centre line of the gate. On the diagram Fig. 5, which explains itself, the pressures



at any depth below the surface of the water may be found by scaling. Horizontal measurements from the line of depths to the lines O A and O B give the pressure of the water in tons and pounds on the square foot respectively; to the line O C the pressure on 1ft. of the depth of cross section when the radius of the line of pressure is 85ft.; to the line O D, the pressure on 1ft. of cross section when the radius of the line of pressure is taken at $65\frac{1}{2}$ft.

* Vide "Minutes of Proceedings," Inst. C.E., vol. lv.

† A table in Mr. Thomas Stevenson's treatise on "The Construction of Harbours" shows that greenheart is an exceptionally durable timber, and will withstand the attacks of the *limnoria terebrans*, and the action of sea water for many years. "It appears," says Mr. Stevenson, "to have been first used as a material by Mr. J. Hartley, who published, in the 'Minutes of the Institution of Civil Engineers,' an account of its virtues in 1840, as ascertained at the Liverpool Docks. Its cost is considerably greater than Memel, or than most other timber in common use."

THE DANUBE BRIDGE PROJECT.

By ROBERT HUDSON GRAHAM.

No. IV.

The Holzmann project.—Messrs. Holzmann presented only two high-level designs. Their Danube project proper consists of a braced iron arch composed of four 200-metre spans and two small 36-metre, independent, lattice girder, approach spans. The approach span at the embankment end rests on a gridiron plate supported by a bed of concrete. Its other end is carried by an iron column, built upon the up-stream side of the masonry substructure, and continued in overhang to meet the main platform. Each arch has three joints, one at the crown and two at the abutments. The iron foundations of the river piers rest upon piling, driven down to 13·89 metres below zero datum, the under surface of the caisson being 5·11 metres above the same level. The pile system is bound together by a bed of concrete 3 metres thick. The caisson dimensions—Fig. 22—are 33·3 by 12 metres at base and 33·3 by 10·5 metres at crown; those of the masonry 32·8 by 10 metres at low water, 28·2 by 8 metres at high water, and 28·2 by 4·9 metres at bedding surfaces, which are 2·25 metres above high-water mark. The rake of the ice-breakers is 0·46, and their shape rectangular in plan, narrowed to a sharp edge on the up-stream side. The maximum earth pressure under the river piers is 4·25 kilogrammes per square centimetre, and the mean 2·98 kilogrammes. It is optional to build the piers in limestone rock, faced with granite, or to form them into cylindrical iron envelopes, filled in with concrete. The pairs of bed-plates—Figs. 22 and 20—are braced by strong iron cells, the outer faces of which lie normal to the thrust. The river abutments are formed into arched granite blocks or rounded plates, inside of, and below which, lie the spherical hinged joints of the arch and the *galerie de mines*. The right end of the bridge abuts on the bed of limestone rock rising sheer from the water edge, and the left upon separate inclined pile systems, bound together by a bed of concrete. The interval between the centres of the two systems is 17·86 metres. Rising from the abutments are half arches, of scythe form, connected at the crown by an expansion joint. The neutral axis of the entire arch is parabolic. Its branches are focally braced by struts and cross-braced by a double system of diagonals. The rise is 43·158 metres, and the depth of rib varies from 2 metres at the point and hilt to a maximum of 7 metres at the full swell of the scythe. The pairs of arches are 4·66 metres apart at the crown and 17·858 metres at the springings. The permanent way is excentrically placed on the up stream side. The whole system is braced together in the planes of the rib flanges, and transversely between the struts and suspension rods. The vertical struts carrying the platform are built up of four corner angle irons, braced in the four planes, and the tension rods by four angle irons set back to back so as to form an I section. The straight girders carrying the way are solid web, 1·1 metre deep and 6·4 metres apart. The cross girders are 1 metre deep, spaced at intervals, varying from 5·88 to 10·1 metres. A series of longitudinal girders, 0·84 metre deep, and 9·675 to 10 metres span, carry the sleepers. Allowing for rivet holes, the working limit of stress was taken at 7·5 kilogrammes per square millimetre, and assuming a live load of 3200 kilogrammes per current metre of bridge and 400 kilogrammes per current metre of footway, with a wind pressure of 270 kilogrammes per square metre of exposed girder surface, the total load per current metre of the arch and platform, exclusive of the suspension rods, is 8000 kilogrammes. The small girder on the left bank is 2 metres deep, filled in with a cross lattice and actuated and levelled by means of a screw bearing upon the gridiron plate already mentioned. The Balta approach is 2620·2 metres long, composed of viaduct and embankment. The viaduct alone is 1600 metres long, the longest continuous portion being a length of 300 metres. The Balta foundations lie 7 metres below high-water mark. The high-level bridge over the Borcea is of the same type as that just described over the Danube. There are two main spans, each 140 metres, and two short approach spans, each 36 metres. The rise is 39 metres, and the rib depth 2 metres at the point and hilt, and 5 metres at the full swell of the scythe. The pairs of arches are 5·98 metres apart at the crown and 17·648 at the springings. As the river piers were calculated to withstand the uni-lateral thrust of a single arch, it was contemplated to erect the principal four points of each span simultaneously, by means of hydraulic jacks working from a fixed scaffolding. The total tender for this project was stated at £924,000. The boldness and originality of the Holzmann design seems so prone to invite opinion that we may be excused for making the following observations. In the first place, from an æsthetic point of view, it cannot be denied that this arch possesses a certain grandeur and unique elegance of form, derived partly from the vastness of the span, but much more from the graceful taper and folding form of its outline. Unfortunately, however, the æsthetic is not the first and most important consideration in arch design. The question of strength and stability naturally precedes; and therefore it may be asked whether or not jointed arches are the fittest and most economical forms for covering large spans? Perhaps it will be wiser to approach this delicate question first a little timidly from a distance, by the consideration of analogous cases. Now, it is a certain fact that an upright column, fixed at both ends, is, other things being equal, stiffer than a hinged column. So, also, is a parallel girder, fixed at both ends, stronger in itself than a girder merely supported at both ends. By analogy, therefore, it would seem correct to infer that, in the intermediate case, an arch fixed at both ends must be stiffer than a freely supported or jointed arch. Still, it is not always safe to argue by analogy, any more than it is generally wise to depend on that alluring *ignis fatuus* called practical engineering instinct. In problems of this difficult nature it is more prudent to rely upon the judgment of those, learned in the laws of stress, who have had occasion thoroughly to sift and compare the relative advantages of the two systems. Wherefore we will here take the evidence of the late Professor Culmann, who just before his lamented death was called upon, in conjunction with the late Gustave Bridel and Cantons-Ober-Ingenieur Ganguillet, to award in the competition for the Schwarzwasser Bridge. This evidence will be read with all the more interest because only recently Culmann's opinion on this subject was made a question of dispute between two able engineers, whose names have been introduced either in the course or history of the Danube Bridge competition. It would appear that Culmann, in alluding to jointed arches, has somewhere made the remark, "Alte Praktiker kommen bisweilen auf die Idee auch im Scheitel noch ein Scharnier anzubringen;"—"The idea has sometimes occurred to old practitioners to add another joint at the crown of the arch." Taken apart from the context the phrase seems a little ambiguous, and the "old practitioners" might be well excused for missing the intended irony, or even for misinterpreting it in the sense of a compliment. The following extract from the report of Professor Culmann on the Schwarzwasser competition, which I translate from a series of articles by Cantons Ober-Ingenieur Ganguillet, published in the *Schweizerische Bauzeitung*, will clear away all doubt from the subject. Culmann says:—"Generally speaking, we hold that fixed are stronger than hinged arches, and that the adoption of the latter is only justifiable in cases where the springings might run the danger of opening and causing the wedges to fall out. Messrs. Ott seem to have been in fear of this last effect; for in their memoir they mention that, in consequence of the expansion under heat, negative stresses would certainly manifest themselves in the flanges of the arch; and, moreover, as there was no existing structure from which they might judge to what extent the springings would open under this influence, or how far the result might be obviated by deepening the abutments, it seemed to us imperatively necessary to study the effects of temperature upon the Ott arch, in order to learn to what extent the springings must be widened, so as to preclude any subsequent spread. The results of this inquiry may be summarised as follows:—The rotation of hinged springings is very great; a one-sided load and an extension of 1 in 2000 due to temperature would cause a rotation of 0·00432, expressed in arch length of unit radius, by which a springing 2·5 metres deep would open to an extent of about 0·0108 metres. In fixed abutments this kind of movement is much less; a one-sided load upon the first eight or last twelve joints of this arch would displace the thrust line only by about 0·72 metre, whereas with an abutment depth of 2·5 metres the displacement must attain 1·25 metres before any rotation can take place. In order to drive the thrust line upon the outer edge of the springing it is necessary to increase the horizontal component of the thrust by about 8 tons. This is equivalent to an elongation of 0·031 metre prior to rotation. The total extension at the rate of 1 in 2000 would be 0·057 metre. In order, therefore, to annul the remaining extension of 0·026 metre there is required an additional horizontal thrust of 7 tons, which is equivalent to an arcal rotation of 0·0096. Under this effect a 2·5 metre abutment depth would spring about 0·0024 metre and the wedges would fall out. The obvious remedy is to deepen the abutments. Now, a thrust of 7 + 8 = 15 tons, under a one-sided load upon the first eight or last twelve joints, would displace the direction of the reaction by about 1·625 metre, which furnishes an abutment depth of 3·25 metres. We recommend, therefore, that the abutments be deepened either by the addition of brackets or by an absolute increase in the width of springings from 2·5 to 3·25 metres, and we believe that then the Ott arch would possess greater stability than it would have had with jointed ends. In principle, Messrs. Chappuis' arch agrees more closely with our views than the Ott design. Still the abutment depth of the Chappuis' arch is insufficient and its form unsuitable. The gradual swell of the Chappuis' arch in the sense of from crown to abutment seems more appropriate than the constant depth of the Ott form, being better adapted to envelope the diverging reaction lines in the vicinity of the springings.

Subsequently to, and in consequence of this report, the Ott arch, designed by Messrs. Röthlisberger and Simons, was modified according to the views set forth in Culmann's report, the rib being deepened to 3·5 metres at the abutments, and narrowed at the crown to 1·5 metres. It was then formally accepted, and afterwards built and erected. According to the above extract it is evident that Culmann only intended to compare the respective merits of fixed and double-hinged arches—that is, arches with fixed abutments and arches with hinges at the ends of each flange; and therefore his strictures do not apply with equal force to single-hinged arches such as the Cail or Holzmann. There can be no doubt that the stresses in a single-hinged arch admit of much easier determination than those in a fixed, or even in a double-hinged system. Moreover, there could be no pivoting of one flange end relatively to the other of the kind described by Culmann as occurring in double-hinged systems. It should also be mentioned that there is a certain consistency of design in the Holzmann arch, in making the maximum swell correspond with the section of greatest bending moment. Nevertheless, bending moment effect is not the only consideration to be kept in view in fixing the character of an arch. It would seem unwise to reduce the rib depth excessively at the very section where the thrust attains a maximum, and the reactions under varying loads and temperature diverge in all directions. Again, in lapse of time, and under a heavy traffic, the bolt at the crown might set, in which event the bridge would pass from the category of a three, to that of a two-jointed structure. Now, for the same section, the bending moment is greater in a two than in a three-jointed arch; hence, in the event of set, the strength of the bridge would be considerably weakened. Wherefore, on these accounts, and notwithstanding the artistic merits of the design, it would appear that the jury acted wisely in declining to sanction a three-jointed arch for such an immense span.

The Röthlisberger-Simons project.—Messrs. Röthlisberger and Simons also presented two projects, namely, a high-level, braced iron arch design for the Danube, and a double-swing, low-level, parabolic girder bridge for the Borcea passage. The Danube bridge comprises only three main arches, each of the enormous span of 206·7 metres, or 678ft. The object of this enlargement of the spans was to diminish the number of piers in the river current, and thereby the number of obstacles to free navigation. Great spans necessitate heavy piers, and as the ice in the winter season accumulates between the piers, exerting upon them, in the act of forcing a passage, an immense lateral thrust, it appeared only rational to increase the spans within the limits of convenience, proportionate strength, and economy. A gradient of 1 per cent., beginning over the third arch and running in the direction of the Balta, leads to a reduction of 2 metres in the heights of all the viaduct piers, and does away with a 200 metre length of the highest portion of the embankment. The platform traverses the arch, being suspended within and supported on struts without. Two footways, each 2·7 metres wide, are placed by the side of the way. Wind effect has been met by a somewhat novel contrivance. Below and attached to the main platform is a horizontal wind girder, running the whole length of the span. The function of this girder is to receive and carry to the piers the wind pressures exerted upon the train and platform, so that during a heavy gale the arches themselves sustain no additional strain. The friction between the girder ends and the masonry would alone suffice to balance the resultant shearing actions at the piers, but for further security the ends are also bolted down. A double system of transverse bracing, applied between the rib flanges of the arch, conveys to the piers the wind pressures striking that part of the structure, whilst a slight splay in the plan of the arches affords additional lateral stability. The system of erection presents another novel feature. In order not to interfere with the navigation and to avoid interruption of work during the ice season, it was proposed to have no staging rising from the river bed. As far as the intersection of arch and platform, the pairs of ribs abutting at any pier would be symmetrically projected as cantilevers, retained by cables anchored to scaffolding built upon the pier itself. Then would follow the first section of the horizontal wind girder, so as to form a tie rod between the ends of the erected parts of the adjoining arches. Subsequently a temporary lattice girder would be lifted and suspended between the cantilever projections of each arch, and upon this, as a base, the middle sections would be raised simultaneously, and gradually closed over a fixed centre. The river foundations are laid at 8 metres below, those of the right abutment at 7·5 metres above, and those of the left abutment at 2 metres below zero datum. The foundations of the viaduct piers rise gradually from 3·6 to 15 metres above zero datum. The bridge is terminated by two cupola towers, severely classic in style, the most striking features of that on the right being two Byzantine round towers enclosing a central Doric arch, upon which rises the ledge carrying the approach-girder and elevated way. The upper sections of these towers are hollow, and contain the winding staircases leading to the footways. The lower sections are filled in with rubble masonry, and the whole finished in ashlar work. The caissons under the towers are made of wood, their dimensions being 30·2 by 13·7 metres at base and 29·5 by 13 metres at crown. The ceiling is cross-planked 7 metres deep. The plan is rectangular, with bevelled corners, and the under sides all round form iron-shod triangular cutting edges. The dimensions of the river caissons, which are also built in wood, are 32·9 by 15 metres at base, and 31·9 by 14 metres at crown. The stone superstructure tapers from 30·8 by 11·7 metres on the ground line to 29·63 by 9·1 metres near high-water mark. The piers proper—which are square-pyramidal in form, with vaulted space between—taper from 17·7 by 7·9 metres at foot to 14·65 by 4·5 metres at summit. In build the left is very similar to the right abutment tower, the bases of both being protected by rough masonry footings confined by round piling. Wood was chosen as the caisson material for several reasons — first and chiefly because it promised to be cheaper; secondly, because a thick wooden ceiling is more rigid, and less likely to set and cause fissures in the masonry during the sinking operations than an iron ceiling of equal strength; and, lastly, because under similar conditions, the greater comparative lightness of wood reduces the effective earth pressure from 2·5 to 3 kilogrammes per square centimetre. To obtain the same pressure with an iron caisson would entail an additional outlay of something like £30,000. The magnitude of this difference is explained by the fact that at Cernaroda iron and masonry work are very dear, whilst wood, brought down by the Pruth and Sereth, is relatively cheap. The main arch spans are, as stated, each 206·7 metres long and rise 37·76 metres. Their outline is polygonal, the neutral axis coinciding with the pressure line of static load. This disposition effects an absolutely equal repartition of stress between the flange members of the ribs; and, moreover, the wind bracing can be directly applied to the polygonal faces without the aid of secondary supports or gusset pieces. The rib-depth increases from 2·5 metres at the crown to 5 metres at the abutments. This 5-metre springing span was found to be adequate and sufficient to envelope all diverging pressure lines. The crown depth was reduced in order to provide a greater elasticity against the strains set up by variations of temperature. The pairs of arches are 12 metres apart at the springings and 8·29 metres at the crown. The rib sections forms a double T, with the webs 1·2 metre apart and the separate flanges tied together over their whole development by an angle-iron trellis. The lattice-work in elevation is simple, being composed of vertical struts 3·06 metres apart, alternating with diagonals. All the bar sections form a cross, made up of four angle irons. The pairs of struts of the ribs are transversely braced by a flat-barred trellis. The ends of the arch flanges are received and wedged into chairs, Figs. 19 and 24, bolted to inclined bedding surfaces on the piers. These chairs have each an under surface of 1 by 1·4 metre, and a bearing area of 600 by 160 millimetres. The supporting struts and suspension rods, which carry the platform, constitute a series of braced columns. The maximum length of rod or strut is 13·16 metres. Both struts and rods are built of four corner columns cross-braced in the four planes, and tied together at their lower or upper ends by a cross lattice girder. The pairs of rods are braced transversely by diagonals, reaching from the top flanges of the inner ribs down to about two-thirds of their own lengths. At their intersection the diagonals are stiffened by a rose, as well as by being attached at a higher point to the ordinary cross bracing of the arch. The character of the strut bracing is very similar, with the difference that the diagonals are carried from the lower inner flanges of the ribs fully up to the top ends of the struts, where they join the platform. The latter forms a continuous girder, with fourteen supports in a length of 206·7 metres. The common span is therefore 15·9 metres. The upper flange is a T-section, whilst the lower flange forms an inverted channel section, to which is fixed the horizontal wind girder. Between the series of cross girders connecting the main girders run two lines of 5·3-metre span longitudinal girders, each distant 0·9 of a metre from the general centre line. These longitudinal girders directly support the sleepers. Under the influence of temperature variations the whole platform system rolls freely over its supports. The horizontal wind girder is calculated to transmit the entire wind effort upon train and platform. All the bars of this girder are of I section, which protects it against vertical deflection and greatly facilitates the jointing up. The stresses throughout the bridge were determined by Culmann's graphic methods, and the stress diagrams afterwards submitted to Professor W. Ritter and formally approved by him. Aware that Culmann's method of treating elastic arches is unknown to a large section of British engineers, and feeling convinced that an example of its power to deal with the very intricate problem of finding the stresses in a fixed arch would prove of interest and utility, the writer begged Messrs. Röthlisberger and Simons to be so good as to develope their graphic treatment of the Danube arch, with which request they kindly complied; so that the next and concluding article of this series will be mainly concerned with an account of the note courteously communicated to me by Messrs. Röthlisberger and Simons.

For the rest, each arch is constructed to carry a total load of 11·8 metric tons per current metre, composed as follows:—Weight of construction, 7·5 tons; rails, sleepers, and flooring, 0·74 tons; footways, 0·56 tons; test load, 3 tons; total, 11·8 metric tons. The working limits of stress were taken, for the arch proper, at 6 kilogrammes per square millimetre, and for the wind girder at 8 kilogrammes per square millimetre. The Balta Viaduct was divided into seven continuous girder sections, each of four spans, and each span 40 metres. The line of embankment is serpentine, with a gradient of 1 per cent. over a range of 2962·5 metres, upon which occur two reverse curves of a common radius of 600 metres and lengths of 584 and 385 metres respectively. The semi-parabolic swing bridge over the Borcea has a total length of 311 metres, composed of two pairs of double 57·5-metre swing spans and two independent side spans, each 40·5 metres. An enormous amount of conscientious labour has been bestowed upon this design, separate drawings being given of the minutest details. The total tender for this arch, which is a perfect model of the polygonal type, was £814,000.

REMOVING RED SHORTNESS FROM IRON.

The large deposit of magnetic iron ore at Cornwall, Pa., is rich in copper and sulphur, the greater portion of the latter is removed by roasting, but the copper alloys with the iron in smelting, the analyses showing 0·75 to 1·25 per cent., and the iron is very red short or brittle at a red heat. This is so well established that the largest owner of the property has "C.R.S." as the trade mark, standing for "Cornwall Red Short." This metal is used to some extent in the Bessemer process, as the phosphorus is low—0·05 per cent.—mixed with good hematite pig iron, but until recently it has never been used in the open hearth process, as the product has been too red short for hammering or rolling. This iron being the cheapest as to cost and the largest in supply in the United States, it became desirable to remove the red short property, so that it could be more generally put into use, so during last autumn some was sent to Mr. James Henderson, at Bellefonte, Penn., to make trials with in his open hearth furnace. The first trial, we are informed, showed that the red short property was removed in the most simple and economical manner by use of silica, the charge was one-half No. 3 Cornwall pig, one-half Bessemer steel rail crop ends, and 5 per cent. of iron ore charged upon silica brick in the proportion of 60 lb. of the brick to one ton of metal; the bricks were burnt, and composed of ninety five parts of sand and five parts of lime by weight, and were charged on the highly heated hearth in the cold state, the hearth being in the condition for use without them; cold pig iron was charged upon the brick, and steel scrap on the pig iron. By the time the pig melted the brick became partly fused, and adhered to the bottom, and remained there, and gradually wasted away, during the decarbonisation of the metal, and passed up through the metal, removing the copper. The next trial was the same kind of metal and ore, but without the silica brick, and the steel was too red short to be of use. The trials with this metal continued over several weeks with the silica brick, with uniformly satisfactory results, whether all pig iron with ore was used, or pig ore and scrap. When sand alone was used it removed the red shortness, but a portion adhered to the hearth and gradually raised it, so it became necessary to melt it out with lime afterwards; the better way being to mix the lime with the sand at the start, and thus keep the hearth from rising, which was the practice afterward. Brick made with ninety-five parts of sand, 5 per cent. of lime and mixed with glucose and water in the proportion of twenty parts of water to one of glucose, and air dried, is the most suitable, as the brick insures the hearth being kept in order.

The ingots of metal produced are remarkable from the fact that the ingot rolled without previous blooming gives as good results as those that have been bloomed. Tests made by parties in Pennsylvania, who rolled some of the ingots, gave elastic limit, 42,687 lb.; tensile strength, 66,289 lb. per square inch, with 25 per cent. elongation in 8in., and with no better results from bloomed ingots. This metal when rolled into plates punches cold and doubles over upon itself at all temperatures without any cracks at the bends. From this it will appear that while silica in excess prevents removal of phosphorus and causes cold shortness, it, when used with iron containing copper, acts oppositely and prevents red shortness by removing the copper.

The "Electrician."—We have received from its publishers the two last volumes—xii. and xiii.—of this journal. Modern electrical appliances have enormously extended the field of electrical science, but these volumes show that it is much larger than would be imagined. There is a continuous flow of electrical news to be dealt with, to say nothing of the discoveries to be announced and the treatises on the various branches of the science to be given to the world. To judge by the names of the foremost electricians of the day who we find are contributors to its pages, the *Electrician* takes a very high place indeed among the technical journals of the day.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Stephen Hockey, assistant engineer, to the Pembroke, additional, for the Arethusa; John Moysey, acting chief engineer, to the Wild Swan; William Walker, engineer, to the Hibernia, additional, for service in the Decoy; William George Mogg, assistant engineer, to the Indus, additional, for service in the Raleigh; Frederick Skelton, Edward H. Willey, Peter Colquhoun, and William B. Rock, chief engineers, additional to the Excellent; William Siddorn, chief engineer, to the Dolphin; George Whiting, chief engineer, to the Triumph; Edwin J. Austen, engineer, to the Asia, for service in the Emerald; Sidney G. Haddock, assistant engineer, to the Shannon; John F. Ryder, engineer, to the Indus, for service in the Raleigh; and George S. Cornish, engineer, to the Cambridge, for service in the Sabrina.

RAILWAY MATTERS.

A SERIOUS collision occurred last Sunday evening in Brussels between two steam tramcars bringing skaters from the Bois de Cambre, and twenty persons were injured.

THE trains on the Midland Railway were delayed on Wednesday evening over an hour near Darfield Station by the breakdown of a coal wagon in a train running from the Houghton Colliery Company's sidings.

THE relative costs of production of steel and iron rails are as under, taking steel as unity:—Steel rails: Pig iron consumed, 100; coal, 100; labour, 100. Iron rails: Pig iron consumed, 105; coal, 150; labour, 190.

IT has this week been stated, at the annual meeting of the Dudley Chamber of Commerce, that Belgian iron is delivered in India at about the same rate as is charged for the conveyance of that kind of material from Dudley to London, which is about 15s. per ton.

A SEVERE railway accident occurred on Monday near Wagga Wagga, New South Wales. Owing to the heavy rainfall, amounting to 8in. in thirty-six hours, the embankment gave way, and a train which was passing was completely wrecked, several passengers being killed or injured.

THE Russian Minister of Railways has given an order for 100 locomotives to the Kolomna Works and 40 to the Maltzeff Company—province of Nijni Novgorod—to be delivered during the ensuing year. The price, the *Contract Journal* says, is 31,000 roubles—£3100—for the first half delivered in both cases, and £3000 for the remainder.

THE whole of the railway company of Royal Engineers being now employed on service in Egypt and South Africa, it has been considered desirable to form another railway company for future emergencies. Officers and men have been ordered from various stations to assemble at the School of Military Engineering, Chatham, for the purpose.

THE following cases, involving no personal injury, are reported amongst the accidents of the first nine months of 1884, on the United Kingdom railways:—Five cases of failure of machinery, &c., of engines; 876 failures of tires; 2 failures of wheels; 4 of ropes used in working inclines; 232 broken rails; 8 fires in trains; 1 fire at a station, and 2 other accidents.

AN iron girder, at the new Blackfriars Bridge, weighing several tons, which was being hoisted from the river, fell last Thursday, when about 30ft. from the water owing to the breaking of the chains. Chains and cranes are very uncertain things. A big crane in London, which had been accustomed to lift heavy loads, fell the other day with nothing on it.

OF the 876 tires which failed in the United Kingdom during the first nine months of 1884, 18 were engine tires, 4 were tender tires, 5 were carriage tires, 18 were van tires, and 831 wagon tires; of the wagons, 599 belonged to owners other than the railway companies; 808 tires were made of iron, and 68 of steel; 32 of the tires were fastened to their wheels by Gibson's patent method, 12 by Mansell's, and 1 by Beattie's, none of which left their wheels when they failed; 823 by bolts or rivets, 3 of which left their wheels when they failed, and 8 by other methods; 30 tires broke at rivet holes, 95 in the solid, 13 at the weld, and 738 split longitudinally or bulged.

THE accidents on the American railways in November are classed as to their number and causes as follows by the *Railroad Gazette*:—Collisions: Rear, 30; butting, 12; crossing, 3. Derailments: Broken rail, 5; broken frog, 2; broken bridge, 1; spreading of rails, 3; broken wheel, 1; broken axle, 2; broken truck, 1; accidental obstruction, 3; cattle on track, 4; misplaced switch, 7; purposely misplaced switch, 3; rail purposely removed, 1; unexplained, 14. Other accidents: Broken coupling rods, 2; broken axle not causing derailment, 1; car burned while running, 1. Total, 96. No less than 9 collisions were caused by trains breaking in two; 5 by misplaced switches; 5 by mistakes in orders or failure to understand them properly; one each by a flying switch, and by the wreck of a preceding train.

AN ingenious person has invented a design for representing upon a large mirror all the traffic of the line as it moves from station to station, and even from one mouth of a tunnel to the other. On the surface of the glass are represented the several lines under the control of the signalman and his neighbours. These, the *Railway News* says, appear as horizontal marks upon the glass, with small vertical interruptions indicating the stations. Along the lines pass little arrows which keep pace in their course with the movement of the real trains below, being set in motion by means of an electric arrangement in connection with the rails. As the trains pass over the rails they come in contact with metal brushes fixed at the side, and these communicate an electric shock to the motors of the signal plate, sending on the emblematic arrows along the glass.

A GENERAL classification of the American railway accidents in November may be made as follows:—

	Collisions.	Derailments.	Other.	Total.
Defects of road	—	11	—	11
Defects of equipment	9	5	3	17
Negligence in operating	35	7	—	42
Unforeseen obstructions	1	6	1	8
Maliciously caused	—	4	—	4
Unexplained	—	14	—	14
Total	45	47	4	96

Negligence in operating was thus the leading cause of 44 per cent. of all the accidents reported. A division according to classes of trains and accidents is as follows:—

Accidents.	Collisions.	Derailments.	Other.	Total.
To passenger trains	3	18	3	24
To a pass. and a freight	9	—	—	9
To freight trains	33	29	1	63
Total	45	47	4	96

This shows accidents to a total of 141 trains, of which 36, or 25½ per cent., were passenger, and 105, or 74½ per cent. freight trains. Of the total number of accidents 52 are recorded as happening in daylight and 44 at night.

THE Baltimore and Ohio Railroad Company is building a Philadelphia branch, from a point of connection with its main stem to the northern boundary line of Cecil county, in the State of Maryland, where it connects with the road which the Baltimore and Philadelphia Railroad Company is constructing through Delaware by way of Wilmington and into the city of Philadelphia. The bridge spanning the Susquehanna river is a work of magnitude. It will be 6346ft. in length, 94ft. above mean low tide, and will rest on eleven granite piers, having their foundations on the bed rock of the river, of from 116ft. to 179ft. in height, with an area of 12ft. by 35ft. at the top. Large and substantial starlings, or ice-breakers, have been added to the general dimensions of the water piers. The foundations for six of the piers have been difficult, reaching, as they do, a depth of 85ft. below low water, and necessitating the use of caissons with air chambers, in which the men engaged in removing the *débris* in order to reach bed rock have worked under pressure of 37 lb. per square inch. Much of the masonry for the foundations and piers has been placed, and all will be finished about the time the superstructure is ready. The superstructure will be of steel. It is to be built by the Keystone Bridge Company for delivery and erection in the early spring, and will consist of seven deck and two through spans. The lengths of the deck spans will be—one of 520ft., four of 480ft. each, one of 375ft., and one of 200ft. The two through spans will be 520ft. and 375ft. respectively. There will be 2288ft. of iron viaduct, averaging 67ft. in height, for the construction of which in the shops of the company arrangements have been made. All the other bridges on the line between Baltimore and Philadelphia will be of iron, and will be built at the shops of the company.

NOTES AND MEMORANDA.

IN Greater London last week 3612 births and 2237 deaths were registered, equal to annual rates of 36·3 and 22·4 per 1000 of the population.

FROM a Government return just issued it appears that in 1883 5,171,963 tons of coal were carbonised for gas-making purposes by companies belonging to other than local authorities, and 2,459,341 tons by those owned by local authorities, or a total of 7,631,304 tons. The quantity of gas produced was 76,837,967,813 cubic feet of gas.

THE deaths registered during the week ending January 24th in twenty-eight great towns of England and Wales corresponded to an annual rate of 24 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The six healthiest places were Brighton, Blackburn, Derby, Hull, Bradford, and Oldham.

IN London last week 2803 births and 1807 deaths were registered. The annual death-rate per 1000 from all causes, which had been 25 and 23·7 in the two preceding weeks, declined to 23·1 last week. During the first three weeks of the current quarter the death-rate averaged 23·9 per 1000, against 21 and 20·5 in the corresponding periods of 1883 and 1884.

ON Säntis, Switzerland, the annual rainfall during the year September, 1883—August, 1884, inclusive of melted snow, was 67·83in. The heaviest rainfall of any month was 15·12in. in July, 1883, and the lightest 0·71in. in February of the same year. On the top of Ben Nevis, for the five months from June to October of 1882 and 1883, the mean rainfall was 44·35in.; and on Säntis, for the same five months of 1883 and 1884, the rainfall was 43·95in.—the summer rainfall of the two places being thus nearly the same. These amounts, *Nature* remarks, are very greatly in excess of what several theories of the distribution of the rainfall on the slopes and tops of mountains would lead us to expect.

THE *Annales Industrielles* describes cork bricks, which it says are now being employed for various purposes, such as for coating steam-boilers and ice-cellars, and for many other purposes, are thus made:—The cork is freed from woody particles and other impurities by a winnowing process; the wind from the ventilator throws the cork into a second machine, where it is cut to pieces, and is thence drawn up in buckets and ejected into a mill, where it is ground to an impalpable powder, which is then kneaded up with a suitable cement and pressed into bricks. The cork bricks are first dried in the air, and afterwards by means of artificial heat. They are hard and not liable to decomposition, and keep off moisture, heat, cold, and sound.

THE following description of an early gas engine, taken from the *Scientific American* of July 23rd, 1846, is quoted from the *Printing Times and Lithographer*. The engine was at that time to be seen at the store of Samuel Perry, in Front-street, near Whitehall, in New York:—"The machinery consists in part of a cylinder, piston, pitman, fly-wheel, and governor—in this respect similar to a steam engine. A small quantity of spirits of turpentine is kept in a warm state, and the vapour arising therefrom is mixed with fifty times its volume of atmospheric air. A small quantity of this hydrogenated air is drawn into the cylinder and ignited by a movement of the machinery, producing a slight explosion, whereby the remaining air—at least nine-tenths of the whole—becomes so heated that it drives forward the piston with great force. This engine is said to be capable of working 10-horse power, and it is intended to substitute resin instead of turpentine, which will reduce the expense of feeding it to about 50 cents per day. The ingenious inventor has had some difficulties to encounter in the construction of the first engine, but has a fair prospect of being well remunerated for his labour."

