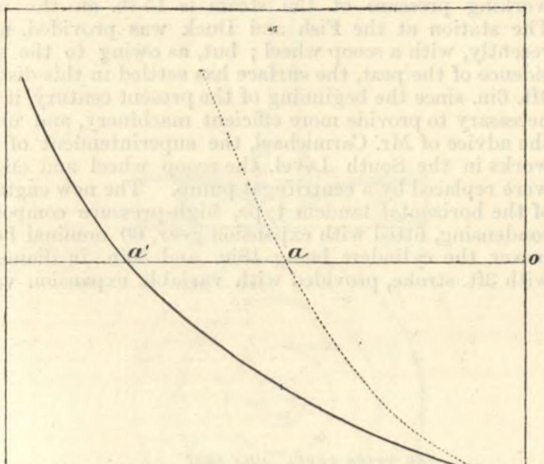
ELASTIC EXTENSION: A SPECIES OF MOTION.[1]

By ROBERT HUDSON GRAHAM.

(*Concluded from page* 146.)

(8) *Assaying the Curve.*—The shape of a given curve, such as *a o*, Fig. 3, may be distorted by changing the fundamental scale of one of the ordinates, according to which it has been drawn. Supposing, for example, we double the horizontal scale of loads by simply doubling the length representing a given load; then it is clear that any point *a* upon the original curve is launched forward to a^1, where its abscissa is doubled, whilst its ordinate remains the same. In this way the whole curve is projected from the dotted line to the black, as shown upon the figure.

Fig. 4



If, therefore, the original curve were of a particular nature, when plotted to a given scale or ratio of co-ordinates, it would at once lose cast by plotting the series of loads upon an exaggerated scale. The distorted form would, however, be derived from the original curve by projection in a constant ratio; and the original curve would be mathematically discoverable from the given projection.

In assaying any extension curve for cissoidicity it is advisable first to apply the ordinary cissoid test as shown in Fig. 2; that is, take the origin O at the limit of elasticity upon the curve, where it begins to break away from the straight line; describe the range-circle upon the distance O *l* contained between the limit O and the infinite ordinate to the curve at *l*; divide the range into any number of equal parts, and, using the centre O as a focus, draw the series of rays O 1, O 2, O 3, O 4, . . . meeting the series of ordinates from $1^1, 2^1, 3^1, 4^1$ . . . in 1″, 2″, 3″, 4″ . . . all points upon the required cissoid. If the curve so constructed coincide with the extension curve, there is no scalar distortion. Should, however, the artificial curve vary much from the extension curve, it is necessary to ascertain whether this divergence is due to scalar distortion or to causes altogether independent of scale. If the variation arise merely from scalar effects, the primitive cissoid can be derived from its given projection according to some constant mathematical law. Now the general equation to the cissoid of extension is § 4.

$$y^2 = \frac{t^3}{2\,r - t};$$

if this curve be distorted by enlarging the scale of time and loads and keeping the scale of extensions constant, the new ordinate y^1 will equal y, the old ordinate, and the new abscissa t^1 will bear a constant ratio to t, the old abscissa of any given point. Let this ratio $\frac{t^1}{t} = n$; then, in order to return to the old equation, we must multiply all abscissæ t^1 of the projected form by the coefficient $\frac{1}{n}$, leaving the ordinates constant. Hence we can retain the primitive equation to the curve, provided that all abscissæ taken from the projected curve be multiplied by the coefficient $\frac{1}{n}$; thus

$$y^2 = \frac{\left(\frac{t^1}{n}\right)^3}{2\,r - \frac{t^1}{n}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This equation contains two unknown quantities, the coefficient n and $2\,r$, the range of the original curve. In order to determine these two quantities, we must establish two equations by taking two values of y corresponding to two values of t from the given projection of the extension curve. Thus, for example, in Fig. 5 we have $y = 6$, when $t = 12$; and $y = 16$, when $t = 19$; hence, upon substitution and making $x = \frac{1}{n}$, we obtain the two equations

$$(6)^2 = \frac{(12\,x)^3}{2\,r - 12\,x} \text{ and } (16)^2 = \frac{(19\,x)^3}{2\,r - 19\,x},$$

by the first of which the range

$$2\,r = 48\,x^3 + 12\,x, \quad . \quad . \quad . \quad . \quad (2)$$

and substituting in the second this value of $2\,r$ in terms of x,

$$\frac{6859\,x^3}{48\,x^3 - 7\,x} = 256. \quad . \quad . \quad . \quad . \quad (3)$$

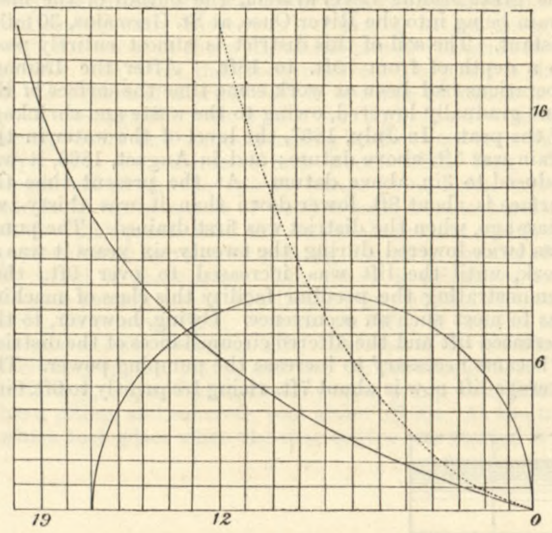
Dividing the numerator and denominator of this fraction by x, the common factor, and solving, we find that very approximately the coefficient of distortion

$$x = 0{\cdot}575\,;$$

and, thence, by substituting this value of x in Equation (2), the range, $2\,r = 17$.

Constructing the cissoid curve upon this range, as shown in Fig 5, it will be found that the abscissæ of all points upon the extension curve, which has been distorted by

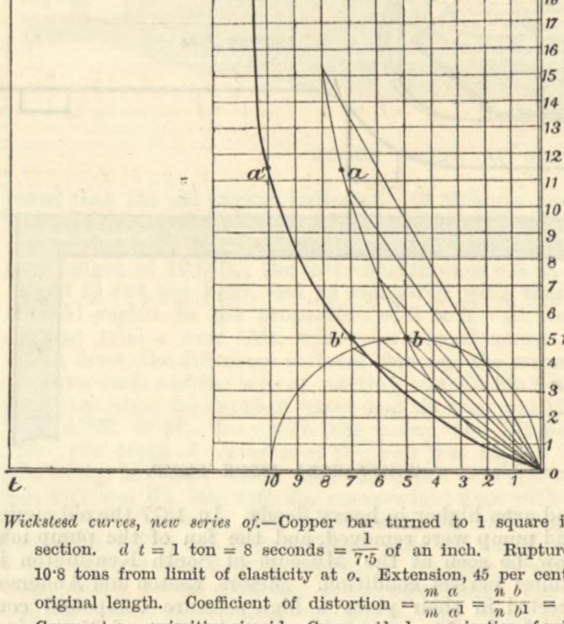
Fig. 5



adopting an exaggerated scale of loads, bear the constant ratio of $\frac{1}{x}$ to the abscissæ of corresponding points upon the primitive cissoid.

I have applied this kind of test to a fairly large number of extension curves, and have proved them in all cases, without exception, to be either primitive cissoids or projections of primitive cissoids. The dark line of Fig. 5 is the exact *fac simile* of a Wicksteed curve; so also is the dark line in Fig. 6, the data and results of the assay being given below the figure in the second case. I am indebted to Mr. J. Wicksteed, of Messrs. Buckton and Co., Leeds, for a copy of these curves. In everything connected with accurate experiment upon elasticity and its autographic diagrammatic expression, Wicksteed has taken a prominent lead.

Fig. 6



Wicksteed curves, new series of.—Copper bar turned to 1 square inch section. $d\,t = 1$ ton $= 8$ seconds $= \frac{1}{7{\cdot}5}$ of an inch. Rupture at 10·8 tons from limit of elasticity at *o*. Extension, 45 per cent. of original length. Coefficient of distortion $= \frac{m\,a}{m\,a^1} = \frac{n\,b}{n\,b^1} = 0{\cdot}7$. Curve *o b a* = primitive cissoid. Curve $o\,b^1\,a^1$ = projection of primitive cissoid through the angle whose cosine is 0·7. Range = 10, diameter of circle of primitive curve.

It need not be remarked that the valves $y, \frac{d\,y}{d\,t}, \frac{d^2\,y}{d\,t^2}$ are the same, whether taken from the primitive or derived forms; because, although $d\,y$ may be smaller when expressed in terms of an augmented unit of scale $d\,t$, the number of these augmented $d\,t$ to the current inch is also smaller in the same degree. In other words, the velocity of extension in any particular test must necessarily be the same, no matter what may be the scale of its representation upon paper. The foregoing conclusions appear at present in the garb of a particular induction, founded upon a large number of cases of bar, as distinguished from wire, tests. Whether it may be safe and justifiable to generalise this induction, so as to include all curves of every origin and species, is a question upon which it might be unwise to dogmatise. Nevertheless, it would seem that most extension-curves are so closely allied to cissoids as to perfectly tolerate the application of the rules and graphic processes developed in the preceding articles. But it must be carefully borne in mind that in cases where the curve proves to be a projection of a cissoid, the graphic method of determining the velocity of extension, the elastic acceleration, and the rest is applicable only to the primitive curve, which can be easily discovered by the method above explained. In choosing the two values of y and t^1 in the curve-projection of the cissoid as given by the test, in order to establish the two equations necessary to determine the unknowns n and $2r$, it is well to select those portions of the curve which stand well out and clear of the focus where the two curves tend to blend and coalesce, and where consequently the corresponding values of the two ordinates are not well-defined.

(9) *Recapitulation.*—In conclusion, the author begs to state his belief that the novel treatment of elastic extension, set forth in this paper, will be found to comprehend and satisfactorily explain the usual phenomena attendant upon ordinary metallic tests, excluding cases of exceptional character. The chief motives which prompted the author to write the paper were a desire to submit his researches to the judgment of other minds, to stimulate discussion upon the subject, and to draw attention to what appeared to him the simplicity and elegance of the elastic graphic expression for the velocity of extension, the acceleration, the new feature of elastic excess, and the increment of extension due to the vibratory effect of the load.

With respect to the work of other minds in this special field of thought, no attempt has hitherto been made to bring elastic extension under ordinary dynamic laws. There is, indeed, a paper by Sir W. Thomson on "Elasticity, a Mode of Motion," read before the Royal Institution, which deals with the subject from a physical, or rather metaphysical, point of view. It would seem to be a proof that elasticity, like heat, is in ultimate analysis an aspect of motion. But engineers, even those who are of a pronounced scientific bent, will take leave of the great master of physics whenever he passes beyond that clear line dividing the territory of practical mathematics from the vague spaces of metaphysical speculation.

With regard to the variation of rate at which the load is added, and its effect upon the ultimate strength of metallic wire, a series of experiments of a more or less rigorous nature was carried out in the Glasgow University Laboratory, and an account of them published in the "Proceedings of the Royal Society"—vol. xxix., p. 221. The deduction based upon these experiments, as given in Mr. J. T. Bottomley's paper, was that "wire broken rapidly receives an elongation of over 25 per cent. on the average; whilst the same wire broken slowly is elongated only by about 7 per cent." The length of wire employed was 16ft., and its diameter ·036in. In one case, when loaded at the rate of ½ lb. per minute, the specimen broke under a total load of 45 lb., and a total extension of 25 per cent. At another time, when loaded at the rate of 1 lb. every three minutes, it finally broke under a load of 45¼ lb., and an elastic extension of 29·6 per cent. In a third instance, when loaded at the rate of 1 lb. every twenty-four hours, it broke under a load of 48 lb., with an elongation of 7·58 per cent. Lastly, a bright annealed specimen of the same dimensions, when loaded at the rate of 1 lb. every twenty-four hours, broke under a load of 47 lb., and an extension of 6·92 per cent. The same specimen, loaded at the rate of ½ lb. per twenty-four hours—which, by the way, is not the same as 1 lb. per forty-eight hours—broke, firstly, under a load of 47 lb., and an extension of 4·79 per cent.; and, secondly, under a load of 46½ lb. and an extension of 6 per cent. The rate of load was afterwards reduced so low as a shot per day; but, whilst greatly edified at the astonishing patience of the operator, engineers will be more particularly interested in swift than in slow rates of fracture. It will be seen that these experiments tend to confirm the theory that extension varies largely, whilst the ultimate breaking-strength varies but little, for different rates of load addition. Thus, whilst the rate diminished from ½ lb. per minute to ½ lb. per day, the ultimate extension decreased from 25 per cent. to about 7 per cent.; whereas, for the same variation of rate, the ultimate breaking-strength increased only by about 2 lb. It must, however, be carefully borne in mind that the analogy between intermittent loading of this nature and the continuous loading assumed in our investigation is far from being complete.

At a later date some experiments were undertaken by Mr. Herbert Tomlinson, towards the expenses of which the Government Research Fund contributed a sum of £4000. An account of these experiments will be found in a paper communicated by Professor W. G. Adams to the "Phil. Trans." of the Royal Society, 1883. There is, however, little to be found in them immediately bearing upon the question of time-tests. It is only stated in a general sort of way that "in the case of a wire which has suffered permanent extension, the extension decreases in proportion as the time between the loadings increases." This fact was also pointed out by Professor Ewing—"Proc." Roy. Soc., 1880, vol. xxx., page 510. The same phenomenon had, however, as we have seen, previously appeared in Mr. Bottomley's experiments; and, in fact, long before that time it had formed part of the engineering faith, and had been incorporated in the principles of bridge construction under the form of varying co-efficients for live and dead loads.

In case absolute accuracy were required in ascertaining the nature of the extension curve, it would, of course, be necessary to employ the method of least squares. But we need scarcely remark that, owing to defects in the tracing gear, and to other mechanical imperfections, the coloured pencil does not trace a perfectly continuous curve, and therefore we are free to consider all the tests and results in the light of tolerable approximations to the truth. All theories based upon experimental data are necessarily imperfect in their origin, which fact enables us to dispense with excessive refinement in the practical operations to which they give rise.

The elastic excess z, is the strain measuring the loss of tension, $\frac{E\,\varpi\,z}{l}$, due to acceleration and other accidental causes. Its value is determined independently of sign, and its nature is essentially negative. Thus, as explained in Art. 3, the actual tension, $\frac{E\,\varpi\,y^1}{l}$, is always less than the static extension, $\frac{E\,\varpi\,y_0}{l}$. Taking account of the contraction of area from ϖ to ϖ^1, this tensional loss may be expressed by $E\,(y_0\,\varpi - \varpi^1\,y^1) \div l$.

[1] The first part of this paper, excluding Sec. 7, was finished in January of this year, and read in the following month by an eminent Cambridge, as well as by an eminent Glasgow, professor.

THE DRAINAGE OF FENS AND LOW LANDS BY STEAM POWER.

By W. H. WHEELER, M. INST. C.E.

No. XI.

The Ten Mile Station.—The scoop wheel at this station is 43ft. 8in. diameter, having been increased 20in. from the original dimension by lengthening the scoops. There are fifty scoops, 7ft. 6in. radial length by 3ft. wide. The average dip of the scoops is 3ft.; the greatest, 5ft. 6in.; and the lift 11ft. average, and 14ft. maximum. This wheel lifts the water into the Ten Mile river, which is not tidal, the tide being shut out by sluice doors at Denver Sluice. There is, however, a considerable rise in the river during tide time. These scoops drip from the radial line at an angle of 38 deg., being tangent to a circle of 18ft. diameter, and on an average head and dip of 14ft.—11ft. head and 3ft. dip—enter the water at an angle of 34 deg., and leave it at an angle of 72 deg. The wheel makes $4\frac{1}{4}$ revolutions a minute. When working to its full extent, the wheel is capable of discharging 213 tons per minute. This wheel has been provided with a movable breast, as at the other station. The engine for driving the wheel is similar in character to that at the Hundred Foot Station, and was altered and adapted for working with a higher pressure of steam in a manner similar to the other. The cost of alterations at the two stations was over £6000. The estimated capacity of the two wheels at the maximum dip is 410 tons per minute. This is equal to a discharge of water due to a continuous daily fall of 0·17in. of rain. In the year 1883, which was a very wet season, the engines ran as follows:—

		Hundred Foot engine.	Ten Mile engine.
Total hours run ...		2288	2280
Coals consumed ...	tons	691	589
Average dip of the scoops	... feet	3·30	3·08
Greatest dip of the scoops	... feet	5·33	4·58
Average head ...	,,	13·80	11·16
Greatest head ...	,,	17·2	13·4

The estimated discharge, calculated with the average dip of the scoops given above, is 122·12 tons per minute lifted 13·80ft., equal to 114·40-horse power of water lifted, with a coal consumption of 5·99lb. per horse-power of water lifted for the Hundred Foot engine, and 128·55 tons lifted 11·16ft., equal to 97·38-horse power, with a coal consumption of 5·93 lb. per horse-power, for the Ten Mile Station. Taking the two wet years, 1881 and 1883—1882 being omitted, as during this time the machinery was under alteration—the cost of lifting the water was as follows:—Coals, £717; attendance and other expenses, £203. The area drained being taken at 35,000 acres, this gives 12·62d. per acre per annum for working expenses. The average height to which the water was lifted at the two stations being taken at $11\frac{1}{2}$ft., gives 1·10d. per acre per foot of lift, or, for coals only, of 0·85d. per acre. Coals costing about 17s. per ton.

Whittlesea Mere.—This pumping station is in the Middle Level, in the county of Huntingdon, and contains about 6000 acres. The Mere originally was a large lake or morass, which produced nothing but reeds and wild fowl. This, with the surrounding fen, was embanked and drained by steam power by the proprietor, Mr. Wells, in 1851-52, being the first instance in this country where the centrifugal pump was applied to this purpose. The results obtained with the Appold pump at the trials of this machine at the Exhibition of 1851, demonstrating its suitableness for the purpose. The engine then erected was of 24 nominal horse power, driving a double inlet horizontal spindle Appold centrifugal pump, 4ft. 6in. diameter, with an average velocity of 90 revolutions a minute, equal to 1431ft. per minute; the lift at that time being from 4ft. to 5ft. The pump was driven by a double-cylinder steam engine, with steam at 40lb. pressure, and vacuum $13\frac{1}{2}$lb. It raised 15,000 gallons—67 tons—per minute to a height varying from 2ft. to 5ft. The total cost was £16,000, of which about £2000 was for the machinery. The general arrangement of the pumps is shown by the sketch, Fig. 10. The pump discharged into Bevil's river, a branch of the Nene, which forms a part of the great Middle Level system, the outfall of the main drain being into the River Ouse, at St. Germains, 30 miles distant. The soil of this district is almost entirely peat, to a depth of from 15ft. to 18ft. After the drainage operations had been at work some time the surface of the land gradually lowered, owing to the waste and shrinkage of the peat. In July, 1857, the level of the water in the drain was 5ft. above datum; and in August, 1860, it was reduced to 3in. above datum. At the present time the surface is about 8ft. lower down than it was thirty-two years ago, when the district was first drained. The pump was twice lowered during the twenty-six years it was at work, until the lift was increased to over 9ft., thus demonstrating the peculiar facility this class of machine has to meet such an occurrence. Owing, however, to the increased lift and the altered circumstances of the district, it became necessary to increase the pumping power. The average lift now is about 7ft., rising frequently to 9ft. 6in., and even higher in heavy floods. In 1877 the old engine and pump were removed, and the fan of the pump may now be seen at the Museum at South Kensington in almost perfect condition. Messrs. Easton and Anderson erected in their place a high-pressure compound condensing beam engine, with expansion gear, of 65 nominal horse-power, making about 36 revolutions a minute with 60lb. steam. The boilers consist of one single flued and one double flued Cornish boilers. The pump, which is placed in a well outside the engine house, is driven by a double set of motions, the first set consisting of a toothing on the fly-wheel driving a pinion which actuates a horizontal shaft for driving a wheel geared into a bevil wheel on the vertical shaft of the pump. This is hung by an onion bearing to a cast iron frame bolted to the top of the pump well, which is formed with a wrought iron cylinder fixed in the centre of the sluice connecting the main drain with the river. This cylinder was used as a convenient mode under existing conditions of forming the pump well, and reduced the first cost by avoiding the necessity for building a brick well. This sluice is 12ft. wide on the inlet side and 6ft. on the delivery side. The fan is a single inlet fan of 6ft. diameter by 16in. deep, and is speeded to run up to 104 revolutions a minute when on a lift of 11ft. The quantity of water delivered is 96 tons per minute, or on a lift of 7ft. 6in., with a speed of 96 revolutions of pump, 155 tons per minute. The engine and boiler are contained in a brick building. The chimney shaft is 53ft. high and 3ft. diameter at the top inside. The cost of the machinery was approximately £3500, plus the value of the old machinery.

Burnt Fen, Norfolk.—This district is situated in the south level of the Bedford Level, and is entirely Fen land. The area drained by the pumps is 15,000 acres. There are two pumping stations, about four miles apart—one at the Fish and Duck, on the south side of the district, discharging into the river Lark, about three miles above its junction with the Ouse; the other on the north, discharging into the Little Ouse, about two miles above Brandon Creek Bridge. The main drains between the two stations are in connection, so that the water can run to either station. These pumping stations are about eight and fifteen miles respectively above Denver Sluice, where are self-acting doors, which shut against the tide at the time of high water. The lift at the north station is rather the highest, the average of the two stations being about 10ft. 6in., rising in heavy floods to 16ft. The north station consists of a scoop wheel 34ft. 6in. in diameter, with scoops 4ft. 9in. long by 2ft. wide, motion being given by one engine of 40 nominal horse-power. The wheel is driven by a condensing engine of the old marine side-lever type, having the beam below the cylinder. The piston has 3ft. 6in. stroke, and makes 28 revolutions of the engine to $5\frac{1}{2}$ of the wheel. The working pressure of the steam is 15 lb. on the inch. The station at the Fish and Duck was provided, until recently, with a scoop wheel; but, as owing to the subsidence of the peat, the surface has settled in this district 4ft. 6in. since the beginning of the present century, it was necessary to provide more efficient machinery, and under the advice of Mr. Carmichael, the superintendent of the works in the South Level, the scoop wheel and engine were replaced by a centrifugal pump. The new engine is of the horizontal tandem type, high-pressure compound condensing, fitted with expansion gear, 60 nominal horse power, the cylinders being 18in. and 30in. in diameter, with 3ft. stroke, provided with variable expansion valve working on the back of the high-pressure valve. Steam is provided by three Lancashire boilers, 25ft. long by 7ft. diameter; the working pressure being 65 lb. Only two of the boilers are in use at the same time. The engine makes 70 revolutions with steam at 65 lb. in the boiler, and cut off in the small cylinder at half of the stroke, the pump making at the same time 105 revolutions with a lift of 14ft. per minute, and delivering 120 tons. The case of the pump is 9ft. 6in. diameter, situated in a well immediately outside the wall of the engine house. This well is 9ft. 10in. in diameter; the diameter diminishing below the pump to 6ft. The outlet for the discharge is 9ft. 6in. above the centre of the pump, and is 5ft. 6in. high by 3ft. 6in. wide. The pump is driven by a bevil wheel geared into a bevil pinion on the crank-shaft, which is 11ft. long. The fan is single, made of gun-metal, 6ft. diameter by $12\frac{1}{2}$in. deep at the periphery, with a short suction pipe attached to the case below the disc. The spindle is suspended by an onion bearing supported by a girder across the top of the cylinder of the pump well. When the pump is working it is found that little weight is carried by the onion bearing, as the disc is so arranged that the water entering it supports the moving parts. The pump was calculated to lift the following quantities:—121 tons at 9ft.; 115 tons at 10ft.; 109 tons at 11ft.; 104 tons at 12ft.; 100 tons at 13ft.; 96 tons at 14ft.; 92 tons at 15ft.; 89 tons at 16ft. These quantities were exceeded at the trials of the pump. The engine bed occupies a space of 30ft. by 5ft. 6in. The engine and pump were supplied by Messrs. Hathorn, Davey, and Co., of Leeds. The contract price, including the well and fixing in the old building, the makers taking the old engine, was £2700. A drawing showing the arrangement of the pump and engine will be found in THE ENGINEER, vol. lvii., February, 1884, and an enlarged view of the pump is now given in Fig. 11. Careful observations have recently been taken by Mr. Carmichael as to the con-

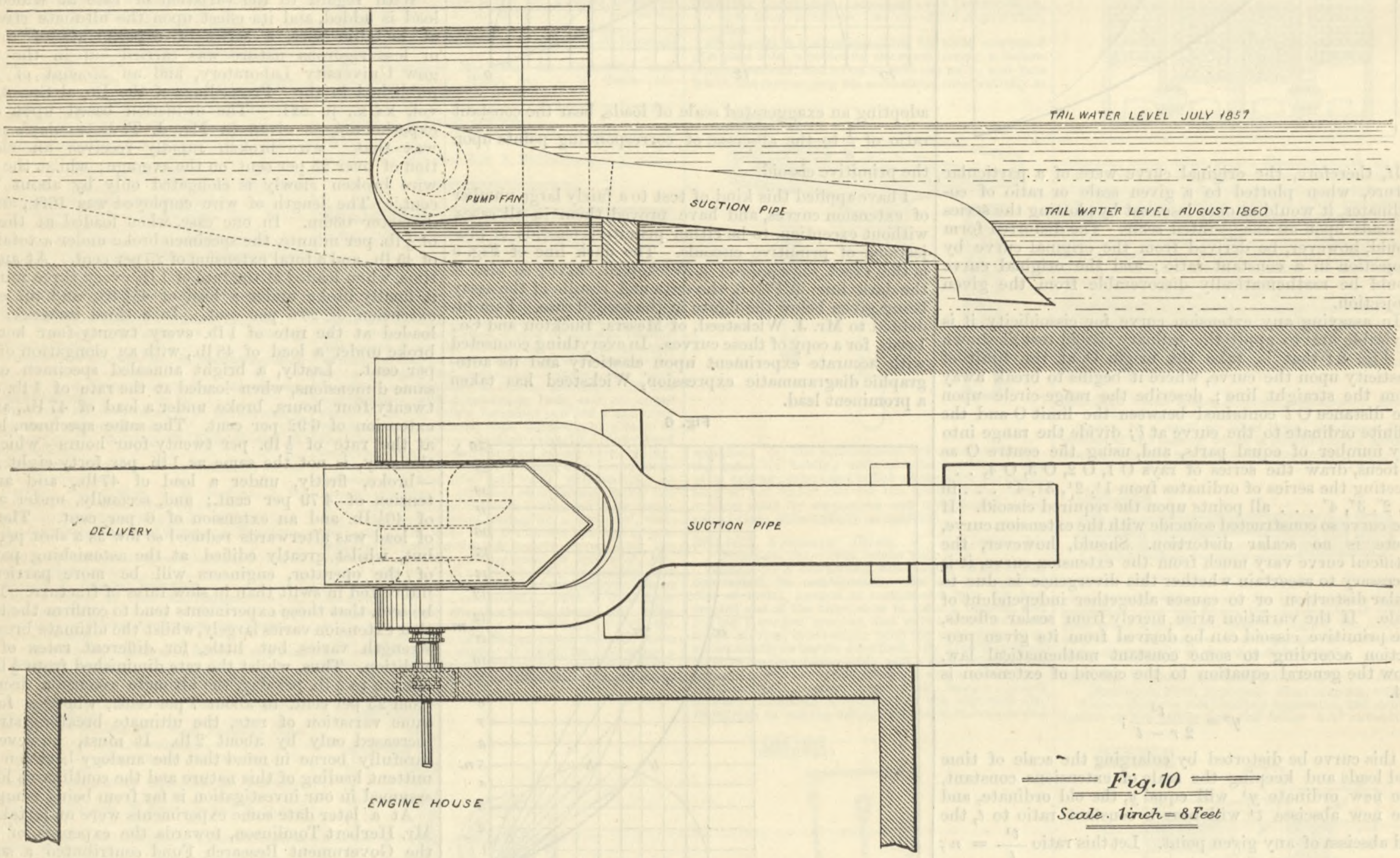


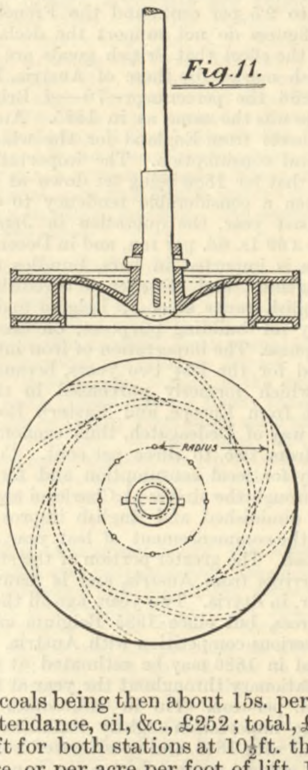
Fig. 10

Scale. 1 inch = 8 Feet

WHITTLESEA MERE PUMP.

sumption of coals by this engine under ordinary working conditions, the quantity of water delivered being ascertained by measuring the quantity passing through the outlet drain. With a lift of 11ft. the quantity of water discharged was 120 tons per minute, with a consumption of three tons of Derbyshire coals in twelve hours. This is at the rate of 6¼ lb. per horse-power of water lifted per minute. The quantity of oil used for lubricating is at the rate of one gallon in twelve hours. The consumption of coals in this district has varied during the last twenty years from about 250 tons to 1000 tons in a year according to the rainfall, the average cost for the

Fig. 11.