ON Säntis, in the Canton of Appenzell, 8094ft. high, the mean annual atmospheric pressure is 22·237in., the highest monthly mean during the year September, 1883—August, 1884, being 22·429in. in August, and the lowest 21·993in. in March. On Ben Nevis, 4406ft. high, the mean annual pressure is 25·257in., the highest mean being 25·400in. in July, and the lowest 25·141in. in January. The difference between the highest and lowest is thus 0·436in. and 0·259in. respectively. On Säntis the mean annual temperature is 28·2 deg., the highest monthly mean being 41·4 deg. in August, and the lowest 18 deg. in January. The annual mean for Ben Nevis is 30·9 deg., the highest monthly mean being 41·3 deg. in July, and the lowest 22 deg. in February. The lower mean temperature of Säntis is thus wholly due to its colder winters. The most marked difference in the climates of the two situations is revealed by the hygrometer. On Säntis the mean annual relative humidity for the two years is 84, the highest monthly mean being 93 in September, 1882, and the lowest 71 in March, 1884. On Ben Nevis, on the contrary, the lowest mean monthly humidity was 90 for May, 1884, and the highest for January of the same year, when the mean dry bulb was 25·50 deg., and the wet bulb 25·47 deg., showing an approximate humidity of 99.

THE standard of light proposed by Hefner von Alteneck has recently been described by Dr. Bunte before the German Gas and Waterworks Managers' Society. This standard consists of a lamp burning amyl-acetate by means of a simple cotton wick. The designer has deliberately adopted a lamp with a wick, because he has found, on experiment, that a lamp without a wick is a comparatively complicated and troublesome affair. The height of the lamp flame is, however, fixed, because experience shows that with a known diameter and height of flame the illuminating power is constant; and this is true of all descriptions of luminous material, whether paraffine, oil, or candles. The standard is defined as being the light given by a freely burning flame of amyl-acetate, burning to a height of 40 mm. from a solid round wick, contained in a tube of German silver, 8 mm. in diameter internally, and 8·3 mm. in diameter externally, standing 25 mm. above the body of the lamp, and lighted ten minutes before the observation is made. The power of the lamp is equal to the average of an English standard candle with a flame 43 mm. high. The lamp itself is very simple, without a chimney; and the height of the wick is regulated by a cog mechanism of the most ordinary kind. An upright rod, with a projecting wire, stands upon the lamp to gauge the height of the flame. The amyl-acetate is sold in Berlin at 6 marks the kilogramme delivered.

IN their report on the water supplied to London during December, 1884, Messrs. William Crookes, F.R.S., William Odling, F.R.S., and Dr. C. Meymott Tidy, F.C.S., say:—"Of the 148 samples of water submitted to full analysis—or one sample daily, exclusive of Sundays and holidays—43 samples were furnished by the New River and East London Companies, in chief measure from the Lea; while the remaining 105 samples were furnished by the five companies taking their supply from the Thames. As regards the quantities of organic carbon—and, consequently, of organic matter—present in these 105 Thames-derived samples, the mean result was 0·132 part, and the maximum result in any one sample, 0·186 part in 100,000 parts of this water, this maximum proportion of organic carbon corresponding to the presence of a little over three-tenths of a grain of organic matter in a gallon of the water. The mean result of the previous half-year was 0·130 part, giving an average for the year 1884 of 0·131 part of organic carbon in 100,000 parts of the water, as against an average of 0·143 part for the year 1883, of 0·160 part for the year 1882, and of 0·180 part for the year 1881; these results showing, accordingly, a successive gradual yearly diminution in the small proportion of organic matter present in the Thames-derived water supply. During the past six months we have examined 1073 samples of water drawn from the mains of the seven companies taking their supply from the Thames and the Lea, and have been able to register 1062 of these samples, or just 99 per cent. of the whole, as being clear, bright, and efficiently filtered." There are now nearly 1000 miles of water mains kept constantly charged by the London water companies.

MISCELLANEA.

A COURSE of lectures on "Modern Applications of Electricity in the Arts" is about to be given at the University College, Gower-street, by Dr. J. A. Fleming.

MESSRS. SYMONS AND CO. announces the publication at the end of next week of a book on gas engines, by W. Macgregor. It will be one of the "Specialists" series.

THE Admiralty contract for the next five years for the manufacture of chain cables, mooring chains, &c., has been placed in the hands of Messrs. Henry Wood and Co., Liverpool.

THE Russian Minister of War lately signed a contract for the delivery of steel rails, to the value of £149,000, for the Kizal Arvat and Askabad section of the Transcaspian Railway.

MESSRS. PATERSON AND COOPER have issued a circular showing that electro-plating and electro-metallurgical apparatus may now be bought in sets ready made, like electric bells and American pin bridges.

A RAINFALL map has been issued by the Mining Department of New South Wales, showing the borings which have been made throughout the colony for water, not only by the Government, but by private individuals.

A BILL has been introduced to the Bengal Legislative Council to enable the Calcutta Port Commission to raise three millions sterling for the purpose of constructing docks. Some mercantile authorities consider the work premature, as the trade of the port does not yet require new docks, but on this point there is much difference of opinion.

"I CAN always tell the nationality of an engineer by the complaint he makes," said an old engine builder and repairer in one of our contemporaries. "The Scotchman is always worried about the 'bock losh;' Englishmen and Irishmen are always fighting 'the thump,' which they firmly believe was left there for them to remove; the German is very much concerned about 'dem walves;' while the Yankee has a hard time to 'keep her from chawin' too much steam."

THE death is announced, at the age of fifty years, of Commandant Roudaire, whose name is intimately associated with the project of a Saharan Inland Sea. This scheme was fully described by M. Roudaire in the *Mémoires et Compte Rendu des Travaux de la Société des Ingenieurs Civils* for November, 1883. Although strongly supported by M. de Lesseps, it was opposed by the great number of competent scientific authorities. With the death of Colonel Roudaire the scheme will probably drop.

THE *Dundee Advertiser* states that for a long time it has been known to a few of the leading mining men in Fife that a large area of coal lay between the well-known and extensive collieries of the Perth Coal Company and the Cowdenknowes Coal Company. These fields are about to be opened up by a large limited liability company, and all the latest improvements in mining are to be utilised. The output expected is 10,000 tons a day, and as there is a proved thickness of 151ft. 6in.—not including shale—the colliery will last for many years to come and will give employment to a great number of men.

DR. DIVERS, Principal of the Imperial College of Engineering, Tokio, recently met with a curious accident. It appears that he had taken in his hand a bottle supposed to contain perchloride of phosphorus, but, finding the stopper fast, was heating the neck to release it, when it burst, the bottle disappearing as dust, and the contents as gas. Dr. Divers was nearly suffocated by the fumes, and one eye was injured. When the last mail left, it was not in a state to be critically examined; but strong hopes are entertained that the sight will be restored. The accident is supposed to be due to the decomposition of the perchloride of phosphorus, which was old.

THE classification of the vessels of the German Navy has undergone a thorough change. In future all ships hitherto described as ironclad frigates and ironclad corvettes will be known as "panzerschiffe"—ironclad ships—and the vessels now classed as ironclad vessels and ironclad gunboats as "panzerfahrzeuge"—ironclad vessels. Spar-decked corvettes will be "kreuzerfregatten"—cruiser frigates—and flush-decked corvettes "kreuzercorvetten"—cruiser corvettes. The vessels now classed as gunboats—Albatross class—will be known as cruisers, and the vessels now described as first-class gunboats as gunboats. The designation of second-class gunboats is abolished.

TWO important and interesting cases with reference to secondary battery patents in the United States have recently been decided. Interferences were raised against the Sellon and Swan patents, which belong to the Electrical Power Storage Company, by Starr and Brush, and in both cases the fight has been most obstinately, and at great cost, contested for nearly two years, appeal after appeal having been heard. The results of the last appeals are that priority of invention has been awarded to both Sellon and Swan, as against Starr and Brush. As against Brush, the decision on this last appeal is absolutely final; but in the case of Starr a further appeal is still possible.

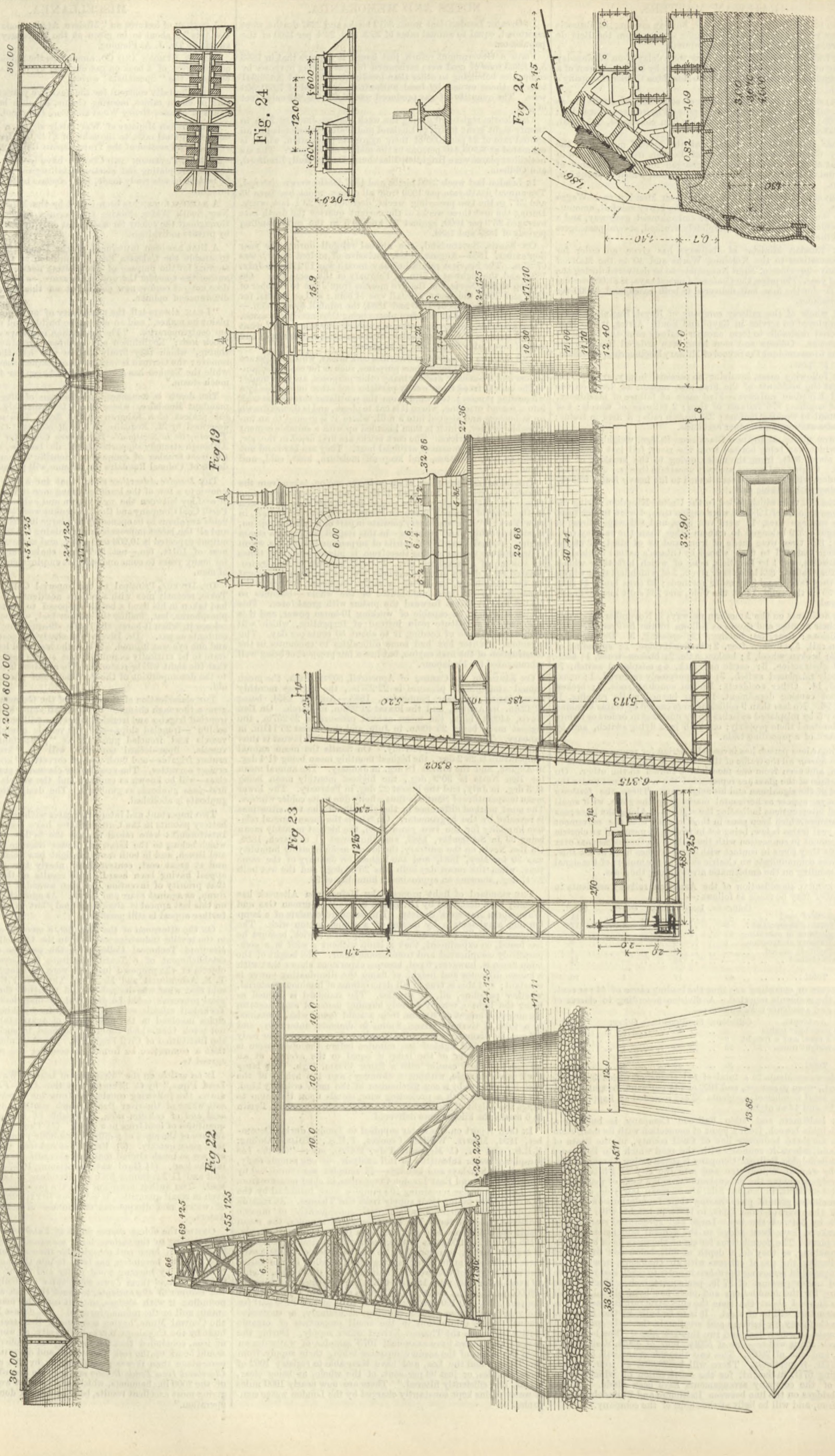
ON the afternoon of the 19th inst. a meeting of those interested in the textile industries was held in the Council Chamber of the Bradford Technical College, for the purpose of discussing the establishment of a Textile Institute for Great Britain. The objects of the proposed institute were explained at length by Mr. T. R. Ashenhurst and Mr. B. H. Thwaite, F.C.S. Mr. Thwaite said that what was desired was an institute through which technical processes could be discussed by manufacturers themselves. Technical schools were all very well for teaching youths the principles involved in the production of textile fabrics, but they did not teach that which could be acquired by such organisations as the Institution of Civil Engineers. Mr. Ashenhurst then proposed that a committee be formed to consider the matter, which was agreed to.

IN an article on the "Existence of Lead in Water passed through Lead Pipes," by C. Schneider, in the *Arch. Pharm.*, the author draws the following conclusions from his experiments:—(1) The soft water of the river Bober, which contains traces of sulphuric acid and of calcium salts, is capable of taking up considerable quantities of lead from new pipes. (2) The formation on the inner surface of the pipes of a difficultly soluble protecting layer does not take place quickly. (3) Even after eighteen years' use lead pipes are not so much altered that water is quite prevented from dissolving the lead. (4) Hard water containing 10·57 grammes sulphuric acid and 11·2 grammes lime per hectolitre is capable of dissolving lead. The author considers that the presence of carbon dioxide, even in small quantities, is sufficient to explain the solvent action of water, and disapproves of the use of lead pipes for spring waters.

ONE of the oldest copper mines of Lake Superior for years has been raising to the surface large masses of copper and rock combined, which have cost considerable time and money to separate. The practice heretofore has been to pile the masses together and heat them by burning wood under and about them, and, when heated, to cool them down with water suddenly, and thus, after the manner of the ancients, to crack the rock and separate it by pounding it with sledges, until it could be made to go into the stamp mill or the refining furnace. Mr. James Dunstan, agent of the Central Mime, having seen one of the steam helve hammers built by the Cuyahoga Works in this city, at work on large masses of iron, concluded that the same power applied to mass copper would break up the rock it contained and dress it to a much higher percentage than it was possible to do by the old method. The *Cleveland Iron Trade Review* says:—"He accordingly ordered one of the 2500 lb. hammers, which has been at work for six weeks, giving most excellent results, both as to work done and economy of operation."

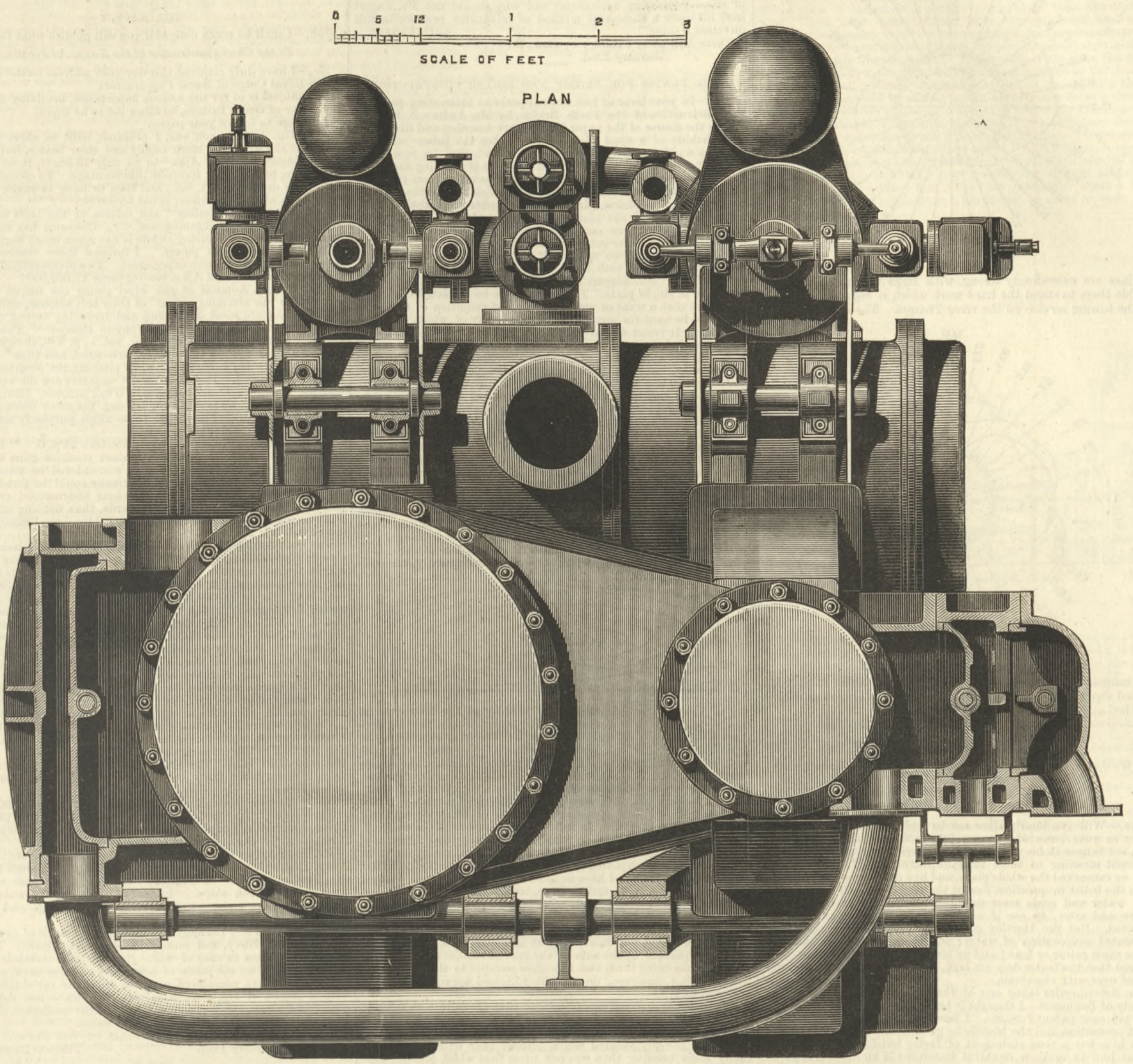
COMPETITIVE DESIGNS FOR A DANUBE BRIDGE.

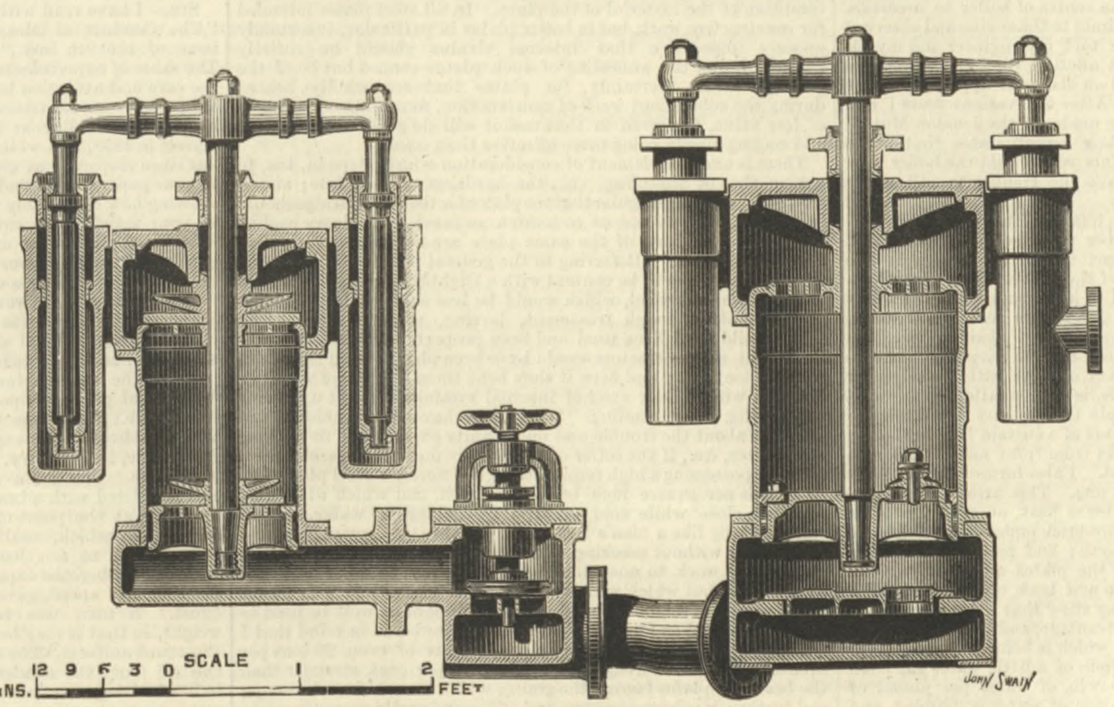
(For description see page 77.)



COMPOUND ENGINES OF THE TUG BOATS HIBERNIA AND COLUMBIA.

DE MAATSCHAPPY DE MAAS, DELFTSHAVEN, HOLLAND, ENGINEERS.

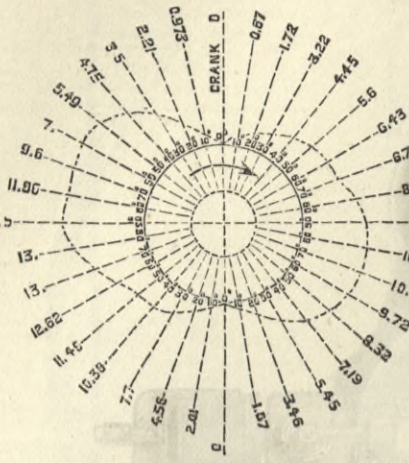




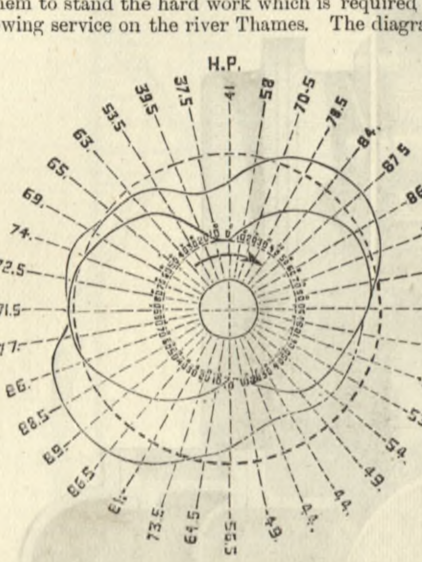
DETAILS OF AIR AND CIRCULATING PUMPS

THE above-named screw steamers have been built by de Maatschappy de Maas, of Delftshaven, Holland, to the order of Mr. William Watkins, of London, and under the superintendence of Mr. Alfred Watkins. The question of screw tugs *versus* paddle tugs becoming very important, it was decided to put as much power into each as was consistent with her principal dimensions. The vessels are 120ft. between perpendiculars, 22ft. moulded breadth, and 13ft. 3in. moulded depth. The weights are so disposed that the immersion of the propeller remains practically constant, whether the bunkers are empty or contain 100 tons of coal, the variation in draught being from 6ft. to 10ft. forward. Should a further immersion of propeller be required, water ballast tanks are constructed under the cabin floor containing about 20 tons. The vessels are constructed with a raised deck amidships and a captain's bridge forward, and are supplied with steam steering gear and steam anchor windlasses. The Hibernia is constructed of iron and the Columbia of mild steel, with a cast steel rudder and stern frame, supplied by Messrs. Jessop, of Sheffield. This cast steel stern frame is arranged with large apertures in front of the stern post, thus forming a sluice keel, and the advantages of this arrangement were very apparent when testing the manœuvring powers of both vessels. The engines are compound surface-condensing, with cylinders 23in. and 47in. diameter by 24in. stroke, and are capable of working up to 600 indicated horse-power on an emergency, although the average full power, with 100 revolutions is 530 indicated horse-power. Steam of 100 lb. is supplied by a cylindrical boiler 13ft. diameter and 10ft. 1in. long, with three furnaces 36in. diameter. The total heating surface is about 1600 square feet. The high-pressure cylinder is provided with an expansion valve working on a separate face in a separate casing; at the same time there is an auxiliary throttle valve provided, admitting steam direct into the main high-pressure valve casing. The object of this arrangement is to be able to handle the engines at a moment's notice without having to put the expansion valve out of gear. The engines can be reversed to full speed almost instantaneously. There is provided a steam starting gear astern of simple construction, but quick in its action, so that the engines are always under control. Tug steamers having often to stop suddenly, an arrangement has been made to blow off steam into the condenser while the engines are standing. The donkey engine is one of Messrs. Tangye's direct-acting type, and at one end forms an auxiliary circulating pump and at the other a feed pump, which can draw from the condenser and feed the boiler while the engines are standing. The circulating pump is arranged to act as an air pump in case of accident, and the donkey engine can then be employed to work as a circulating pump. This was tried by uncoupling the air pump, and with the comparatively small circulating pump working as an air pump, and the donkey drawing the water through the condenser tubes, a steady vacuum of 24in. was obtained, which was considered highly satisfactory.

The thrust is taken by a large disc on the shaft working in a block which has two central supports on the sole plate. It is so arranged that a constant stream of water may be applied without coming in contact with the bearing surfaces. These vessels easily attain a speed of 11½ knots, with 90 revolutions at sea; the measured mile trials showing greatly in excess of this. The



engines are exceedingly strong, with large bearing surfaces to enable them to stand the hard work which is required of them in the towing service on the river Thames. The diagrams show



the tangential efforts as deduced from the indicator cards; the dotted circle shows the ideal condition of equal effort during a revolution.

LETTERS TO THE EDITOR.

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

THE BLOW PIPE FLAME FURNACE.

SIR,—Will you kindly allow me to reply to Mr. Schonheyder's letter in your issue of January 9th, 1885, in which he admits he does not believe in his own figures, but says others have attached a different meaning to them than he intended. He then explains how he ransacked the whole place, and had every pipe disconnected from the boiler in question, except the feed pipe. He kept watch over water and coals most minutely during the test, and even before and after, to see if any foul play or leakage could be detected. But the Hartley calorimeter test does not agree with his stated evaporation of water; and therefore he says that the boiler must prime or leak; and as Mr. Schonheyder has now been assured that the boiler does not leak, he concludes that much water passed over with the steam.

Mr. Schonheyder being one of the Council of our Society—the Society of Engineers—I thought it best to invite that gentleman to test my new patent furnace. I have nothing to say against his great precaution and the trouble he gave us, and I expected nothing from him but a true statement of facts; but I certainly did not expect him to make a doubtful statement in an important paper like THE ENGINEER which he cannot prove to be correct. Mr. Schonheyder tested the steam on his own account three or four times from a pipe about 8ft. from the centre of boiler to ascertain if it was dry, and he listened many times to the engine and observed continually the water gauge, and he told my engineer and myself the steam was "pretty dry," and at another time the steam was "fairly dry." Mr. D. K. Clark had an elaborate apparatus to test the steam, and found it to be dry. After the various tests I had a minute examination of the boiler made by the London Mutual Boiler Insurance Company, and their report states that "the boiler has no leakage whatever." This report and the boiler may be examined by anyone who will take the trouble to call at my works, 3, Mill-lane, Bromley-by-Bow.

I further beg to state this boiler, 18ft. by 7ft., only evaporated with the best coal 6½ lb. of water per pound of coal up to 1880, when I made my first improvement to prevent smoke in the furnace, and in the jury's report of the Smoke Abatement Committee, page 121, this boiler is found to have made 8·81 lb. of water per pound of hard steam coals with 17½ square feet of grate area. Since that time I have steadily worked on, and again reduced the area of the fire-bars to five square feet for the purpose of concentrating the combustion and formation of heat with considerably less consumption of cold air. This is the smallest grate area ever attempted in a furnace. I made the fire-bars sloping downwards, and blow-holes in the lower part of a curtain hanging before the fire, so that the gases should meet from front and bottom at a certain angle to develope greater heat. I also formed an air guide under the fire-bars with a few steam jets. This arrangement produced a long transparent flame of intense heat, never before seen in a furnace; this heat is kept by a fire-brick embankment close to the boiler plates for its whole length; and to prove that this intense heat is entirely absorbed by the plates and water within, it may here be stated that on the top and back end of the boiler only 356 deg. Fah. are left. This may show that every particle of the coal is made use of to the best advantage, and the considerably diminished admission of atmosphere, which is being forced together with the combustible gases and the help of a little water gas from the steam jets below, evaporated 11·48 lb. of water per pound of coal from 74 deg. Fah. This evaporation of water is doubled, and attacked on various sides, as the coals gave only 12·8 lb. from 212 deg. Fah. To this latter test of burning coal I must object, and several chemists have told me of their doubts to such test, except when the analyses are given minutely of the proportion of carbon and hydrogen contained in the coals, and I think my doubts to that test are quite as reasonable as Mr. Schonheyder's, as he claimed more units of heat per cubic foot of coal gas than anyone else was able to do by his cooking apparatus at the Crystal Palace two years ago, and I trust Mr. Schonheyder will be able to prove his assertion, and not condemn an entirely new system, which is hardly understood or properly examined by anyone, and unknown to the profession.

Mr. Schonheyder, in concluding his report, says:—"I am bound to admit that the combination of the furnace arrangements evidently assisted the cause of intense heat and very perfect combustion; as a rule the top of the chimney was quite clear."

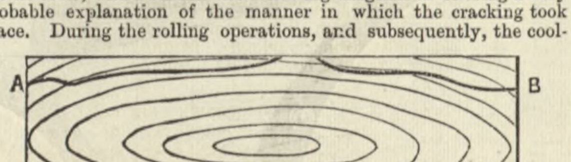
Iron, in its yearly reports on steam generation, concludes as follows:—"Everyone admits that there is room for improvement in steam-generating appliances; and why should not Mr. Engert have hit upon a successful method of advancing practice in this direction a stage?" A. C. ENGERT.

Three Mill-lane, Bromley-by-Bow, E.,
January 22nd.

STEEL PLATES FOR BRIDGE AND BOILER CONSTRUCTION.

SIR,—In your issue of last week appears an interesting paper on the construction of the Forth Bridge, by Mr. Andrew S. Biggart, and in the course of the paper Mr. Biggart describes and illustrates the cracking of a steel plate—intended for the tubes—while an attempt was being made to bend it cold, and gives us some interesting particulars as to the present methods of bending the plates hot. With your permission I should like to make some reference to the cause of the cracking of the cold plate, and its probable remedy. In my opinion, Mr. Arrol, the contractor, rightly "attributes the failure of the plate to the unequal cooling at the steel works"—or elsewhere—and, as Mr. Biggart pointed out, that conclusion was "borne out by the fact that different parts of the same plate are not so uniformly easy or difficult to cut," and further says that "both these experiences are often found in a single plate." Mr. Biggart might have said, "unfortunately often found in a single plate," for is it not to be regretted that there should be such a want of uniformity in the condition of any plate that is to be used for structures, on the safety of which so much depends? It is not stated whether or not the plate which failed was annealed before leaving the steel works where it was manufactured, but appearances are against the assumption that it was; and we may, therefore, fairly conclude that it was not, the more so because it is a well-known fact that many principal steel plate makers send their plates out without annealing them. It must be admitted by all steel plate users—who, by the way, have the best means of judging—that such practice is of very doubtful wisdom, unless the steel is of the mildest possible character, and even then it is unwise, for, granting that it is not an absolute necessity with the mildest plates, it is, nevertheless, a precaution, and one which is so easily taken and costs so little that one would think it much the best plan to avoid all possible risk.

That internal strains set up in cooling were the cause of the failure of the plate above referred to appears to be fully confirmed by the manner in which it cracked, and the direction which the cracks took; and I submit the following diagram as offering a very probable explanation of the manner in which the cracking took place. During the rolling operations, and subsequently, the cool-



ing of the plate would proceed most rapidly at the four corners, and we may take it that each of the spaces between the elliptical lines which I have drawn would be of a different temperature, the variation being gradual, and the centre of the plate being the hottest. When, therefore, the cooling proceeds rapidly, the strains that are set up within the material, due to the unequal contraction of the corners and the centre, and due to the rolling of the unequally heated material, are considerable, and the lines of the ellipses will represent approximately lines of what we may call "equal internal strain." It follows, therefore, that the cracking, once started, will take place approximately along these lines; and a reference to the diagram will show that the cracks have, as nearly as might be expected in practice, followed the lines. What makes the explanation I have suggested appear correct, is that all the three cracks, A, B, and C, have tended in similar directions and from similar points, and, according to the sketch you gave, none of them appear to have run out on the long edges of the plates. It would be easy, and perhaps most natural, to suppose that the cracks A and B, starting at opposite ends of the plate, would run parallel to the axis of the curved surface around which the plate was being bent, and therefore parallel to the long edges. They did not, however, do so, but followed approximately the elliptical form.

Mr. Baker, it appears, was of opinion that the failure was due to the fact that the edges and ends of the plate were not planed; but this can scarcely be accepted as the cause, as a soft steel plate, even with roughly sheared edges, should bear without cracking vastly more bending than was put upon that which failed. Certainly a sheared and rough edge might conduce to the failure, but it appears most probable that the primary cause was in the strained condition of the material of the plate. In all steel plates intended for constructive work, but in boiler plates in particular, it certainly appears imperative that internal strains should be entirely destroyed, and the annealing of such plates cannot but be of the greatest value. Certainly, for plates that are wholly heated during the subsequent work of construction, annealing is, perhaps, of less value, but even in that case it will do good, twice heating and cooling slowly being more effective than once.

There is another element of consideration which steps in, too, to govern that of annealing, viz., the hardness of the plate; and it strikes one as being singular that the plates for the Forth Bridge should be of such a character as to harden so much by ordinary cooling that "different parts of the same plate are not so uniformly easy or difficult to cut." Referring to the general purposes of construction, is it not wiser to be content with a slightly less tensile strength and use a milder steel, which would be less susceptible to changes of temperature, rough treatment, jarring, vibration, &c. Had such a mild steel been used and been properly annealed, it is probable that the contractors would have been able to bend the plates cold without risk; and even if they bent them hot, there would be less risk with milder steel of internal strains being set up during the cooling after bending. We should have less prejudice, and hear less about the trouble and uncertainty experienced in working steel plates, &c., if the softer qualities were more in demand instead of those possessing a high tensile strength. Surely a steel plate of 25 to 26 tons per square inch tensile strength, and which will stand doubling close while cold or after quenching in water, or will stand dishing like a man's hat, and then heating, quenching, and hammering without cracking, is much to be preferred for boilers and general work to one which will stand, say, 30 or 35 tons per square inch, but which will not bear all the practical tests I have mentioned. It might be said that iron might as well be used as such a soft steel as I speak of, but it must be borne in mind that I am speaking of *plates*, and that a steel plate of even 25 tons per square inch tensile strength is at least 25 per cent. stronger than the best iron plates (across the grain), which is no mean advantage; and further, it is homogeneous, and will stand vastly more "punishment" than the iron plates. Certainly, compared with steel of higher strength, there is a disadvantage as regards the extra weight of material required. But how much more safe and easy the material is to work under adverse conditions! and until workmen in all branches are more accustomed to the manipulation of steel, it is better to have reliably soft and easily workable material should be placed in their hands whenever its intended use will admit of a choice being made. For general engineers' purposes, boilers, &c., steel possessing ductility, softness, and ease of working is generally the most useful and desirable; and we find at the works from which I write, that our soft and comparatively "low carbon" steels are as a rule preferred, and that where stronger steels are required for plates &c., it is most satisfactory to give thorough annealing, though, as a matter of fact, we anneal all plates of whatever kind. THOS. TURNER.

Corngreaves Ironworks, near Birmingham,
January 19th.

THE NAVY.

SIR,—I shall be much obliged if you will publish what follows:—

To the Chief Constructor of the Navy, Admiralty.

Sir,—I have duly received this day your address to the members of the Royal Corps of Naval Constructors.

The subject is of far too serious importance, involving as it does the safety of Great Britain, to allow me to be silent.

I propose to follow your paper.

p. 2. The Agamemnon was, I presume, built so short with the idea that she would be more handy and steer better, but to build two—Agamemnon and Ajax—to go only 13 knots, is to sacrifice everything by a clearly foreseen disadvantage. To design a ship for a light draught, 23ft. 6in., and then to have to make it artificially 26ft. aft so as to steer, is not scientific.

p. 3. Mr. Barnaby notices "the fulness of the lines and ends, and the lengthened Agamemnon, *i.e.*, Colossus, has altogether avoided difficulty in steering, while it has given much higher speed with the same engine power." I foresaw those results. It is, however, a very expensive experiment. Two comparatively useless ships, Agamemnon and Ajax, costing some £1,500,000!

p. 3, 4. "An Admiral of the Fleet giving the names of ships stripped to 'an alarming extent' of their belt armour, and declaring that they are most dangerous, and including among them the Conqueror and the Hero." Sir Thomas Brassey—"The British Navy"—gives the plan of Conqueror, vol. i., p. 446, showing about one-tenth the length of the vessel unarmoured, and thus "stripped to a most alarming extent," for while pitching the steering of the ship is jeopardised. The Hero and Conqueror are the very worst fighting machines I can conceive. Weak armour, 12in., such a superstructure aft as to mask for 100 deg. the stern defence power of the heavy guns. I included these ships purposely and intentionally for the reasons given above.

Mr. Barnaby condemns the whole nineteen at p. 6. "It is conceivable that some such provision against machine guns would be a wise addition where weight can be surrendered to meet it. In the Agamemnon, for example, 2in. armour could be put in a belt 6ft. wide." Mr. Barnaby thus abandons unarmoured ends; but 3in. steel has been pierced at 600 yards, thus nothing under 6in. will succeed. The French have 16in. and 14in.—see Brassey, p. 316—in a belt 8ft. 1in. wide.

The statement, p. 4, that I believe Warrior and Black Prince completely belted is, I presume, a mistake. It is contrary to fact; I have treated them as utterly obsolete. Mr. Barnaby is misleading about seamen. Exercise, 1885, p. 1657, gives 43,330, *Etat majors et equipages à terre et à la mer*, 5537 *Artillerie de Marine*, and 21,022 *troupes;* to our "Fleet service afloat," including coastguard, 43,592—p. 8, Estimates, 1884-85—Marine Artillery, 2192; Marine, 10,208. So the French sailors are only 262 less than ours!

Again, Mr. Barnaby is in error when he states, "Such questions as these are, I say, left almost untouched by naval officers." I do not think that Mr. Barnaby could strengthen what I have written on this subject. See also Sir A. Ryder and Admiral Phillimore, two Commanders-in-Chief, and very many more; Naval Prize Essay, &c. &c. I most earnestly wish Mr. Barnaby would prove his words where he states, "And she has inscribed on her rolls 170,000 seamen, while in England, including all reserves, there are not 100,000." The French part I believe; the latter I cannot. His statement that "the French have in armed commissioned ships 15,000 against the 22,000 of England" is most misleading, as shown above.

p. 4. Modern treatises are ephemeral and of little value.

The Form. "The typical English battle-ships built and proposed, having unarmoured ends," appals and fills me with dismay. How it must delight the enemies of Great Britain!

Mr. Barnaby, at p. 5 states, "As to the absolute strength of the Navy, I entirely concur with those who desire that it shall be twice as powerful as that of France;" and he is the man who has weakened nineteen ships. I observe that Mr. Barnaby omits reference to the resistance of armour to long-range and oblique fire—its main use.

I again advise Mr. Barnaby to "imitate the vessels of every class in the French Navy, and merely double the number." Thus we cannot be beaten in case of war. Now we most certainly should be, unless we alter our mode of armouring and our naval policy.

p. 8. I always considered mastless ironclads my children, but with a height of freeboard equal to Hercules — see Admiralty correspondence; I believe that Dreadnought modernised would have few equals, with guns high out of water.

ADMIRAL OF THE FLEET,
Torquay, January 14th. THOMAS SYMONDS.

THE CONDUCT OF EXPERIMENTS.

SIR,—I have read with much pleasure your interesting article on "The Conduct of Mechanical Experiments," contained in your issue of the 9th inst., with every line of which I entirely agree. The value of experiments of this character depends altogether upon the care and attention bestowed upon every detail, which too often are passed over as trivial and unimportant. My object in writing to you is to call your attention to an experiment conducted by myself in 1858, and which doubtless, from the length of time which has since elapsed, has escaped your notice. The details are given in your paper of the 2nd April, 1858, page 260, and are curious as showing how completely the various elements of uncertainty noticed in your article were anticipated. With your permission I will refer in detail to the experiment, hoping that it may be of some interest to such of your readers as may take a serious view of the importance of this class of investigation.

Before doing so, however, I may as well first explain that in the course of business it was frequently my duty to draw up contracts in which the element of economy of fuel was of the first consideration, and in which an undertaking was entered into on the part of the manufacturer at Reading that the consumption of Welsh coal per horse-power per hour—useful effect—should not exceed 3 lb., and it was with a view to the certainty of the result that I instituted the experiment. It was carried out during the right time, in February, 1857, with the factory engine, and lasted ten hours. The main shaft was disconnected from the works, and was fitted with a brake wheel, acting as a dynamometer. The diameter at the point of suspension was 4ft. 7½in., giving a circumference which, multiplied by the revolutions per minute—sixty—equal to a velocity of 870ft. per minute. The weight balanced during the experiment was 1517 lb., which, being multiplied by the speed, gave a trifle less than 40-horse power useful effect. A man was constantly watching the lifting of this weight, so that it may be said that the load on the engine was constant and uniform. The temperature of the water supplied to, and run off from the condenser, was registered twice per hour, and indicator diagrams taken at the same periods. The quantities of water from the condenser and evaporated by the boiler were carefully taken by weight, as was also the quantity of coal used during the whole time. In order to insure perfect accuracy as to the discharged water and that evaporated by the boiler, it was weighed in filling the boiler, and at the termination of the experiment the same course was pursued when emptying the boiler; the difference, if any, of the first and final weighings having to be added or subtracted to the weight of water supplied to the boiler during the ten hours' trial which would give the true amount of water evaporated. The weight of water discharged by the condenser was arrived at in the following manner;—A tank, 4ft, by 4ft. by 4ft. deep, was placed on a weighing machine, and properly balanced weights to the amount of one ton and a-half were then placed on the beam. The water from the condenser was then run into this tank until its weight balanced those on the scale beam. The communication was then cut off by means of a sluice, and the water allowed to run off by opening the outlet sluice. During the emptying of the above tank the condenser water was received into another smaller tank, which was discharged into the large tank, when it was ready to be refilled. An attendant was stationed exclusively to attend to this duty, and recorded the number of times the tank had been emptied. The duty being constant, so was the amount of injection, and therefore the totals of discharge suffered no variation during the ten hours the experiment lasted. The water from the steam jacket and covers was also noted and weighed, as was also that drawn by the donkey for supplying the boiler; so that every element of uncertainty referred to in your leader was prevented.

As regards the quantity of fuel used, it was very carefully weighed for the run, previous to starting; the steam was raised up to 50 lb., and the grate completely cleared. The trial was then proceeded with, and only a few clinkers had to be raked out at the end, the pressure of steam in the boiler standing at the same figure as at the commencement. The coal had to be ignited after the grate had been cleared by a few chips and wood shavings. Having thus far described the general mode of conducting the experiment, it may not be out of place to say that the boiler was of the ordinary Cornish type, 22ft. long, 5ft. diameter; the internal flue 2ft. 8in. diameter, and fitted with the ordinary dial pressure gauge, with ashpit and flue dampers.

The engine was horizontal, expansive, and condensing. The diameter of the cylinder 21in.; length of stroke, 30in.; jacketted, and top and end covers all in direct communication with the boiler, and fitted with a drip to carry off the condensed water. There were two slide valves—the ordinary admission valve, and also a variable cut-off valve working on the back face of the former. This valve was made in two parts, which were brought either closer together or further apart according to the degree of expansion required. This was regulated by an automatic arrangement with the governor—an arrangement now in general use, but which, at the time of which I am speaking, was not commonly employed. The air-pump was double acting, 6½in. diameter, and was worked by carrying the piston-rod through the back cylinder cover, so that its length of stroke was identical with that of the cylinder.

Trials of Steam Engines.

Description.	S. Pinchbeck in 1858.	B. Donkin in 1869.
Diameter of jacketted cylinders ..	21in.	24in. and 13$\frac{3}{16}$in.
Length of stroke in inches	30in.	54in.
Pressure of steam in boiler	52 lb.	40·9 lb.
Number of revolutions per minute	60·03	32·48
Name of coal used	Powell's Duffryn.	Powell's Duffryn.
Duration of trial	10 h. 2 m.	10 h.
Quantity of coal used..	1232 lb.	1193 lb.
Quantity of water evaporated ..	11,080 lb.	10,404
Quantity of water discharged by condenser	247,080 lb.	244,990 lb.
Average heat of well water	38 deg.	53 deg.
Average heat of condenser water ..	82 deg.	89·54 deg.
Difference in degrees..	44 deg.	36·54 deg.
Mean vacuum in inches	27	27
Degree of expansion allowing clearance	$\frac{1}{8\cdot6}$	$\frac{1}{11}$
Mean indicated horse-power	47	46·21
Consumption of coal per horse-power per hour	2·62	2·61
Quantity of water evaporated per pound of coal	9	8·72
Horse-power on dynamometer ..	40	—

So much has been written respecting the superiority of high and low-pressure engines over the single cylinder that I do not feel inclined to venture on so tender a subject, but I inclose herewith a tabular statement of the results of my experiment in 1858, as compared with a similar experiment made in the year 1869 by Messrs. Bryan, Donkin, and Co., on a double high and low-pressure engine, with results wonderfully similar to mine, and in which the consumption of fuel is practically the same. JOHN PINCHBECK.

9, Victoria-chambers, Victoria-street, S.W.,
January 21st.

WIND PRESSURES ON ROOFS.

SIR,—In reply to Mr. R. H. Graham's letter to THE ENGINEER dated 21st November, 1884, asking me how I have come to the conclusion as to his taking the weight of 45 lb. on the authority of M. Levy, I have to inform him that he in his reply to an anonymous correspondent, and in support of his argument, plainly says "I have neither object nor intention to decide a question of this nature upon my own reasoning and authority," and quotes M. Levy's authority, and ingenuously tells us that as M. Levy adopted the lower pressure of 28 lb. and 33 lb. per square foot for dead and accidental load for similar roof, he is safe in assuming 45 lb. per square foot instead of supporting his argument by facts and figures, which clearly shows that he worked upon M. Levy's authority.

The real point under discussion is not the question of authority. The question at issue is whether the weight assumed by Mr. Graham—45 lb. per square foot for dead and accidental load—or that given by the anonymous correspondent—56 lb. per square foot—is right. According to my calculations, as per details given in my last letter to THE ENGINEER, I found that the result nearly agreed with that of your anonymous correspondent. To this Mr. Graham responds that he has adopted the weight after diligent inquiry and calculations. I fear there is something wrong in both his inquiry and calculations. He assumes a pressure of 45 lb. in two dissimilar roofs of different spans and pitch, without taking the form of roofs into consideration, which is quite against practice and theory. He has assumed the weight in all the examples of graphic treatment of stresses in framework. Is this the right way and practice of the profession to come to the proper conclusion as to the weight of particular existing roofs by assumptions or by inquiry, particularly when he gives the examples of graphic treatment of stresses in framework for the study and guidance of young students?

With regard to the distribution of wind pressure on roofs, Mr. Graham says, "We are differing in principle if not in effect." I say there should not be any difference at all in treatment of wind pressure if worked on right principles; but as Mr. Graham follows the old practice of taking the wind pressure as vertical load, which is now admitted by all as an incorrect mode of treatment, the fallacy of this treatment is proved by Hutton's experiments and its exposition by Professor Unwin, that the wind pressure should be treated as normal. This principle of treatment was taken up and followed by the continental engineers and authors long before Mr. Graham's publication of graphic and analytic statics, and it is strange that he has not adopted the same principle, expressing desire to follow the old beaten track on a plea of simplicity of treatment, and on assumption that any error will be insignificant in practice. This sort of teaching to young aspirants of engineering is very dangerous, and will lead to serious consequences. DORABJU B. RABADINA.

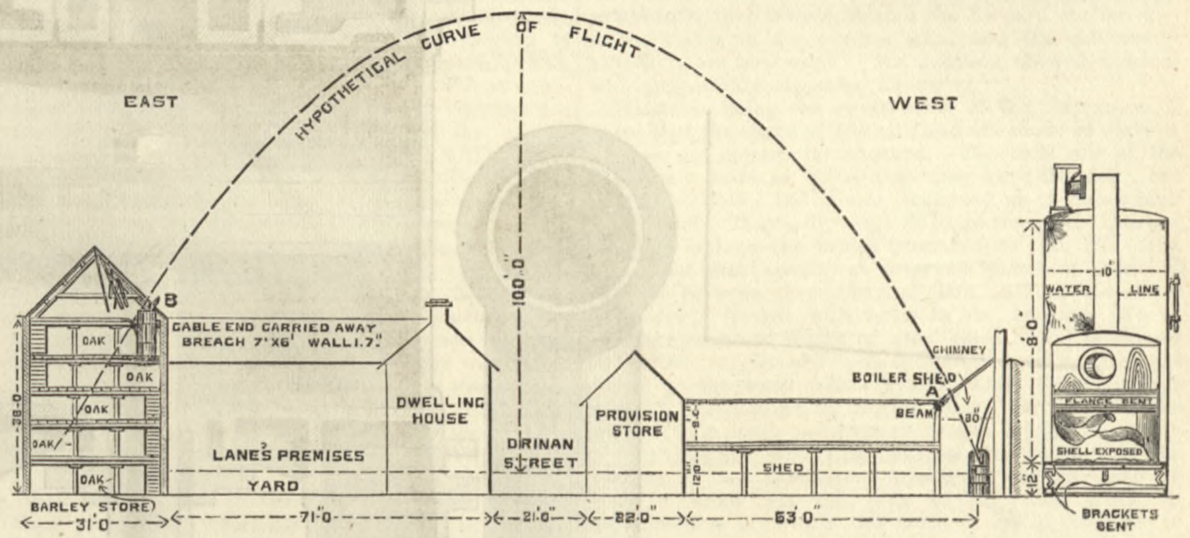
Bombay, January 1st.

REMARKABLE BOILER EXPLOSION.

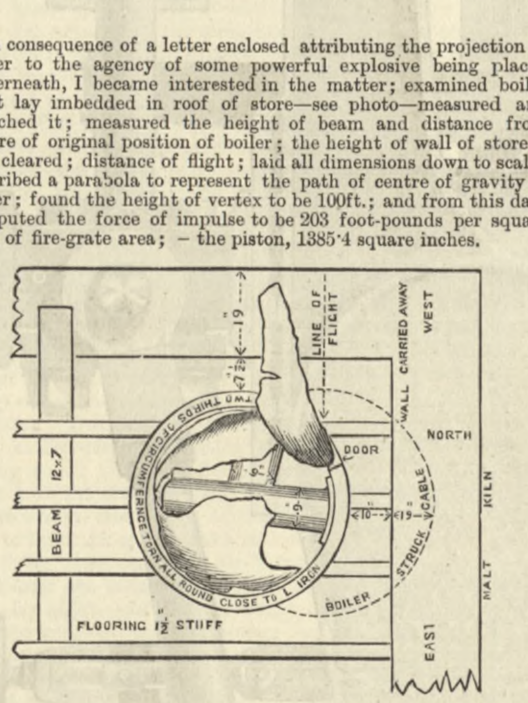
SIR,—Herewith I beg to enclose cuttings from a local journal, photo of drawing, and particulars, &c., of a very extraordinary boiler explosion which occurred here about 10·30 a.m. on the 15th December, 1884, on which occasion a boiler of the vertical cylindrical type, with two cross tubes in fire-box, weight, as deduced from scantlings, about 3521 lb., *i.e.*, 1 ton 11 cwt. 2 qrs., was suddenly projected upwards from its position through roof of shed, and in its flight reached a height of not less than 100ft., passed over intervening houses and street, and in its descent encountered roof of store, passed through, passed through top loft, and was "brought up" by resistance of second loft. This accident was happily unattended with any injury to life or limb.

The boiler had been used for heating purposes only, feed supplied from pressure of main ranging from 30 to 50 lb. per square inch in accordance with requirements as to other supplies. Communication with main service by stop cock. Feed pump dispensed with. The safety valve weight having been lost, cannot tell the working pressure of boiler. From the appearance of valve seat and the "rusted-up" state of lever, &c., I consider the whole was inoperative.

The fire-box is very thin, say only from $\frac{3}{16}$in. to $\frac{5}{16}$in. in thickness, the original being about ⅜in., and the collapsing of it caused the explosion. From the general appearance of fire-box I consider the accident attributable to excessive internal pressure, suddenly rupturing the very thin plates of it. The torn portions extended all round for about two-thirds of circumference. The rent was stopped by the fire door ring at one end and strong patch at the other end. The whole contents of boiler were discharged at once on to the blazing fire and grate, which acted as a piston. Boiler was thus hauled upwards in an oblique direction, consequent on the inaction of the portion unruptured.



In consequence of a letter enclosed attributing the projection of boiler to the agency of some powerful explosive being placed underneath, I became interested in the matter; examined boiler as it lay imbedded in roof of store—see photo—measured and sketched it; measured the height of beam and distance from centre of original position of boiler; the height of wall of store it just cleared; distance of flight; laid all dimensions down to scale; described a parabola to represent the path of centre of gravity of boiler; found the height of vertex to be 100ft.; and from this data computed the force of impulse to be 203 foot-pounds per square inch of fire-grate area; – the piston, 1385·4 square inches.



By the law of falling bodies, the force of impact is equal to the force of impulse, and the

$$\sqrt{\frac{\text{of height of projection} \times 8 \times \text{weight of boiler}}{\text{area of the fire-grate}}} = \text{foot-pounds}$$

per square inch;

$$\therefore \sqrt{\frac{100 \times 8 \times 3521}{1385\cdot4}} = 203 \text{ foot-pounds per square inch of fire-}$$

grate area = the impulse the boiler must have received to impel it 100ft. high.

Now as I have before said, the boiler was projected at least 100ft. to leap over the beam at the commencement of its flight, and over the wall at the other end; but it may have gone 150ft. high. Then in such case we have: $\therefore \sqrt{\frac{150 \times 8 \times 3521}{1385\cdot4}} =$ 249 foot-pounds per square inch of fire grate. The latter is the highest point it could have reached. Taking into consideration the slight amount of damage done to store, which opposed its momentum, and the damage to boiler itself, the amount of impact in the latter case would be on roof = 133 foot-tons.

As I have explained particulars in photo., together with the cuttings from papers, recapitulation would be useless; and I have only to say if you consider this communication and enclosure worthy of a place in your valuable columns, you will oblige me by kindly inserting it, as the way in which I have worked out the problem may be of some use to a few of your readers.

2, Rockbore-terrace, Old Blackrock-road, Cork, January 10th. RICHARD HARTLAND.

CRACKING OF STEEL PLATES.

SIR,—Referring to the explanation proposed in the paper by Mr. A. S. Biggart, published in THE ENGINEER, January 16th, page 54, to account for the failure in certain directions of steel plates, allow me to point out that the following rather more complete explanation of the forces resident in a plate was given in a paper read before the Society of Engineers in October, 1880:—

"Plates when taken from the rolls or from the annealing oven are generally laid on a flat surface to cool, but whether laid down or stood on edge, cooling takes place somewhat more rapidly towards the corners and edges than at the middle. At first, the whole plate is of the same temperature, which may be that of redness. The exterior parts first assume the rigidity of cold steel, and contraction takes place on the interior parts which remain at a higher temperature, and therefore the contraction has taken place under a tensile strain. Thus, if a plate of 1in. in thickness is considered in illustration, it will be seen that a corner of, say, 6in. on either edge has an area on the two sides of 36 square inches, but it has also the additional effective cooling area of the edges, which adds 12 square inches, making for a surface area of 36 square inches a total of 48 square inches of effective cooling area by radiation and evection. If, on the other hand, an area on the two sides at the centre of the plate, of 36 square inches of such surface, be taken into consideration, it will be seen that the edge surface can only be considered as cooling by conduction. Thus the effective cooling area of the outer parts of the plate is much more efficient than the central parts. These outer parts having, then, become rigid and contracted under tension, exert a correspondingly compressive strain upon the interior parts still at a higher temperature, and thus more or less amenable to compression. This tensile strain upon the outer parts or borders of the plate is gradually eliminated as the interior parts cool, and is finally changed into one of compression as the inner parts contract in cooling under a molecular tensile strain, due to the incapacity of the rigid border to follow the inner parts in their contraction. In the cold plate put into a structure there is thus initial molecular strain differentiating from compression at the edges to tension towards the centre. If the plate is cooled under circumstances inducing unequal cooling, these internal strains are aggravated, and they may possibly be of such magnitude that extraneous strains that would not materially affect a tough iron plate may be sufficient in a harsh steel to cause rupture. Further, when a plate of such a character is being rivetted up every rivet is compressed under a very high strain to make it fill the holes, and thus, acting as a viscous fluid, adds to the strains already tending to destroy the plate." W.

January 27th.

AUTOMATIC BOILER FEEDING.

SIR,—In view of the many accidents that occur to boilers through shortness of water, is it not time that the Boiler Insurance Companies should consider the question of automatic boiler feeding? Every boiler is required to have its own safety-valve to provide against excessive pressure of steam, why should it not be equally provided with an arrangement for preventing the shortness of water?

Two, at least, of such feeders are now before the public—Fromentin's and Mayhew's—and were automatic feeding demanded by the insurance companies, no doubt other forms would soon be produced, and one very common source of danger with steam users would be effectually overcome. AUTOMATIC.

January 19th.

RAILWAY RATES.

SIR,—I have this day read Mr. Stretton's comments on matter furnished by me and contained in your previous issue. I see nothing in them throwing any light to the contrary of that I have written. I will admit that when we may eventually destroy and eliminate the first and second-class traffics, that the mainstay may then centre in that of the third-class, for the simple reason that we should have no other. We have travelled fast in that direction. I have received proofs of some matter I sent a fortnight back for the February issue of the *Railway Engineer*, and if your correspondent will read it, I have therein stated that if our present first and second-class passengers were turned into third, the fares received would be minus a sum of £4,000,000. It must perplex anyone to argue in the direction of profits from such a change. Mr. Stretton will also see he is in error in suggesting that raising fares is the only plan before us; also that the seven railways earned 2·90 less in 1883 profits. FREDK. T. HAGGARD.

East Barnham-grove, Bucks,
January 20th.

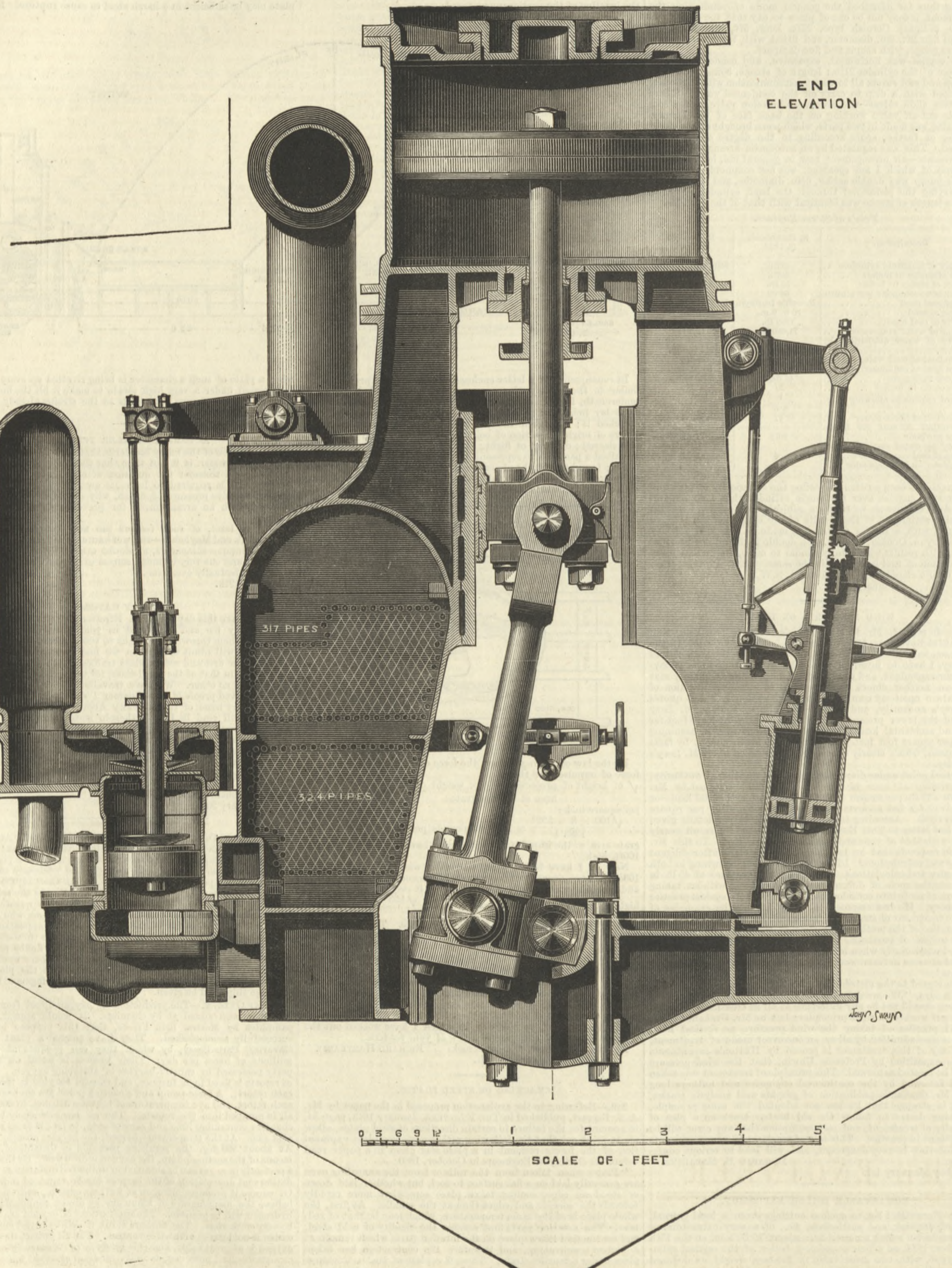
THE OCEAN DOCK SCHEME.—When the last South Australian mail left considerable interest was felt in the movements of the Ocean Dock Company. Was the work being done of a permanent and genuine character? Could they get the necessary capital to carry out their project, or would they forfeit the £14,000 penalty to the Government for breach of contract? Would the scheme be modified or altered? These and numerous other questions were being daily asked. The *Colonies and India* says, one who has seen the work testifies to its so far presenting the appearance of a substantial and permanent character, and we have the assurance of those who profess to know that there was no doubt about the capital being forthcoming, and that therefore there would be no forfeiture to the Government. It appears that the plans have been so altered that, if carried out, increased wharfage and facilities for large ships will be given.

CHEAP OXYGEN.—The production of oxygen direct from the air has long been aimed at by chemists. It would appear, from a pamphlet by Messrs. Brin Frères, that this purpose has been successfully accomplished. They have erected a plant in Rue Gavarini Paris-Passy, by which they can produce about four millions of litres per day. Their process is based on the property possessed by caustic barytes of absorbing oxygen. A series of retorts is fixed in a furnace, and caustic barytes is inserted in each retort. A force-pump and a suction-pump are connected with each retort, and at a temperature of between 500 deg. to 600 deg. C. air is pumped into the retorts. The air has previously been in a chamber containing lime and caustic soda, to free it from carbonic-acid gas. At the temperature named, the barytes absorbs oxygen. At about 800 deg. the resulting peroxide is deoxidised, and, by means of the suction-pump, the oxygen is drawn off. By this process a perfectly pure gas can be obtained in unlimited quantities. The oxidation and deoxidation of the barytes can be repeated indefinitely. Of course it produces nitrogen as well as oxygen, and the authors believe the manufacture of ammonia by direct combination with hydrogen will be possible. The applications of oxygen are likely to be very numerous. The authors think it will be found superior to carbonic-acid gas in aërated beverages. For all antiseptic purposes oxygen is of great value, and it is likely to be extensively employed in metallurgical processes, as in its medium elevated temperatures are more readily obtained than in the atmosphere.

COMPOUND ENGINES OF THE TUG BOATS HIBERNIA AND COLUMBIA.

DE MAATSCHAPPY DE MAAS, DELFTSHAVEN, HOLLAND, ENGINEERS.

(*For description see page* 81.)



PUBLISHER'S NOTICE.

*** *Next week a Double Number of* THE ENGINEER *will be published containing the Index to the Fifty-eighth Volume, and a large quantity of extra matter. Price of the Double Number,* 1s.

TO CORRESPONDENTS.

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

*** *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.*

E. P. (Castelnau).—(1) *Probably; depends on the shape of the stern.* (2) *Depends on the ventilation. If that is good the stove will do no harm.* (3) *The whole arrangement is very dangerous; put in proper traps.* (4) *No.* (5) *The advantage you would gain by making your engine condensing would not be worth the trouble. The condensing pipes would take a knot an hour off the speed.* (6) *Yes.*

ERRATUM.—*In our last impression, page* 70, *for Bremner's valve gear, read Bremme's valve gear.*

THE STRENGTH OF SPRINGS.
(*To the Editor of The Engineer.*)

SIR,—Can any of your readers inform me where I can obtain sound information, theoretical or experimental, respecting the deflection and strength of the principal forms of locomotive, wagon, and hackney carriage springs? Is the deflection of a spring affected by increasing its compass, other things being equal? If so, in what manner and to what extent is it affected? SPIRIFER.

CANE LUBRICATORS.
(*To the Editor of The Engineer.*)

SIR,—We notice in your last issue that some one is inquiring for the makers of cane lubricators. Some weeks since you published a description of a cane lubricating arrangement for loose pulleys, &c. We immediately tried it, and found a most perfect and wonderful result. We shall be very glad to make such cane lubricators for your correspondent if he will send us particulars of his requirements.

T. AND W. SUMMERS.

High Orchard Ironworks, Docks, Gloucester,
January 28th.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Friday, Jan. 30th, at 7.30 p.m.: Students' meeting. Paper to be read and discussed, "The Iron Bridges on the Hull, Barnsley, and West Riding Junction Railway," by Mr. F. W. Stokes, Stud. Inst. C.E. Mr. B. Baker, Member of Council, in the chair. Tuesday, Feb. 3rd, at 8 p.m.: Ordinary meeting. Paper to be read with a view to discussion, "The Design and Construction of Steam Boilers," by Mr. David Salmond Smart.

SOCIETY OF ENGINEERS.—Monday, Feb. 2nd, at 7.30 p.m.: The President for the past year, Mr. Arthur Rigg, will present the premiums awarded for papers read during the year. The President for 1885, Mr. Charles Gandon, will deliver his inaugural address.