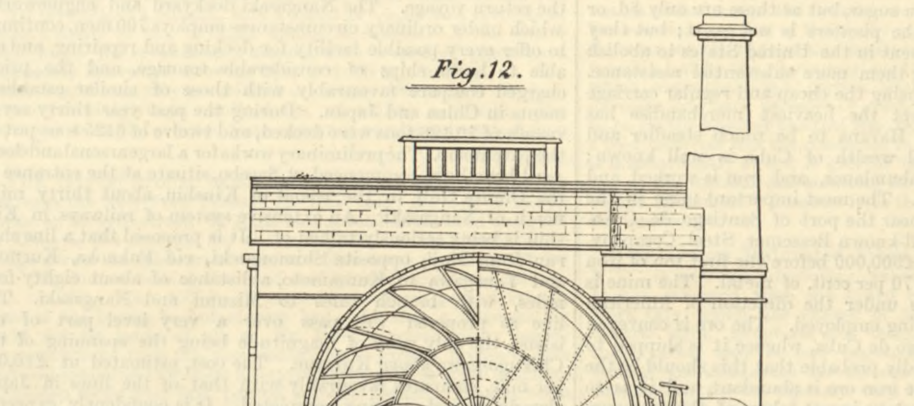


years 1881-83, coals being then about 15s. per ton, was, for coals, £674; attendance, oil, &c., £252; total, £926. Taking the average lift for both stations at 10½ft. this is equal to 14·81d. per acre, or per acre per foot of lift, 1·42d.; or for coals only 1·02d. During this time both scoop wheels were in operation. The main drain, which brings the water to the pump, is 20ft. wide at the bottom, with slopes of 1½ to 1. The average depth of water when pumping is going on, varies at starting from 5ft. 6in. to 3ft. at leaving off; the surface inclination also varying from 2½in. per mile to 4in.

Prickwillow.—This pumping station is for the drainage of a large district in the South Level, being part of the Great Bedford Level, in the county of Cambridge. The taxable area of the district is about 11,000 acres, but the area of land actually drained by the engines at Prickwillow is about 25,000 acres; the drainage of a large area of higher land bordering on the Fens finding its way into this Fen drainage system. The water is lifted by both engines into the River Lark, about fourteen miles above Denver sluice, where the river discharges into the tidal stream from the same main Fen drain, which is 20ft. wide, with slopes 1½ to 1. The depth of water at starting the engines is generally about 6ft. 6in., decreasing to 4ft. 6in. after the pumping has been going on. Since the erection of the new engine and pump this drain has been found to be too small to keep up a full supply, the inclination on the surface being at the rate of six inches in a mile, which is greater than should be the case in a large main engine drain. The height the water has to be raised on an average is 10ft., rising as high as 17ft. in high floods in the river. Steam power was first applied to the drainage of this district in 1832, a 60-horse power low-pressure condensing engine being then erected by the Butterly Company to drive a scoop-wheel 33ft. 6in. in diameter; and this engine, with the aid of numerous wind engines previously in use, and retained as auxiliaries, preserved the district from injury fairly well. The continuous subsidence of the surface of the land and the increased height the water rose in the river, due to the rapidity with which floods now come down from the uplands, rendered this drainage power inadequate. It was found by experience that, owing to the constant variations in the levels of the water, both in the main drain and in the river, the scoop-wheel became so water-logged and unwieldy, and the loss by leakage so increased by the great head of 10ft. to 13ft., against which it frequently had to work, that, notwithstanding the great prejudice which all Fen men have in favour of the scoop wheel, Mr. Carmichael, the superintendent of the South Level, advised the Commissioners to adopt another form of machine which would adapt itself automatically to the variations of lift, and which, under the varying circumstances of the discharge, would absorb the whole power of the engine to the best advantage, and for this purpose he selected one of the Appold type, which, although they had been in use for some time in other parts of the Fens, were as yet untried in the South Level. The new engine and pump were intended to relieve the old engine of the greater part of its duty, more especially in times of excessive floods, and to drain out the water to a lower level than was practicable with the scoop wheel. The new machinery was erected by Messrs. Easton and Anderson, under Mr. Carmichael's direction. The engine is a 60 nominal horse power compound condensing beam engine, supplied with steam at 65 lb. pressure by two Lancashire boilers. The high-pressure cylinder is 15in., and the low-pressure 25in. diameter, with 4ft. 6in. stroke. The pump is of the vertical spindle pattern, with single inlet, with balance fan 5ft. 4in. diameter and 1ft. 2in. deep, placed at such a level that the lowest water in the drain will cover it. The inlet is 2ft. 8in. diameter, formed on the lower side only, special provision being made for balancing, the weight of the column of water above the fan being balanced by the fixed inlet piece, which also serves to steady the lower end of the fan spindle. The meeting faces between the fan and the fixed case are both turned in the same direction, so that wear as it takes place can be taken up simply by lowering the fan spindle by means of an adjustment provided for the purpose. To take up the momentum of the water issuing at great speed from the fan, patent guide curves were fitted, which turned the water gradually into the vertical direction and at the same time assisted to bring it to rest. In this particular instance these guide curves were not found to be of much avail, as when the river was very low the delivery was lower than the top of the blades, and consequently there was a churning action going on with the water in the well, which caused vibration in the spindle. They were, therefore, removed. The pump is placed at the bottom of a brick well, in one side of which is the outlet passage 4ft. wide by 4ft. 6in. high, fitted with self-acting doors and communicating with a cast iron outlet pipe 4ft. 6in. diameter and about 68ft. long. The upper end of the fan spindle hangs in an onion bearing, and is driven by a pair of bevil wheels from a horizontal shaft which passes into the engine-house, on which is a pinion driven by annular gearing, bolted to the rim of the fly-wheel of the engine. The pump is calculated to lift 95 tons per minute at 8ft. lift, 88 tons at 9ft., 83 tons at 10ft., 78 tons at 11ft., 74 tons at 12ft., 71 tons at 13ft., 68 tons at 14ft., 65 tons at 15ft. The cost of the machinery, including engine, pump, and two boilers was £3853. The buildings, engine-house, boiler-house, pump well, chimney base, piling, and concrete, cost about £1064. At the trials which took place when the new engine was started it was found that the old engine indicated 103·33-horse power when delivering the water to a height of 9·78ft.; the new engine when indicating 106-horse power delivered 75·93 tons to a height of 10·84ft.; the coal consumption was at the rate of 2¾ cwt. per hour, and as compared with that of the old engine in the proportion of 3 to 5. At a subsequent trial a weir 13ft. wide was placed across the outlet drain, the difference of level between the water in the inlet drain and the weir at starting was 8ft. 9in.; with the scoop-wheel the depth of water over the weir was 12in., with a lift of 9ft. 6in.; with the pump, the lift being 10ft., the depth of water over the weir was 13½in. The lift being increased about 3ft., the depth of water over the weir was 4in. less with the scoop-wheel than with the pump. At the trials that were made, the new engine indicating 106-horse power, 75·93 tons of water were lifted by the pump 10·84ft., equal to 56-horse power of water lifted, or an efficiency of 52·79 per cent. The old engine, indicating 103·33-horse power, the wheel lifted 71·45 tons to a height of 9·78ft., equal to 47·43-horse power of water lifted, or an efficiency of 46 per cent.; the coals consumed by the new engine were at the rate of 2¾ cwt. an hour, or 5·50 lb. per horse-power of water lifted per hour. In ordinary working at the present time the consumption is at the rate of five tons in 30 hours for a lift of from 11ft. to 12ft. Taking the horse-power as before at 56, this gives 6·66 lb. per hour; or, if the work be taken at 74 tons lifted 11ft. 6in. high, a horse-power of 58·45, and coal consumption of 6·39 lb. The old engine and wheel consumes six tons of coal in 24 hours; if the horse-power be taken at 48·12 as before, this gives 11·64 lb. an hour. The cost of this pumping station, including both machines, on an average of the three years 1881-2-3, for coal, oil, attendance, &c., was £625, of which £483 was paid for coals, which represents about 644 tons. This is equal to a cost per acre for land drained of about 6d., or, taking coals only, 4·62d., and taking the average height the water has to be lifted at 9ft. 6in., this is equal to 0·80d. for all expenses, and 0.62d. for coals only per acre per foot of lift.

The Upwell, Outwell, Denver, and Welney south district is situated in the Middle Level in Norfolk, being part of the Great Bedford Level. This district was originally drained by scoop wheels driven by windmills. The quantity of land which is drained by the two wheels is about 9000 acres. The pumping station is at Nordelph, about three miles from Downham. It was anticipated that the construction of the new Middle Level drain in 1846 would do away with the necessity of pumping the water off the district, but experience showed that this was not the case. The height to which the water had to be raised was, however, reduced from about 9ft. to 4ft. In order, therefore, to thoroughly drain this district the Commissioners determined to provide better appliances for raising the water than those hitherto in use. Tenders for pumping machinery were advertised for, and that of Messrs. Appleby and Co. was accepted. The new machinery, the arrangement of which is shown in Fig. 12, was erected in 1877, and consisted of a scoop-wheel 24ft. in diameter by 4ft. wide, and, according to the maker's calculation, capable of delivering 3500 cubic feet (98½ tons) per minute to a height of 4ft., equal to 26·51-horse power of water lifted. The wheel makes five revolutions a minute, equal to a speed of 6·27ft. per second at the periphery. It is constructed principally of wrought iron. The scoops, eighteen in number, 10ft. long and $\frac{3}{16}$in. thick, are curved, and shrouded by wrought iron plates, and are connected to the wheel by curved arms, 2in. by 2in. by ⅜in. The sides are $\frac{3}{16}$in. thick at the periphery to ⅜in. at the centre. An adjustable curved shuttle is provided at the inlet to the wheel, by which the admission of the water is regulated. This shuttle is supported at the top by two arms, which project and clasp the axle of the wheel. Part of the pressure of the water against the shuttle is thus brought to bear on the axle, causing considerable friction. The cill over which the water is delivered is curved to the radius of the wheel. The wheel is keyed on to a wrought iron shaft 9in. in diameter, which runs in adjustable gun-metal bearings. On one side of the wheel is bolted a geared wheel made in segments, 20ft. in diameter, of 3in. pitch and 6in. face, and into this works the pinion on the engine crank shaft. The engines are of 40 nominal horse-power, of the horizontal high-pressure compound condensing type. The high-pressure cylinder is 10in. in diameter and 20in. stroke. The low-pressure cylinder is of 20in. diameter and 20in. stroke. The low-pressure cylinder and condenser are on one base, the air pump being fixed in the chamber of the condenser. The high-pressure cylinder is placed on a separate base parallel with the other cylinder. The fly-wheel is 9ft. in diameter. Steam for the engines is generated in two Cornish boilers, 20ft. long by 5ft. diameter, fitted with Galloway tubes, the safety valves being weighted to a pressure of 80 lb. of steam. The engines and boilers are contained in a brick building. The chimney is of brick, built square, 60ft. high. The contract price for building and machinery was £2680, of which £700 was for the buildings, chimney, and casing for wheel. This is equal to £74·68 per horse-power of water lifted for the machinery, and £26·40 for the buildings, together £101·08. This is the only wheel in the Fen-land that has curved blades. The head and dip of this wheel in ordinary floods are about 8ft. 6in. The relative proportions of each varying as the water lowers in the inlet or rises in the outlet drain. As an average the dip may be taken at 4ft. 6in. and the head at 4ft. With the wheel making five revolutions a minute, and allowing 20 per cent. for slip of water and leakage, and this deduction is borne out by the quantity of water flowing down the engine drain; the discharge is equal to 4305 cubic feet—120 tons—a minute. The quantity of coals consumed for this discharge, with 4ft. head, is about two tons in twelve hours, equal to 11·440 lb. per horse-power per hour of water lifted. By the side of the engine-house stands one of the old windmills which is still used to drive a scoop wheel 20ft. in diameter and 2ft. wide, and which when there is sufficient wind assists in raising the water from the district. When both steam and wind engines are at work the quantity as given above is about equal to the discharge of a continuous fall of ¼in. of rain in twenty-four hours over the area of 9000 acres, of which the district is comprised.

Fig. 12.



SCOOP WHEEL AT NORDELPH.