SOCIETY OF ARTS.—Monday, Feb. 2nd, at 8 p.m.: Cantor Lectures. "The Distribution of Electricity," by Professor George Forbes, M.A., F.R.S.E. Lecture I.—General statement of the problem. Electrical distribution for lighting supply from a central station. Success of electric lighting largely dependent on economy of distribution. Comparison with gas. Limits to the smallness of conductors. Waste of energy in mains. Undue heating of mains. Fall of potential. Methods proposed for laying mains (1) for low potential; (2) for high potential. Testing mains. Wednesday, Feb. 4th, at 8 p.m.: Ninth ordinary meeting. "Education in Industrial Art," by Mr. Charles G. Leland. Earl Brownlow will preside. Thursday, Feb. 5th, at 8 p.m.: Howard Lectures. "The Conversion of Heat into Useful Work," by Mr. W. Anderson, M. Inst. C.E. Lecture VI.—Hot-air engines; nature of their action, mechanical details, limits of efficiency. Compressed air refrigerating machines. The steam engine, non-condensing, condensing, and compound; nature of its action, mechanical details, limits of efficiency, results actually obtained.

DEATH.

On the 22nd Jan., suddenly, at 2, Royal-parade, Cheltenham, THOMAS PARKER WATSON, M.A., Mem. Inst. C.E., late Chief Resident Engineer at Port Elizabeth, South Africa, aged 56.

THE ENGINEER.

JANUARY 30, 1885.

THE CREEPING OF RAILS.

IN this country we are little troubled by the creeping or longitudinal motion of rails. It is known that a tendency to move in this way is manifested by rails on inclines when the traffic is heavy, the rails tending, as a rule, to slip down the hill; and motion has been observed on curves, apparently due to the difference in length between the outer and inner rail. In the United States, however, creeping seems now and then to assume very serious proportions; and a paper on the subject was recently read by Mr. J. B. Johnson before the Engineers' Club at St. Louis. Our readers will no doubt remember that there is a magnificent railway bridge there, and we learn from Mr. Johnson's paper that the rails on this bridge creep *a foot a day*. At first sight there seems to be a mistake somewhere about such a statement as this, and an English engineer is disposed to think that Mr. Johnson is poking his fun; but so far as can be seen there is no joking about the matter. The paper is written with commendable precision and neatness of detail. The main facts are that the rails always move in the direction of the traffic—that is to say, down on the down line and up on the up line. The creeping is confined to the bridge proper and to its eastern approach, which is on a series of short girders on iron columns. It is on a grade of 1 in 66 and 2500ft. long. The bridge is 1600ft. long, and the summit of the incline is on the middle of the bridge, which is 5ft. higher than either end. The amount of creeping is greatest on the approach, being for the year Sept. 1st, 1883, to September 1st, 1884, in the ratio of 162 to 100, as compared with the creeping on the bridge. The distances are in the ratio of 156 for the approach to 100 for the bridge. All manner of expedients have been tried without any avail to prevent the movement of the rails. Steel spikes, bolts, strips, and fish-plates have been sheared or broken; frog crossings and switches pulled out of line or torn up bodily; the rails have been twisted and depressed by the crowding and pushing forward of those in the rear against those in front. The rails have completely beaten the engineers, and provision is now made for this movement at three points on each track, viz., at the entrance upon the east approach, at the east abutment, and at the west abutment. On the north track, since the rails go west, openings are constantly enlarging at the approach and closing at the west abutment. On the south track the rails go east, so the openings are enlarging at the west abutment and closing at the approach. Where the openings are enlarging, short pieces of rail are taken out and longer ones put in their place, and where they are closing up, longer bits are removed and shorter inserted. This has to be done many times a day at each point where the rails are cut. On account of the switches located at the east abutment, it is necessary to have cut sections on each side of these, making four places in each rail where this movement has been provided for. Every second day the foreman in charge of the day squad measures the movement that has occurred, on both approach and bridge, and keeps a careful record of the same. The monthly movements are copied into the reports and are on a file in the offices of Mr. Wuerpel, the superintendent of structure, and of Colonel C. Shaler Smith, the engineer of the bridge company.

The St. Louis case is not isolated. The Pennsylvania Company had a good deal of trouble with creeping rails on a bridge at Harrisbugh over the Susquehanna. The exact amount of the creeping was never known, but the fact of the creeping was proved by the displacement of the curves at each end of the bridge, as much as 4ft. of rails being removed from one end of the bridge to the other at one time. But creeping was stopped here by the use of a peculiar fish-plate, consisting of a piece of angle iron projecting wider than the flange of the flat-footed rail, and resting on the cross sleeper. There are four spikes fitted to notches in the edges of the angle iron, and these are able to hold the rail. Each rail is held independently, and it is to be observed that on the St. Louis Bridge, where eight men are kept constantly at work—five by day and three by night—correcting creeps, as explained above, no attempt has been made to secure each rail separately. The fastenings were put in in batches or groups, on the theory that if a connected line of rail is held fast in one place it cannot move longitudinally in any place.

Our readers will no doubt want to know why the rails creep on the St. Louis Bridge. We fear that we shall disappoint them when we say that we do not know certainly why they creep. The results of the creeping are not very serious, and the phenomenon gives constant employment to eight men, who, it seems, would otherwise be out of work; so that it is not an unmixed evil. Our principal reason for dealing with it at any length is that the whole affair constitutes an interesting engineering conundrum, which takes this form: Why do the rails on the St. Louis Bridge creep a foot a day? No less than six distinct explanations—that is to say, answers to the riddle—have been supplied by American engineers, and we have no hesitation at all in saying that not one of them is satisfactory. Briefly they may be summed up thus:—(1) The creeping is due to the inclines; (2) it is due to stopping the trains on a down grade; (3) it is caused by the pounding of the wheels against the ends of the rails at the joints, so driving them forward; (4) that it is due to the deflection of the bridge under the rolling load; (5) that it is due to the distortion of the arch of the bridge; and (6) that it is due to the pæning of the rail by the tread of the wheels. We need scarcely stop to point out that not one of these explanations (?) sets forth why it is that, although similar actions and influences are at work all over the country, it is only on the St. Louis Bridge that they should operate to produce creep. Mr. Johnson very properly denounces them all as futile, and advances an explanation of his own. Unfortunately, he is not very lucid in his style, and it is not easy to grasp his precise meaning; but his view seems to be that the rails are deflected under passing loads, that the bottoms of them become longer than the top, and that they are compelled to creep forward. We do not quite follow Mr. Johnson's meaning; and lest we should do a probably very ingenious and possibly satisfactory theory an injustice, we give his own words as follows:—"The secret of the whole matter is, that the rail rolls itself across the bridge on its outer or extended side, and by as much as this is longer than the neutral axis, by so much it will creep for a single wave passing. This amount is directly proportional to the length of the structure, and to the amount of the deflection. If another wave follows this, however, its additional effect will be constant and will not increase with the length of the structure; in other words, this and all succeeding wave effects of the series will be directly proportional to the deflection alone. The total train effect will therefore be proportional to the weight and number of the cars passing; in other words, to the tonnage of the train. This has been seen to be true on the bridge. On the approach the effect of the grade comes in to modify this ratio. From the above reasoning it is evident that if the rail were supported at a point above the neutral axis, as under the head, for instance, there would be a tendency to creep backwards, or against the direction of the traffic, from the compression of this upper side. There would still be a forward tendency, however, due to the wave motion of the rail, inasmuch as the neutral line of the rail, when thrown into waves, is longer than the corresponding linear distance. If the rail be supported from the upper surface, as has been done in the model to be exhibited, then the backward motion due to the compression of the upper flange would more than counterbalance the forward motion due to the waves in the neutral axis, and the rail would actually move backward." Mr. Johnson showed a model which apparently supported his views.

Whatever being the explanation of the phenomena, it seems that the shape of the rail, and its mode of fixture, exercise an important influence. The rails are of the Vignoles type, in so far as that they have flat feet; but they have heavy bull heads, mounted on a rather high central web. They only weigh 60 lb. to the yard. Channel bars are laid on the bridge from end to end, 12in. deep and about 9in. apart; at intervals plates of iron are rivetted between these channel bars, so that the whole resembles a trough with holes in the bottom. Where there are no holes, blocks of gum wood, 5½in. thick, are laid in the troughs, and these support the rails, which are spiked to the wood pillow blocks, while these last are spiked to the bottoms of the troughs. The pillow blocks are each 17in. long, the alternate spaces being 19in. Any of our readers who may address themselves to the solution of an interesting problem, will do well to bear in mind that the rails in all cases move in the direction in which the train is going, that is to say, they are pushed forward, not drawn back, and this is the case even on the incline. Thus the mean movement up the hill was 401ft. in the twelve months, and down the hill 414ft. It is worth adding that Mr. Johnson holds that similar tendency to creep is manifested in bridges. If a bridge have its two ends similarly mounted, whether both on rollers, or both on slides, when a train comes upon it from the right, this end is at once pinned fast by the weight of the train, and as the train moves over the bridge it causes a certain amount of deflection in the truss. This deflection lengthens the bottom chord and shortens the top one, so that if the truss is supported at the bottom chord, the left end moves to the left, but if it is supported at its top chord, as decked bridges sometimes are, the left end will move to the right. Mr. Johnson states that he has observed this movement when it amounted to as much as ⅜in. As the train goes off the truss recovers its normal position, the lower chord shortens up and the upper one lengthens out, but now the left end is pinned fast by the departing train while the right end is free to move. The recovery will take place at this end, therefore; so that if supported at the bottom chord the truss is pulled forward, and if supported at the top chord it will be moved backward by an amount equal to the distortion of the corresponding chord. If one end is on rollers and the other anchored fast to the pier, then, of course, the movement all occurs at the roller end, regardless of the direction of the train. Mr. Johnson states that he has understood that the Louisville bridge moved north from this cause by some 6in., when it was found necessary to anchor one end fast to the pier. It would be, to say the least, an awkward circumstance if a bridge quietly walked off the abutment at one end and dropped into the water. American engineers are certainly blessed with sensational experiences which do not fall to our lot in this country.

LONDON FIRES.

ON January 1st, 1866, under the powers of an Act obtained in the previous year, the Metropolitan Board of Works took over the whole of the London Fire Engine Establishment, electing Captain E. M. Shaw, previously superintendent of the force, as chief officer of the new Metropolitan Fire Brigade. The establishment thus transferred to the Board had been maintained for more than thirty years by an association of the principal fire insurance companies. In addition to this voluntary organisation, it is to be noticed that for nearly a hundred years it had been the duty of the churchwardens and overseers of each parish to keep a fire engine for putting out fires in the parish, under an Act passed in the fourteenth year of King George III. This venerable parochial institution was of some service in its day, for we find that when the duty of extinguishing fires first devolved on the Metropolitan Board, that body was anxious for the parish engines to be maintained for a period until better means could be provided. Accordingly, arrangements were made with the authorities of parishes in which an efficient engine and staff had up to that time been maintained, to continue the same for a limited period, on behalf of the Board. The need of this supplementary help is evident when we observe that the stations previously held by the insurance companies were only seventeen in number, in addition to two floating stations, of which one was at Southwark Bridge and the other at Rotherhithe. The additions maintained by the parishes were twenty-seven in number, or perhaps twenty-five, as two appear to have been kept up by private parties, one being associated with the name of Mr. W. Roberts, of Millwall, and the other with the firm of Messrs. Penn and Son, of Deptford. Observing the localities of the various stations, it is evident that the insurance companies were looking after their own interests by concentrating their force in the central districts. They went no farther afield than Lucas-street, Rotherhithe; Horseferry-road, Westminster; Cock-hill, Ratcliff; and Wellclose-square. They even went no great way westward, their principal stations in that direction being Chandos-street; Crown-street, Soho; Wells-street, Oxford-street; King-street, Baker-street; and King-street, Golden-square. There was a strong force at Watling-street, and other stations in Farringdon-street, High Holborn, Whitecross-street, and Bishopsgate-street Without. When we look at the parish list we find such places as Camden Town, Hammersmith, South Kensington, Paddington Green, Holloway-road, Bow, Greenwich, Lewisham, Brixton, and Wandsworth. To this day we find a few relics of the old system in the shape of a volunteer force in certain neighbourhoods, private engines and amateur firemen existing in some of the suburbs of the metropolis. Neither can it be said that these are mere impertinent intrusions on the domain of the regular Brigade, the need of such protection in the outlying parts being occasionally apparent. More remarkable than this is the fact that not long ago the City authorities were loud in their complaint that changes had been made by the Metropolitan Board which left the City area insufficiently protected. The removal of the head-quarters from Watling-street to the Southwark Bridge-road was particularly objected to, as weakening the defence of the City against fire. In deference to the views of the Corporation on this subject, the strength of the Watling-street station has been partially restored, though only in a slight degree, and this concession, coupled with some other alterations, has been followed by a cessation of the alarm previously expressed.

When the Metropolitan Board first entered upon its functions as the protector of London against fire, it found itself provided with a staff comprising 130 men of all ranks. To these were added such of the engine-keepers and firemen formerly in the services of the parishes as were deemed qualified for the duties required of them, the number of persons so appointed being thirteen. With other additions, the total strength of the force by Midsummer, 1866, amounted to 184 men. Twenty-seven manual engines were included in the transfer, and in six months these were exactly doubled. In the same period the steam fire-engines were increased in number from eleven to twenty-one. The total expenditure for the maintenance of the Brigade for the year ending March 25th, 1867, was £83,399. By Midsummer, 1869, it was announced that having been actively engaged for three years and a half in making the necessary provision for the effectual protection of the metropolis against fire, the Board had so far succeeded that but little remained to be done in order to perfect the organisation throughout "every district of the metropolis." In July, 1867, the machinery of the Royal Society for the Protection of Life from Fire passed into the hands of the Board, and the greater part of the society's staff was at the same time incorporated with the Fire Brigade. This addition to the force must be borne in mind in estimating the numerical progress of the Brigade, considered as an organisation designed for the extinction of fire. The number gained at the outset by the transfer of the fire-escape staff seems to have been about 80, and may have been rather more, the number of escapes being 85. Looking, therefore, to the middle of 1869 as the date when the Metropolitan Fire Brigade was first rendered practically complete, according to the ideas of the Metropolitan Board at the time, we find the fire-engine stations to have risen in number from 17 to 50, the number on the staff from 130 to 378, and the year's expenditure from £83,399 to £89,737, in addition to a temporary loan of £35,000. The period when the fire department was transferred to the Metropolitan Board was one in which there was obvious cause for anxiety as to the security of the metropolis. From 1860 down to 1865 inclusive, there had been a continued increase in the number of fires, the rise being from 1089 to 1502, or 38 per cent., in five years. In addition to the absolute increase, there was the important fact that fires of a specially destructive character were rising out of proportion to the aggregate. Out of 1502 fires which occurred in 1865, as many as 512, or 34 per cent. of the whole, were of the class denominated "serious." It was in the course of this fiery period that the terrible conflagration at Cotton's Wharf took place, which burned for a whole month, and immolated the veteran Braidwood. Thus painfully the inadequate character of the arrangements for extinguishing fire was being demonstrated. That there should be as many as ten serious fires per week for a whole year might be termed almost a scandal, and certainly implied something defective in the government of the metropolis. Fires are inevitable in the present nature of things; but it rests with human resource to keep them within bounds. In 1866 things were better than in 1865, but they were still far too bad, the serious fires being 326, or 24 per cent. of the total. In 1867 the serious fires were less than half the number they were two years before, and were 18 per cent. of the total, after which they remained at about 14 per cent. for three years, dropping as low as 8 per cent. in 1872, when the actual number became less than a fourth of that in 1865. With a continually increasing population, the result may be looked back upon as remarkable, and as affording proof of the efficiency given to the fire department by the action of the Metropolitan Board. What would have been the state of affairs had the old organisation alone existed it is difficult to conceive. The total number of fires was nearly the same in 1872 as in 1865, and yet the loss and damage must have been immensely less.

The low proportion of 8 per cent. of serious fires in London was not repeated after 1872 until 1881, and at the latter date the actual number was larger, being 167 instead of 120. The problem to be faced is the continual growth of London. The extent of the population in each year has to be considered if we would rightly gauge the value of the Brigade. It happens that, relatively to the population, serious fires were lower in 1872 than in any other year from 1865 downwards. Taking the number per 100,000 of the population, the serious fires were 17 in 1865 as compared with 3·61 in 1872. In 1881, when serious fires were 8 per cent. of the total, as in 1872, the ratio to the population had risen to 4·40. During the three years closing with last December, the serious fires have been continuously 9 per cent. of all the fires, but the actual number has been rising more rapidly than the population, the ratio per 100,000 of the people increasing from 4·21 to 4·82. The ratio last year was higher than in any year since 1873, when it was 4·92. The absolute number of fires last year was large, being greater than in any year on record. It thus exceeds the number in 1883, which was in excess of that for any year preceding. But the year 1870 has to be looked back upon as having more fires in proportion to its population than any other. Neither was it even exceeded in the mere number of its fires until 1881. In reality, 1870 was a worse year than 1884. It had fewer fires, but the ratio to the population was 60·42, as compared with 56·95 last year, and the serious fires were nearly twice as numerous in proportion to the population as they are now. Still we do not like to see the serious fires gaining on the population, as they have been doing since 1881; but perhaps they will recede. The actual number of these fires last year was higher than they have been since 1871. Captain Shaw apparently reckons on his success in reference to serious fires according to their percentage of all the fires. But it is obvious that this percentage might fall simply because the total number of fires increased. Thus the serious fires were 9 per cent. of the total last year, and 11 per cent. in 1875; but reckoned per 100,000 of the population, they were 4·82 last year against 4·68 in 1875. It must also be noticed that the aggregate number of fires last year had a higher ratio to the population than any year except 1870, though it was nearly equalled by the ratio for 1871. Another fact of some interest is the quantity of water thrown upon fires. In the disastrous year 1870, the water employed amounted to 5737 gallons per fire, an unusually small quantity, and the question arises whether this had anything to do with the large number of fires classed as serious. In other words, were the engines unequal to the work they had to do? In 1873 the water used was 14,606 gallons per fire, and the serious fires were less by 110 than in 1870. Last year was unexampled for the quantity consumed, the total being 42 million gallons, or 18,348 gallons per fire. This indicates a large amount of engine power, and may perhaps go some way towards justifying the criticism which the fire offices are understood to endorse, that fires are now "drowned" out rather than "put" out. The services of the Salvage Corps come into play, as mitigating the damage caused by water.

The statistics which we have laid before our readers, and which are by no means limited to the figures found in the official reports, may be held to prove that the Metropolitan Fire Brigade was not established a day too soon. The transfer from the insurance companies to the Metropolitan Board was a most politic measure, as placing the establishment on a broader basis, both in regard to finance and the manner of its administration. The 130 men in January, 1866, and the 377 at Midsummer, 1869, at which latter date the Board considered the organisation very nearly perfect, have now become 589, besides fourteen "pilots" and sixty-six coachmen. The twenty-seven manual engines received from the fire offices have become 124, and the steam fire engines have risen from eleven to forty-seven. The expenditure last year on the working account was £115,133, leaving a balance of debt of over £7000. The fire engines of the fifty-five land stations travelled a distance considerably exceeding twice round the globe. Captain Shaw is moved to say a word for the splendid force which he has so long and ably directed, and states in his report just issued: "I have made a special study of what is done by forces of every kind in all countries, and I think I can justly say that no public body of men anywhere has ever, even in an exceptional year, been called on to go through as much constant severe labour as this Brigade has undergone in the last few years, and especially during the year 1884." He modestly adds:—"I dare say we have made some mistakes, but I know that all ranks have worked hard and done their best." Of the quality of the Brigade there can be no question, but it would be hazardous to assert that in quantity it is equal to the reasonable demands of the metropolis. Had the *personnel* of the Brigade been augmented since 1869 in the same proportion as we find the rateable value of the metropolis to have risen, the number of men in the force would now be 683 instead of 589. It is a singular fact that while the Metropolitan Board can legally expend on the Brigade what they please in the shape of capital, the revenue, out of which the working expenses must be met, is limited, the rate for the Fire Brigade being fixed by law as not exceeding a halfpenny in the pound. Hence the Board can buy engines and establish stations out of capital, but the men must be remunerated out of revenue, and here the pinch is felt. The necessity for having a powerful brigade, continually undergoing development, is shown by the fact that, as a general rule, every accession to the population of the metropolis brings about more than a proportionate increase in the number of fires. There are fluctuations in regard to this order, and of late there have been signs of improvement; but the number of fires last year, compared with the population, shows that the law still operates, though it is difficult to assign a sufficient reason.

RECENT DYNAMITE OUTRAGES.

THE circumstances connected with the three attempts to injure national property and to destroy life made on Saturday last, January 24th, have been fully related in the daily papers. We have hitherto taken no notice of such attempts. They hardly come under the head of engineering science in any form. It may be well, however, to offer a few observations on them, and in doing so, while we have but little to say, we can claim to give such facts as we notice on very high authority. The attempts were all of the same character, of course—one concerted plan of attack. That at Westminster Hall was probably the best carried out, and that at the Tower the worst. The questions that most concern us are what were the actual means employed? Who were the agents? and, What is the object and probable scope of such attempts? questions, doubtless, that are more easily asked than answered. That, however, is no reason why we should not give such information or make such conjectures as it may be in our power to offer.

The explosive employed was unquestionably the same as has been used on previous occasions, namely, a kind of dynamite or nitro-glycerine compound, termed lignine, in which sawdust is used to take up the nitro-glycerine. On previous occasions the actual material has failed to explode, and has been examined, and there is every evidence that could be looked for after an explosion that this was identical with it. It can be said with confidence to have been manufactured in America, where the name of "Atlas" is given to it. It is of sufficient strength for 5 lb. to be capable of producing very much the effects exhibited on Saturday last. It is probable that each charge may have consisted of somewhere about this amount. Five pounds of the explosive would form a cube of 4½in. on the side, and this, of course, might be easily carried in two, or even one, packet by a man or a woman. This brings us to the question of agents, on which little can be said beyond the fact that they were undoubtedly persons who entered with the visitors. There is some reason to think that they were men dressed in women's dress. With a fuze of some length to enable it to burn long enough to enable the agent to escape, it is obvious that a woman's attire would offer much greater facility for concealing the necessary package than that of a man. A woman might doubtless do all that was necessary, and women have done more desperate things in Russia. Nevertheless, the training and nerve required would be more readily found in a man, and the evidence seems to point to the conclusion that a man in woman's attire was at all events the agent in the case of the Westminster Hall explosion. Curiously enough, we happen to know privately that some question was raised in the mind of those in charge of another public building some days since, at the behaviour of a person dressed as a woman, but who attracted attention by standing and moving like a man, and who appeared to be watching those employed in a way that caused sufficient misgiving for the superintendent to be summoned, though nothing occurred to call for any actual interference with the person in question. If, however, men dressed up as women were the agents on this occasion, it is probable that a change might be made for the future. We can conceive precautions that would be likely to be effectual in cases of "dynamiters" entering public buildings with parties of visitors, but we may have to look for attempts in some other form perhaps for the future.

As to the object and probable scope of attempts of this kind, it is hard to divine any object, except the immediate one of collecting subscriptions from vicious and ignorant classes who expect to see some result for their money, and are not capable of judging how far such as those before us may help forward the revolutionary ends in view. The Tower of London is not now England's stronghold of power, but the name sounds imposing and is historical; and the same may be said for Westminster Hall, or rather the Houses of Parliament, even on a day when holiday visiting takes the place of legislation. The scope of damage to be done in this way is, from a national point of view, very limited. We have said that the Westminster Hall ruffian was the most business-like, and his case deserves special notice. In selecting the crypt to the right of the entrance for his exploit he chose a very confined place in immediate proximity to a mass of supporting masonry, hoping, like Samson, to bring down the whole. We believe we can assure him that this would not have taken place, though undoubtedly much more damage in a pecuniary sense would have been caused than under the circumstances in which the charge actually exploded. As our readers doubtless know, the smoking mass was seen by two ladies and a gentleman, and it was seized up and carried out into Westminster Hall by the gallant policeman Cole, who deserves the Victoria Cross at least as fully as any soldier on service who picks up a fused and burning shell. When he had got down the steps in Westminster Hall, some burning liquid running on his fingers caused him to drop the charge, which exploded on the pavement over the crown of a low arch of the vault beneath. This was easily blown through, the gas forcing stones up from the vault and injuring the gentleman before mentioned—Mr. Edward Green—and causing the policeman in question and another to fall senseless into the vault. It is probable that the fuze had just burnt down to the charge and that Cole's life was saved by his dropping the explosive when he did. It may be said generally that buildings can only be injured locally by so violent an explosive as nitroglycerine. Guy Fawkes was more scientific in his larger attempt. Much waste of money may undoubtedly be caused, and far worse, some innocent human lives may be sacrificed; but it is hard to believe that results which produce indignation and prompt repressive measures, but which can effect no political result, can be long persevered in. If they are, it shows how much money can be collected from very ignorant and vicious classes.

THE IRON TRADE.

THERE are few gentlemen better qualified to speak on the iron industry than Captain Stoddart, the managing director of the Parkgate Ironworks, near Rotherham. Presiding at a recent social meeting, Captain Stoddart referred to the prospects of 1885, which seemed to him to be gloomy. Many theories had, he said, been started as to the cause of the present depression of trade; but he summed up the situation tersely thus—over-production, the loss of markets, and the unsatisfactory political outlook over the whole world. In 1870 something like six millions of tons of pig iron were produced in England, and five and a-half millions of tons were produced in all the other countries of the world. In the year 1883 the home production had increased to eight and a-half millions of tons, and the production on the Continent and America had increased to twelve and a-quarter millions. It thus appeared that while the production in England had only increased 25 per cent., that of other countries in the world had increased to the extent of 50 per cent. In coal, England in 1870 produced 109 millions of tons; the other countries of the world, 93 millions; making a total production of 202 millions of tons. Yet in 1883 the output had increased 164 millions of tons in this country, and 217 millions of tons in the other countries of the world; making the tremendous total of 381,000,000 tons. While the output of coal had thus doubled during the last thirteen years, there had also been an enormous increase in the production of metal, and comparing these increases with what might be taken as the normal increase of the population, it would be found that the latter had not overtaken the former. In 1870 they exported large quantities of material to the Continent, but these nations had now not only doubled their own production, they had competed with England in other countries, and also prevented iron being exported to them. At the same time, England was not alone in the suffering from trade depression. America was troubled with strikes, causing large numbers to be unemployed, both in the coal and iron districts. In France the labouring part of the population were clamouring for bread. Then the political horizon was clouded. War was going on between France and China; England was committed to an expenditure of many millions; and there had arisen in Europe a kind of land hunger amongst the nations of Germany, Russia, and Italy, who were seeking to annex territory all over the world. All these causes could not but impede the operations of trade and commerce, and it was this trade and commerce which they had to rely upon for the development of the resources of this country, as well as for the consumption of the raw material which was produced. Captain Stoddart believes that England has the best raw material in the world, and in almost unlimited quantities. They had also the best and most skilful labour, and, perhaps, the largest amount of floating capital available anywhere. If the labour and capital would only coalesce and work unitedly, and by their developed resources produce the best material at the very lowest prices, he believed the gloom from which we were at present suffering would pass away, and that the country at no distant date would be in a more flourishing position.

STEAMSHIPS AND CREWS.

A STEP has been taken by one of the great mutual marine insurance organisations of the North of England, which may prove of the utmost importance in regard to the future of steam shipping, and of the course of insurance. The Tyne and Wear Steamship Insurance Association has passed a resolution which is to the effect that a minimum number of men shall be assigned to each vessel, having regard to the size and type of the ship, and to the trade in which she is employed. If an insured vessel be sent to sea with a smaller number than that so assigned to her and agreed upon at the commencement of the policy, the vessel shall "be deemed unseaworthy and no insurance shall be paid in the event of loss, where such loss shall have been directly attributable to undermanning." It is a resolution that points to a new departure in marine insurance—one in which the insurers will claim to have more to say as to the number and classes of the crew as well as to the condition and trade of the vessel. It is a step that has been cautiously taken, and one that will in all probability be largely followed up, though it can scarcely be expected that it will be put into practice without a little friction. In the insurance of steamships there is need for the steps forward being cautiously taken, because it is certain that only now is the experience being reaped which should be the basis of all new departures in shipping. The insurance clubs are the best judges of what is needed from time to time, though it is possible that—as with all other bodies—they will need a little pressure now and again to enable the conservative element to be overcome, and the forward step to be taken. There is great need for the reduction of the cost of steamship insurance, and to effect this safely and without hurt, it must be slowly and cautiously done, and the fruits of experience must show what is needful, and when is the best time to put it into practice. We believe that the step now taken by some of the northern insurance associations—for others are following in the track—will be beneficial, and will tend to lessen loss in the future, because it is based, not upon theory only, but upon the teachings of experience.

THE ACTIVE GUN COMMITTEE INQUIRY.

THIS Committee, of whose proceedings we propose to give an account next week, finished the first stage of their inquiry into the cause of the bursting of the Active's gun on Wednesday, January 28th. After trying the effect of small wedges in the bore, the Committee went on to a file, and ended by a steel cold chisel nearly 8in. long, weighing 15½ oz., and 0·85in. by 0·06in. thick at the larger end. The thinner wedges cut into the shot, and slightly into the bore of the gun. The cold chisel broke the shell up. As it is difficult to see what further effect even a larger wedge might produce, the trials of wedging by obstacles in the bore have been concluded. The gun, which is of Elswick make, has stood the test perfectly. As a matter of fact, however, the pressures have not been high up to the last round, whose pressure was not measured when we left the ground.

LITERATURE.

A Practical Treatise on the Manufacture of Bricks, Tiles, Terra-cotta, &c. By C. T. DAVIS. Philadelphia: H. Carey Baird and Co. London: Sampson Low and Co. 1884. 472 pp.

THIS is not a mere description of the outward ways and appearances of men and machines in a brick-making yard, nor is it the production of the man who, priding himself in his merely practical view of things, ignores the teachings of art and theory in the proportion suggested by the old doctrine of the relative value of an ounce of practice and a pound of theory, the word theory being generally as much misapplied as edge tools are said to be by children. The author has given an interesting sketch of the history of brick, tile, and terra-cotta manufacture. In his preface he laments that there are no other books to which he could refer for some guide in writing his own. If he had written his book in England he could not have said this, but if he had no guide he has done well, though perhaps his work will have more value in America than in England, for though the processes of digging, pugging, throwing, making slip, moulding, drying and baking, are much as in this country, there are things which the author might learn here, and more especially as to machinery and the terra-cotta manufacture. He is, however, not far behind even in these, and in brick-making not at all. He seems to be very well acquainted with the sort of thing used round about London for building what are called houses, and does not hesitate to condemn, and gives full reasons for doing so, not only our bricks, but our air-polluting system of clamp burning. It is noticeable that one of the brick machines which he describes with much care and clearness is fitted with a spiral steel blade cut off, instead of the steel wires generally used. This spiral blade cutter is not now at all used in this country; but in the States a difficulty which was felt here has been overcome. This was the trouble which resulted from varied speed of the expressed bar of clay and constant speed of the knife. In the machine described the speed of the knife is controlled by the speed of flow of the clay bar, and hence the difficulty is overcome.

Being an architect as well as a brickmaker, the author has full appreciation of a great deal in the art exigencies of brick and terra-cotta work, which the ordinary brickmaker would not possess. Hence, his book has a value that it would not have if written by a brick or a machine maker, though the latter would not, perhaps, have fallen back in quite as many instances on patent specifications for drawings of machines and apparatus. The book is well written, and will be useful to architects as well as those more immediately concerned in the manufacturing operations and processes described.

Almanach für die k.k. Kriegs-Marine, 1885. Vienna.

THOSE Englishmen who are anxious about the condition of our Navy, and wish to find out how it really compares with those of other nations, may study the subject conveniently in this little book. In it they will find an immense amount of information compressed into a very small space, and arranged for the most part in alphabetical and tabular form, so as to be of very easy reference. We first get the inevitable series of tables of measures and weights, &c. The next thirty pages are occupied by descriptions and dimensions of the ordnance used in the fleets and coast defences of all nations. We see here a neat method of tabulating the penetrative power of the most important pieces of large ordnance that have been made. In one column stand outline sketches, all to the same scale, of the guns, with leading dimensions attached. To the right of these, occupying three-quarters of the page, is depicted a series of eleven thicknesses of armour-plate, at the bottom of the page being placed in columns the thicknesses of armour-plate, of wood backing, and of internal plate. Opposite each gun's mouth these plates are shown as penetrated up to a certain point in the series of increasing thicknesses, the first unpenetrated being shown partially damaged. The next section contains a series of tables, in each of which is given a list of the armoured and unarmoured ships of war of one nation, with the most important arranged in columns, such as the length, beam, draught, displacement, armour thickness at various points, and leading particulars of the artillery. The nations and the ships in each table are alphabetically arranged. England and France each occupy fifteen pages of such tables. Then come twenty-four pages of more detailed, but still very condensed, descriptions of the more important armour-plated ships in the world. Then follows a lengthy section, giving the duties and regulations of all grades of officers in the Austrian service from highest to lowest. Finally, we find a list of the present *personnel* of rank, the age, length of service and rank of each man being given in three columns.

Theory of Deflections and of Latitudes and Departures. By J. W. SMITH. New York: D. Van Nostrand. 1884.