RAILWAYS AND POPULATION.—The following table shows the railway population and area of European countries at the end of 1885. The kilometre is ·62 of a mile:—

Countries.	Total length in kilos.	Area in square kilos.	Population.	Kilos. of railways per 100 sq. kilos.	Kilos. of railways per 100,000 inhabitants.
Great Britain and Ireland	30,843	314,628	35,241,482	9·81	87·4
Belgium	4,410	29,547	5,853,278	14·97	70·5
Luxemburg	362	2,587	213,283	13·99	170·0
Netherlands	2,468	33,000	4,336,012	7·47	56·9
Switzerland	2,761	41,346	2,846,102	6·85	97·0
Germany	36,779	540,599	46,852,450	6·80	79·1
France..	32,491	528,572	37,672,048	6·15	86·2
Denmark	1,942	38,302	1,969,038	5·07	98·6
Italy	10,354	286,588	29,699,785	3·61	34·9
Austria-Hungary ..	22,341	622,310	37,882,712	3·59	58·9
Portugal	1,527	88,872	4,306,554	1·72	35·4
Spain	9,185	497,244	16,961,742	1·65	54·1
Sweden	6,892	450,574	4,682,769	1·53	147·2
Roumania	1,682	129,947	5,376,000	1·30	31·3
Greece	524	64,689	1,979,561	0·81	26·5
Balkan Principalities	2,122	374,961	10,839,391	0·56	19·6
Russia	25,620	5,016,024	85,296,479	0·51	30·0
Norway	1,562	325,422	1,931,000	0·49	80·9
Finland	1,311	373,604	2,176,431	0·35	60·2
Europe	195,176	9,885,423	337,354,068	1·97	57·8

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

Austria—Modification of duties on ships.—Ships will be classed as of iron, or of other non-precious metal, which are not solely fitted with copper or iron, but of which essential parts and the ribs only are of iron. The duty is to be reckoned as heretofore, and the existing regulations relating thereto remain unaltered. On the importation of steamers for use on inland waters or rivers, or of ships for the same purpose classed as above, their displacements will be determined, and the result communicated to the Custom House by a specially appointed technical officer, who will assist the Custom House when desired. To determine the weight of iron or other metal portions of the ship, the persons concerned in making the declaration must produce an exact specification drawn up by the shipbuilder showing the component parts of the vessel, their dimensions, and the material of which they are made, together with a separate statement of the weight of iron, steel, wood, and other non-precious metals. The persons making the declaration are responsible for the correct use of the weights in the specification. The technical officer will examine the correctness of the weights and communicate the result to the Custom House. If the weights be found incorrect, the duty will be calculated on the weights laid down by the technical officer.

Brazil—German exhibitions.—The Central Society of Commercial Geography of Berlin proposes to open in Rio de Janeiro and other South American cities exhibitions of agricultural implements and machinery manufactured in Germany.

Cuba—Trade in 1886.—The past year has been one of gloomy disappointment to all classes in this island. It was expected that in the year preceding, the opinion of the commercial classes in Havana was that the lowest prices for sugar had been reached, and that the large number of failures during the past years had left trade on a sounder basis; but sugar has continued its downward tendency, and the banks have cause to regret several cases of misplaced confidence. The Spanish Cortes proposes to abolish the duties on sugar, but as these are only 8d. or 9d. per cwt. the benefit to the planters is not great; but they are in hopes that the movement in the United States to abolish the import duties may bring them more substantial assistance. The increasing tendency of using the cheap and regular carriage of steamships for all except the heaviest merchandise has caused the import trade of Havana to be much steadier and more regular. The mineral wealth of Cuba is well known; copper is to be found in abundance, and iron is worked and exported in large quantities. The most important mine in the island is that of Jurugua, near the port of Santiago de Cuba. It is the property of the well-known Bessemer Steel Company, who incurred an expense of £300,000 before the first ton of iron was raised; the ore contains 70 per cent. of metal. The mine is worked by Spanish soldiers under the direction of American foremen, about 1200 men being employed. The ore is conveyed by rail to the port of Santiago de Cuba, whence it is shipped to the United States. It is hardly probable that this should be the only spot in the island where iron ore is abundant, and it is to be regretted that more advantage is not taken of the immense natural wealth.

France—Tancarville Canal.—The lateral canal sanctioned in 1886 connecting the port of Havre with Tancarville, on one of the reaches of the Seine between Havre and Rouen, has been completed and opened. The canal is connected with the port of Havre by a new basin called Du Balloy, in area fifty-two and a-half acres, with 2602 yards of quays, laid with rails in connection with the Western Railway Company's lines. The canal is fifteen and a-half miles in length. Between Harfleur and Havre its depth is 19ft. 8in.; between Tancarville and a branch constructed to Havre its depth is 11ft. 6in. The width of all locks is 52ft. 6in. It is expected that the opening of this basin and canal will reduce the freight of goods between Havre and Paris by 1s. 7d. per ton.

Japan—Trade of Hiogo and Osaka in 1886.—An increase took place last year over 1885 under nearly all the chief headings. The quantity imported of assorted iron was 2212 tons; of pig iron, 2360 tons; of iron nails, 2113 tons; of steel, 131 tons. Iron nails, which are generally of Belgian origin, showed considerable increase. In exports a new and interesting feature last year was the shipment of tea from this port by sailing vessels to Port Moody for transport thence to the eastern cities of Canada and the United States by the Canadian Pacific Railway. The native industries continue to progress. The cotton spinning mill at Sangenya, Osaka, has been largely increased in capacity by the addition of another building, and now employs 1073 hands. Both the Chinese and Japanese cotton used requires special machinery, all of which, as well as the boilers and engines, have been supplied by Lancashire makers. The mill is lighted by Edison's incandescent lights; other mills are in course of erection or enlargement. A mill for the manufacture of canvas from Japanese hemp was fitted up at Otsu last year; the machinery in the mill is by Walker and Co., of Lille, France, and about 130 hands are at present employed. Copper works, for the rolling of brass and copper sheathing, and for shipbuilding and other purposes, the drawing of brass and copper rods and wire, have been in existence in Osaka for some years, and are now in active operation; the quantity of copper exported from here last year being 3611 tons, valued at £130,209. A tolerably good gauge of what is being done in establishing new industries here is afforded by the Industrial Museum in Osaka, a visit to which shows to how great an extent the manufacture, in the European style, of various articles is being engaged in by the Japanese home makers. There is a certain unscrupulousness on the part of the Japanese makers in the imitation of foreign labels and trade-marks, which appears to call for some law or international agreement to check it, there being no special legal provision in existence for the protection of foreign trade-marks. The completion of the line between Ogaki and Taketoyo renders continuous the railway connection between the Owari Gulf, on the east coast, and Tsuruya on the west. The construction of a line of railway eastwards from Hyogo, through the Inland Sea provinces towards Shimonoseki, is about to be undertaken by a company called the Sanyodo Tetsudo Kaisha, lately formed in this prefecture. The first section of the railway, taking its departure from the terminus of the Government railway at this port and going to Himeji, a distance of about 35 miles, is soon to be taken in hand. The company is bound by the Government either to complete the line to Shimonoseki, by way of Okayama and other intermediate towns, or in case of failure, to surrender such part as they may have constructed, for its cost, to any company which may be formed to carry the line through the whole way, or to the Government, if it undertakes the completion of the works. There is a reasonable prospect that the line may be carried out as far as the port of Onomachi between Hiroshima and Okayama, a distance of nearly 130 miles from Hiogo, within the next two or three years; but the extension to Shimonoseki is by no means assured.

Japan—Trade of Nangasaki in 1886.—Imports showed a decline of 15·75 per cent. under 1885. The business in metals and their manufacture has been dull, and the prospects are not good. The exports of coal showed an increase in value of £4384 over 1885. Business in Takashima coal was brisk, the output being 340,059 tons; the owners have recently started new mines at Matsushima, which will soon be in working order. The output of the Karatsu collieries was 101,674 tons. The Müke collieries raised 288,039 tons, and those of Taku 45,748 tons. Although general foreign trade has declined at Nangasaki for many years, and is not at all likely to recover, the shipping of this consular district, consisting of the ports of Kuchinotsu and Nangasaki, continues to be of increasing importance, owing to the large shipment of coal so abundantly found in the neighbourhood. The almost inexhaustible supply of coal in Japan will always make both Kuchinotsu and Nangasaki important shipping centres; but though British shipping has hitherto had the largest share of this business, it will be well, in view of the recent development of the German and Japanese mercantile navies, for those owning or sailing British vessels to pay special attention to the opinions and wishes of charterers. Charterers here decidedly prefer German to British vessels by reason of the dispatch given by German shipmasters, in a great measure due to the indefatigable and ready assistance of the crews and officers, which compares very favourably with the attitude frequently assumed in other cases. In the case of one large shipping firm, I have been personally assured that, "owing to these reasons, it can always afford to give better terms to the Germans." Though British ships are well represented both in number and tonnage, there is a perceptible decrease in the percentage in both cases, as compared with the entire shipping of this district. The percentage of British shipping, which was 73½ in 1880 and 84¼ in 1881, fell to 64⅝ in 1886. German shipping has increased from 6 per cent. in 1880 to 22⅞ in 1886. Between 1880 and 1886, while British tonnage has rather more than doubled, German tonnage has increased tenfold. The German Lloyds have, during the past year, extended their main line to Hong Kong, to Yokohama, and their steamers call here monthly on the return voyage. The Nangasaki dockyard and engineworks, which under ordinary circumstances employs 700 men, continues to offer every possible facility for docking and repairing, and are able to build ships of considerable tonnage, and the prices charged compare favourably with those of similar establishments in China and Japan. During the past year thirty-seven vessels of 70,126 tons were docked, and twelve of 6425 tons put on the patent slip. The preliminary works for a large arsenal and dockyard have been commenced at Sasebo, situate at the entrance of the Omura Gulf in the island of Kiushiu, about thirty miles north of Nangasaki. An extensive system of railways in Kinshiu is being seriously talked of. It is proposed that a line shall run from Moji, opposite Shimonoseki, *vià* Fukuoka, Kurmue, and Yanagawa to Kumamoto, a distance of about eighty-four miles, with branch lines to Misumi and Nangasaki. The line as proposed will pass over a very level part of the island, the only work of magnitude being the spanning of the Chikugo-gawa above Kurmue. The cost, estimated at £10,000 per mile, compares favourably with that of the lines in Japan already opened or being completed. It is confidently expected that the traffic will be considerable, especially in coal. The Moji Fukuoka line will tap the rich coalfields of Chikuzen, and the Yanagawa-Kumamoto line those of Higo. The harbours of Misumi and Moji are both deep and well sheltered, though the currents are strong. Fukuoka has a fair anchorage, which could be much improved at a moderate cost. From Tajiro a branch line will run *vià* Saga to Haiyaki, the station near Sasebo, which it is proposed to connect with Nangasaki, a distance of about fifty miles. Subscriptions for this latter line have been opened, and the reception locally has exceeded the most sanguine expectations. A sketch of proposed lines accompanies report.

Mexico—Prospects for British commercial enterprise.—The wholesale and large retail establishments are principally in the hands of French, Germans, and Spaniards, the numerous English houses of business which formerly existed in Mexico having withdrawn, with the exception of the London bank and three others. There is a good prospect for the establishment of new English houses, provided they have sufficiently large capital. This applies generally to all branches of trade, but especially to the machinery and metal trades, which are in the hands of the Germans. The development of agriculture, as well as mining, has been very marked in the past few years, and the economy effected by the use of labour-saving implements and machinery is beginning to be better understood, and the prejudices against them removed. The superior facilities for transport afforded by the railways serve as an extra inducement to intending purchasers, not only on account of diminishing the first cost, but also of rendering it possible, in case of accident, to have broken pieces sent to be repaired and returned without great delays. In view of the great field existing for agriculture and mining enterprise in this country, a fact which is at last beginning to be realised abroad, the machinery trade may yet be considered to be in its infancy, and offers special inducements to business men, in that—most of the articles being free of duty—not so much capital, comparatively speaking, is required as in other businesses. In a secondary degree, it is probable that houses for the sale of English hardwares, which have been almost entirely superseded in this country of late years by similar American and German ones, might be established with a good chance of success. Another class of business in which English capital might be profitably employed is that of ore-buying for shipment to England. There are already two American agencies established in the capital for that purpose, but the cheaper rates of freight to England, and the lower cost of reducing the ore there, would enable English firms to compete with every prospect of success. The business is likely to be one of very great importance, in view of the large number of mines unworked on account of the heavy cost attendant on the establishment of reduction works, and from which large quantities of ore might be exported. If English manufacturers are contented to leave the distribution of their goods in Mexico to merchants of foreign nationalities, though they may continue to retain a certain share of the trade, a considerable part of what they might have will unquestionably be wrested from them by their more active competitors. The superiority of English manufacturers is not so unquestioned now-a-days as to ensure for them a constant demand in foreign markets, and the indifference of the manufacturers to the special requirements of their foreign customers stands out in strong relief to the solicitude shown by American and German merchants to anticipate their wants and provide for them. With equal advantages as regards the prime cost of their productions, and the expense of placing them in the market, it only requires the same tactics of advertising and canvassing, which have been so successfully employed by other nationalities, to secure to British merchants their due share in the trade of Mexico, the future importance of which can scarcely be over estimated.

Portugal—Completion of harbour at Azores.—The Government invite tenders for a contract or contracts for the completion of the harbour works at Harta and Ponta Delgada, in accordance with the plans of the engineer, Mr. David Cohen. The basis for the tender for the harbour works at Harta, which are to be finished within five years, is £244,444, and for the harbour works at Ponta Delgada, which are to be completed within six years, it is £288,888.

Russia—Recent Customs decisions.—River and sea-going vessels of every description, with or without rigging, pay: Iron-built, per ton displacement, first 100 tons, per ton, £6 0s. 4d.; above 100 and not exceeding 1500 tons, per ton, £3 3s. 4d.; above 1500 tons, per ton, £1 1s. 8d. Iron-built vessels imported in parts, with or without engines, shall pay duty on each part according to their corresponding sections.

Turkey—Trade of Constantinople in 1886.—England appears to have suffered in 1885-6, as compared with the present year, a loss of 6·6 per cent. of her trade, whereas the Austro-German loss amounts to 9·5 per cent., and the French loss to 9·1 per cent. These figures do not support the declaration of British merchants to the effect that British goods are being driven out of the Turkish market by those of Austria, France, and Germany. In 1886 the percentage—70—of British shipping at Constantinople was the same as in 1885. Among the imports were copper sheets from England for the whole of Turkey, as well as for local consumption. The importation is increasing year by year, that for 1886 being set down at about 1674 tons. There has been a considerable tendency to decline in prices during the past year, the quotation in January being from £68 3s. 4d. to £69 1s. 6d. per ton, and in December £63 12s. 6d. per ton. Iron is imported in bars, bundles, and sheets from Belgium, England, and Sweden. Swedish iron is most esteemed, English ranks second; Belgian finds a considerable sale, especially for building purposes, on account of its comparative cheapness. The importation of iron into Constantinople has diminished for the last two years, because Samsoum and Trebizonde, which formerly purchased in this market, now receive direct from Europe, and Eastern Roumelia has been importing by way of Dedeagatch, thus economising in charges and freight from two to three per cent. Constantinople imports now only for local consumption and for the ports of the Marmora. Through the strikes at Charleroi and Liege, Belgium importations diminished and English improved. Prices were stationary at the commencement of last year, and were feeble towards its close. The greater portion of the steel imported into the market arrives from Austria, and is manufactured by the house of Thür, in Styria. Two years ago all the steel came from Austrian sources, but since 1885 Belgium and Germany have entered into serious competition with Austria. The amount of steel imported in 1886 may be estimated at 640 tons, and the prices were stationary throughout the year at from £11 17s. 6d. to £13 8s. 9d. per ton. Tin in bars comes exclusively from England. The importation slightly diminished during the past year, compared with 1885, and is estimated at 236 tons. Prices were, in 1886, subject to great fluctuation, caused by the amount of stock held, and the importance of arrivals. In January the quotations were £109 6s. per ton. Prices improved, and closed in December at £126 per ton. During 1886 six concessions for the establishment of factories in Turkey have been granted by the Ottoman Government, one of which was a monopoly for a foundry, granted to an Ottoman official. The factory is to be set up in the province of Constantinople, without prejudice to other existing establishments. During fifteen years no other factory of the same nature is to be erected in the province. Exemption from custom house dues is accorded to all articles necessary for the completion of the works, and 8 per cent. internal duty on goods sent by sea from one Ottoman port to another is abolished as regards all articles produced in the factory. After fifteen years all privileges are to cease. Although proposals have been made in England for capital to work this concession, the affair has not been taken up.

Tunis—Trade in 1886.—England still continues to occupy the first place as an importer in the competition with foreign nations. Her pre-eminence is due to the cheapness and excellence of the products of Glasgow and Manchester. British commerce suffered a decline of 12½ per cent. during 1886, as compared with 1885, chiefly under the head of exports. There was also a small falling off in imports, to which too much attention need not be given. France runs England close in the importance of its commerce with this country. Italy comes next owing to her proximity. The trade with Belgium consists chiefly of iron for building, nails, window, and other glass. These reach this country by steamers sailing from Antwerp at long intervals. After England, France, and Italy, Germany has most relations with Tunis. It is impossible not to recognise the immense progress in commerce and industry accomplished during the last ten years by Germany. The growth of German trade with Tunis is due, to a great extent, to the care which merchants take to study the tastes and wants of their customers, to the frequent visits of German travellers, and to cheap production. The progress is especially remarkable in cotton prints from Eberfeld and Trèves, and in different kinds of hardware. In these articles Germany need fear no rival. What is chiefly needed to give a stimulus to British import trade is the establish ment of direct steam communication with Liverpool, which would permit of the introduction of British goods at cheaper freights. English commercial firms might then hope to sell their hardware and iron, which are at present hardly known in the Regency.[1]

SPEAKING on the character of quicksilver deposits, Prof. S. B. Cristie, of the University of California, in his testimony in a recent case in San Francisco, reported by the American *Engineering and Mining Journal*, says:—Quicksilver deposits, as a general rule, are very different from those of the ores of other metals. Many other metals occur in well-defined fissure-veins, so that there is no difficulty in following the ore, and in many cases of calculating beforehand the amount of ore in sight; but with the exception of the deposit at the Old Almaden in Spain, and to some extent the deposit at the Idria in Austria, the quicksilver deposits, particularly those of California, are characterised by a great and persistent irregularity, so that it makes the mining of these ores much more difficult than that of other metals. New Almaden is a striking example of this irregularity. It has often occurred in the history of the mine that there was none or scarcely any ore in sight, and it has often looked as though the mine must of necessity be shut down, and it has only been by the most careful and painstaking prospecting or dead work that it has been possible to keep up the production of the mine. Very frequently large bodies of ore will almost completely run out, and there will be visible in the face of the works only a slight coloration in the vein matter, which indicates that there is any ore left in that particular place, and by following out this little spring of ore very carefully it may lead into a large deposit. As a result of this, the workings of the mine are necessarily very irregular, and it requires the greatest skill on the part of the engineer in charge of the works to keep up a regular and steady output of ore. Many times in the past history of the mine, the prospecting work has not been carried on on a sufficient scale, and this largely accounts for some of the irregularities of the production of the mine in former times.

[1] See THE ENGINEER, January 28th, page 67.

RAILWAY MATTERS.

"IT is reported with every appearance of authenticity," the American *Engineering News* observes, "that several officers of the Jay Gould roads have been acting on Shylock's motto, 'The villany you teach me I will execute, and it shall go hard but I will better the instruction.' They have been actually buying cross-ties by the million at one price, and turning them over to the company at another price, omitting some of the formalities for such transactions which the law provides. It is a shameful performance, but it is not more shameful than very many of the methods by which the right to object to such little transactions has been acquired by their great chief, and hence it is only natural that the average man should find it easier to chuckle over such a turning of the tables than to feel indignant."

THE following bridge accidents are reported by the *American Engineering News*:—On the Buffalo, Rochester and Pittsburg Railroad, a trestle near Pike, N.Y., was burned, Aug. 2.—On the St. Louis, Arkansas and Texas Railroad, a bridge across the Red River at Garland City, Arkansas, gave way Aug. 2, under a freight train. The engine and seven cars were thrown into the river 49ft. below. Two men were injured.—On the New York, Woodhaven and Rockaway Railroad, about 30ft. of the trestle between Aqueduct and Broad Channel stations were burned Aug. 4.—At Wabash, Indiana, a wooden bridge on Miami street, over the Wabash and Erie Canal, gave way Aug. 8, under a traction engine, which was hauling a threshing machine. The engine fell into the water. One man was killed.

THE Pennsylvania Railroad Company has decided to lay a mile of steel sleeper track on each of the four main divisions. The sleepers will be 9ft. long, and when laid entirely embedded in ballast, the ballast being even with the rail on the outside of the track. The sleeper is 10in. in width, and is shaped thus ⊓, with chairs on top through which the rails are slipped. The American *Engineering News* "presumes the purpose of the experiment—and a very reasonable and a rational one—is merely to acquire information for guidance ten or twenty years hence when the steel sleeper question becomes a real one. It is not likely that they have the least expectations of soon beginning the general use of steel sleepers. We also understand that an experimental mile of track is to be laid with 90 lb. rail and the regular London and North-Western English chair."

THE Republic of Paraguay is not, the *Railroad Gazetet* thinks, much agitated over railroad pools. Its single line is forty-three miles long, extending from the capital, Asuncion, south-east to Paraguay. This road, whose gauge is 4ft. 3½in. and steepest grade 1 in 75, was begun by the State in 1864. The work was soon interrupted by war, and not resumed till 1870. The State managed the road till 1877, then gave it over to a private company, but bought it again in 1885. All the engineers, material, and equipment were brought over from England. The equipment, in 1886, consisted of seven locomotives, six passenger, and fifty freight cars. The gross earnings have been—in 1878, 28,920 dols.; in 1881, 63,000 dols.; in 1885, 93,027 dols. In 1885, net earnings were 28,080 dols., and 118,943 passengers were carried. The road is valued at 1,223,910 dols. An extension to Villa Rica is contemplated.

A GENERAL classification of the American accidents in June last shows:—

	Collisions.	Derailments.	Other.	Total.	P. c.
Defects of road ..	—	5	—	5	6
Defects of equipment	5	6	2	13	15
Negligence in operating	17	20	—	26	29
Unforeseen obstructions	—	7	1	8	9
Unexplained	21	14	—	36	41
Total	43	42	3	88	100

The causes of collisions on American railways in June last where given, were—according to the *Railroad Gazette*—as follows:—

Trains breaking in two	5
Misplaced switch	1
Failure to give or to observe signal	3
Miscellaneous	13
Unexplained	21
Total	43

HARD luck pursues the Belt Line Horsecar Company. Since its stables at Fifty-fourth-street and Tenth-avenue were burned, and all its horses and stock were destroyed, it has been, says a recent *New York World*, "endeavouring to recover its business and former prosperity under the most discouraging circumstances. At present it has sufficient "bobtail" cars to accommodate the most of its traffic on the First-avenue and Fifty-ninth-street branch road, but the route to be covered, which extends all around the city from the Battery to Central Park and along the East and North River fronts, is furnished with only fourteen old-time dingy and "stuffy" cars. To keep these conveyances on any sort of schedule time, it has become necessary to retain five different relays of horses to work on both halves of the full route or circuit. The fire necessitated the purchase of 700 new or "green" horses. The torrid weather that has prevailed lately has had fearful effect upon those inexperienced animals. After dragging the heavily-loaded cars in the broiling sun all day the horses have become so jaded and worn out at night that they have been dropping dead in their stalls at the rate of from two to five at a time. Out of the 700 head purchased by the car company but about 400 remain. The stockholders and directors of the company are now considering the advisability of adopting some other mode of locomotion than animal power. The charter of the company permits this alteration. Some electric motor will probably be adopted. It is thought that by the use of some other than horse power less blockading would be caused, traffic would be made more expeditious and secure, and the road would be operated at a far less expense."

ON Saturday afternoon an extraordinary accident occurred on the Midland Railway near Wath-on-Dearne station. No lives were lost, and so far the injuries to passengers are reported to have been comparatively slight. Considering the damage to rolling stock, however, the wonder is that a great disaster, attended with loss of life, did not ensue. A coal train was being shunted from the down to the up line near the Manvers Main Colliery siding, when one of the drawbars connecting the wagons snapped. The express leaving King's Cross at 12.20 for Leeds and Bradford, and timed to pass north shortly after four o'clock, was momentarily expected. The *Leeds Mercury* says every effort to remove the train was made, and in the meantime the signals at Manvers box to warn the driver not to advance. The passenger train had left Sheffield about four minutes late, and by-and-bye came rushing forward at a speed of about fifty miles an hour. To the horror of the men engaged on the coal train no effort seemed to be made by the express driver to stop his engine. It was also stated that when within one hundred yards of the goods train he saw his danger and reversed the engine. Without a warning shout or whistle the engine crashed into the van of the goods train, smashed it to splinters, reared on end, and then, mounting the adjoining wagon, which it brought level with the ground, actually tore over five other loaded wagons before dropping on to the line, which it crossed, only to finish its career by rolling down the embankment. The driver and stoker stuck to their posts, and when the engine fell the latter was thrown out, lodging under a hedge on the roadside. Although the driver was almost buried by the falling coal and timber he suffered no physical injury, while the stoker sustained a bruise to his right arm.

NOTES AND MEMORANDA.

AT a recent meeting of the Edinburgh Royal Society Professor Tait communicated some results on the compressibility of water, of mercury, and of glass. The average compressibility of a 20 per cent. aqueous solution of common salt per atmosphere for the first 100 atmospheres is 0·0000316. It diminishes rapidly with the percentage of salt in solution. The compressibility of common lead glass is 0·0000027 at a temperature of 19 deg. C.

ADULTERATION of flour by means of potato flour may be detected by means of acids. Take a spoonful and pour upon it a little nitric acid; if the flour be of wheat, it will be changed to an orange yellow; if wholly of potato flour, the colour would not be altered, but the flour formed into a tenacious jelly; if therefore the flour be adulterated with potato flour, it will not be difficult to decide. Again, take a spoonful of the flour, and pour upon it a little muriatic acid; if the flour be of pure wheat, it will be changed to a deep violet colour, without odour; but if potato flour be mixed in it, it will then have an odour like that of rushes.

IN a paper in the *Comptes Rendus*, on the earthquake of June 9th, 1887, in Central Asia, by M. Venukoff, a detailed account is given of the disastrous effects of this disturbance, especially in Vernoï, a town of 17,000 inhabitants, where 1700 out of 2500 buildings of brick and stone were levelled with the ground, while 800 wooden houses remained almost uninjured. As many as 200 persons perished in Vernoï, and over 800 in the surrounding district, chiefly in the Ala-tau Mountains. The first great shock of June 9th has been followed by several others, which still continue, obliging the inhabitants to take shelter under tents on the open plains.

THE *Iron Industry Gazette* gives the following concerning the average speed of cutters on soft cast iron surfaces, making allowance for changes in condition and character of work:—"In order to calculate accurately for milling work, the speed of cutter and amount of feed per revolution must be observed; that known, the computation is as follows: Multiply the number of revolutions of cutter a minute by the length of feed at one revolution, and the product is inches a minute that can be milled. Allowing about 40ft. a minute for surface speed of cutter, a ½in. cutter should run at 300 revolutions a minute, with a speed of $\frac{1}{150}$in. to a revolution, giving a result of 2in. of light milling a minute. A 1in. cutter would make 150 revolutions a minute, with a feed of $\frac{1}{100}$in. on a moderately heavy cut, allowing 1½in. of milling a minute. A 3in. cutter would run fifty revolutions a minute, with a feed of $\frac{1}{50}$in. on heavy work, giving a result of 1in. of milling a minute. The above are examples selected from observed results in practical shop usage."

THE largest bronze casting ever attempted in America was, says the New York *Times* of the 10th inst., made at E. Favy's works, on Forsyth-street. It is the mammoth buffalo head designed by Kemeys, the sculptor, for the east portal of the Union Pacific bridge across the Missouri at Omaha. The head measures 9ft. by 5ft. The box containing the sand and plaster mould was 22ft. by 22ft. by 26ft. Some 4500 lb. of molten bronze was poured into it. Some of the bronze manufacturers had said such a huge casting could not be made at all, so Mr. Favy received many hearty congratulations from the representatives of various bronze casters who had gathered to witness his experiment. Three small crucibles of molten metal were first poured into the mould. The gas vents in the mould were lighted, the fiery stream from the big crucible was started, and in three minutes the casting was a success, so far as any one can tell until the moulds are removed on Saturday. A firm of electrotypers has undertaken to make a reproduction from the cast, and, if successful, this will be an even more remarkable mechanical achievement than the bronze casting.