THIS is a book written for railway surveyors, and the problems to which the theories enunciated are applied are, for the most part, those of setting out railway curves and of curvilinear surveys for the allocation of railway lines in general. A very sensible protest is made against the superstitious adherence to the now antiquated geometrical notions of past centuries in our mathematical school teaching. The axioms and methods of Euclid are, of course, neither wrong nor absurd. But throughout the whole of scientific and practical work we now use habitually, and could not get on without using, very much freer and broader views and more general and powerful methods. The part of the old geometry towards which the author of this book feels particular enmity, is the treatment of angles and angular relations. What he calls a "deflection" is a difference of directions, without reference to the positions of the lines indicating the directions, thus angular deflection having its direction, right-handed or left-handed, indicated by + and −, in order to specify or measure the angle, it being unnecessary to have any actual intersection of lines. The book is written in order to deduce from such more rational fundamental notions a whole system of propositions and problems useful to the railway surveyor. We heartily sympathise with its object, which is, that these modern notions being now completely in possession of all serious modern mathematical workers, we hardly think the expressions of scorn and indignation indulged in are necessary. Nor was it necessary to invent a new nomenclature for the book. Why not adopt the beautifully simple and efficient language of vector geometry introduced by Sir W. Hamilton, and now thoroughly understood by nearly all scientific men?

THE Tipton Gasworks, which were purchased by the Local Board of the township about a year ago, have earned £7004. The cost of works has been £2278, leaving a balance of £4726.

WHEELS FOR A STEAM ROLLER.—The tenders sent in to the Adelaide City Council for supplying wheels to a steam road roller were all regarded as too high, and none was accepted. The *Colonies and India* says the lowest tender was £177 5s. 11d., and the price of the English made article was stated at £90, the duty being given at £4 10s., and the cost of freight at £22 10s., or a total of £117. While the aldermen and councillors expressed themselves willing to keep the work in the Colony, they felt that the difference between the two tenders was too great to permit of the local offer being accepted, and it was resolved to re-advertise the work.

MR. BARNABY ON THE NAVY.

AT the present moment any expression of opinion by Mr. Barnaby has peculiar interest, because he would hardly commit himself to views which he knew were contrary to those of the Admiralty as a body, nor would he be likely to ventilate for the first time views that had not been broached to the Lords. Consequently we may accept any opinion he expresses as the official verdict on any question that he discusses. In his address to the Royal Corps of Naval Constructors, he devotes some attention to personal questions—that is, to the part that has been taken by one writer or another. With this we do not particularly concern ourselves. How far Admiral Sir T. Symonds said or implied that the Warrior or Black Prince is armoured from end to end must be settled between Mr. Barnaby and himself. It must at all events have been an unconscious expression, we should think, and of little moment. Under the same category we may place the question of any responsibility taken by Sir T. Symonds, Lord Henry Lennox, and Sir John Hay, in throwing discredit on the Devastation type of ship, and so stopping building at a critical time. Questions as to the structure of our ships are those deserving our special attention. On these we may quote several passages. Mr. Barnaby says:—"There has been considerable misstatement and exaggeration in the course of the inquiry, and there are many points of great interest which have not been touched, or if they have been, the naval officers who have touched them have preferred to dilate upon questions of naval construction. We have seen, for example, an admiral of the fleet giving the names of ships stripped to an alarming extent of their belt armour, and declaring that they are most dangerous, and including among them the Conqueror and the Hero. He informs the public at the same time that the Warrior and Black Prince are completely belted. This admiral had the Warrior under his command in the Channel Squadron in 1870, and was superintendent of the dockyard, where the contrary of that which he states as to these ships must have been clear whenever they came into his hands."

The stripping of the armour was pretty well thrashed out in the discussion on Sir E. Reed's paper at the United Service Institution and in our notices of it. It amounts to this: French ships latterly have been belted from end to end at the expense of depriving the whole of the ship above the belt of armour except a low barbette wall in front of each gun. English constructors have completely armoured the central portion of the ship as a citadel, and have had to pay the penalty of leaving the ends unarmoured except by a horizontal deck below the water-line. It remains to be seen in action whether our ships or those of France will suffer most under fire. Mr. Barnaby, however, near the end of his address, makes a statement which is so important that we almost fancy there must be some qualification that we do not know of, otherwise we cannot understand why we have not heard of it before. Before noticing it, however, we would observe by the way that we cannot think that Mr. Barnaby is wise in implying, as he does, that Sir T. Symonds, the admiral in question, made a mistake in "dilating" on points of construction. Doubtless mathematical and mechanical questions such as those concerning stability demand very special training to discuss to any purpose. The Captain's fate will ever remain a monument of the danger incurred in dealing rashly with such matters. Such points, however, as the amount of protection under fire, are surely those on which a combatant officer may speak, much more an admiral of Sir T. Symonds' calibre, who has had a dockyard under his charge. The important paragraph to which we have referred is as follows:—

"In order to place in a clear light the question of the extension of the belt to the ends of ships, I enclose a comparative statement made for the purpose:—

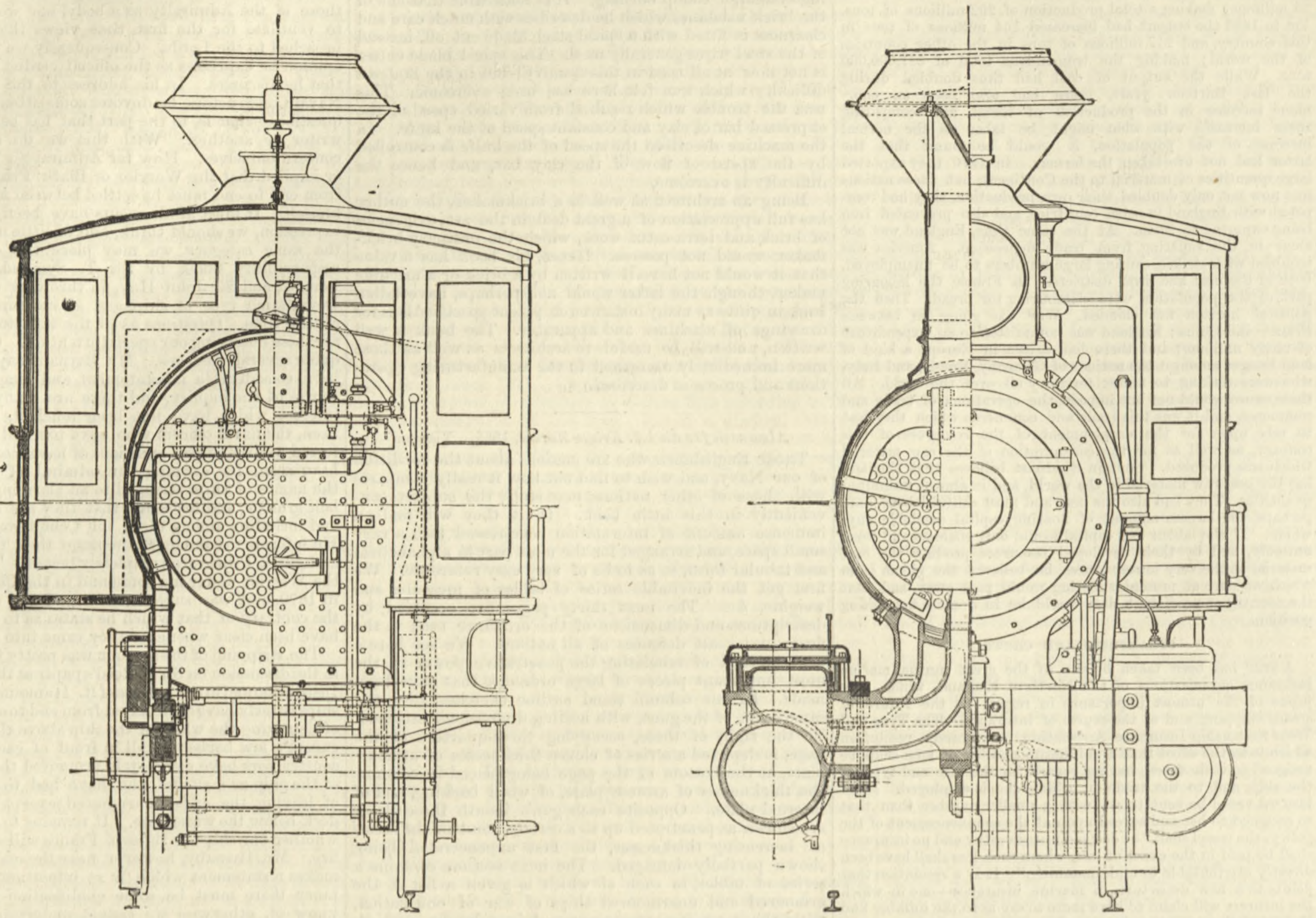
Typical English Battle Ships, Built and Proposed, having Unarmoured Ends.

Name.	Percentage of water line area covered by armour.	Percentage included in coal bunkers beyond the armour.	Percentage of enclosed cork chambers.	Remaining percentage.	Percentage of cubic contents of spaces in last col. occupied by stores, excluding coal and cork spaces.	Buoyancy lost by complete riddling of unarmoured ends.	Total sinkage of ship corresponding.	Displacement.
						Tons	In.	Tons.
Warrior ...	60	None.	None.	40	17·5	850	32	9,210
Resistance ...	59·25	None.	None.	40·75	17·5	780	42	6,270
Inflexible ...	42	30	11·4	16·6	25·4	750	23	11,880
Agamemnon	45·4	18·5	12·85	23·25	24·5	580	22	8,510
Colossus ...	42 75	26·85	12	18·4	22·8	570	18	9,150
Collingwood	54·15	17·4	None.	28·45	22·6	500	17·5	9,150
Camperdown	56·35	17	None.	26·65	21	420	14	10,000
Conqueror ...	96·15	None.	None.	3·85	10	34	1¼	6,200
Last approved design for single turret ship	60·4	17	None.	22·6	21	380	11·5	10,300
Belted cruiser	84·85	None.	None.	15·15	10	41	2	4,900

"In order to justify the stoppage of belt armour short of the ends, we consider it desirable to provide an unusually large metacentric height in the intact ship to provide against loss of it by perforation and water logging. That there is no serious disadvantage in this in respect of rolling is shown by the behaviour of the Inflexible, where the effect of great metacentric height in quickening and accumulating angles of oscillation is compensated for by the large inertia of the wide and heavy citadel, and is reduced by other means. When the French naval officers recognise this new condition of things, and no longer fear

CONSOLIDATION GOODS ENGINE.

THE SCHENECTADY LOCOMOTIVE WORKS, U.S.A., ENGINEERS.

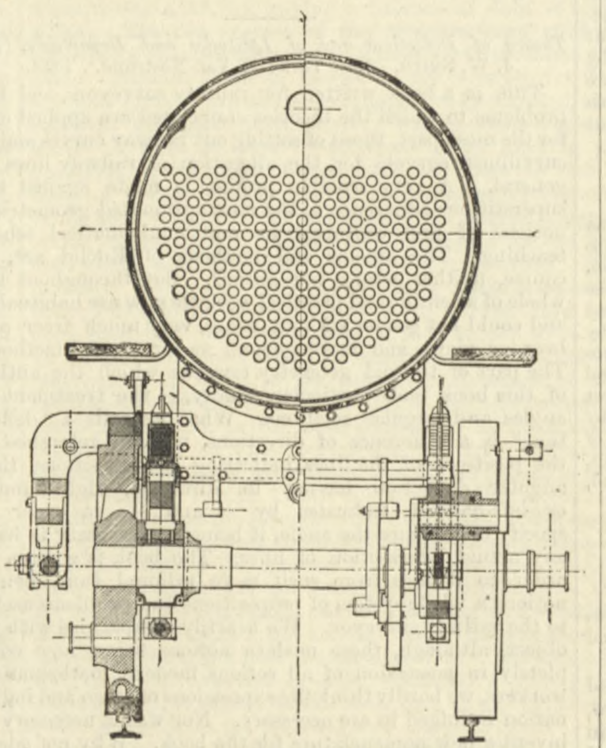


the heavy rolling they have been accustomed to find invariably associated with a high metacentre, they will probably prefer to accept the better protection of their guns or a reduced size of ship. The latest designs of M. de Bussy, the author of the Redoubtable, Dévastation, Foudroyant, Tonnerre, Tempête, &c., provided for a central citadel, with the usual proportions, and metacentric height of ships, and with thin armour at the ends of the belt proof to the quick-firing guns. It is conceivable that some such provision against machine guns might be a wise addition where weights can be surrendered to meet it. In the Agamemnon, for example, 2in. armour could be put in a belt 6ft. wide, with the weight of less than one-third of her ammunition for her turret guns, of which she carries 180 rounds, while the Amiral Baudin, of over 11,000 tons displacement, carries only sixty-six, and the Duperré and Dévastation seventy-six. That it cannot be right to continue armour of anything like the maximum thickness to the ends of the belt, if the question of the behaviour of the ship with high metacentre is once put aside, will be clear from the following considerations:—(*a*) There are existing guns capable of perforating the best armour which can be made, 19in. thick, supported by a far stronger backing than is ever given in a ship. The three targets fired at recently at Spezia—targets built in this manner—were all wrecked by the shot. (*b*) There is no French ship built or building in which the barbette or turret armour reaches this thickness. In the Amiral Baudin the barbette armour is 16½in. (*c*) The way in which the complete belt draws upon the other armour may be seen by the following comparison:—

Alternative designs, with same displacement.	Single turret, as approved.	Same ship, with belt extended and thinned.	Increase in ship if armour not thinned in middle and made 12in. at ends.	Alternative for this increased size, with 14in. armour, not carried to ends.
Length	335ft.	335ft.	355ft.	355ft.
Breadth	70ft.	70ft.	70ft.	70ft.
Speed...	15½	15½	15½	15½
Displacement ...	10,000	10,000	11,000	11,000
Belt	Shortened	Complete	Complete	Shortened
Thickness on belt	18in.	14 to 12in.	18 to 12in.	14in.
Other armour ..	18in.	14in.	18in.	14in.
Armament ...	1 turret, 2 110 ton guns	Same	Same	Two turrets 2 110-tn. guns 2 43-ton guns
Battery for small guns	Aft covered with 3in. armour	Same	Same	Amidships with armoured traverses only

(*d*) In the Agamemnon, where the armour is mainly iron from 18in. to 14in. thick, and where the armament is nearly confined to the two turrets, any reduction of its thickness would have to be faced in view of the fact that the shot which recked the Spezia targets is estimated to be capable of perforating 40in. unbacked iron armour. It may be proper to add that the reversion to the shortened belt is due to the recommendation of the Committee on Designs, in 1871, although they are in no wise responsible for the manner in which it has been carried out."

If M. de Bussy is now designing citadel ships with thin armour at the ends, he has so far adopted the English designs that Sir T. Symonds' suggestion that we should copy French models would scarcely need an answer. The increased metacentric height again is a feature of special importance which has hitherto been little noticed; and the table showing the gain and loss in the various features by alternative designs is very valuable. A point, however, which is more readily discussed in a brief review such as we are taking is the employment of thin armour on portions of citadel vessels which have been left unarmoured hitherto. The introduction of light quick-firing guns has prompted this. It appears as if an ordinary ships' side might be so riddled by these guns that it is desirable to make the slight addition in armour necessary to defeat this



CROSS SECTION OF CONSOLIDATION ENGINE.

particular attack alone even at the sacrifice of some of the ammunition supplied. Something of this kind is being carried out in our Benbow now building. We believe that this is right, not only on account of the 6-pounder guns, but also those of much larger calibre. It has been proved at Shoeburyness that a common shell will perforate unbacked armour of a thickness equal to at least half its calibre, striking directly. Obliquely, the power is less in proportion to the sine of the angle of incidence. Consequently many classes of common and shrapnel shell which were shown to have the most terrible effect on unarmoured structures in the Shannon experiments might probably under conditions of service be kept out by 3in. of steel. Upon this, however, it would be necessary to make experiments. It is a most important point, and well deserves attention. As to thick armour, Mr. Barnaby surprises us by speaking in such strong terms of the strength of the Spezia 1884 backing, because though strong it was soft. The wood was so thick that the plates were liable to yield in a manner that differs from that in the case of less strong but more rigid support.

To discuss all the points raised by Mr. Barnaby, it would be necessary to prolong this article to considerable length. We would, therefore, observe briefly that he calls attention to the fact that ideas move so fast that types are scarcely repeated in either our own Navy or that of France; that he does not feel confidence in Sir Edward Reed's plan of protecting ships against torpedo attack by means of inner bottom plating, although he admits that it has been well worked out. He considers that the chief need of our Navy is in the direction of ships of moderate size and great powers of attack, having high speed, great coal endurance, and powerful guns, such ships being protected by either a water-line belt or plate deck. Very heavily armed ships, Mr. Barnaby thinks, will be chiefly useful in preventing an enemy covering himself wholly by the use of light armour. Powerful guns call for very heavy armour, and the weight of this necessitates part of the vessel being left unarmoured or very lightly armoured. The Agamemnon, we are glad to learn, when drawing 26ft. of water, steers as well as any ship in the fleet.

We agree with Sir Thos. Symonds that no dependence could be placed on the observance of a treaty which was framed to secure our supplies to us in time of war. When Mr. Barnaby suggests that combatant officers should devote themselves to the discussion of such points rather than features in construction, we cannot help feeling it is a hint to them to keep out of mischief rather than serious advice to do useful work. It would argue some simplicity to follow such advice. The number of our seamen is of much greater importance. Mr. Barnaby estimates that England has 22,000 and France 15,000 in commission, but that England has under 100,000, including all reserves, while France has 170,000. This is bad enough; but it will be seen that Sir T. Symonds, in his letter which we print elsewhere, makes a much more unfavourable estimate for England. This, however, is a question that is simply one of fact, to be settled by the production of statistics, and of these we can supply no other than Mr. Barnaby and Sir T. Symonds have already given.

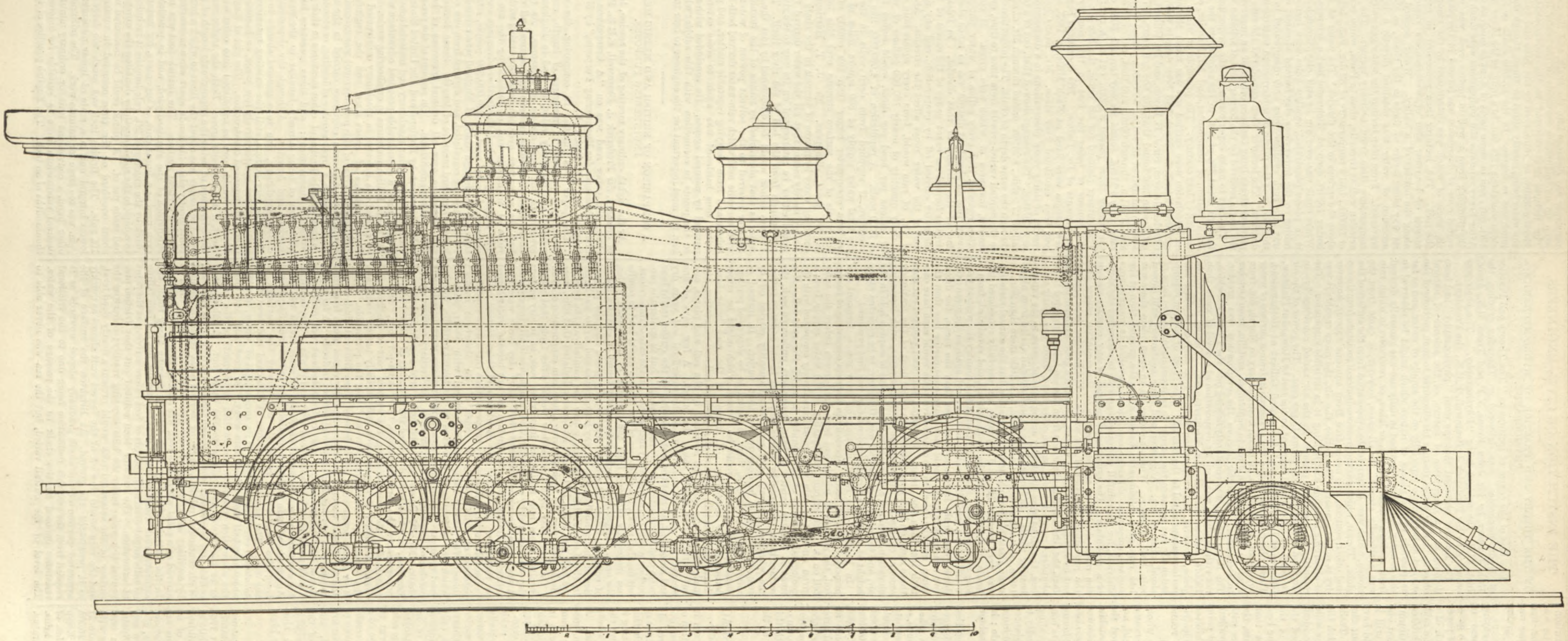
Briefly, the pith of Mr. Barnaby's important address is that while we are slightly modifying our citadel type of ships by extending light armour as a protection against quick firing field guns, France is approaching our designs. The substitution in cruisers of belt armour for horizontal armour which came out in the discussion on Sir E. Reed's paper is just alluded to. Increased building, and greater speed in building, are apparently recognised as necessary, the increase of England's ships being likely to be in the form of swift, powerfully-armed ships of medium size.

CONSOLIDATION GOODS ENGINE.

THE engravings above and on following page illustrate an engine of the "Consolidation" type, now commonly used on United States railways for heavy goods traffic. We are indebted to the American *Journal of Railway Appliances* for the following particulars concerning it:—The

CONSOLIDATION GOODS ENGINE.

THE SCHENECTADY LOCOMOTIVE WORKS, U.S.A., ENGINEERS.



fuel used is bituminous coal, and the gauge of the road is 4ft. 8½in. The total weight of the engine in working order is 48 tons, of which 42 tons are carried on the driving wheels. The total wheel base is 23ft.; driving and rigid wheel base, 15ft. 3in. Diameter of cylinder and stroke of piston, 20in. by 24in.; kind of piston packing, steam packing; diameter of piston-rod, 3¼in.; size of steam ports, 16in. by 1¼in.; size of exhaust ports, 16in. by 2¾in.; greatest travel of slide valves, 5¼in.; lap of slide valves, outside, ⅞in.; inside, $\frac{1}{32}$in.; lead of slide valve in full stroke, $\frac{1}{16}$in.

The diameter of driving wheels outside of the tire, 50in.; diameter and length of driving axle journals, 7in. by 8in.; diameter of truck wheels, 30in.; diameter and length of truck axle journals, 5in. by 9in.; size of main crank-pin journal, 5¼in. by 5¼in.; size of intermediate crank-pin journals, leading 5¼in. by 3¾in., trailing 4in. by 3¾in.; size of front and back crank-pin journals, leading 3¾in. by 3¼in., trailing 3¼in. by 3¼in.; length of driving springs from centre to centre of hangers, front and main, 36in.; back, 36in.; intermediate, 24in. The boiler has a wagon top fire-box; diameter of first ring—outside—56in.; material and thickness of plates in waist and outside of fire-box, $\frac{7}{16}$in. steel; horizontal seams, treble-rivetted, welt strip inside; circumferential seams, double-rivetted; fire-box, inside length, 120in. and 116in.; width, 43⅜in.; depth, front, 53in., back 49in.; material and thickness of plates in inside of fire-box, steel crown, ⅜in.; tube, ½in.; sides and back, $\frac{5}{16}$in.; material and thickness of front tube plate, steel ½in.; water spaces, front, 4in.; sides and back, 3in.; crown, stayed by crown bars, size of crown bars, 9in. by ⅞in. welded at ends; combustion chamber, with 4⅝in. stays; material of tubes, iron; number of tubes, 223; outside diameter of tubes, 2in.; heating surface in tubes, 1274·6 square feet; heating surface in fire-box, 164 square feet; total heating surface, 1438 square feet; style of grate, receding with drop plate; style of ash-pan, hopper, with drop plates worked from cab; exhaust nozzle, double; diameter of exhaust nozzle, 3¼in.; throttle, balanced valve; smallest inside diameter of chimney, 18in.; chimney top above rail, 14ft. 9in.; boiler supplied by two injectors, placed on the right side and at the back; working steam pressure, 140 lb. Weight of tender, with coal and water, 25 tons; number of wheels, eight; diameter of wheels, 30in.; size of tender axle journals, 3⅜in. by 7in.; total wheel base of tender, 24ft. 6¼in.; distance from centre to centre of truck wheels, 4ft. 4in.; style of tender frame, angle iron; style of trucks, 4-wheel channel iron bolster, centre bearing front and back, with additional side bearings on back truck; water capacity, 3000 gallons; fuel capacity in coal bunker, 3½ tons. Total wheel base of engine and tender, 46ft. 7½in. We have here an example of a very favourite class of engine in the United States, when the trains drawn are very heavy and the speed slow. It is, of course, clear that a boiler with under 1500 square feet of surface could not steam two 20in. cylinders if the speed was high.

THE ROYAL INSTITUTION.

PROFESSOR TYNDALL ON ELECTRICITY.

ON Tuesday, December 30th, Professor Tyndall delivered the second of his course of Christmas lectures at the Royal Institution "On the Sources of Electricity."

Professor Tyndall said that when he rubbed a brass tube with a catskin electricity is produced, which escapes at once through the metal and his body to the earth; but let the tube be insulated by a non-conductor, that escape is prevented. In old times substances were divided into electrics and non-electrics, but in the one case the electricity was held on the surface of the body, and in the other it escaped to the earth. In the action of an excited glass tube upon a conductor, the positive electricity of the glass drives away the positive electricity of the brass to the earth. He indicated this passage by causing it to diverge the gold leaves of the electroscope, which divergence he next neutralised by the negative electricity from excited gutta-percha, whereupon the leaves fell together again. He then suspended a poker by silken threads, touched it with an excited glass rod, and then obtained a spark from the poker by which he lit the gas. He placed himself upon an insulated stool, passed an india-rubber comb ten times through the dry hair of his head, and between each application of the comb to his hair his assistant passed it momentarily through the flame of a spirit lamp to discharge the electricity of the comb; his body then contained enough electricity to enable his hand to attract one end of a large lath balanced on a pivot in such a way that it could turn freely in horizontal directions. This experiment, he said, had been exhibited for the first time in that theatre several years ago, and by himself. Electricity, he added, diffuses itself over the surfaces of bodies, and does not always do so equally; for instance, in a cone with rounded edges more electricity is obtained from the point than from the centre. He proved this by means of a little carrier with an insulated handle; this carrier gave a greater divergence of the electroscope leaves when he took the electricity from the point of the cone than it did when he took it from the centre. In like manner he proved that electricity in a metallic disc accumulated more at the edges than at the centre.

The speaker next dealt with the properties of hollow conductors, using in the first instance a silver teapot. He charged with electricity a brass ball held by a silken thread, lowered the ball into the open teapot, then showed that the teapot contained no electricity inside, but plenty outside, especially at the end of the spout. If himself or a little boy could be put inside that teapot, he explained, no electricity would be found there. Faraday once made a little house of laths at the Royal Institution; it was 12ft. square, and covered with tinfoil; while he was inside that house not a trace of electricity could he find there with the most delicate instruments, while the house was in communication with a most powerful battery, and giving strong sparks outside.

Professor Tyndall next spoke of the influence of points, saying that one experimentalist had determined the sharpness of thorns by their action upon electricity. He electrified a great insulated paper tassel, thereby causing its long strips of paper to diverge, and the distant as well as the near approach of a needle point made the strips fall together again; this, he said, explains the principle of the lightning conductor. He exhibited a lightning conductor with several points tipped with platinum; from his little experience he was inclined to think that one point to a lightning conductor was as good as many; still it might be right to have several. The conductors should have a good earth connection at the bottom, and not be put but 2in. into it, as a builder did on one occasion. The Board of Trade has a lighthouse on the north coast of Ireland, in which the bottom of the lightning conductor was once led into the solid rock at the base; he wrote to the authorities, after an accident to the structure from lightning, saying that they invited the lightning to strike the lighthouse, and that the bottom of the copper rod should have been connected with the sea. The best discharger of electricity is a flame; it is more efficient than metal points. A wind flows from electrified metal points, the air being made self-repulsive. He then put some water with the chill off in a flat glass cell, and dusted a little lycopodium on the surface of the liquid; the wind from an electrified point made the particles self-repulsive, and their eddies were exhibited in magnified form upon the screen by the aid of the electric lantern. The electric mill, in which vanes are driven round by the wind from an electrified point, was next exhibited.

The electrophorus, he said, was discovered by Volta, to whom a statue has been erected in the market place at Como, because of the great honour in which that early electrician is held, not alone in Italy, but all over the world. He then brushed the resin and wax plate of the electrophorus with the catskin, brought the conducting disc down upon the plate, and showed how a spark was obtained from the latter. A sheet of vulcanised india-rubber, he proved, will do as the plate of an electrophorus; a disc of tin, with a sealing-wax handle, will do for its conductor; so also will a half-crown attached to a stick of sealing-wax. By the latter means he obtained enough electricity to enable the half-crown to attract the end of a freely balanced lath. He next exhibited the electrical machine of Mr. Whimshurst, who he said was connected with the Board of Trade; he was a man who had not tried to make money out of the machine, but had given it freely to the world.

Next he explained the principle of the Leyden jar, saying that in 1745, Von Kleist, a bishop of Cammin, in Pomerania, charged with electricity a flask containing mercury; a nail running through the cork touched the mercury; this apparatus when charged as just stated gave a shock. In 1746, Cunæus, of Leyden, received shocks from a flask in which water was substituted for mercury; he had such a bottle before him, and should be obliged if some boy would come forward to try the experiment. For some time there was no response to this invitation; at last a boy slowly approached the table, and Professor Tyndall complimented him on his courage, as it did not become an English boy to be afraid. He next informed the lad that after Musschenbroek took his first shock, he narrated his experiences to his friends in Paris, and told them that the sensations were so terrible that he would not take another for the crown of France, but he, the boy, should have one presently. With this encouragement the learned professor handed the bottle to the boy, who took the shock, and returned to his seat.

SEPARATION OF THE PHOSPHATES FROM SLAG AFTER THE THOMAS-GILCHRIST PROCESS.

The increasing adoption of the Thomas-Gilchrist process in Germany during the past few years had turned the attention of chemists in that country to the nature of the slag or refuse products of this new development of the iron manufacture. It was ascertained that amongst other things fully 20,000 tons of phosphoric acid were every year being thrown away with this refuse because no method had been discovered of separating it at a profit. Numerous experiments have been made during the last five years with a view to hitting upon a sufficiently cheap process, but hitherto these attempts were all unsuccessful. A few months ago, however, Professor Scheibler, of Berlin, succeeded in solving the problem. An analysis of the slag from the Thomas-Gilchrist process at one of the chief ironworks in Germany, showed its constitution to be as follows:—Silicic acid 6·23 per cent.; carbonic acid, 1·70 per cent.; sulphur, 0·56 per cent.; phosphoric acid, 19·33 per cent.; iron, 9·70 per cent.; manganese, 9·50 per cent.; lime, 47·60 per cent.; and oxide alumina, 2·58 per cent. Other analyses did not materially differ from this; the quantity of phosphoric acid only varied between 15½ and 20 parts in the 100, while the silicic acid varied from 6 to 11 per cent., the proportion of lime being always nearly 50 per cent. According to the Scheibler process, only the earth phosphates and the silicates are brought into solution. The proportion of metallic oxides found in the solution is of no practical consequence, and thus the quantity of acid employed in the operation is reduced to a minimum. The phosphoric acid can be precipitated directly from the solution in the form of double basic phosphate of lime. It comes out in the shape of a powder in the finest state of division, and owing to the readiness with which in this form it is taken up by the roots of plants, these phosphates furnish at once a very valuable manure without any further treatment. On the other hand, the Scheibler process leaves the metallic substances and part of the earthy bases undissolved in the slag, and since the silicic acid is nearly all taken out with the phosphates, the refuse that remains after the operation furnishes a useful material for blast furnaces and other purposes.

The Krupp Works at Essen.—The great iron and cannon founding establishment of Herr Krupp at Essen is constantly enlarging it space and *personnel*. In 1860 it contained but 1764 workmen, and this number had increased by 1870 to 7084, while at the present time it is over 20,000; if also the women and children dependent on the establishment are included, a population of no less than 65,381 is gathered together, of which 29,000 persons are actually living in houses belonging to the works. The various departments of the Krupp undertaking are eight in number, and embrace the workshops at Essen, three collieries at Essen and Bochum, 547 iron mines in Germany, mines in the north of Spain, in the neighbourhood of Bilbao; the smelting furnaces, a trial ground of 17 kilos. at Meppen for proving cannon, together with others at different places with an area of 7½ kilos. There are 11 smelting furnaces, 1542 puddling and heating furnaces, 439 steam boilers, and 450 steam engines of 185,000-horse power. At Essen alone the works connected with rolling stock comprise 59 kilos. of rails, 28 locomotives, 883 wagons, 69 horses, 191 trolleys, 65 kilos. of telegraph line, 35 telegraphic stations, and 55 Morse apparatus.

THE INSTITUTION OF CIVIL ENGINEERS.

ON THE THEORY AND PRACTICE OF HYDRO-MECHANICS:—PHYSIOGRAPHY.

The first of the course of lectures on "The Theory and Practice of Hydro-mechanics" was delivered on Thursday evening, the 15th January, by Mr. John Evans, V.P. and Treas. R.S., Assoc. Inst. C.E., the subject being "Physiography." The chair was occupied by Sir Frederick J. Bramwell, F.R.S., the President.

The lecturer observed that the word "physiography" had been defined as "a description of nature, or the science of natural objects," but he would restrict his discourse to such portions of the subject as bore more especially on the supply of water, and as far as possible to the phases of nature which might be observed in this country. Water consumed in daily use was generally derived from springs, streams, rivers, or lakes, or reservoirs in which rain was artificially stored. In all cases, however, it came from the clouds, which were in turn fed by evaporation from the surface of the globe. The air, which was the great conductor of moisture from the sea and other sources, was never free from aqueous vapour, however dry it might appear. The hotter the air, the more capable it was of absorbing moisture and holding it in invisible suspension. The quantity of moisture present in the air varied considerably—in England the amount was about 1½ per cent. The power of the air to carry off vapour had been put to the test by Howard at Plaistow, Greaves at Lea Bridge, and Lawes and Gilbert at Rothamstead. These observers had found the evaporation from a surface of water to amount to about 4in. in depth from January to March, 8in. from April to May, 7in. from June to September, and 2in. from October to December. In hotter regions the evaporation was greater. The River Jordan was constantly flowing into the Dead Sea, which, notwithstanding, was kept by evaporation at a level of more than 1300ft. below that of the Mediterranean. Taking the whole globe, however, the evaporation from a free surface of water was perhaps about equal to the rainfall. The effect of cold on vapour-laden air was to cause the vapour to be precipitated in the form of cloud, mist, or fog. A greater and more continued chill caused rain, hail, or snow. While, however, in an open plain there was less rain at a considerable height above the ground than at the surface, somewhat different conditions prevailed in mountainous districts, for the rainfall increased as a rule in ascending the slope of a mountain. The quantity of rainfall of any country was in the main dependent on the position of the mountain ranges and the prevailing direction of the winds. The lecturer here pointed out how India, with its monsoons, afforded a good example of this fact, the Ghâts facing the winds from the sea being subjected to an abundant rainfall, while, on the other hand, Tibet was nearly rainless, the Himalayas effectually acting as condensers to the vapour-bearing winds. In England the annual rainfall varied from about 140in. at Seathwaite, in Cumberland, to a little more than 20in. in some parts of Norfolk and Lincolnshire, but the annual variation was very great. Mr. G. J. Symons had carefully considered the limits of fluctuation in the total rainfall, and concluded, from a long series of years, that in any part of this country the wettest year would have a rainfall of nearly half as much again as the mean; the driest year would have one-third less than the mean, the driest two consecutive years would each have one-quarter less than the mean, and the driest three consecutive years would each have one-fifth less than the mean. Dr. Hann had well pointed out that there must on high mountains be an upper limit of the maximum amount of rain. "The decrease of temperature, with increasing elevation, involved a decrease in the amount of vapour held in the air, and the maximum rainfall was, therefore, to be expected at the height at which, as a rule, condensation was first produced."

In England the rapid melting of snow was a frequent and principal cause of floods, especially in districts consisting of porous soil, the surface of which had been hard-frozen before the snow fell on it. The amount and quality of the water supply from a given amount of rain were most immediately connected with the geological character of the country in which the rain fell. If a tract of country existed of bare, impervious, unfissured rock, the surface being traversed by valleys conveying to one common outlet, the whole of the rain, less some small quantity carried off by evaporation would be delivered by that outlet. If, instead of complete valley systems, there happened to be depressed portions forming basins, lakes would be formed, which might be either permanent or temporary. If, instead of the rock being bare, there was a certain amount of superficial soil and vegetation, any moderate shower would be absorbed by the soil and plants, and but little water would reach the outlet. A few days of fine weather in summer would render the superficial soil again dry and absorbent, so that the water passing to the outlet might bear but a small proportion to the rain that fell; but in winter the proportion would be immediately increased. In the case of impervious, but fissured rocks, the existence of the fissures would lead to results not materially differing from the presence of lake-basins within the area. Impervious rocks were mostly found in elevated tracts of country, where the rainfall was usually great, and the proportion of the rainfall finding its way into streams and rivers was large. In the Loch Katrine district, where the rainfall at the head of the loch was 103in. in 1854, it had been calculated that 82in. were discharged from the loch, showing a loss from evaporation of 21in. On heavy clay land the outflow would differ from that which resulted from rain falling on impervious rock, as in dry seasons clay was fissured by contraction, and though practically impervious, it was by no means unabsorbent; but heavy clay lands were now artificially drained, and the surface did not become water-logged as formerly. Both in clay districts and those formed of impermeable rocks, it frequently happened that there were superficial patches of drift gravels or sands of an absorbent nature; these, after heavy rain, became charged with water, some of which was subsequently delivered at the lowest outfalls, forming land springs. Again, on permeable rocks there were occasionally patches of impermeable clay, such as the Tertiary outliers on the chalk. Mr. De Rance had published a hydro-geological map of England, in which he had divided the character of the soil into the impermeable, the partially porous, the "supra-pervious," and the permeable. Roughly speaking, the western part of England and Wales consisted of impermeable and partially porous rocks, and the eastern of the "supra-pervious" and the permeable. Many river basins consisted of two or more of these different kinds of soil, and the flow of water in them consequently varied much from time to time; in wet weather they were subject to floods. A large portion of England consisted of more or less absorbent rock, underlying a still more absorbent superficial soil; and it was to this fact that the comparatively permanent character of some rivers was due. Any moderate rain falling on an absorbent soil at once disappeared from the surface and found its way among the particles of the soil. The new red sandstone at Liverpool had been found to absorb one-twenty-second of its own weight of water, of which about one-half would not drain away. In loose sand and chalk the absorption was from one-twelfth to one-ninth of the weight, or at the rate of two gallons to the cubic foot. A cubic foot of oolites and limestones would absorb ten to fourteen pints of water. With continued rainfall, anything beyond what could be retained by capillary attraction gradually gravitated downwards until it arrived at a point where the rock was already charged with water. In the bottom of valleys with streams running along them, the saturated rock would be found near the surface, but the rain falling on hills might descend hundreds of feet before arriving at the point of saturation. The lecturer then pointed out that friction prevented the water under the hills escaping readily; otherwise the surface of the saturated rock would present a nearly dead level, and the rain would flow off at the lowest vent almost as quickly as it penetrated the ground. At Brighton the surface of the saturated portion of the chalk gradually sloped upwards as it receded from the sea, this inclination being due to the frictional resistance opposed by the chalk to the passage of the water. The level of the outfall varied, but the sea was never able to penetrate any distance into the chalk, and the rainfall sufficed to keep up an inclination seawards in the water line in the chalk. The lecturer next referred to the subterranean water-level in Hertfordshire, as influenced by the hills and valleys, the level of the water being mostly allied to these, though the inclination was much less in degree. In the middle chalk in Hertfordshire the slope was about 12ft. 6in. to a mile, in the lower white chalk about 19ft. 6in., and in some parts of Kent as much as 40ft. to the mile. After heavy rainfalls the inclinations were much steeper. Where the pumping from a well in porous rock was excessive, an inverted cone of depression was formed in the plane of saturation, the angle of which was determined by the amount of friction in the rock. The lecturer then proceeded to explain the phenomenon of bournes, also of watercourses running at intervals along the bottom of a valley. Water seemed readily to find its way along layers of flints in the chalk, so that, in boring, an accession of water was obtained directly a layer of flint was traversed. From deep borings the water generally rose at a higher temperature than from ordinary springs. The water from the artesian well at Grenelle, close to Paris, which came from a depth of 1800ft., had a temperature of 82 deg. Fah., being about 30 deg. above the springs in the district. The water at the bottom of a boring 1334ft. deep at Richmond had a temperature of 75½ deg. Where chalk was overlain by stiff clay, through which, however, it in places penetrated, swallow-holes were formed, and the rain falling on the impervious clay formed streams, which made their way into such swallow-holes and disappeared in the chalk; and this, too, was the origin of subterranean watercourses in limestone districts. The lecturer then considered the case of the effect of pervious strata lying between others of an impervious character on the water received by the former, and of artesian wells.

The first to make experiments on the proportion of percolation through about 3ft. of soil to the rainfall on the surface were Dr. John Dalton, of Manchester, and Mr. Maurice, of Geneva, about the end of last century. The principle on which the experiments on percolation were carried out was much the same in all cases, and was described. Much had been done in this direction by Mr. Charles Greaves, Sir J. B. Lawes, and Dr. Gilbert. The two latter gentlemen had found that, for the ten years, 1871 to 1880, out of a mean rainfall of 31·451in., 14·040in. passed through 20in. of soil and 13·241in. through 60in.; and that, out of 16·365in. of summer rain, only 4·111in. found its way through 60in. of soil; while in the winter there passed 9·130in. out of a rainfall of 15·086in. The lecturer claimed for his uncle, the late Mr. John Dickinson, the honour of being the first in this country to repeat the experiments of Dr. Dalton. His operations began in 1836; but new gauges were fixed at Nash Mills, in 1853, and observations had been continued ever since. Mr. Evans had arranged the results of thirty years' observations in a diagrammatic form, which he exhibited. The average showed that, out of a total annual rainfall of 27·843in., 6·519in. passed through 3ft. of soil and 10·590in. through the same depth of chalk. The proportion of the percolation to the rainfall varied greatly from time to time, even for the same seasons, instances of which were given. It could not be too often repeated that every gallon of water pumped and carried away from an absorbent district was so much abstracted from the flow of the streams of that district. In inland districts the streams formed an exact gauge of the excess of the rainfall over the water carried off by evaporation, and any artificial diminution of the water must affect the streams. An annual supply of 4in. of rain would, from every square mile of country, give a daily quantity of nearly 160,000 gallons of water, which, at 32 gallons per head per diem, would suffice for a population of 5000 souls. A population of 4,000,000, like London, would, therefore, if supplied from deep wells in the chalk, absorb the total water supply of 800 square miles of country, or of an area one-quarter larger than the county of Hertford, and the whole of the surface streams over this large area would, in dry years, disappear. Mr. J. T. Harrison's scheme for obtaining water by means of tunnels in the chalk of the Thames Valley merely meant that all the water derived from the tunnels would either be intercepted on its way to the river, or filter into the tunnels from the bed of the river itself. The flow of the Thames below would be diminished by just the same amount of water as that abstracted by means of the tunnels. Finally the lecturer referred to the solvent powers of water when charged with carbonic acid which rain-water derived both from the atmosphere and from decaying vegetable matter, and pointed out how water thus hardened was again to some extent softened and purified by natural agents. He concluded with some remarks as to the points in connection with this subject which appeared to him the most important for the engineer to bear in mind.

A COMPARISON OF BRITISH AND METRIC MEASURES FOR ENGINEERING PURPOSES.

At the eighth ordinary meeting of the session, held on the 20th of January, Sir Frederick J. Bramwell, F.R.S., President, in the chair, the paper read was on "A Comparison of British and Metric Measures for Engineering Purposes," by Mr. A. Hamilton-Smythe, B.A., M. Inst. C.E.

The paper was limited to comparing the advantages for engineering purposes of measures of length, surface, capacity, weight, and pecuniary value, as used in England, with decimal systems of the same classes of measures. As the arithmetical notation of all civilised nations was decimal, all decimal systems had the advantage over others of dispensing with the compound rules of arithmetic and of facilitating the use of logarithms. The metric system had the further advantage over other decimal systems of being used by 240,000,000 people, with whom 60 per cent. of the foreign trade of England was carried on, and of all its terms being correlated, and derived from one convenient, well-known standard measure of length. Some British measures had the advantage over all decimal measures of being capable of finite ternary subdivision. On account of the pre-eminent position held at present by England and the United States in the manufacture of engineering machinery and material constructed to exact British sizes, a considerable practical advantage was derived from the use of British measures in engineering works. A large amount of capital was invested in machinery constructed to manufacture British articles of exact sizes, and the engineering literature expressed in terms of this measurement was extensive and valuable. English and American engineers carried in the memories, ready for application, a great number of leading, or standard, dimensions, so that the substitution of other measures in their general practice would be inconvenient; and these measures had the further advantage of being already familiar to the working classes in England and America. Although the depreciation in value of certain machinery, due to a general change in measurements, would be very serious, still the existing machines would in any case last but comparatively few years, or become superseded by others of improved construction. The gist of English engineering literature would soon be translated into other terms of measurement, if the necessity arose. Both the metre and the yard had the advantage of being the approximate length of a human stride, and the former was about the limit to which a human being could conveniently place his hands apart when measuring with accuracy along a vertical surface. The British foot was merely a ternary subdivision of the standard yard, and in practice was often not even used as a linear unit. Carpenters, for instance, measured a plank by the number of 2ft. rule lengths it included, and had then to complete the total length by doubling the number of units they had made use of. A plank could be measured with a metre in about one-third of the time occupied in measuring it with a 1ft. rule. The British inch was much too large to serve as the lowest integral unit in a scale of linear measurement, and even $\frac{1}{16}$in. was too large for minute work. The millimetre was, on the other hand, a convenient unit for ordinary minute work, and its decimal subdivisions were as suitable for microscopic work as thousandths of an inch. The English practice of taking levels for building work in feet and their decimal subdivisions, and of translating the resulting dimensions into feet, inches, and fractions of inches for the workmen, was most troublesome and productive of error. For all ordinary levelling the division of the metric levelling-staff into centimetres was sufficiently minute, as the centimetre divisions could easily be subdivided at least binarily, by ocular estimation, and metric levelling was practically more accurate for building work than levels taken with a British staff on account of the dimensions given to the workman being in the same terms as those actually noted through the level. The 20 metre chain had the advantage over Gunter's chain in that it was capable of subdivision into the smaller linear measures, whereas Gunter's link was the lowest integral subdivision of Gunter's chain, and was too large for any work but land measuring. For engineering calculations it was desirable that the linear unit should have its multiples and sub-multiples arranged in accordance with the universal system of arithmetical notation; that it should be the basis of the units of measures of surface, capacity and weight; and that it should be international. The metre complied much more fully than the yard with these requirements. In calculations relating to the pressure of materials upon surfaces, the intimate correlation existing in the metric system between the measures of weight and capacity was valuable, and hydraulic calculations were much simplified thereby. An engineer using the metric system had practically but one unit of measurement to deal with throughout his work, all his field measurements and the scales of all his plans being decimally expressed in terms of a metre. An engineer using British measurement had to deal with many different kinds of measures having complicated relations to each other, and also with a number of gauges, trade sizes and local customs, which rendered comparisons of cost exceedingly difficult. Many of these would become obsolete if the metric system came into general employment. The habitual use of British measures debarred English and American engineers, to a great extent, from profiting by foreign technical literature written in terms of metric measurement. The advantages of an international language of measurement for engineering purposes were so great, that they would counterbalance the advantages of any new decimal system based on units of British measurement. In so much of the work of a civil engineer's office as consisted in taking out quantities and making estimates, about one-third more work could be done within a given time with metric measures and decimal currency than could be effected with British measures and currency. Assuming that binary subdivision was more convenient for common purposes than decimal subdivision, there was nothing to prevent the use of binary subdivisions of the metric measures, as they all admitted of precise decimal equivalents. The metric scales for plans and drawings were simple, and facilitated mental comparison between the dimensions on paper and the distances in nature they represented. As regarded the saleability of articles manufactured in series of sizes, there was no reason to suppose that purchasers would continue to prefer series of sizes advancing by the exact metrical equivalents of the sixteenths of a British inch if the fractional divisions of an inch were no longer in ordinary use as linear measures. The maximum advantage from the use of metric measures could not be obtained unless they were used in conjunction with a system of decimal currency. The reasons given by the late Sir John Herschel and Sir George Airy, Hon. MM. Inst. C.E., for preferring the decimal subdivision of the pound sterling to any other decimal arrangement of British currency, appeared unanswerable. By depreciating the nominal value of the existing bronze tokens by 4 per cent., the British currency would be completely decimalised without the introduction of new coins. For purposes of account, the penny would be 0·004 of a pound sterling, or four mils., but the name of penny could be retained. The alteration of national measures of pecuniary value could only be effected by compulsory legislation, whereas the general adoption of the metric system, being already legal, though not compulsory, might be brought about gradually through the example and influence of engineers. Judging from continental experience, it would seem that the best prospect for reform lay in the initiative being taken by those professions most directly interested. If the Standing Orders of the Houses of Parliament allowed Parliamentary plans and estimates to be submitted in metric measurements at the option of the engineer, practical opportunities would be afforded of testing the relative advantages of metric and British measures for engineering purposes in England.

THE PHYSICAL SOCIETY.

AT the last meeting of the Physical Society, January 24th, Professor Guthrie, president, in the chair, Messrs. J. Rose Innes, A. Howard, and A. M. Worthington were elected members of the Society. Some "Lecture Experiments on Spectrum Analysis" were shown by Mr. E. Cleminshaw. The chief point in these experiments was the production of a brilliant light without the use of the electric arc. A small quantity of a solution of the salt to be experimented on is put into a flask in which hydrogen is being evolved by the action of zinc upon dilute sulphuric or hydrochloric acid; the bottle is provided with three necks, one being fitted with an acid funnel, one with a jet, and by the other is introduced a current of coal-gas, or better, of hydrogen, by which the size of the flame can be increased and regulated. The jet, which is about $\frac{1}{16}$in. diameter, is surrounded by a larger tube, by which oxygen is admitted to the flame, the result being a brilliant light giving the spectrum of the salt substance, which is carried over mechanically by evolved hydrogen. The spectra of sodium, lithium, and strontium were shown upon the screen; and the absorption of the sodium light by a Bunsen flame containing sodium was clearly seen.

An instrument to illustrate the conditions of equilibrium of three forces acting at a point was exhibited by Mr. Walter Baily. This instrument consists of a circular disc of soft wood, from the back of which an axle projects. The disc is provided with a graduated circle, and its centre marked by the intersection of two fine lines upon a small mirror. Three compound threads, each consisting of two threads connected by a short piece of elastic, are knotted together, the free end of each being fastened to a pin. Two of these pins are stuck into the disc at such a distance from the centre that the knotted ends cannot reach the centre without stretching each thread, and the remaining pin is then adjusted, so that this condition is fulfilled. There are now three forces in equilibrium acting at the knot. The angles between their directions are obtained from the readings of the graduated circle where it is crossed by the threads. To determine the magnitude of these forces, the axle of the disc is held horizontally and turned till a thread is vertical, the pin is then removed, a scale pan attached to the end of the thread, and weights added till the knot is brought back to the centre. This is repeated with the other threads. It was found possible to show the proportionality of the forces to the lines of the opposite angles with an error not exceeding 1 per cent.

Mr. C. H. Hinton read a paper on "The Poiograph." As the result of a process of metaphysical reasoning, Mr. Hinton has come to the conclusion that relations holding about number should be extended to space. Starting from the premises that the relation of a number to a number is a number, *e.g.*, the relation of 6 to 2 is 3, the author proceeds to carry these principles into the considerations of space, and concludes that when properly understood the relation of a shape to a shape is a shape, and that of a space to a space is a space. The shape that shows the relation of a shape to a shape is called a poiograph." To form a poiograph the content of each shape is neglected, and the shape is represented by a point, each point being by its co-ordinates representative of the properties of the shape considered. The resultant shape is a poiograph.

DEEPENING PORT PIRIE.—The South Australian Marine Board have been informed by the treasurer that £10,000 was included in the Loan Bill of 1884 for further deepening operations at Port Pirie. This will make the sum at present available for the purpose about £11,000, which will last about twenty-one months, and will enable the Board to deepen the channel to 12ft. 6in. at low water.

THE AQUIDABAN.

THE large, fully armoured, and powerfully armed turret ship, named the Aquidaban, which was recently launched from the yard of Messrs. Samuda Brothers at Poplar, will closely resemble the Riachuelo, whose place she took on the stocks about twenty months ago; and it may be noted that the new ship thus affords a remarkable instance of the rapidity with which private shipbuilders can construct such vessels. The hull of the Aquidaban is built throughout of Siemens steel, and numerous water-tight compartments provide for the safety of the ship in case of serious damage to any part. To a height of 2ft. above the water line she is sheathed with teak and metal to prevent fouling; while the stem and stern post—the former fitted with a powerful ram—are formed of solid gun-metal castings. A water-line belt of steel-faced armour, from the works of Messrs. J. Brown and Co., 7ft. deep, and varying from 7in. to 10in. and 11in. in thickness, protects the engines, boilers, and magazines, and the hydraulic pumps for working the turrets; and an armour deck 2in. thick extends over the engine and boiler-rooms, and is so constructed at the bow to strengthen the ram, and at the stern to protect the tiller and steam steering apparatus. It is expected that the engines, of 4500-horse power indicated, made by Messrs. Humphrys, Tennant, and Co., will give a speed of $14\frac{1}{2}$ knots. They are of the three-cylinder compound inverted direct-acting type with surface condensers. The boilers, eight in number, are contained in four boiler-rooms. By the erection of a middle line bulkhead provision is made, in the event of one boiler or engine-room being flooded, for still working the vessel, though, of course, at a reduced speed by the other set of engines. In action the stokeholes can be closed, and with the forced draught so created the speed may be increased to $15\frac{1}{2}$ knots. The coal bunkers will hold 800 tons of coal—a quantity sufficient, it is calculated, to enable the vessel to run for twenty-three days consecutively at a speed of 10 knots per hour, or a distance of over 6300 miles. The two turrets, which are placed *en échelon* and revolve within the armoured breastworks covering the loading gear, are, like the breastworks, plated with 10in. steel-faced armour, and at the fore end of the vessel is fitted a pilot tower similarly armoured to give protection to the steersman and officer in command during a fight. The armament of the Aquidaban will consist of four 9in. 20-ton Armstrong breech-loading guns, which will be so placed in the écheloned turrets that a concentrated fire may be delivered right ahead, directly aft or broadside. On the upper deck will be fitted four $5\frac{3}{4}$in. Armstrong breech-loading guns with Vavasseur mounting, two at the bow and two at the stern. There are further five ports for discharging Whitehead torpedoes—two on each side and one right aft. The Aquidaban will carry a second-class torpedo boat, and for defence against craft of that kind will carry fifteen Nordenfelt guns. She is to be ship-rigged, the lower masts, which are already stepped, being of steel. The dimensions of the new ship are—length between perpendiculars, 280ft.; extreme breadth, 52ft.; draught of water, 18ft.; displacement, 5000 tons. Immediately after the launch she was towed into Millwall Dock, and it is expected that she will be completed in about three months' time.

PROPOSED NEW SHIP CANAL.—A steamship route between Harwich and Liverpool, for some reason to be called the Ipswich and Birmingham Ship Canal, is the subject of a pamphlet by Mr. Joseph Robinson. "It is estimated that 70,000 men would be required to complete the canal in seven years. The length of this canal would be about 200 miles; the estimated cost £50,000,000. For the purpose of raising the vessels from one level to another, it is intended that inclined planes should be constructed in place of locks, excepting Ipswich locks, so that the steamships may continue from station to station without stopping, if required, so that the whole length of that canal—200 miles—may be travelled in one day, including such stoppages. It is intended that locomotive engines shall be employed for the purpose of towing the vessels through the canal. For this purpose rails 4ft. $8\frac{1}{2}$in. gauge are to be laid on each bank of the canal. The canal will be divided into seven sections, as follows:—Section A, or Ipswich district, 35 miles of canal; Section B, Cambridge district, 30 miles; Section C, Bedford district, 30 miles; Section D, Northampton district, 25 miles; Section E, Birmingham district, 25 miles; Section F, Wolverhampton district, 30 miles; Section G, Liverpool and Manchester, 30 miles. Each ship or string of small boats will be towed through each section of the canal in about two hours. A locomotive engine will be attached to the vessel running on the bank of the canal. For example, a vessel arriving at Ipswich from the east, the engine would be attached and the vessel would be towed to Cambridge, thus completing Section A. The locomotive would be uncoupled from the vessel and return to Ipswich, if required, receiving information by telegram where to meet the next vessel—at Ipswich or Cambridge. A second locomotive would tow the vessels on Section B—that is, from Cambridge to Bedford—changing engines in like manner on each section of the canal, allowing the vessels time to take in goods or passengers at each of the seven stations, if required." Mr. Robinson thinks the Government might help by furnishing the Canal Commissioners with 50 millions sterling.

CLIMATE AND HEALTH.—Dr. Poore delivered his second Cantor lecture on "Climate in its Relation to Health," at the Society of Arts, on Monday evening. He began by alluding to the fact that the crew of the Eira enjoyed excellent health in the Arctic regions under conditions which, in this country, or still more in the tropical countries, would be considered most mal-hygienic. The reason probably was that in the Arctic regions putrefaction and allied changes were impossible, owing to the cold and dryness, and the diseases dependent on putrefaction were also impossible. Attention was drawn to the effect that most of the diseases which were fatal in tropical countries were connected with putrefaction and decay, and as instances of this, malarious diseases, yellow fever, and cholera, were brought forward. Since putrefaction depended upon the access of minute organisms to the putrescible matter, and since these organisms were found in the atmosphere as well as in the soil and water, a study of the floating matter in the air became most important. The air has been systematically examined in Paris and Berlin, and especially at the Observatory of Montsouris in the former city. Among floating bodies in the air were to be found spores of fungi, pollen, grains of starch, alga, &c., besides mineral matters of great variety. Miquel, by means of cultivation experiments, had been at great pains to estimate the number of bacteria and allied micro-organisms in the air, and the result of his experiments has shown a striking connection between the density of population and the number of bacteria in the air. Thus, in each cubic metre of air there were found at the following stations the bacteria in numbers as follows:—In the high Alps the air was pure, absolutely free from bacteria; on the Lake of Thun, at an elevation of 560 metres, ·8; near the hotel of Thun, 2·5; in a room of the hotel, 60; in the park at Montsouris, 760; and in the Rue de Rivoli, 5500. The largest numbers found were in the hospitals, where each cubic metre of air contained as a minimum 5500, and as a maximum 28,000. In order that bacteria and other microbes may flourish, a suitable soil is necessary. Raulin's experiments with *Aspergillus Niger* were explained. Raulin found that he could grow a uniform amount of aspergillus on a given area of a liquid of definite composition. This liquid contained, among other things, $\frac{1}{50000}$ part of zinc, and if the zinc were omitted, the crop of aspergillus fell to $\frac{1}{10}$ of the normal; and if $\frac{1}{1000000}$ of nitrate of silver were added, the fungus would not grow at all. This showed the importance of mineral ingredients in the composition of the "soil," and this fact helped in some measure to explain why it was that people seldom had the same fever twice. The reason being that the first attack exhausted the blood of something which was necessary for the growth of the organism upon what the fever depended.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, January 19th.

AN organisation has been established in this city to be known as the American Protective Tariff Association, and its object is to be the protection and development of American industries in all branches of trade. All persons favouring protective principles are eligible for membership. Besides the usual officers there will be 109 directors to represent the various industries. The annual meeting was fixed for the third Wednesday in September. A resolution was adopted declaring the association opposed to the importation of foreign labour under contract. This movement has been contemplated for a year or two. It was originated a few months ago in Eastern Pennsylvania by the pig iron manufacturers, who have been threatened by southern and western iron. The purpose is to secure representation from all the industries of the country, and to organise a club or association, somewhat after the manner of the Cobden Club of Great Britain, which shall represent the manufacturing, commercial, railroad, financial, and other great interests. The members are active, and will work with vigour to secure the co-operation of representatives and all other interests, great and small. This effort to combat the movement for the lower duties will likely lead to a corresponding effort upon the part of those interested in revenue reform agitations. Work in this direction has been progressing quietly during the past two years by the revenue reformers, and a great deal of effective work has been done. The industrial development in the South has stimulated protection sentiments in quarters where heretofore protection was denounced.

The manufacturers of Tennessee, Alabama, and Georgia recently gave a hearty welcome to a democratic protectionist of Pennsylvania, who has had presidential aspirations. The South has been opposed to protection, but the influx of northern capital and northern people has raised public sentiment in those States, and it is probable that the apparent advantages of higher duties will gather adherence. Meanwhile revenue reform agitations are extending in the West, and it would be but guess work to attempt to say what the condition of the public mind will be a year or two hence. A conflict is in progress, and the protectionists are preparing to place themselves upon a strong foundation to meet opposing effort.

Last week 446 mercantile failures were announced; this week the number is but little below it. The greatest failure of the season is that of an iron firm in Western Pennsylvania, whose liabilities are reported by telegraph at upwards of 5,000,000 dols. A financial failure in this city has given rise to a number of rumours as to the standing of some of our strongest houses. The coal combination is having a good many difficulties to contend with, in the way of competition within and competition from without. The demand for fuel has greatly fallen off, while the facilities for mining and shipping have been greatly increased. The manufacturing interests look for a break in this combination. The local banks and financial institutions of this city have 135,000,000 dols. of idle money in their vaults, for which there is no demand. This indicates the very reverse of healthful conditions. As compared to 1883, the total exports, including specie, show a falling off of 16,600,000 dols. only. The manufacturing interests of the country have their eyes turned to an export trade with Central and South American Republics, and the Government is taking steps to ascertain how such a trade could be best secured. Public sentiment is growing in favour of the subsidising of steamship lines, but the present Congress will not touch the question.

Our cotton crop, according to the latest and best estimates, will foot up 6,000,000 bales, the largest ever known. This estimate is above those previously given, and shows that cotton will be more abundant than was anticipated, and hence speculating interests are preparing for a decline; but an extending demand growing out of cheaper cotton may offset this decline, and secure steady prices.

Wheat exports are 7,000,000 bushels in excess of last year. The upward tendency has been resisted, in view of the possible encouragement that higher prices would give to Indian wheat.

The lumber interests of the North-West have figured out, that in view of the over-stocked condition of the lumber markets, only 4,000,000,000ft. of timber can be logged this year, as against 7,000,000,000ft., the usual winter cut. The activity in building operations throughout the country has stimulated the preparation of lumber in all sections to an unusual degree, and the falling off in requirements is now forcing itself upon the attention of the lumber interests. The total shipments of white pine from this port during 1884 were 62,501,006ft., against 63,687,000ft. the previous year. The total cut in the North-Western lumber region last year was 4,534,291,561ft., an increase over the cut of 1883 of 447,811,966ft. The stocks on hand, December 1st, aggregated to 795,708,522ft.

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

(*From our own Correspondent.*)

THERE is a decided tendency at date to restrict operations at the mills and forges, in consequence of the scarcity of orders at remunerative prices. Several large firms are laying off portions of their works, and are running the remainder short time. Among these are Messrs. W. and G. Firmstone, of the Crookhay Ironworks, West Bromwich, who have just put to stand one-third of their puddling furnaces, and who entertain but little expectation that they will be restarted for some time to come. Simultaneously, Messrs. Penn, of the Providence Ironworks, in the Dudley district, have put their operatives under notice of their intention to close the works. The concern is only a small one, and it is known that the proprietors have considerable deliveries of pigs coming in, so probably the notice points rather to a re-arrangement of wages than an absolute stoppage. Messrs. Bridge, Gill and Gill, West Bromwich, have just laid off their hoop mill. This action by the ironmasters is increasing the amount of unemployed ironworkers' labour which previously existed in the district, and the outlook for the operatives who are idle is decidedly gloomy. No early re-engagement appears likely for them, and they cannot much mend their position by migrating to other ironmaking centres.

The reports brought to 'Change this week did not lead to the anticipation of any early alteration for the better. Ironmasters of the longest standing will not venture to predict when a revival will probably make its appearance. Restriction of operations to within narrow limits is a prevailing feature among home and export buyers. Only one feature is more prominent, and that is the persistent efforts to buy at lower prices.

Considerable inquiries are on the market for sheets for India and Australia, and some of the European countries are ordering, but not yet with any energy. Good sheet makers will not quote less than £6 17s. 6d. for hard singles, and £7 7s. 6d. to £7 10s. for doubles, but it is known that some needy makers are accepting £6 12s. 6d. for singles, and £7 2s. 6d. for doubles. Enquiries are to hand on United States account for soft steel sheets for working up purposes, but some question is entertainsd as to whether they should not be regarded in the light of "feelers," to permit of a comparison between English and American prices. The rates quoted by local makers are £9 to £9 10s. for singles delivered Liverpool, £10 to £10 10s. for doubles, and £11 10s. to £12 for lattens. It is believed by those who are well informed that American buyers will find that there is not much to be gained by importing English steel sheets with prices so favourable as now in the American steel trade.

Hoop iron inquiries for America are expected to arrive in April and May, but the business done will probably this year be less than ever, consequent upon the fall in the American prices. Ordinary export hoops are quoted this week at £5 12s. 6d., and occasionally a little under at the works.

The tube strip trade is quiet. Supplies can be bought as low as £5 7s. 6d.; yet even with this figure prevailing for raw materials tube-makers complain that the present prices of manufactured goods are very unsatisfactory, and an attempt is just now being made to re-organise the association which on several previous occasions has existed in the tube industry.

Makers of marked bars are rather busier than they were in December on orders for, in some cases, America and Holland. At the Earl of Dudley's Round Oak Works the production has been of equal extent this month to that of, perhaps, any month last year. The output is on home account in tire, horseshoe, and rivet iron. The marked bar basis of £7 10s. has now ruled for two years, the price having been reduced from £8 on February 1st, 1883. Medium qualities are firm at £6 10s., and other sorts range down to £5 15s. and £5 10s. The latter figure is 5s. per ton above the price of certain classes of finished iron sent here from other districts.

Galvanisers, other than those of first standing have not yet received much influx of business in the sheet department, for merchants' orders still lag; but the best firms have generally enough to do. All alike, however, complain of the low level to which prices have got. Ordinary galvanised sheets of 24 gauge are to be had delivered from this district at £11 5s. Liverpool. Inquiries have recently come to hand for galvanised sheets and for constructive ironwork on Spanish account, to repair the great destruction to property caused by the earthquakes in the south of that country. The orders, where they have been accepted, will have to be despatched with all possible promptitude.