A RECENT process—Herr Ladewig's—of manufacturing from asbestos fibre a pulp and a paper that resist the action of fire and water, consists in mixing about 25 per cent. of asbestos fibre with about from 25 to 35 per cent. of powdered sulphate of alumina. This mixture is moistened with an aqueous solution of chloride of zinc. The mixture is washed with water and then treated with a solution composed of one part of resin soap and eight or ten parts of water mixed with an equal bulk of sulphate of alumina, which should be as pure as possible. The mixture thus obtained should have a slightly pulpy consistency. Finally, there is added to it 35 per cent. of powdered asbestos and 5 to 8 per cent. of white barytes. This pulp is treated with water in an ordinary paper machine and worked just like paper pulp. In order to manufacture from it a solid cardboard, proof against fire and water, and capable of serving as a roofing material for light structures, sheets of common cardboard, tarred or otherwise prepared, are covered with the pulp. The *Scientific American* quoting the *L'Industrie Moderne* says the application is made in a paper machine, the pulp being allowed to flow over the cardboard.

A VERY easy method, and one that may be very useful to observers of physical phenomena, for determining astronomical time, has just been described by M. d'Abbadie at a meeting of the Académie des Sciences in France. Two instruments of small cost are required—one, a prism of glass, called a "dipleidoscope," and having one of its angles fixed in the meridian parallel to the axis of the earth. About noon one sees in it by reflection two images of the sun, which blend into one at the moment of true noon, and in order to better determine the moment, one notes with a second watch the contact of the first and second edges. The mean of these two instants gives the true noon. The equation of time published in the *Annuaire du Bureau des Longitudes* permits the true time to be deduced afterward, and consequently the advance or retardation of the pendulum and its rate. We may add that the dipleidoscope is about forty years old. The other instrument gives more exact results. It consists of a little lens furnished at its focus with five wires, fixed and equidistant. When required, it can be directed far from the meridian. The moment of passage of a star across each of the wires is noted, the sum of the instants is doubled, and divided by ten, giving the second and tenth of a second when the star was behind the central wire. In this way the sidereal time of the passage is obtained. A simple calculation gives the time by a table published in *Connaissance des Temps*.

AT the shop of the Sedgwick Mainspring Company, Chicago, can be seen a very interesting application of electricity to the arts. It consists, says the *West. Electrician*, of tempering watch springs by means of the electric current. In one part of the room stands what is known as a one-light dynamo. The conductors from the dynamo lead to another part of the room to a bench, on which stands an ordinary oil tempering bath. One of the conductors connects with a point within the oil bath, and the other to a point without. The piece of flat, soft steel wire that is to be tempered to the blue colour is fed under the point on the outside of the bath first, and then under the one on the inside. When it reaches the latter the circuit is complete, and the wire immediately becomes uniformly heated. No means have been taken to measure the current exactly for the purpose of doing the whole work mechanically. The variation in the percentage of carbon in different pieces of steel forbids the delicate process of tempering from becoming a purely mechanical piece of work. Therefore, with the electric current, as with a fire, the colour of the steel determines the length of time that it shall be heated. Several advantages are claimed for this process of tempering. The chief one is that the steel does not have time to oxidise after it has been heated to the proper colour before it is under cover of the oil, and consequently, that the steel wire is of the same thickness when it is tempered as it was before it entered the process. The heating is uniform throughout the length of the spring, and there is less liability of defective spots. The process is a rapid one, the springs being heated and passing into the bath at the rate of 4in. a second.

MISCELLANEA.

THE offices of the Civil and Mechanical Engineers' Society have been removed to No. 6, Queen Anne's-gate, Westminster, where the meetings will be held in future.

THE tender of Messrs. J. and E. Wright, of London and Birmingham, has been accepted for the manufacture and delivery of the two steel cables required for the Birmingham Cable Tramways Hockley section.

ON Wednesday, the 17th, the screw tug Victoria, built by Edward Finch and Co. for the Brazilian Coal Company, Cardiff, ran a very successful trial. Her dimensions are—length, 90ft.; breadth, 17ft. 6in., by 8ft. 9in. depth of hold. She has a compound surface condensing engine, 16in. and 30in. by 22in. stroke, with a boiler designed for a working pressure of 100 lb. per square inch. She steamed down Channel for some hours, averaging eleven and a-half knots per hour, after which she entered Cardiff, from which port she sailed on the 22nd inst. for Rio de Janeiro, where she will be employed, and for which service she is specially designed and fitted with teak decks, &c., and covered with a permanent awning.

THE following is given by a contemporary as a curious effect of motion on the human body (?):—A correspondent writes that he was carefully weighed at his hotel on Tuesday morning, and the result was 11 st. 7 lb. He walked to the railway station a hundred yards distant, and weighed 11 st. 12 lb. He travelled nearly 6 miles by train, and lost 4 lb. on the journey, weighing 11 st. 8 lb.; in this case the loss was rather over 4 oz. of flesh per minute. A few hours afterwards he returned to London, and weighed 11 st. 9 lb., and at the hotel again weighed 11 st. 7 lb. He walked to another machine, where fifteen minutes afterwards he weighed 11 st. 10 lb. The experiment was made to satisfy a niece—who declared that no two of the machines indicated similarly—that the machinery of the company was necessarily accurate and trustworthy.

THE American *Mechanical Engineer* proposes a cut-off on the condenser, and says:—"If some means could be devised whereby the cylinder could be shut off from the condenser after the latter had swept the cylinder clear, good results might follow. For a certain portion of the stroke, after the condenser communication was cut off, the vacuum would be maintained, but it would be speedily lost by the re-evaporation from the walls of the cylinder, which re-evaporation at certain later periods of the stroke would develope into back pressure of greater or less moment. It remains to be shown whether the fuel loss, by an open communication with a cold reservoir like the condenser in which the heat of the cylinder is intermittently swept, is greater than it would be by deterioration of the vacuum, and resulting back pressure caused by a cut-off on the condenser." It seems to us that the Cornish engine answers the question.

THE Union Indurated Fibre Company, Mechanicsville, N.Y., is now manufacturing tubes or pipes from wood fibre. It has arranged with the Board of Electrical Control, of New York City, which has charge of laying underground all wires electric light, telephone and telegraph, for a large quantity of these tubes, and is now negotiating with one of the largest natural gas companies for an extensive supply of pipes. The claims made for the pipe are very broad. Tests made in connection with the Board of Electrical Control, or Subway Commission, showed the material to have a tensile strength of about 1100 lb. to the inch, and 2¼in. pipe will stand 80 lb. to 100 lb. pressure to the square inch. The tubes are light, strong, and cheaper than iron. They are now made in lengths of about 5ft. and threaded with the standard iron pipe thread, so they can be connected with iron pipe. Two and one-half inches is the smallest size now made.

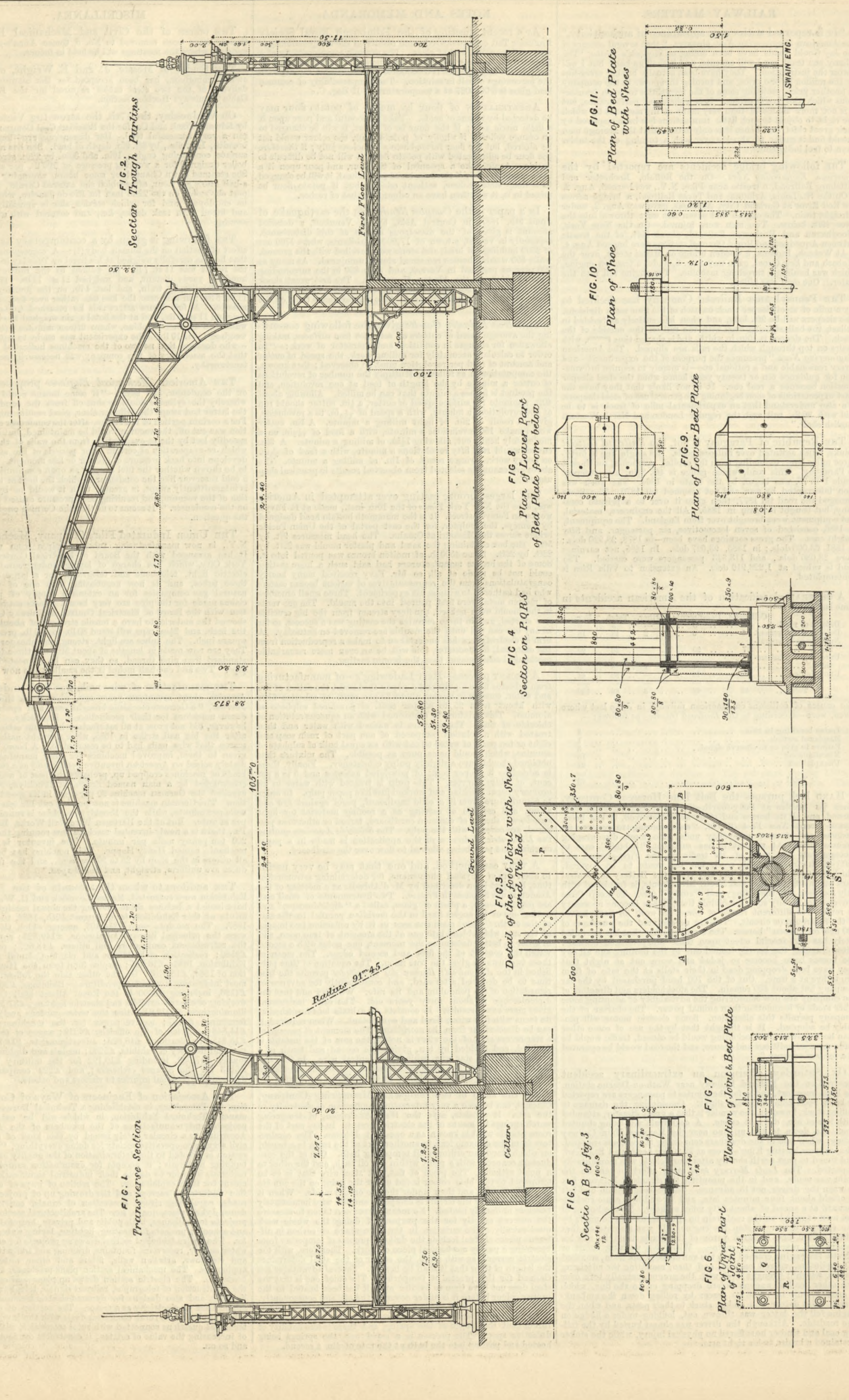
THE manufacture of wire nails was first undertaken in America about seventeen years ago, when, says the *Industrial Journal*, "a German mechanic brought over and operated a half-dozen machines for their production in Kentucky. Wire nails, however, did not grow at all satisfactory in public estimation until after the big nail strike in 1885, when wrought nails became so scarce that wire nails had to be resorted to. A boom being thus given to them, improved machines for their manufacture immediately seized on American inventive genius, and as a result several kinds of machines cropped up, probably the best of which was one constructed by a man named Smith, of Brooklyn, N.Y., which excelled the German machine 20 per cent. in its speed of production. The German machine is now putting out 132 ten penny wire nails per minute, while the Brooklyn machine is running out 170 per minute. But at the Hartman Wire Nail Works, Beaver Falls, Pa., there is a newly-invented machine now running that produces 200 ten penny nails per minute. The inventor is a Prussian mechanic named Henry Happe. This machine has been leading all others in the shop by 25 to 30 per cent., and the nails it produces are uniform, straight, and well shaped."

THE auditors to whom the accounts of the Inventions Exhibition were entrusted, Messrs. Lovelock and H. W. S. Whiffin, have issued a balance sheet showing the actual receipts and payments of this Exhibition from August 12th, 1884, to July 30th, 1887. The receipts were £214,403, among which the following were the principal items:—Admissions, £149,825; royalties from the refreshment contractors and others, £18,627; publications, £8580; realisation of buildings and plant—Colonial and Indian Exhibition, 1886—£16,325; surplus fund from the Health Exhibition of 1884, £15,516. On the other side the following are the most interesting items of expenditure:—Buildings, £30,778; rent, £4126, including £3000 to the Royal Albert Hall Corporation; working of electric exhibits and electric lighting, £37,521; garden illuminations, £9213; lighting the water gardens and illuminated fountains, £3107; motive power for the machinery exhibits, £14,848; salaries of the officials, £6219; wages of the servants, £18,845; publications, £10,829; advertisements, £14,970; reception and delivery of exhibits, £5230; medals and diplomas, £3078; music, £17,039, including £10,192 for the military bands, and £6113 for the Strauss orchestra; and £229 compensation for damage and personal injuries to visitors and others.

THE Association of Engineers of Ways of Communication, St. Petersburg, is establishing a Technical Bureau and Permanent Technical Exhibition, in which will be exhibited the projects and manufactures of the members of the Association. According to a circular lately issued by this kind of proprietory civil service co-operative society for doing everything, "the general section is devoted to the determination of the quality and worth of building materials; it accepts for examination samples of such materials in order to define their industrial signification and the means for their exploitation. The section of ways of communication undertakes surveys and the drawing up of projects for railroads, regulating rivers, excavation of canals, constructions of dams, dykes, piers, quays, &c. The architectural section draws up projects for buildings, both public and private, hospitals, theatres, and schools; projects for heating, lighting, laying water in houses, &c. The hydro-technical section draws up projects for canalisation, water supply, reservoirs, fountains, draining and irrigation of fields and meadows, artesian wells, filters and other water-purifying appliances. The mechanical section plans machines, locomotives, boats, &c. The electric section draws up plans and estimates for the construction of telegraphs, railroad signals, telephones, electric lighting, and also designs for dynamo-electric machines, and the application of electricity as a motor. The section of engineering art as applicable to rural economies deals with the investigation of technical questions connected with rural economies, with the object of increasing the value of estates; it constructs connecting roads," and so on.