The depression in the native pig iron trade is unrelieved, and 55s. to 57s. 6d. is pretty much the most that can be got for hot-blast all-mine pigs, although the nominal quotation is 60s. Common cinder pigs may here and there be had at, for good contracts, as low as 35s. Sales in 500-ton lots continue to be made by agents of outside brands, in cases where they will accept low figures. Northampton pigs have this week changed hands at less than 40s. per ton, and Derbyshires are in proportion. The furnaces blowing in South Staffordshire number about thirty-five, and but little is just now heard of the intentions to increase the production of second and third-class qualities which were talked about last quarter.

Machinists and engineers around Birmingham do not give an encouraging account of the state of current business, and it is in many cases found necessary to limit production either by wholly discharging some of the operatives, or by putting them upon short time. At some concerns both of these courses have been adopted. Certain engine building firms, however, in the North Staffordshire district keep busy. Constructive engineers in South Staffordshire are pretty steadily engaged in the completion of contracts booked some while back, the bridge work now in hand being in much part on account of the colonies. Gasometer makers report that their branch is showing a little more movement. In the galvanised roofing trade there is a good deal of business about, but at low prices.

The wrought iron tube trade is depressed. The majority of the works are only on three days a week, and one large concern has temporarily closed a branch establishment at Wednesbury. A few exceptional firms there are, however, who are full of work.

Competition amongst producers in the hardware trades shows no sign of abatement, and it is difficult to see where the matter is going to stop. The only wonder is that so few firms comparatively have succumbed to the inevitable.

There seems considerable probability that the novel and important movement in the nut and bolt trade in the Midlands, to which reference has previously been made, will be successful. The united action of employers and employed is being carried out to the great advantage of the respective associations. Last week three firms who are members of the Employers' Association gave notice to their men that they must join the Workmen's Association; and another large employer, who is not a member of the employers' organisation, has been asked to join it. If he declines his men will, too, be asked to come out on strike.

A strike in the gas tube trade is on foot in the Old Hill and Halesowen districts. The masters wish to enforce a reduction in wages amounting to 12½ per cent., urging that they are compelled to do so in consequence of the very serious depression and the unremunerative prices obtained. The men state that they cannot live on the reduced wages. It is expected that the strike will not last long.

The operations for the relief of the unemployed in Birmingham are being carried out with vigour.

Much satisfaction is expressed this week that Mr. Chamberlain should have made known that the statement that he had signified his intention of accepting the second reading of the railway companies new Bills on the condition that they were referred to a strong special committee is "absolutely without foundation." Mr. Chamberlain adds that before coming to any conclusion he will certainly want to hear what the Midland Traders' Association have to say. This opportunity is to be afforded next Thursday, when a conference of traders and representatives of chambers of commerce and agriculture, and all interested in the question of railway rates in the Midland counties, will be held in Birmingham.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The past month has brought forward poorer results for the opening of the year than have probably been known for a considerable time past, and a generally despondent tone prevails with regard to the future. With the exception of one or two special transactions there has, during the month, been an absence of any weight of buying, and, in fact, consumers in many cases have not been able to take their deliveries of the iron already bought. To effect sales, pig iron makers would in many cases be willing to book for delivery over the whole of the year at present rates, but buyers, as a rule, prefer to go on from hand-to-mouth, and neither low prices nor long forward delivery apparently offer any inducement for speculative buying in the present depressed state of the market. Manufactured iron makers are so short of work that a large number of the puddling furnaces in this district has recently been put out, and this has tended to materially reduce the consumption of forge pig iron, whilst there is a slackness all through the foundry trade, which is also restricting the demand for the better qualities of pig iron. Throughout every branch of the iron trade the outlook for the future is certainly very discouraging, and it is difficult to find anyone, even of the most sanguine temperament, who takes a hopeful view of the prospects for the ensuing year.

There was a well-attended iron market at Manchester on Tuesday, but there were very few orders giving out. Makers showed even more willingness than last week to book for long forward delivery at present rates, and in some cases sellers were open to take very low prices, but apparently with comparatively little or no practical result so far as the actual securing of business was concerned. Lancashire pig iron makers are getting small orders, chiefly where they have an advantage in low rates of carriage, and as these are still keeping them going, they hold on to their late rates of 41s. to 41s. 6d., less 2½ for delivery equal to Manchester, but on the basis of these figures they are being under-sold. For good district brands, 41s. to 41s. 6d., less 2½, delivered here, also remain the minimum figures quoted by the leading makers, but there are some of the Midland brands which could be got readily at from 40s. to 41s., less 2½, and good foundry Middlesbrough is offered at about 43s. 4d. net cash delivered equal to Manchester.

For hematites there is only a very small enquiry, with prices averaging about 53s. up to 54s., less 2½, for good foundry brands delivered here.

In the manufactured iron trade business is extremely quiet; the average basis of prices remains at about £5 10s. for bars, £5 17s. 6d. to £6 for hoops, and about £7 for local made sheets delivered into the Manchester district, but buyers with good specifications for prompt delivery would no doubt in many cases be able to buy on more favourable terms than the above.

Last week I gave a summarised extract from the reports of the leading trade union societies connected with the engineering trades, with the object of showing the view taken by the men themselves as to the state of trade. I will now add information gathered from authoritative sources representing the large employers in the engineering trades throughout the country, from which it will be seen that they also take a very despondent view with regard to the future. There is no doubt that in spite of the assumed revival in the shipbuilding trade generally depression is increasing, and along the east coast especially this is being felt very keenly. Hopes are expressed that some of the Government work which is being given out may find its way into this quarter, but the competition is expected to be so fierce, that beyond helping to keep yards going very little profit is looked for out of any orders that are secured. Iron shipbuilders declare that two-thirds of their men are out of employment and on the funds of their respective societies, and that to meet the increased outlay this entailed, the compulsory payments from the men who are in work have been raised 50 per cent., that is from 1s. up to 1s. 6d. per week. Tested further by the ironmoulders' society, where trade is declared to be worse than it has ever before been known, it may be added that in this society the weekly subscriptions have been raised 25 per cent., and the Amalgamated Society of Engineers is calling up a special levy for the benevolent fund of 6d. per member. I am informed that in all the Trades' Union societies the outlay for the support of unemployed members is in excess of the revenue drawn from subscriptions, and a continuance of the present depressed state of trade will in some cases seriously test their resources. The locomotive building trade does not appear to be giving way to the same extent as other branches of industry, and some of the large firms have work in hand for a considerable time forward. As a proof of this I may quote a paragraph from one of the local papers, which, under the heading "Good News for Gorton," states that "Messrs. Peacock, engineers, of Gorton, have got a large foreign order for locomotive engines that will keep the works in full employment for three years." There is, however, a general feeling that depression is also coming over even this branch of trade. Railway rolling stock makers are pretty well employed on orders in hand, but the weight of actually new orders coming forward is not large. Special tool makers are pretty well off for work, but the general tool trade is rather quiet. Cotton machinists are in some cases busy, and in the Oldham and Bolton districts a fair amount of activity is being maintained amongst the leading makers; this, however, does not extend generally, many of the Lancashire machinists being very slack, and in all cases the competition for orders is very keen. The leading inland boiler makers are all fairly busy, but this is a branch of trade that is now in few hands, and is not so readily affected as some other industries.

Mr. Thos. Fletcher, of Warrington, has recently been experimenting with a small retort he has specially designed for testing small quantities of coal at gasworks. The retort is of the usual D shape, but made of cast iron, and 18in. long, 6in. wide, and 4½in. high, and is constructed for testing about 3 lb. of coal. The retort is heated by a line of gas burners, and when empty it was got to a good working heat in fifteen minutes, starting all cold. At present the retort is only in an experimental stage, and has not yet been properly fixed; when all the details have been got right, and it has been properly built in, better results are expected, and there is little doubt that a small retort of this description will be found very useful to gas managers.

In the coal trade a general quieting down is reported, with pits getting into short time, and stocks in many cases accumulating. The little extra push for house fire coals following the holidays, and which was also helped up by the recent spell of rather severe weather, has disappeared, and orders are now coming forward very slowly for the time of the year. Other classes of fuel for iron making and general trade purposes continue only in very poor demand, many of the works not taking anything like their average quantities, and common round coal is very low in price. In quoted rates generally there is no material giving way, but stocks under load are being forced on the market at very low figures, and the tendency of prices is in the favour of buyers. At the pit mouth best coal averages 9s.; seconds, 7s. to 7s. 6d.; common coals, 5s. 9d. to 6s. 3d.; burgy, 4s. 6d. to 5s.; best slack, 3s. 9d. to 4s.; and common, 2s. 9d. to 3s. per ton.

Shipping continues moderate, with good qualities of steam coal delivered at the high level, Liverpool, or the Garston Docks, averaging 7s. 3d. to 7s. 6d. per ton.

The attempts to establish a sliding scale for the regulation of miners' wages in West Lancashire have now been practically abandoned. The divergence between the views of the coalowners on the one hand, and the men on the other, as to the preliminary basis for the sliding scale, were so wide as to afford no hope of agreement, and the further discussion of the matter has now been adjourned *sine die*.

Following the action taken in other trade quarters in opposition to the increased rates of railway charges proposed in the Bills which are to be submitted to Parliament by several of the railway companies, the matter has been brought forward for consideration by the South-west Lancashire Coalowners' Association. Two of the principal companies, over whose lines the bulk of the coal traffic in this district passes, are not included in the Bills to come before Parliament, but the course taken by the others is regarded as simply the thin end of the wedge, and the Association decided to take action to protect the interests of the coalowners in the district.

The annual report and balance-sheet just issued by the committee of the Manchester Corn Exchange shows a continued successful working of the Association. Although the surplus on the year's working is less than in the previous year, owing to special expenditure and a reduction in the scale of subscriptions, the number of members has been increased to 396, and there is a balance of income over expenditure of £19, leaving the funds in the hands of the Society, including furniture and stock, at £155.

Barrow.—The inquiry for hematite qualities of pig iron is much more quiet than it has been, and there is no disposition on the part of consumers to order large parcels of iron. The demand on home account is fairly maintained, but so far as continental and foreign orders are concerned there is a very great depression, and particularly so on foreign account, as apart from continental. The value of iron has also gone down to a limited extent, No. 1 Bessemer being quoted at 45s. per ton net at works; No. 2, 44s. 6d.; and No. 3, 44s., with forward deliveries at 1s. per ton over this figure. Stocks remain large, but they are not accumulating. The output of the furnaces represents about 27,000 tons per week. The steel trade is rather more hopeful, and local makers are better off for orders than they have been, while the prospects for the year are altogether more cheerful than they were last year. The value of steel is also higher than it has been, and it is noteworthy that makers are now practically able to do business at a profit. The demand for iron ore is quiet, and the value is steady at from 8s. 6d. to 10s. per ton net at pits. Mr. Evans, of the Rhymney Ironworks, Wales, has been appointed manager of the Barrow Hematite Steel Company's Works in the place of Mr. Davy, of Sheffield, who completes his term of office in April. The general engineering work now in progress in the district, such as the new high level bridge at Barrow and the extension of Ramsden Dock excursion pier, are progressing very satisfactorily.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE local newspapers are filled with statements as to the Denaby Main dispute. For the owners was stated a few days ago that the dispute arose out of several very simple circumstances. In the first place, the Denaby men had hitherto been allowed to send out large and small coal mixed together at one price. This had led to very careless working and an unnecessary production of small coal. The company now proposed to pay the men one price for large coal and another for small. The colliers declare that the prices offered will amount to a reduction, but the employers maintain that with proper care they will be able to earn as much as before. The second matter in dispute refers to packing. It has hitherto been the custom to pay the colliers 7s. 4d. per yard for gate packs, for the execution of which work they have been accustomed to employ other men at a remuneration of from 5s. to 5s. 6d.; such an arrangement, it is contended, exists at no other colliery in the kingdom. This work being unconnected with coal getting, the company wishes to take it into its own hands. The colliers object, alleging that it is convenient for them to fill up their spare time in assisting in its operation. The Denaby Company is willing to allow them to keep it, but is only prepared to pay for it at the market value, namely, the same price as the men who have hitherto performed it have been paid. The average daily wages earned by Denaby colliers during the last few months, deducting all stoppages for oil, tools, &c., are stated at 9s. 4d., 8s. 8d., and 5s. 10d. per day, in Nos. 1, 2, and 3 districts respectively. It is added that the lower wages earned in No. 3 district will shortly be removed.

The latest movement on the part of the men has been a meeting at Mexborough on Tuesday. It was stated that the pit would be thrown open shortly on the basis of 7s. per day to colliers and 5s. to fillers who would go to work. It was resolved unanimously that if this offer were made, the men should return to work. Later in the day, however, it was known that the reported reopening of the pit was not correct, so that the dispute seems no nearer settlement than before. Very few of the tenants occupying the company's houses have as yet left the village, though many of the non-unionists have obtained work elsewhere. There is a good deal of suffering in the district, owing to the most regrettable and extensive disagreement.

Mr. F. T. Mappin, M.P., who is himself a steel manufacturer, spoke at a meeting of the subscribers to the Sheffield Technical College this week, when he made several statements which are certain to attract attention, if they do not excite a renewal of the steel controversy. He called attention to the complaints that had been made with regard to Sheffield steel makers not being able to supply the Government with the steel required by them for making guns, either in bulk or of the quality required. Two Sheffield houses, he stated, had sent representatives who had given evidence before a committee sitting at the War-office, and their evidence had been entirely antagonistic to each other. One of these gentlemen, on being asked a question in regard to the density and the hardness of steel inside or out, stated that which he—Mr. Mappin—believed he had no scientific knowledge of, and the gentleman who sat next him said his statement was quite wrong. He—Mr. Mappin—had evidence in his pocket from scientific men that the opinion of the second gentleman accurately represented the case, and he had also evidence from Sheffield houses corroborating the scientific opinion. It was not very gratifying for him to hear two of his townsmen representing important houses in the steel trade giving evidence so contradictory of each other, and he used this incident as an argument for higher technical education. If these gentlemen had been scientifically educated, they could not have given such contradictory evidence. He was not speaking off the book. He had seen the experiments actually made upon the steel which one of his townsmen stated as being entirely opposite, when eminent men in London, who had made the tests, knew the facts to be as stated. The tests required by the Government for steel to be used for ordnance were such that it was impossible to attain them without scientific knowledge. It was useless for any steel houses in Sheffield to attempt to take contracts from Government unless they employed the very highest science. Sheffield was late in the field in this respect, but he trusted their efforts would result in enabling them to supply steel for the largest guns that the Government might require. The Government had an establishment for manufacturing steel at Woolwich. The reason they assigned for this establishment was that they could not get what they wanted from Sheffield, and hitherto this had been the case. But if Sheffield was prepared to supply what was wanted he was satisfied; there were ways and means of compelling the Government to encourage the manufacture in Sheffield of the large masses of steel of suitable quality that were required for the largest calibre of ordnance now in use, or likely to be so in the future.

The Tilghman Sand Blast Company, of Bellfield Works, Sheffield, has just brought out an ingenious process, the invention of their manager, Mr. Matthewson, which is adapted for the frosting and ornamentation of electro-plate and other metal goods. The apparatus is much less complicated, less expensive, and more compact and convenient to work than previous processes. The frosting of the surface may be coarse or fine, as required, and the power can be regulated so as either to cut the holes right through the metal or down to the most delicate engraving. The company has already granted several licenses to use the new process.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade is still in a dull and unsatisfactory condition. No change of any moment has taken place since last report. The market held at Middlesbrough on Tuesday last was but moderately attended, and scarcely any sales took place. Prices were maintained at the rates quoted a week before, but buyers offered less, and said they were prepared to wait. The price at which merchants are prepared to sell No. 3 g.m.b. for prompt delivery is 35s. per ton. Certain makers have also accepted this price, but the principal firms still ask 3d. to 9d. per ton more. Forge iron is firm at 33s. 6d. per ton, the demand being well maintained. Makers, as usual, ask 3d. to 6d. per ton more than merchants. It is not probable that there will be any change for the better in respect of pig iron prices until the shipping season commences at the end of February.

Messrs. Connal and Co. had in stock at their Middlesbrough store on Monday last 51,569 tons of pig iron, being a decrease of 260 tons for the week. At Glasgow they hold 579,343 tons—a reduction of 146 tons for the week.

Exports proceed at but a moderate rate. So far they are about 10,000 tons less than last month, and to a similar extent behind January, 1884. Up to Monday last 48,480 tons of pig iron had been shipped from the Tees, one-half of this quantity being for Scotland. Germany and Holland are taking much less than usual.

The directors of the Consett Iron Company have decided to pay an interim dividend of 5s. per share, being at the rate of 7⅔ per cent. per annum.

There is nothing new to be said in respect of the finished iron trade. Orders arrive but slowly, and the few works which are still in operation are so maintained only with the greatest difficulty. Prices remain unaltered.

Notices have been issued by the Wear Shipbuilders' Association for the following reductions in wages to take effect in a month's time:—Carpenters, 3s. per week; smiths and joiners, 2s. per week. The carpenters are at present being paid 34s. per week, and the smiths and joiners 32s. per week.

The Haverton Hill Salt Co., a firm which commenced boring operations some time since, on land opposite Newport-on-Tees, have come upon salt at a depth of about 900ft. They have perforated the deposit to a thickness of nearly 100ft., without reaching the lower limit. They have decided to commence the erection of works at once.

Meanwhile there has been trouble at the first bore hole put down at Port Clarence, viz., the one belonging to Messrs. Bell Brothers. From this almost all the brine hitherto obtained has been pumped. The tubing which lines it has either broken or has become leaky. At any rate the pump will not draw, and operations must of necessity discontinue until the difficulty be overcome.

Messrs. Allhusen and Co., of Newcastle, are proceeding energetically with their boring on the Cowper Marsh, but have not yet reached the salt.

The Darlington Steel and Iron Company has just set to work a new mill at its Albert Hill works. The rolling train is of its own design and manufacture, and is capable of producing various sections of rails, channels, and joists, from 10 lb. to 150 lb. per yard. The engines were made by Messrs. Davy Bros., of Sheffield, and are of their well-known reversing type. The cylinders are 50in. diameter by 54in. stroke.

The accountant to the North of England Board of Arbitration certifies that the amount of finished iron produced during November and December was 60,031 tons, and the average net selling price was £4 19s. 9·36d. The output is less by 12,000 tons than that of September and October, and the average realised price is also less by 1s. 11½d. per ton.

The annual meeting of the Board of Arbitration was held at Darlington on Monday last. Mr. W. Whitwell remains president, and Mr. T. Cullen vice-president for the current year. The other officers were also re-elected. A new standing committee was appointed with Mr. Dale as referee, and to this committee was entrusted the duty of preparing a new sliding scale in accordance with the recommendation recently made by Dr. R. S. Watson, the arbitrator.

An American writer recently criticised rather severely the method adopted in England for warming railway carriages. He called our system "warming by flasks," and said it was obviously wrong, because as the traveller lost his heat so did the flask! There is much truth in this. If it were an absolute necessity to generate the heat elsewhere than in the carriage, perhaps the flask after all might not be such a bad arrangement. For on account of its high specific heat water contains a larger store of heat in a given cubic space than can be obtained in any other way. It is also perfectly safe; but it is by no means efficient, as now practically worked. In main line express trains and in first-class carriages it is well looked after, and there is not much to complain of. But in branch lines and in classes other than first it is usually attended to in a niggardly or fitful manner. The passenger at starting has perhaps a warm carriage. He arrives at a junction and changes, and finds no flask at all. Another change, and he finds a carriage with one in, but containing only cold water, and so on. On the Continent warming by slow combustion charcoal bricks in metal boxes under the seats is mainly in vogue. These are highly efficient. They are worked from the outside; they make no dirt or smoke whatever, and if they have a fault it is that the carriage is sometimes rather overheated. This, however, can always be remedied by opening the window. But the usual deficiency of heat in an English railway carriage in winter has no remedy. Why cannot our railway managers take a lesson from abroad as to heating their carriages in winter? This might be fittingly done whilst they are reforming the arrangements for lighting them after sunset.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE iron trade has again been very quiet in the past week. Little attention is being paid to warrants by speculators, but the few sales that occurred have been at slightly receding prices. The amount of the pig iron shipments is still unsatisfactory, those for the past week amounting to 6422 tons, against 6391 tons in the preceding week, and 6819 tons in the corresponding week of 1884. There is some more appearance of business with Germany, but France, Italy, and the United States are taking very small quantities of iron at present. The amount of the production is unchanged, there being ninety-three furnaces in operation compared with ninety-seven at this time last year. Up to date, the exports of Scotch pigs show a comparative decrease of 7000 tons, and the difference in the output is not believed to be so much. This will account for the small increase that is being made to the stock in Messrs. Connal and Co.'s stores.

Business was done in the warrant market on Friday at 42s. 1d. cash. On Monday forenoon transactions occurred at 41s. 11½d. to 41s. 11d. cash, and in the afternoon at 41s. 11½d. to 42s. Tuesday's market was depressed, with the quotations at 41s. 10½d. and 41s. 11d. Business was done in the warrant market on Wednesday at 41s. 11½d., and to-day—Thursday—transactions took place from 41s. 11d. to 42s. cash, closing with sellers at that figure.

The ironmasters have been keeping their prices well up, but the continued depression is telling somewhat upon the rates, which are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 52s. 3d.; No. 3, 47s. 3d.; Coltness, 55s. 6d. and 51s.; Langloan, 56s. 6d. and 51s. 6d.; Summerlee, 52s. and 47s.; Calder, 52s. 6d. and 47s.; Carnbroe, 49s. and 46s. 6d.; Clyde, 47s. and 43s.; Monkland, 43s. and 40s. 9d.; Quarter, 42s. 6d. and 40s. 6d.; Govan, at Broomielaw, 43s. and 40s. 9d.; Shotts, at Leith, 52s. 6d. and 51s. 3d.; Carron, at Grangemouth, 49s. (specially selected, 53s. 6d.) and 48s.; Kinneil, at Bo'ness, 45s. 3d. and 44s. 3d.; Glengarnock, at Ardrossan, 49s. and 43s.; Eglinton, 43s. 6d. and 40s. 6d.; Dalmellington, 47s. 6d. and 43s. 6d.

The manufactured iron trade is in some of its branches fairly active, and in others quiet, but quotations for almost all sorts of materials are pronounced too low. At present the shipments of manufactured iron and steel goods from the Clyde are comparatively small. In the course of the past week two locomotives, valued at £4400, were despatched to Calcutta, £3800 worth of machinery for the East, £1000 steel goods for the United States and India, and £24,000 general manufactures for different parts of the world.

In the shipping department of the coal trade there has been considerably less doing at some of the ports. At Glasgow the quantity despatched was smaller than in the preceding week. The shipments at Ayr were 6911 tons; Troon, 3853; Grangemouth, 5328; Irvine, 2241; and Greenock, 326 tons. Inland orders are scarce in some districts, but the pits are, on the whole, kept steadily moving in the West. In Fife and Clackmannan the trade is not in a very healthy state. The shipments at Burntisland are poor, having averaged only 7000 tons a week since the beginning of the year. While the collieries in the East are working full time, shipping orders are not sufficient to carry away the output, and stocks are therefore accumulating. The Fife quotations at the ports are 6s. 6d. to 7s., but these prices are very difficult to maintain.

A new colliery has just been opened by Mr. Archibald Russell at Whitehill, adjoining his Greenfield Colliery, the object being to work the mineral under that and the adjoining estate of Auchenraith. The last estate is understood to be the last in the Hamilton coal-field to be taken up for mining operations. The shaft, which has been sunk to the Splint seam, is 275 yards in depth.

Some time ago the Clyde shipbuilders agreed to reduce the wages of all classes of their workmen by ½d. per hour. Representations were made to them on behalf of certain trades that such a reduction would bear very hardly after the privations they had already suffered through ill trade, and it was also pointed out by the memorialists that they had received comparatively small remuneration throughout the busy times. Delegates of the masters and men met and fully discussed the situation, the result being that the reduction, which takes effect without delay, will be ¼d. instead of ½d. an hour. Orders have been received by shipbuilders at Dumbarton and Port Glasgow for a number of sailing vessels of a medium size, and they are reported to have been accepted at very low rates.

After a lengthened inquiry as to the best means of providing additional bridge accommodation across the Clyde further down the harbour than Jamaica Bridge, a Joint Committee of Glasgow Town Council and of the Clyde Trustees are to recommend the construction, at an estimated cost of £70,000, of a swing bridge with accommodation for passengers, vehicles, and railway traffic.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE coal trade is decidedly improving, and many of the coalowners have quite as much as they can do to meet the demand. I am not surprised at this, seeing the easy quotations ruling. Buyers have taken advantage of the long stagnation, which caused prices to become almost imperceptibly low—dropping by 3d. a ton in order to tempt business, until a point was reached which seemed favourable, and then orders were put in. A good deal of business is being done in best samples—4ft., 6ft., and 9ft.—at 9s. 6d. per ton. The result of drooping prices has been the declaration of the Ocean sliding scale by the auditors to authorise a reduction in colliers' wages of 1¼ per cent., or 3d. per pound. This will not be a severe affliction, as with the mass of colliers it will not amount to more than 3d. or 4½d. per week. The Ocean Colliery management has been successful in striking the Upper Garw seam in their new taking, at a depth of 170 yards. Good progress is being made at the new colliery near Aberdare Junction. I am also glad to report favourably of Tila Cock scheme, which has had a good impetus from the favourable report of Mr. Kirkhouse. Bedlinog pits are also improving in output, and it is stated that the Dowlais Company will forthwith build fifty houses in this valley. Harris's Navigation is steadily improving. The air has been doubled in quantity, admitting of the men working well, and the output is increasing steadily. This should be the great colliery of Glamorgan in time.

The vitality of the coal trade is more shown in best steam than house coals, and all that can be said of these is that recent quotations remain. Small coal and coke are dull.

Mr. Llewelyn, late of Lletty Shenkin Colliery, has been appointed manager at Penrhwceiber in the room of Mr. Bevan, resigned.

Mr. Walker is, as might be expected, getting on well at Barry. The natural slopes and sites generally are reported to be very favourable, and will allow of a good deal of masonry to be dispensed with.

Swansea coalowners and other merchants are concerned in the rumoured coalition between railway companies to increase the rates on coal, iron, &c. No step has been taken yet, and some satisfaction has been expressed with the intimation from the London and North-Western Company that there will be no change in their rates.

Iron and steel remain in a prostrate state. Only a "bread-and-cheese" business appears to be made at the principal works. The introduction of steel bar has told adversely against some works which had been kept going by making tin bar, or bar iron for tin-plate making—just as wire works have succumbed to the increased price of steel due to the formation of the syndicate. The works at Treforest—steel—are closed. Iron and steel shipments have been heavier during the week. Newport sent off 2400 tons to Calcutta, 800 tons to Natal, and 180 tons to Rio Grande. Swansea sent away 1500 tons of tin-plates to Philadelphia and 1000 tons to New York. Patent fuel is improving at Swansea, and last week showed an excess of 3000 tons of shipments.

A report that the colliers' wages in the Forest of Dean had been reduced is current. I am glad to state that there is no truth in it.

Great quantities of iron ore have been coming in this week. Most of it has been sold by contract, so ironmasters are not without hopes. At Dowlais huge tips abound, secured before the impost of a rate. Ironmasters regard last news from American iron centres as hopeful.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Jan. 24th, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 11,471; mercantile marine, Indian section, and other collections, 2288. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m to 4 p.m., Museum, 1214; mercantile marine, Indian section, and other collections, 165. Total, 15,138. Average of corresponding week in former years, 13,944. Total from the opening of the Museum, 23,693,667.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

20th January, 1884.

765. PENCILS, R. Reyburn, London.
766. MEASURING MARINE DISTANCES, H. P. Dowling, Waterford.
767. CLOCKS, &c., J. Cooke, Birmingham.
768. METALLIC PACKING RINGS for PISTONS, A. McLaine, Belfast.
769. SYRUPING AERATED WATERS, T. H. Duckworth and S. Wright, Manchester.
770. DISPLAYING ADVERTISEMENTS, &c., J. Hewitt and D. B. Farquharson, Bootle.
771. COAL SHOOTS for STEAMSHIPS, W. Denny, Glasgow.
772. TROUSER FASTENER and TROUSER STRETCHER, T. A. Segrave, Mullingar.
773. CATCH and LOCK and STAPLE for FARM, &c., GATES, T. Elcome, Margate.
774. COAT and CLOAK SUSPENDERS, W. Edwards, Birmingham.
775. HIGH-PRESSURE SCREW DOWN COCK for COLD WATER, &c., R. and J. Read, Malton.
776. PLACING, &c., BOBBINS in SEWING MACHINES, W. P. Thompson.—(*C. and C. Miehling, U.S.*)
777. STERILISING LIQUIDS, W. P. Thompson.—(*H. Danvers and C. Beretta, France.*)
778. SEWING MACHINES, H. Gamwell, Liverpool.
779. PATTERNS for PLATE MOULDING, G. Oulton, Liverpool.
780. INFANTS' FEEDING BOTTLES, E. Hall, Grantham.
781. INFANTS' FEEDING BOTTLES, E. Hall, Grantham.
782. CAULDRONS and SAUCEPANS, &c., H. D. Child, Twickenham.
783. SINGEING WOVEN FABRICS, T. Schofield and F. Barker, Cornbrook.
784. ADJUSTING the BEARINGS of the AXLES of VEHICLES, H. and W. P. W. Weatherill, Manchester.
785. METALLIC SLEEPERS for PERMANENT WAY, P. Kirk, Manchester.
786. GENERATING and DISTRIBUTING ELECTRICITY, A. G. Brookes.—(*O. Gassett, United States.*)
787. NAILING MACHINERY, A. G. Brookes.—(*J. W. Brooks, United States.*)
788. CASTORS for FURNITURE, &c., E. W. Hughes and J. C. Bromfield, London.
789. DIAL or FACE for WATCHES, CLOCKS, &c., H. Downing, London.
790. RAZOR GUARDS, F. W. Gilbert, London.
791. COLOURING the EDGES of SELVEDGES, E. Weild, Chorlton-upon-Medlock, and H. Bickards, Northenden.
792. WICKET-KEEPING GLOVES, &c., J. Heard, London.
793. EMBROIDERING MACHINES, E. Cornely, London.
794. WORKING of FURNACES for BURNING PYRITES, A. Allhusen, London.
795. RELIEF VALVE for STEAM ENGINE CYLINDERS, J. H. Johnson.—(*T. M. Fell, United States.*)
796. WEATHER-BAR ARRANGEMENT for SWING WINDOWS, B. Banks, W. Phillips, and E. Verity, London.
797. SAFETY VALVES, G. Wilson, London.
798. COMPOUND TELEGRAPH WIRE, H. J. Allison.—(*M. G. Farmer, United States.*)
799. TWINES and CORDAGE, G. L. Brownell, London.
800. TREATING SULPHIDES in ALKALINE SOLUTIONS, H. W. Deacon, F. Hurter, and W. Elmore, London.
801. DIALS or FACES of WATCHES, &c., H. C. Wilkinson, London.
802. GAS, A. J. Boult.—(*J. Hanlon, United States.*)
803. FIRE EXTINGUISHERS, J. M. Giblin, London.
804. TELEPHONE RECEIVERS, H. P. Pratt, London.
805. GAS, A. J. Boult.—(*J. Hanlon, United States.*)
806. FASTENING DRESS COLLARS, &c., A. Heronimos, London.
807. BABY'S RUN, L. M. Carter, London.
808. CAR-AXLE LUBRICATOR, S. J. Wallace, U.S.
809. GLOVE FASTENERS, E. J. Kraetzer, Boston, U.S.
810. APPLIANCES to BICYCLES, A. C. Henderson.—(*R. Nagel, Germany.*)
811. APPLICATION to TORREFYING APPARATUS of WARMING MECHANISM, B. J. B. Mills.—(*J. P. Cot, France.*)
812. TELEGRAPHIC INTERCOURSE between TRAINS and STATIONS, B. J. B. Mills.—(*C. Diener and C. A. Mayrhofer, Austria.*)
813. AWL, F. T. Heales, London.
814. CORRECTING ERRORS of AIMING when using FIRE-ARMS, C. Foley, London.
815. UTILISING HEAT DEVELOPED by COMBUSTION, H. J. Haddan.—(*W. M. Jackson, U.S.*)
816. RAIL FASTENING DEVICE, B. Gallagher, London.
817. EMBROIDERING MACHINES, H. J. Haddan.—(*S. Berger and H. Stöckel, Saxony.*)
818. METHOD of MOUNTING the SADDLES of VELOCIPEDES, J. White and J. Asbury, London.
819. BREAKING ELECTRIC CIRCUITS, V. Willis, London.
820. ENSILAGE APPARATUS, A. B. Richardson, London.
821. PRODUCING TEXTILE FABRICS, A. M. Clark.—(*E. Maertens, U.S.*)
822. HYDRAULIC and other STOP VALVES, A. M. Clark.—(*F. Muratori and E. Cros, France.*)
823. BOTTLES, &c., W. Stobbs, London.
824. FRAMES for CYCLOSTYLE COPYING APPARATUS, A. F. Link, London.—(*E. Klaber, Germany.*)
825. SUPPORTING SHADES over CANDLES, J. F. Marchant, London.
826. BEDSTEADS, E. Curley, London.
827. BICYCLES, W. D. Bohm, London.
828. CHARGING BOTTLES, A. Clark, London.
829. ELECTRIC LIGHTING of RAILWAY TRAINS, W. Mather, Manchester, J. Hopkinson, London, and E. Hopkinson, Manchester.
830. SOFTENING WATER, J. Hanson, London.
831. MEASURING TAPES, W. R. Lake.—(*M. Maticevic, Austria.*)
832. STOCKINGS, W. R. Lake.—(*W. Esty, U.S.*)—24*th October*, 1884.
833. TREATING WOOD, W. R. Lake.—(*E. Z. Collings and C. F. Pike, U.S.*)
834. STEAM BOILERS, R. Penman, London.
835. BOX-IRONS, E. G. Brewer.—(*P. de Mol, Belgium.*)
836. GOVERNORS for STEAM ENGINES, &c., A. Therkelsen and J. Brunn, London.
837. LACE CLIPPING MACHINES, J. H. Johnson.—(*C. H. Willcox, United States.*)
838. PORTABLE COUNTING APPARATUS, E. Edwards.—(*A. Petetin, France.*)
839. MONKEY SPANNERS, S. P. Wilding.—(*J. Bussereau, France.*)
840. STEAM HEATING APPARATUS, W. R. Lake.—(*P. H. Inman, United States.*)

21st January, 1885.

841. JOINING LEAD PIPES, C. Shields, Manchester.
842. UNIVERSAL ADVERTISING ENVELOPE, G. G. Bollon, Exeter.
843. DISINFECTING APPARATUS, J. Robertshaw and J. T. Turner, Manchester.
844. STOPPER and NECKS of BOTTLES, R. Waycott, Paignton.
845. DOMESTIC FIRE PROTECTOR, J. Gullery, Belfast.
846. PROPELLING VESSELS, J. R. Leaver, Swansea.
847. BAKERS' and BUTCHERS' CARTS, C. W. Wheeler, London.
848. GAS MOTOR ENGINES, F. G. Myers, Northampton.
849. ADJUSTABLE SPANNERS or WRENCHES, J. Case, Sheffield.
850. FASTENING for GLOVES, &c., W. P. Thompson.—(*La Société Veuve Buscarlet et Fils, France.*)
851. JARS, &c., for HOLDING AIR-TIGHT FOOD, &c., B. Williamson, Liverpool.
852. COAL-CUTTING MACHINE, D. Cockshaw, Glass Houghton, near Normanton.
853. CHEST EXPANDERS, T. Keane, Birmingham.
854. BOTTLE STOPPER, S. Davey, Birmingham.
855. SCREW COUPLINGS, J. H. Carruthers, Glasgow.
856. WATCHES, &c., M. L. Levy, Birmingham.
857. MINERS' SAFETY LAMPS, W. Clifford, London.
858. SECURING WHEELS to AXLES, P. U. Askham and F. Chamberlain, London.
859. WELT on KNITTED FABRICS, F. Keywood, London.
860. SEPARATING, &c., FIBRE from PEAT, F. Baird, London.
861. ROWING BOATS, S. Russell, Stanwell.
862. MEASURING FLUIDS or LIQUIDS, J. Humphreys, Leeds.
863. BOTTLE STOPPERS and BOTTLES, J. Rebbla, Halifax.
864. ROLLER BLIND FURNITURE, J. Hudson, London.
865. UTILISATION of SUGAR SCUM, A. G. Wass, London.
866. CLEANING the TUBES of BOILERS, A. G. Wass, London.
867. TWO-WHEELED CAB, T. Benson, London.
868. VENT PEG, H. Agar, Worcester Park.
869. ADJUSTABLE STEPS for BICYCLES, &c., W. Phillips, London.
870. METALLIC ALLOYS, J. H. Johnson.—(*The Société Anonyme le Ferro Nickel, France.*)
871. LUBRICATORS, &c., F. H. J. Trier.—(*B. Stauffer, Switzerland.*)
872. LUBRICATORS, T. W. Mitchell, London.
873. PARTITIONED BOTTLE CRATE, F. Foster, London.
874. BRONCHITIS KETTLES, A. G. Bayley, London.
875. ENVELOPES, LABELS, &c., H. J. Haddan.—(*J. E. Métra, France.*)
876. STYLOGRAPHIC PENS, O. Bussler, London.
877. ELASTIC WEBS, &c., W. Stokes and R. Hudson, London.
978. GOVERNORS for STEAM ENGINES, C. W. Pinkney, London.
879. BLIND ROLL FURNITURE, &c., H. A. Williams London.
880. REPAIRING and BINDING CHIMNEYS, J. Gillespie, London.
881. NEEDLE THREADER, W. Eglin, London.
882. STOPPERING BOTTLES, M. L. Macaulay, London.
883. GAS LAMPS, T. C. J. Thomas, London.
884. HARDENING of STONE, B. J. B. Mills.—(*C. Laboré, France.*)
885. GAS LAMPS, T. C. J. Thomas, London.
886. COMBINED PRINTING or ENDORSING STAMP, INKING PAD, MATCH-BOX HOLDER, and CIGAR CUTTER, M. Lindner, London.
887. ECONOMISING FUEL, J. R. Furneaux, London.
888. VALVE or COCK, J. B. Chaplin, London.
889. PRODUCING RAPID MOTION of ROTATION, &c., E. Ciotti, London.
890. ELECTRO-TELEPHONIC RECEIVERS, A. A. Campbell-Swinton, London.
891. ROLLS for ROLLING TEE BARS, &c., A. de L. Long, London.
892. PRODUCING ILLUSTRATIONS in NEWSPAPERS, &c., T. P. Ritzema, London.
893. GAS LAMPS, T. C. J. Thomas, London.
894. DESIGNS in ENAMELLED METAL WORK, L. Dalpayrat, London.
895. KNITTING SIMULTANEOUSLY TWO or more BANDAGES, &c., J. H. Haywood, London.
896. MALLETS, A. J. Boult.—(*O. E. Wait, U.S.*)
897. TILES, &c., A. J. Boult.—(*F. C. A. Meier, Germany.*)
898. ROCKING CHILDREN'S CRADLES, F. Pearson, jun., and E. D. Payne, London.
899. PRODUCING MOTIVE POWER, C. J. Eyre, London.
900. PURIFYING, &c., SEWAGE, &c., F. M. Lyte, London.
901. KEEPERS PLATES for LOCKS, &c., of RAILWAY, &c., DOORS, G. D. Peters, London.
902. BRACELETS, &c., W. Penney, London.
903. FILTERS, J. H. Jacobs, London.
904. STEAM BOILERS, G. Kingdon, F. C. Simpson, and J. B. and E. F. Denison, Dartmouth.
905. BLOCKING and MAKING PIES, T. Shackleton, London.

22nd January, 1884.

906. CANAL and RIVER LOCKS and DRY DOCKS, F. Lees, Oldham.
907. PENCIL SHARPENER, W. Appleby and T. Wood, Manchester.
908. FILTERING, &c., SUBSTANCE from CARBONACEOUS or LIGNITE CLAY, G. H. Ellis, Exeter.
909. TURKEY CARPET IMITATIONS, W. P. Thompson.—(*J. Kohn and Co. and F. Waltzlawik, Austria.*)
910. DRYING BRICKS, &c., J. A. Graham, Liverpool.
911. NOSING MOTIONS of SELF-ACTING MULES, B. A. Dobson and R. C. Tonge, Manchester.
912. VALVES and VALVE GEAR, J. C. Spence, Newcastle-on-Tyne.
913. ROLLERS for MANGLING, W. H. Blackwell and J. Ridyard, Ashton-under-Lyne.
914. DRAWING COMPASSES, M. Turnor, Birmingham.
915. PRODUCING COMBUSTIBLE GASES from FINELY-PULVERISED COAL, F. J. Jones, Bewdley.
916. DUPLEX TORPEDOES, &c., W. Welch, Southsea.
917. FIXING and INSULATING SUPPORTS for ELECTRIC WIRES, B. Pitt, Bristol.
918. EMBOSSING, &c., DESIGNS upon FABRICS, &c., E. J. Homan, Manchester.
919. SPLIT COITERS, E. Hollingworth, Halifax.
920. UTILISING the WASTE HEAT of FURNACES, &c., T. Wright, Halifax.
921. DENOTING TIME on the TWENTY-FOUR HOURS' SYSTEM, J. Dyson, Halifax.
922. CHECKING the SHUTTLE in LOOMS, E. Hollingworth, Halifax.
923. VEHICLES and SEATS, W. Bodell, London.
924. RECESSED or PINIONED TAP, W. J. Pollard, Little Ilford.
925. CLEANING MALT and GRAIN, J. J. Robson, London.
926. BAG for BICYCLES, T. Farrington, London.
927. PIN SCARVES, F. Theak and A. L. May, London.
928. ROTARY STEAM ENGINE, J. E. Bannister, Lewisham.
929. SLEEVES of COATS, JACKETS, &c., S. Staniforth, London.
930. ACCELERATING MOTION of TRICYCLES, &c., R. M. and C. T. Weaver, Wolverhampton.
931. SAFETY BRAKE APPARATUS for LIFTS, T. Hicken, London.
932. GRIPPING JAWS for LATHES, &c., W. Macilwraith, London.
933. RACK or HOLDER for HAND STAMPS, E. M. Richford, London.
934. PERAMBULATORS, G. C. Bond and J. Sadler, London.
935. EMBROIDERED FABRICS, E. Reichenbach.—(*H. Galuska, France.*)
936. TOOTH BRUSHES, A. B. Harrison, London.
937. VEHICLE WHEELS, J. Marshall, London.
938. THRASHING MACHINES, J. Marshall, London.
939. REPEATING FIRE-ARMS, W. Arthur, London.
940. BEARINGS for CARRYING the HUB LAMPS of VELOCIPEDES, J. R. Henson, London.
941. HOLDERS for LEAD, CHALK, &c., O. Bussler, London.
942. HORSESHOES, G. W. H. Gervase, London.
943. TAPS for MEASURING QUANTITIES DRAWN, &c., W. Vavasour, London.
944. PISTONS, P. Brotherhood, London.
945. AUTOMATIC WEIGHING MACHINES, C. Reuther, London.
946. FINISHING YARNS, &c., A. Thompson and R. O. Ritchie, London.
947. CUTTING or BORING MINERALS, J. G. Cranston and T. Heppell, London.
948. DOOR KNOBS or HANDLES, &c., C. Longbottom, London.
949. BREECH-LOADING FIRE-ARMS, J. Mengel.—(*H. Schlund, China.*)

950. FIRE-GRATES, H. Walker and G. Clark, London.
951. ENABLING INVALIDS to READ, &c., in a RECLINING, &c., POSITION, J. Carter, London.
952. CLOCKS and WATCHES, A. C. Reyrolle and H. L. Leconte, London.
953. FIRE-ARMS, J. H. Johnson.—(*L. M. R. Daudeteau, France.*)
954. SHIRTS, CUFFS, &c., M. Wilson, London.
955. SECURING the FALL-DOWN HEADS of CARRIAGES, E. Nunan, London.
956. PRESSURE GAUGES, J. Jackson, London.
957. REGULATING INDUCED CURRENTS of AIR, H. F. Green, London.
958. TAPS and VALVES, W. Stobbs, London.

23rd January, 1885.

959. GRINDING, &c., CUTTERS, W. F. Smith and A. Coventry, London.
960. SELF-ACTING BOLT FASTENERS, A. Graham, Birmingham.
961. LOOM WARP BEAM WEIGHTING, &c., MOTIONS, J. Hudson, Halifax.
962. SIGNAL BELLS, W. H. Ryder, Birmingham.
963. GAS MOTOR ENGINES, G. Whittaker, Manchester.
964. CAUSING METERS to TRANSMIT a RECORD of their INDICATIONS to a CENTRAL POINT, J. Sturgeon, London.
965. FORMING, &c., HAT BODIES, G. Atherton, Manchester.
966. RETORTS for DISTILLING, &c., SHALE, H. Kenyon, Manchester.
967. DISTILLING, &c., COAL, SHALE, &c., H. Kenyon, Manchester.
968. T SQUARES, H. A. Fletcher, Gravesend.
969. TRICYCLES, &c., T. H. Ward, Tipton.
970. FIXING SWING TOILET MIRRORS, A. C. Robinson, Manchester.
971. CIGARETTE HOLDER and PENCIL POINT PROTECTOR, W. H. Williams, Birmingham.
972. SHIPS' LIGHTS, W. Harvie, Glasgow.
973. EVAPORATING, &c., LIQUIDS, G. S. Hazlehurst, London.
974. TRIPLE EXPANSION STEAM ENGINES, G. Rodger, London.
975. TIE HOLDER, E. M. Shaw, Halifax.
976. TRIPODS for PHOTOGRAPHY, A. Pumphrey, Birmingham.
977. SLEEVE LINKS, H. P. Harrison, London.
978. CRICKET and LAWN TENNIS BATS, J. Rice, London.
979. KNIVES, J. Simmons, London.
980. ADJUSTABLE DIP-PIPES, S. B Darwin, London.
981. SELF-ACTING STOP VALVES, J. C. Bauer, Brockley.
982. MAKING DRAWING COMPASSES, &c., M. Turnor, London.
983. GLOBE HOLDERS for GAS, &c., LAMPS, E. Atkins, London.
984. SECURING the FORE-END of BREECH-LOADING GUNS to the BARRELS, R. Redman and S. Whitehouse, Birmingham.
985. CLOCKS, &c., A. H. Storey, London.
986. DISPLAYING ADVERTISEMENTS, &c., J. L. McKim, London.
987. SLIDE REST TOOL, J. Martignoni, Frankfort-on-the-Main.
988. HANDLES for BUTTON-HOOKS, &c., W. Bown and G. Capewell, London.
989. CURLING, &c., HAIR, W. Bown and G. Capewell, London.
990. PREPARING VULCANISED INDIA-RUBBER, W. Smartt, London.
991. GRINDING LATHES, H. Greenwood, London.
992. ELECTRICAL MOTORS, R. A. Lee and J. E. Chaster, London.
993. CLAMPS, T. N. Palmer.—(*W. H. Golding, U.S.*)
994. VELOCIPEDES, E. C. F. Otto, London.
995. PUTTING a CONTINUOUS PRESSURE upon ENSILAGE, W. Bayliss, E. Jones, and R. Howarth, London.
996. PIGMENTS or COLOURS, J. C. W. Stanley, London.
997. ARMOUR-PLATES or SHIELDS, J. T. Cocking, London.
998. COMBINING MUSIC REPOSITORY with PIANOFORTES, F. Oetzmann, London.
999. COMPOUND STEAM ENGINES, T. W. Worsdell, London.
1000. DRAUGHT and DUST EXCLUDERS, J. C. Taite, T. W. Carlton, and T. W. Worsdell, London.
1001. LIQUID FUEL FURNACES, J. H. Selwyn, London.
1002. REMOVING INTERNAL STOPPERS from the NECKS of BOTTLES, F. J. Beaumont and F. S. Turner, London.
1003. INDICATING the OCCUPATION of ROOMS, &c., S. Meacock, London.
1004. WHEELS for CARRIAGES, &c., B. Plant, London.
1005. PRESSES for BALING COTTON, &c., A. E. Cummins, London.
1006. VANILINE, C. A. Day.—(*A. Scheidel, Italy.*)
1007. HOLDERS for BLACK LEAD, &c., O. Bussler, London.
1008. PENCIL SHARPENERS, O. Bussler, London.
1009. SHOES for HORSES, &c., for ROUGHING, &c., PURPOSES, C. M. Westmacott, London.
1010. VALVE GEAR for HIGH-PRESSURE, &c., ENGINES, A. J. Bickmore.—(*W. Voit, Prussia.*)
1011. DROP-DOWN GUNS, J. H. Hannay, London.
1012. SELF-LIGHTING GAS BURNERS, A. Stent.—(*I. D. Guyer, United States.*)
1013. ALUMINATE of SODA, F. M. Lyte, London.
1014. STENCIL PLATES for GRAINING, &c., METALLIC GOODS by ELECTRO-METALLURGY, J. J. Callow, London.
1015. INDICATORS for ELECTRIC BELLS, C. W. Stewart and R. Oakley, London.

24th January, 1885.

1016. LAMPS for BURNING VOLATILE HYDRO-CARBON, &c., F. R. Baker, Birmingham.
1017. GLOBES, &c., for GAS, &c., LAMPS, C. J. Cuin, Birmingham.
1018. SHIPS' FENDERS, G. Barnley, Westmoreland.
1019. TWENTY-FOUR HOUR DIAL, T. C. Rye, London.
1020. ROLLED METAL SLEEPERS, P. Kirk, Manchester.
1021. ATTACHING HANDLES to TIN, &c., GOODS, J. W. Sankey, Birmingham.
1022. CAPS employed in ROVING, &c., FIBROUS MATERIALS, J. C. Rouse, Halifax.
1023. STEERING GEAR for SHIPS, W. Adair, London.
1024. HANDLE for BUTTON-HOLES, &c., H. A. Hill, Birmingham.
1025. TRICYLES, H. J. Pausey and C. T. Crowden, London.
1026. PURIFYING COAL GAS, J. Hanson, Bingley.
1027. MICROPHOTOSCOPES, R. Gallaud-Mason, Manchester.
1028. COUNTER SHAFTS, T. N. Palmer.—(*C. H. Russon, United States.*)
1029. ADJUSTABLE BALL BEARINGS for VELOCIPEDES, F. C. Wrighte, Birmingham.
1030. HEADS, &c., for BICYCLES, &c., F. W. Mitchell, Liverpool.
1031. MAGNESIUM, E. von Püttner, Liverpool.
1032. GELATINISED GRAIN for BREWING, J. Death, jun., Cheshunt.
1033. HANGING, &c., RAILWAY, &c. WINDOW SASHES, E. J. Hill, London.
1034. SCUTTLES for COAL, &c., G. Camm, London.
1035. ROTARY ENGINES, W. Stowe, London.
1036. COATING METAL PLATES with TIN, &c., H. Hall, London.
1037. SWITCH BOARDS, T. J. Handford.—(*C. Lemon, New Zealand.*)
1038. COMPOUND to be used in CONSTRUCTING SMELTING and other FURNACES, C. Bramall, London.
1039. CRUSHING COKE, &c., D. E. Langham, Merton.
1040. ROLLER BEARINGS for VELOCIPEDES, &c., J. K. Starley, London.
1041. BOOTS, SHOES, &c., W. H. Atkinson, London.
1042. HOLDING RAILWAY CARRIAGE or other WINDOWS in any POSITION, F. Bosshardt.—(*E. Long, India.*)
1043. NUT-CRACKERS, C. C. Hull, London.
1044. TRAMWAY ENGINES, S. Butler, London.
1045. THERMOMETERS, W. Hempel, London.
1046. VATS or BACKS, W. T. Ramsden, London.
1047. LAMPS, E. FitzGerald Law, London.
1048. SUPPLYING FRESH AIR to FIREPLACES, &c., F. H. Smith, London.
1049. TOOLS for the MANUFACTURE of GLASS BOTTLES, T. Turner, London.
1050. PUMP VALVE, J. J. Tyler, London.
1051. ROTARY FANS, J. S. Walker, T. A. Walker, and E. R. Walker, Liverpool.
1052. CIGARETTES, E. E. David, London.
1053. KEEPING STEAM BOILERS FREE from INCRUSTATION, W. R. Lake.—(*A. E. E. Jeanolle, France.*)
1054. SHOEING HORSES, J. E. Jarvis, London.
1055. CRICKET BAT HANDLES, J. E. Williams, Birmingham.
1056. NOZZLES for DIFFUSING SPRAY, A. F. Link.—(*M. Mestern, Saxony.*)
1057. BOILERS for CLOSED KITCHEN RANGES, &c., H. Thompson, London.
1058. FINE ALPACA FABRICS, S. C. Lister and H. G. Tetley, London.
1059. BEVELLING for FRAMES of SHIPS, S. W. Snowden, London.
1060. BRAKES, H. Brockelbank, London.

26th January, 1885.

1061. TANDEM CONVERTIBLE TRICYCLES, J. Carver, London.
1062. MEASURING, &c., the LENGTH of YARN, A. Hitchon, Halifax.
1063. RAILWAY SLEEPERS and CHAIRS, J. C. Bunten and A. Murray, Glasgow.
1064. COP SHUTTLES for POWER LOOMS, &c., D. McGregor, Dundee.
1065. COOLING TIRES of WHEELS, C. G. McDowell, Warrington.
1066. FURNITURE DRAWERS, W. H. Blackwell, Hooley Hill, near Manchester.
1067. TONGS for CURLING the HAIR, W. Foxcroft, jun., Edgbaston.
1068. DRIVING or EVAPORATING the SPIRIT from PROOFED HATS, &c., W. J. Battersby, E. Barratt, and J. Aldred, Manchester.
1069. STAIR PADS and BED QUILTS, T. Griffiths, Manchester.
1070. COMBINED READING LAMP and STICK, &c., W. G Richardson, London.
1071. PRESSURE GAUGE MOUNTINGS, H. Tee, Tipperary.
1072. PHOTOGRAPHIC CAMERAS, J. Thomson, Liverpool.
1073. CUTTING the PILE of FUSTIANS, &c., J. Platt, Manchester.
1074. SUPPORTING and FACILITATING the CASTING LOOSE of a VESSEL'S ANCHOR, A. M. Clark.—(*R. P. Trefry, Nova Scotia.*)
1075. GUIDING the BOW in VIOLIN PLAYING, G. W. Morgan, Aberdeen.
1076. CONDENSER PIPE for SMOKING TOBACCO, &c., B. H. Thwaite, Tranmere.
1077. VALVES and VALVE GEARING for STEAM ENGINES, J. A. Gregory, Bristol.
1078. BUTTONS, W. E. Heys.—(*T. Winkel, Germany.*)
1079. BLOTTING PAD, &c., W. E. Heys.—(*R. T. Peerdt, Germany.*)
1080. SOAP, &c., W. G. Little, Rotherham.
1081. CLOSING and OPENING BOTTLES, &c., S. Bunting, Dublin.
1082. MARBLE RACING GAME, J. Davies, Buckley.
1083. CHILDREN'S TOY, J. Davies, Buckley.
1084. REVIVIFICATION of HYDRATE of LIME, J. Reid, Birmingham.
1085. PRINTERS' QUADRATS, &c., W. J. Stonhill, Orpington.
1086. BOTTLE and STOPPER. H. Agar, Worcester Park.
1087. CHEESE PRESSES, J. Gray, Glasgow.
1088. GALVANIC or PRIMARY BATTERIES, C. Maltby-Newton, London.
1089. ATTACHING BREECHING-STAPLES to SHAFTS, W. H. Clift and W. G. Kington, Ludlow.
1090. SOCKET CHISELS, D. Ward and G. Hayward, London.
1091. PLANING, &c., WOOD, B. Sutcliffe, Halifax.
1092. FIXING TROUSERS, T. Pike, London.
1093. WATCHES and other TIMEKEEPERS, J. Simmons, London.
1094. PERMANENT WAY of RAILWAYS, H. H. Perry, East Croydon.
1095. BUOYANT SEATS, B. J. Grimes, London.
1096. ARTICLES for LADIES' WEAR, S. Tomkins, London.
1097. CORK-CUTTING MACHINES, J. Cort and S. Stevenson, London.
1098. CORK SIZING MACHINES, J. Cort and S. Stevenson, London.
1099. SHIFTING DIAL for WATCHES and CLOCKS, G. Sprenger, London.
1100. BALANCED SLIDE VALVES, T. F. Veasey.—(*W. G. Smith, United States.*)
1101. TELEPHONIC and TELEGRAPHIC APPARATUS, J. Stephen, Glasgow.
1102. DECORATING SURFACES of PLASTERING WORK, R. Warwick, North Plaistow.
1103. CRYSTALLISED COLOURS, &c., H. Rees, Wandsworth Common.
1104. LOCKS and LATCHES, A. G. Brookes.—(*A. H. Willemer, Germany.*)
1105. SUPPORTING MUSIC, BOOKS, &c., H. T. Sugden, London.
1106. VESSELS for CONTAINING HOT or COLD LIQUIDS, D. B. Morison, London.
1107. CLIPPING HAIR, &c., W. Bown, Birmingham, and G. Capewell, Aston.
1108. SAFETY STIRRUP, H. J. Haddan.—(*J. Chaput, France.*)
1109. UMBRELLAS, C. A. Esmond, London.
1110. REGULATING SHUTTLE-BOXES in LOOMS, D. Crabtree, London.
1111. PICTURE, &c., HOOKS, E. and W. H. Tonks, London.
1112. SECURING MILK CANS against ROBBERY, H. Wise, London.
1113. BRAKE SHOES, A. J. Boult.—(*J. J. Lappin, Canada.*)
1114. BOOTS and SHOES, B. Ellis, London.
1115. CONVERTING VELOCIPEDES into BICYCLES, &c., W. Smith and G. Hicking, London.
1116. CONVERTING VELOCIPEDES into TRICYCLES, &c., W. Smith and G. Hicking, London.
1117. STARTING TRAMWAY or other VEHICLES, H. H. Lake.—(*J. Goodfellow, United States.*)
1118. LAWN-MOWING MACHINES, J. E. Ransome, G. Ling, and W. Moulton, London.
1119. SOLITAIRE and other STUDS, &c., L. C. H. Mensing, London.
1120. PHOTOGRAPHIC CAMERAS, F. W. Branson, London.
1121. SPRING POWER for WORKING ORDNANCE, L. Raskazoff, London.
1122. BRAKES, C. H. Bartlett, London.
1123. BICYCLES, &c., R. Varty, London.
1124. ROASTING or DRYING GRAIN, A. Perry and J. V. Walmsley, London.

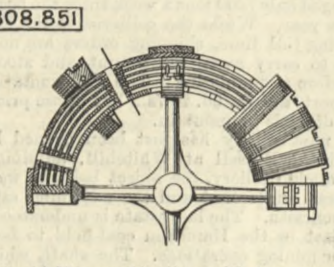
SELECTED AMERICAN PATENTS.

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

308,851. ARMATURE FOR DYNAMO-ELECTRIC MACHINES, *Benjamin F. Orton, New York.—Filed January 25th*, 1884.

Claim.—(1) The combination, with an armature core made up of core sections free from projections and of proper size to permit the armature bobbins to be slipped into place endwise upon it, of a carrier or supporting frame, upon which abutting ends of the core sections rest, and clamping devices whereby the core sections may be held together at their abutting ends, where they rest on the frame. (2) The combination, with the armature segment having notches or recesses at its sides, of the key pieces in said notches and between the armature bobbins, as and for the purpose described. (3) The combination, with the armature bobbins, of the interposed attached key pieces made up of superposed metal plates, as and for the purpose described. (4) The combination, with the armature segments having slots or recesses in their sides, of the key pieces, as and for the purpose described. (5) An armature segment or section made up of superimposed plates curved to the form of the armature ring or cylinder, and having notches or recesses in their edges, in combination with key pieces fitting said notches, as and for the purpose

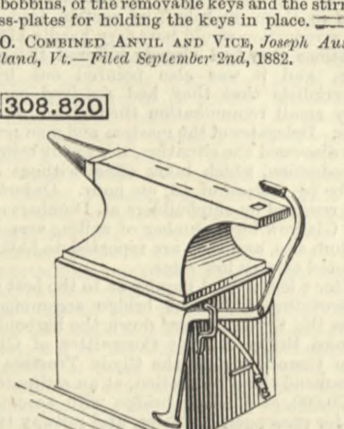
308.851



described. (6) The combination, with two segments or sections in a sectional armature, of two L-pieces bolted to one another and individually bolted to the abutting ends of the segments, as and for the purpose described. (7) The combination, with the armature and its bobbins, of the removable keys and the stirrups and cross-plates for holding the keys in place.

308,820. COMBINED ANVIL AND VICE, *Joseph Austin, Rutland, Vt.—Filed September 2nd*, 1882.

308.820

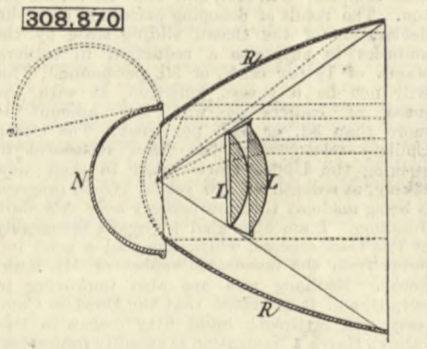


Claim.—The jaw and foot lever in one piece, as described, jointly with the anvil.

308,870. COMBINED REFLECTOR AND REFRACTING LENS, *C. B. Boyle, New York, N.Y.—Filed August 18th*, 1882.

Claim.—(1) The combination of paraboloid reflector R, cut away at back, as shown, curved reflector N, arranged to intercept and return backward rays, and a plurality of lenses L, so arranged concentrically within said paraboloid reflector as to intercept all rays which would directly pass beyond the edges of the reflector, substantially as and for the purpose set forth. (2) The combination of paraboloid reflector R,

308.870

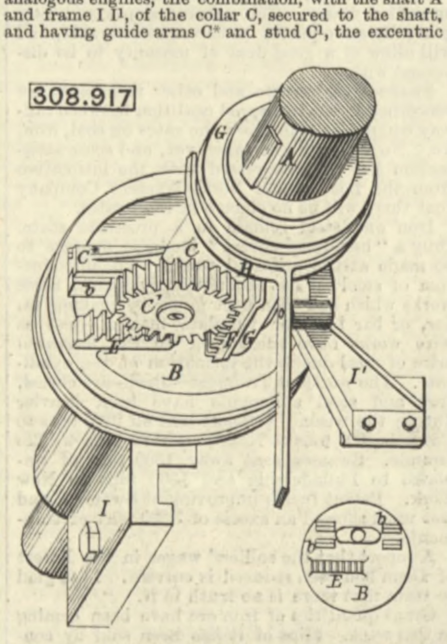


having back opening, as shown, a plurality of lenses L, posed therein so as to intercept all forward rays not impinging on the reflector R, and curved reflector N, of a greater diameter than said opening, and arranged without said opening in such relation to the flame as to reflect a portion of its radiant light back through a point upon the optical axis near to but forward of the position of the flame, substantially as and for the purposes set forth.

308,917. REVERSING VALVE GEAR, *Matthew R. Moore, Indianapolis, Ind.—Filed July 20th*, 1883.

Claim.—In a reversing valve gear for steam and analogous engines, the combination, with the shaft A and frame I I^1, of the collar C, secured to the shaft, and having guide arms C* and stud C^1, the excentric

308.917

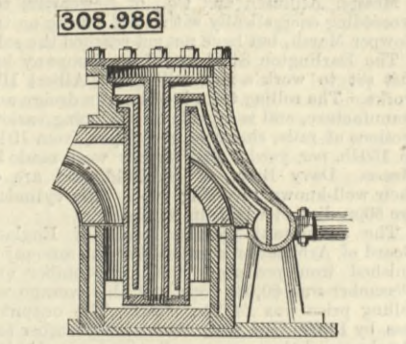


B, having guideways *b* and rack E, the collar G, having projecting arms G^1, supporting rack F, and having feather connection with the shaft, and the lever H, all arranged and operating as and for the purposes set forth.

308,986. CONVERTER, *Jacob Reese, Pittsburg, Pa.—Filed May 5th*, 1884.

Claim.—(1) A converter having a fixed metal chamber surrounded with a water-jacketted iron lining and a non-metallic bottom, and provided with a metallic dome having a non-metallic lining and a water-jacketted air tuyere, constructed and arranged substantially as and for the purpose set forth. (2) A converter having a fixed metal chamber surrounded by an annular water-jacketted iron lining and a non-metallic bottom, and provided with an adjustable dome lined internally with a non-metallic substance, substantially as and for the purpose set forth. (3) A converter having a fixed metal chamber surrounded by an annular water-jacketted iron lining and a non-metallic bottom, and provided with an adjustable pivotted dome having a water-jacketted air tuyere,

308.986

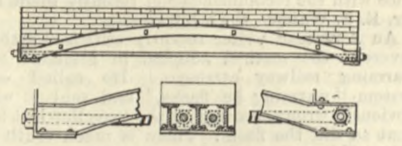


whereby the tuyere may be inserted and withdrawn from the metal quickly without impairing the water or the air connections, substantially as and for the purpose set forth.

309,063. GIRDER, *Charles H. Kellog, Buffalo, N.Y.—Filed February 18th*, 1884.

Brief.—A rolled metal beam formed with a curved body and horizontal ends in one piece and of uniform

309.063

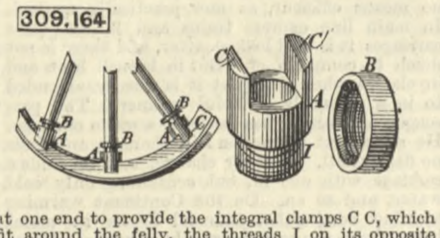


cross section, the ends being in line with a tie rod connecting them.

309,164. TIRE TIGHTENER, *Robert Ruffin, Como, Miss.—Filed April 30th*, 1884.

Claim.—The combination, with the spokes, felly, and tire, of the hollow cylinder A, recessed or slotted

309.164



at one end to provide the integral clamps C C, which fit around the felly, the threads I on its opposite shouldered end, and the cylindrical nut B, working on the threaded end of the cylinder A against the shoulder, as set forth.

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