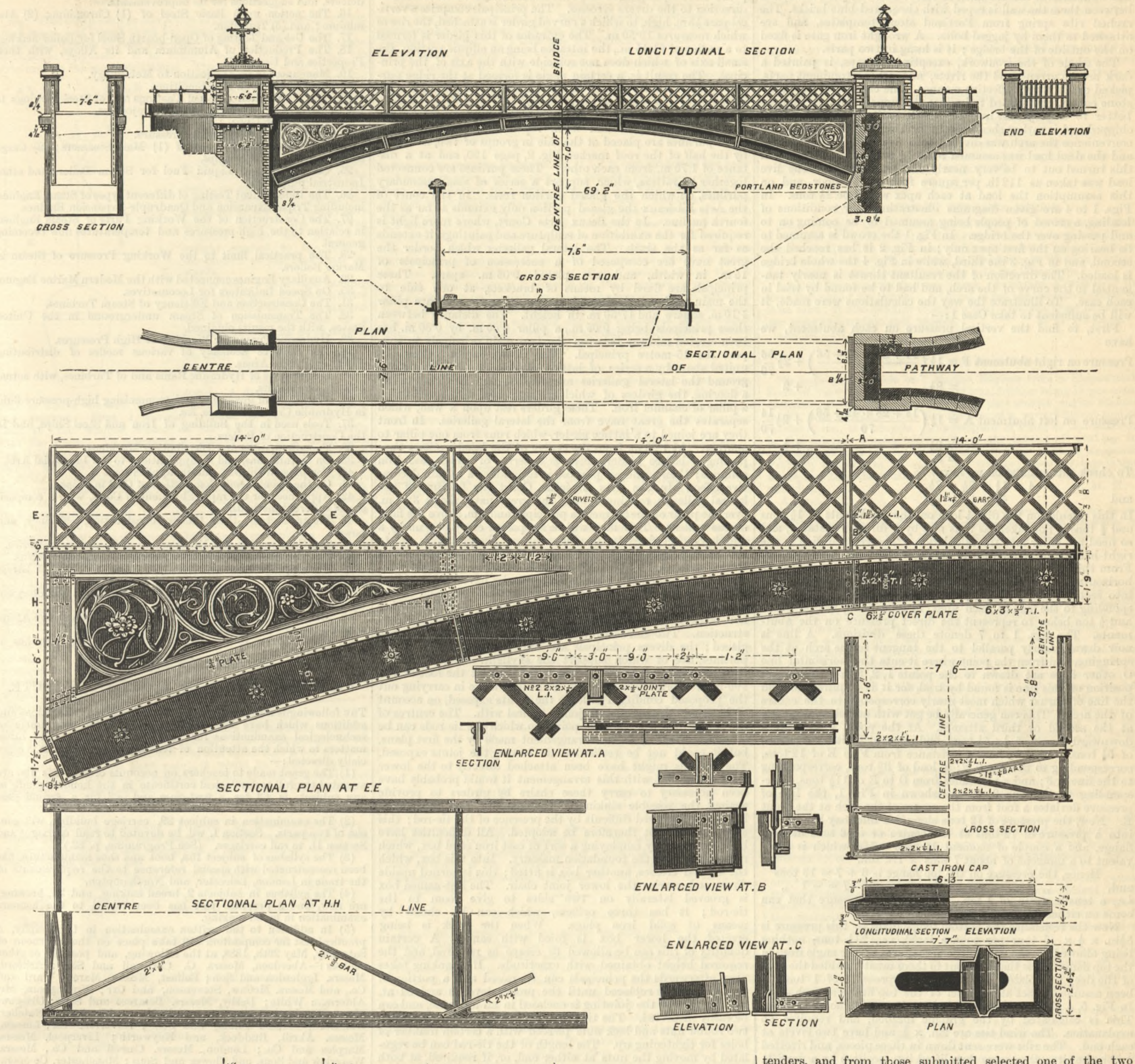
FINE ARTS COURT, PARIS EXHIBITION, 1889.

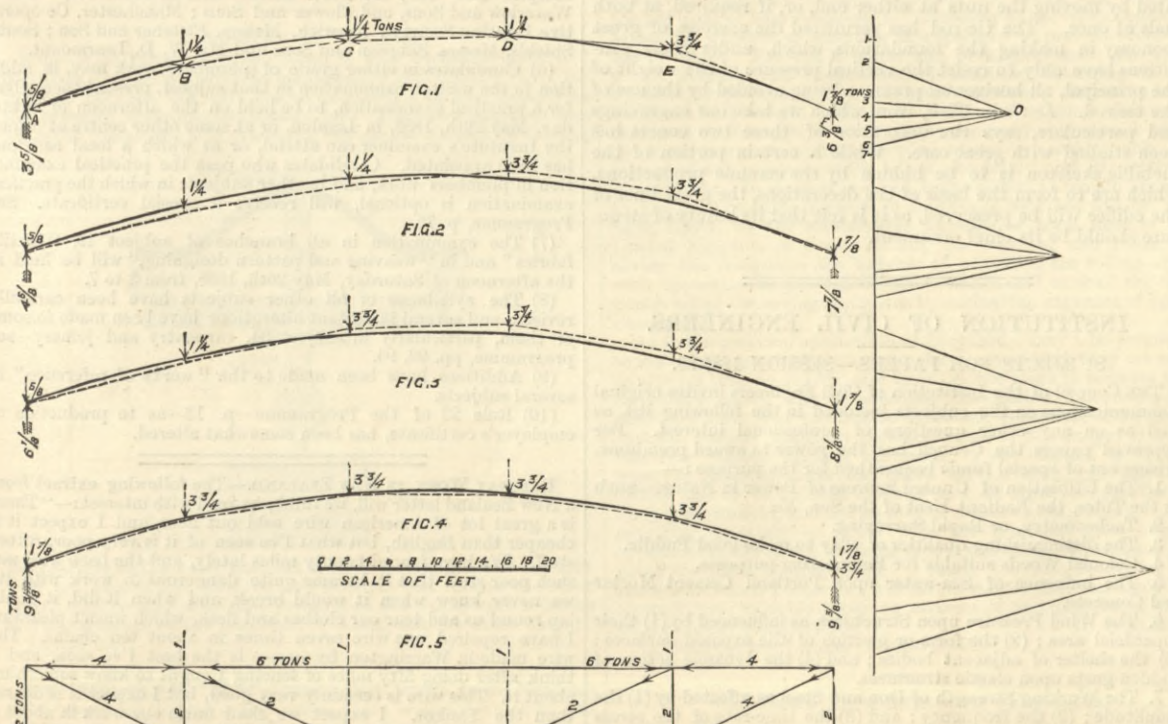
(For description see page 192)



RAVINE BRIDGE, LOWESTOFT.

MR. R. M. PARKINSON, A.M.I.C.E., ENGINEER.





RAVINE BRIDGE, LOWESTOFT.

THE illustrations above show a bridge lately erected at Lowestoft over the Ravine, in the Belle Vue Park. This bridge has been presented to the town by Mr. Youngman, the first mayor of Lowestoft, to commemorate the Jubilee year of her Majesty's reign, and was opened with some ceremony on the 29th of August last, that being the second anniversary of the grant of a charter of incorporation to the town.

Mr. Youngman advertised in our columns for designs and tenders, and from those submitted selected one of the two designs of Mr. R. M. Parkinson, Assoc. M.I.C.E., of Melton Constable, who let the ironwork to Messrs. Wm. Whetford, of Millwall, but himself constructed the abutments.

The contract was settled on the 7th of May, the first sod was turned on the 22nd of June, and the bridge completed in all respects, and, as before stated, opened on the 29th of August. The general dimensions are: clear span between abutments, 69ft. 2in.; width between girders, centre to centre, 7ft. 6in.; height of parapet above floor, 3ft. 9in.; height of floor above roadway, 30ft.; rise of arch, 7ft.; depth of arch, 1ft. 9in. A camber of 6in. at the centre has been given to the parapet, and this has the effect of preventing the apparent sag that presents itself to the eye when a parapet is not cambered. The arched ribs are composed of ¼in. web plates 6in. × 3in. × ½in. T I bottom flange; two 2½in. × 2½in. × ⅜in. L I's for top flange, and are well braced together at distances of 14ft. The web goes right through the top flange, and partly forms the spandrels, the plainness being relieved by a wrought iron bead. Rosettes also are put on the rib, and these very much relieve it. The spandrel proper is of cast iron, each being cast in two pieces, as it was found difficult to cast them whole on account of the unequal cooling.

The parapet is of open lattice-work, but not open enough to let children get through. It is composed of two 2in. × 2in. × ¼in. L bars for top and bottom flanges, with 1½in. × ¼in. bars, an 2in. × 1½in. × ¼in. channel irons for stiffeners; these latter are carried well down into the rib, and well tied and braced to give lateral stiffness. The top of the parapet is surmounted by an oak handrail. Wind ties are provided, and the girders well anchored into the brickwork; but provision has been made for expansion everywhere but in the arch, where, of course, this could not be done. All the joints have been made with special regard to neatness, the engineer being of opinion that small details are of primary importance in a bridge of this kind. The flooring rests on the bottom flange of the handrail, and is 3in. thick. The boards are 9in. in width, and are placed ¼in. apart and coated with Stockholm tar.

The abutments and wing walls are constructed of cement concrete faced with brickwork varying from 9in. to 18in. thick. It was first intended to use lime concrete, but as time was an object, and unless care is taken in using it, this is liable to swell and displace the brickwork, it was thought better to use cement, for there would have been but little saving effected. The quoins and panels in the piers are of white brick, and the piers are finished with caps of cast iron and ornamental lamps. The wing walls have a low handrail as a protection to children. The standards of this are fixed in 9in. × 7½in. stones, and between them the wall is coped with chequered blue bricks. The arched ribs spring from Portland stone templates, and are attached to them by jagged bolts. A wrought iron gate is fixed on the outside of the bridge; it is hung in two parts.

The whole of the ironwork, excepting the caps, is painted a dark bronze green; and the rivets, and other prominent parts, picked out in a very effective manner. The caps are of Portland-stone colour, and sanded to imitate the stone. It was thought better to employ cast iron for these, as it is not liable to get chipped and is rather cheaper. In making the calculations, for convenience the arch was divided into five bays of 14ft. each, and the dead load was assumed to be 1¼ tons at each apex, and this turned out to be very nearly the true weight. The live load was taken as 112 lb. per square foot of the floor, and on this assumption the load at each apex would be 2½ tons. In Figs. 1 to 4 are given diagrams illustrating four conditions of loading, a crowd of people being assumed to be coming on to and passing over the bridge. In Fig. 1 the crowd is assumed to be bearing on the first apex only; in Fig. 2 it has reached the second, and in Fig. 3 the third, while in Fig. 4 the whole bridge is loaded. The direction of the resultant thrust is nearly tangential to the curve of the arch, and had to be found by trial in each case. To illustrate the way the calculations were made, it will be sufficient to take Case 1:—

First, to find the vertical pressure on each abutment, we have

$$\text{Pressure on right abutment F} = 1\tfrac{1}{4}\left(\frac{14+28+42+56}{70}\right) + 2\tfrac{1}{2}\,\frac{56}{70}$$
$$= 2\tfrac{1}{2} \qquad + 2$$
$$= 4\tfrac{1}{2}.$$
$$\text{Pressure on left abutment A} = 1\tfrac{1}{4}\left(\frac{14+28+42+56}{70}\right) + 2\tfrac{1}{2}\,\frac{14}{70}$$
$$= 2\tfrac{1}{2} \qquad + \tfrac{1}{2}$$
$$= 3.$$

To check this calculation we have

$$4 \times 1\tfrac{1}{4} + 2\tfrac{1}{2} = 7\tfrac{1}{2},$$
and
$$4\tfrac{1}{2} + 3 = 7\tfrac{1}{2}.$$

In this calculation the direct load on the abutments of 1⅞ tons and ⅝ tons is not taken, as it is met by a direct resistance, and so need not enter into the calculation. The vertical line in the right-hand figure is now drawn, and a horizontal line also through it. From this to any scale the pressure 4½ tons is set up above the horizontal line, and of 3 tons below it, and this is divided again into sections of 3¾ tons, 1¼ tons, 1¼ tons and 1¼ tons, corresponding to the load at each apex, 1⅞ tons being set off above and ⅝ ton below to represent the direct pressure on the abutments. The figs. 1 to 7 denote these divisions. A line is now drawn nearly parallel to the tangent to the arch at the springing, and from the point where it cuts the horizontal line O other lines are drawn to the points 1, 2, 3, &c. The exact position of this line is found by trial, for it is required to find the line of thrust which most nearly corresponds to the centre of the arch. This can generally be got with sufficient accuracy at the second or third attempt. At the point F we have a downward thrust of ⅝ + 4½ tons, and opposed to it a resistance of 5⅛ tons. At E we have a resistance from F to E of 12 tons, corresponding to the line 0, 2; a load of 3¾ tons, corresponding to the line 2, 3; and a resistance from D to E of 11½ tons, corresponding to the line 3, 0. As shown in Fig. 1, the line of pressure deviates a foot from the centre of the arch at the point E. Now, the pressure of 12 tons along this line may be resolved into a pressure of 12 tons at the centre or of 6 tons at each flange, and a couple of moment 12 tons × 1ft., which is equivalent to a moment of about 7 tons × 1ft. 9in.

Hence, the pressure on the top flange is 6 + 7 = 13 tons
and, „ „ „ bottom „ „ 6 − 7 = − 1 „
i.e., a tensile strain of 1 ton. The greatest pressure that can come on either flange is 18 tons, as in Case 3.

Now the resistance the bottom flange gives to this pressure is 8½in. × ½ × (5 tons per square inch), *i.e.*, 21¼ tons, nothing being allowed for the web. The actual area of the angle irons in the top flange is less than this, but to them must be added the help of the deep web plate. For the wind a pressure of 1 ton has been assumed to act at the level of the top flange at each apex. In Fig. 5, a plan showing the wind strains and bracing is given. This is calculated by the graphic method, and requires no explanation. The wind ties are 2in. × ⅜, and have two rivets at each end. The ribs were sent down in three pieces, and rivetted up on the site; they were then lifted into position by a derrick, and the handrail then fixed. After this the abutments, which had previously been brought up to the top of the skewback, were proceeded with, and after the ironwork had received its third coat of paint, the flooring fixed; after which the handrail and final coat of paint were added.

The foundation was sand, which was well rammed at the back of the abutments, to enable them safely to receive the thrust of the arch. It was first meant to make the handrail take part of the strain, but after consideration it seemed quite safe to put the whole thrust on the abutments, as this was but 50 tons on each.

THE INTERNATIONAL PARIS EXHIBITION OF 1889.

THE courts devoted to the "beaux arts" and the "arts libéraux," at the Paris Exhibition in 1889, will run parallel with the great centre of the Champs de Mars, on each side of the central garden on that portion of ground situated between the Eiffel tower and the road which now runs across the Champs de Mars. Each of these two courts is composed of a great central nave, with annexe galleries on two sides at right angles to the Seine. The width between the principals of each nave is 52·80 m., the height is 28·20 m., and the distance between each principal, 18·10 m. Each court is surmounted in the middle by a great dome 60 m. high, rising 30 m. above the ridge of the edifice. These figures will show on what a large scale the Exhibition has been conceived. The two courts now under notice are in every way equal to the Machinery Hall. They are the work of M. Formigé. The Beaux Arts and Arts Libéraux Courts are identical, except on two points which will be mentioned further on. These courts are connected with the divers galleries of the Exhibition by a long gallery 30 m. wide serving as a vestibule; this is called the Rapp Gallery, its axis will be at right angles with that of the Beaux Arts Court. On the Seine side the court terminates by a gallery of the same width as the great nave, increased by that of the annexe galleries, and this is called the Seine Gallery. The principals composing each court are 18·10 m. apart from centre to centre; but the neighbouring bays of the Rapp and Seine galleries, which have an immense glazed gable, are smaller in dimensions, being only 6·25 m. Each of the principals, which is 52·80 m., is formed of two distinct principals—see p. 190—0·45 m. apart. These two principals, which are of especial lattice form, are united to the right of each purline by rigid uprights. The principal is jointed at three points at its springings and at its summit, with a view of definite direction to the divers stresses. The principals comprise a vertical part 15 m. high, to which a curved girder is attached, the rise of which measures 13·50 m. The extrados of this girder is formed to a radius of 91·45 m., the intrados being an elliptic portion, the small axis of which does not coincide with the axis of the principal. The result is, a certain angle is formed at the ridge purline by the intrados of each of the halves of the principal. On each side of the hinge at the apex, and at 0·85 m. from the axis, there is a purline which supports a ridge piece, useful for the purpose of inspection and when repairs are required. The other purlines are placed at the side in groups of two, as shown by the half of the roof marked Fig. 2, page 190, and at a distance of 1·70 m. from each other. These purlines are connected together by rafters, which support a series of small secondary purlines, on which the glazed portion rests. In the court of the Arts Libéraux the glazed portion only extends as far as the fourth purline. In the Beaux Arts Court, where more light is required for the exhibition of sculpture and paintings, it extends as far as the sixth. The lateral galleries which border the great nave are composed of a succession of principals of 15 m. in width, and are placed 9·05 m. apart. These principals are fixed by means of brackets, at one side to the main roof principals, and at the other to a square pillar 1·10 m. square and 17·50 m. in height. The distance between these principals being 9·05 m., a pillar 0·60 m. by 0·80 m. has been erected midway between the two main principals to support the 15-metre principal. The divers façade pillars are united above by a series of lattice arcades. At 7 m. above the ground the lateral galleries are divided into two storeys by a flooring, the girders of which are supported in the middle by a pillar of channel iron. These girders rest upon a wall, which separates the great nave from the lateral galleries. In front they are joined to a lattice girder, which runs from one pillar to another. At 1·25 m. from the centre of the façade pillars supporting a lattice girder there is a series of small cast iron columns; their principal purpose is to produce a certain decorative effect. In the Arts Libéraux Court the flooring of the lateral galleries continues over the great nave, rising 3·50 m. over the pillar of the 50-metres principal, and 5 m. above the floor of the gallery. This floor will be supported every 9·05 m. by a double bracket fixed to the abutments of the principals and to the intermediate pillars. The floor of the lateral galleries of the Beaux Arts Court will stop at the abutment of the main principals. The principals of the lateral galleries have been designed with a tie-rod, which is the more economical form, and can be used in this case because the height required above the flooring not being great, the tie-rod in no way interferes with the construction. Two-thirds of the width of the lateral galleries are glazed; the divers principals are united by a system of seven purlines, five of which support the skylight. The details on page 190 illustrate the tie-rod and the joint at the foot of the 105-metres principal. Certain difficulties arose in carrying out the proposed condition to leave the joints exposed, on account of having both tie-rod and joints to deal with. The centres of the joint pins are the best points to which the tie-rods can be attached. This was the arrangement made by the first plans, but it could not be realised while leaving the joints exposed. The tie-rods might have been attached directly to the lower joint chairs, but with this arrangement it would probably have been necessary to carry these chairs by girders to provide against the possible sinking of the masonry, and this would have been rendered difficult by the presence of the tie-rod; this system could not therefore be adopted. All difficulties have been overcome by employing a sort of cast iron sand box, which rests directly on the foundation masonry. Into this box, which the tie-rod crosses, another box is fitted; this is turned upside down, and carries the lower joint chair. The last-named box is grooved laterally on two sides to give room to the tie-rod; it has three orifices, which can be closed by means of solid iron plugs. When the work is being erected the lower box is filled with sand. A certain quantity of this can be allowed to escape as required, and the required height obtained with exactitude. If a sinking takes place afterwards the principals can be raised and a portion of the sand can be replaced until the proper level is arrived at. All this part of the jointing is enclosed in an iron case, and can be easily inspected. The tie-rod is furnished at either end with two round nuts and lock nuts pierced with a certain number of holes for tightening up. The length of the tie-rod can be regulated by moving the nuts at either end, or, if required, at both ends at once. The tie-rod has permitted the exercise of great economy in making the foundations, which, under these conditions have only to resist the vertical pressure of the weight of the principal, all horizontal pressure being avoided by the use of the tie-rod. *Le Genie Civil*, from which we take our engravings and particulars, says the decoration of these two courts has been studied with great care. While a certain portion of the metallic skeleton is to be hidden by the ceramic productions, which are to form the basis of the decorations, the great lines of the edifice will be preserved, as it is felt that its beauty of structure should be its chief ornament.

INSTITUTION OF CIVIL ENGINEERS.

SUBJECTS FOR PAPERS.—SESSION 1887-88.

THE Council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. For approved papers the Council has the power to award premiums, arising out of special funds bequeathed for the purpose:—

1. The Utilisation of Unused Sources of Power in Nature—such as the Tides, the Radiant Heat of the Sun, &c.
2. Tacheometry, or Rapid Surveying.
3. The distinguishing qualities of Clay to make good Puddle.
4. Colonial Woods suitable for Engineering purposes.
5. The influence of Sea-water upon Portland Cement Mortar and Concrete.
6. The Wind Pressure upon Structures, as influenced by (1) their superficial area; (2) the form or position of the exposed surfaces; (3) the shelter of adjacent bodies; and (4) the dynamic action of sudden gusts upon elastic structures.
7. The Working Strength of Iron and Steel as affected by (1) the amplitude; (2) the frequency; and (3) the time-rate of the stress variations.
8. Description of any new or peculiar form of Mountain Railways for very steep gradients.
9. Recent Irrigation Works in California.
10. Machinery and Arrangements for Distilling Water by Multiple Effect.
11. The effect of different Qualities of Water on the condition and duration of Cast Iron Pipes.
12. On the Sale of Water by Measure.
13. Uniformity in system—international—of Coast Lighting by lighthouses, light vessels, and their auxiliaries, automatic lighted beacons and buoys.
14. Recent Improvements in Cable Tramways.
15. The Present Position of the Manufacture of Steel—its defects, and suggestions for its improvements.
16. The action upon Basic Steel of (1) Chromium; (2) Aluminium; and (3) Tungsten.
17. The Use and Testing of Open-hearth Steel for Boiler-making.
18. The Production of Aluminium and its Alloys, with their Properties and Uses.
19. Manganese in its application to Metallurgy.
20. Improvements in Zinc-Smelting.
21. The Application of Steel Castings and of Steel Forgings to the Construction of Ordnance and of Projectiles.
22. Rapid-firing Guns.
23. On Forging by Hydraulic Pressure.
24. The most recent types of (1) Mail Steamers; (2) Cargo Steamers; and (3) War-ships.
25. On the Use of Liquid Fuel for Steam Boilers and other Industrial purposes.
26. The Independent Testing of different types of Steam Engines, including Triple-Expansion and Quadruple-Expansion Engines.
27. The Construction of the Working Parts of Steam Engines, in relation to the high-pressures and temperatures now becoming general.
28. The practical limit to the Working Pressure of Steam in Marine Boilers.
29. Auxiliary Engines connected with the Modern Marine Engine.
30. On Speed Indicators for Locomotives.
31. The Construction and Efficiency of Steam Turbines.
32. The Transmission of Steam underground in the United States, with the results obtained.
33. Hydraulic Pumps for Working at High Pressures.
34. The Relative Economy of various modes of distributing Power over large Areas.
35. Descriptions of Hydraulic Rams and of Turbines, with actual quantitative results.
36. The means of governing and economising high-pressure fluid in Hydraulic Cranes, Engines, &c.
37. Tools used in the Building of Iron and Steel Ships, and in the Construction of Boilers.
38. Type-Composing and Distributing Machines.
39. On Natural Gas, and its applications to the Industrial Arts.
40. Compressed Oil-Gas, and its applications.
41. On the Spontaneous Combustion of Coal in Ships.
42. Appliances for the rapid Shipment of Coals, with a comparison of different methods.
43. Electro-Motors; their theory, construction, efficiency, and power.
44. The Construction and Maintenance of Secondary Batteries.
45. The Distribution of Electricity for the Lighting of Towns.
46. The application of Electricity to the Working of Street Tramways.
47. The application of Electricity to Smelting and Metallurgical Operations.
48. Means of insuring the Safety of Blasts in Explosive Atmospheres.
49. Contributions to the Bibliography of special branches of Engineering.

CITY AND GUILDS OF LONDON INSTITUTE.

THE following is a summary of the more important alterations and additions which have been introduced into the programme of technological examinations for the year 1887-8, and of other matters to which the attention of teachers and secretaries is especially directed:—

(1) The grant made to teachers on accounts of students who are awarded the full technological certificate in the honours grade of any subject, is £3 for a first-class and £2 for a second-class certificate.

(2) The examination in subject 29, carriage building, will consist of two parts. Section I. wil. be devoted to road carriages and Section II. to rail carriages. (See Programme, p. 82.)

(3) The syllabus of subject 16B, boot and shoe manufacture, has been reconstructed with special reference to the requirements of the trade in London, Leicester, and Northampton.

(4) The syllabus in subjects 2, bread making, and 3A, brewing, are new, and a practical test has been added to the honours examination in bread making.

(5) In addition to the written examination in typography, a practical test for compositors will take place on the afternoon of Saturday, May 26th, 1888, at the following, and possibly at other centres:—Aberdeen, Messrs. G. Cornwall and Sons; Ashford, Messrs. Igglesden and Son; Belfast, Messrs. Marcus Ward and Co., and Messrs. McCaw, Stevenson, and Orr; Birmingham, Mr. Alderman White; Derby, Messrs. Bemrose and Sons; Glasgow, Messrs. Blackie and Sons; Greenwich, Messrs. Merritt and Hatcher; Guildford, Messrs. Billing and Sons; Haverfordwest; Lincoln, Messrs. Akrill, Ruddock, and Keyworth; Liverpool, Messrs. Marples and Co.; London, Messrs. Cassell and Co., Messrs. Waterlow and Sons, and Clowes and Sons; Manchester, Co-operative Printing Society; Norwich, Messrs. Fletcher and Son; South Shields, Messrs. Simpson and Sons and Mr. W. D. Learmount.

(6) Candidates in either grade of plumbers' work may, in addition to the written examination in that subject, present themselves for a practical examination, to be held on the afternoon of Saturday, May 26th, 1888, in London, or at some other centre at which the Institute's examiner can attend, or at which a local assistant has been appointed. Candidates who pass the practical examination in plumbers' work, and in other subjects in which the practical examination is optional, will receive a special certificate. See Programme, p. 75.

(7) The examination in all branches of subject 19, "textile fabrics" and in "weaving and pattern designing," will be held in the afternoon of Saturday, May 26th, 1888, from 3 to 7.

(8) The syllabuses of all other subjects have been carefully revised, and several important alterations have been made in some of them, particularly in subject 34, carpentry and joinery—see programme, pp. 93, 94.

(9) Additions have been made to the "works of reference" in several subjects.

(10) Rule 22 of the Programme—p. 13—as to production of employer's certificate, has been somewhat altered.

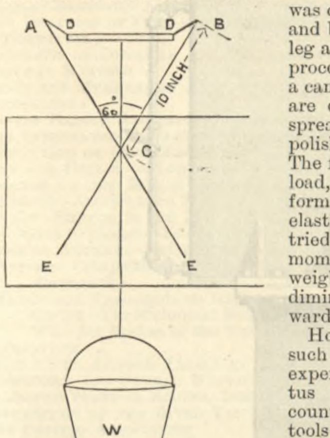
RAILWAY WORK IN NEW ZEALAND.—The following extract from a New Zealand letter will, we think, be read with interest:—"There is a great lot of American wire sold out here, and I expect it is cheaper than English, but what I've seen of it is very poor, rotten stuff. We have fenced twenty miles lately, and the barb wire was such poor stuff that it became quite dangerous to work with it; we never knew when it would break, and when it did, it would lap round us and tear our clothes and flesh, which wasn't pleasant. I have repaired one wire seven times in about ten chains. The wire made in Warrington by ——— is the best I've seen, and I think after doing fifty miles of fencing I ought to know something about it. This wire is certainly very good, but I expect it is dearer than the Yankee. I expect we shall finish our work in about a fortnight. We should have done it before now, but the whole job was stopped and every man on the line paid off because they hadn't fish-plates and bolts to finish the last three-quarters of a mile with, and what was worse, there wasn't a fish-plate in the colony, and the job has to stand till some arrive from England. The Government find all ironwork and sleepers, and not long ago the work was stopped for want of dogs, and there were none nearer than Dunedin, so we had to wait for these being brought round."

LETTERS TO THE EDITOR.

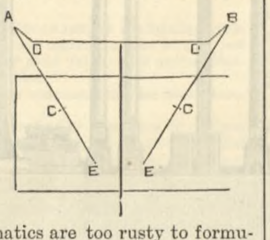
[*We do not hold ourselves responsible for the opinions of our Correspondents.*]

STRESSES IN A CAMP STOOL.

SIR,—The camp stool puzzle seems to get a wondrous complexity in small space, and I don't think the disputants will derive full benefit unless each breaks at least one camp stool for himself! "Common Mechanical Engineer" is in honour bound to do so after his strictures on the mathematicians. The camp stool of my childhood was commonly a piece of turnery and broke at the joint between a leg and rail. I find that in the process of taking one's seat upon a camp stool the tops of the legs are drawn inwards while the toes spread, whether the floor be polished oak or Turkey carpet. The form and dimensions of the load, in most cases, stop the former tendency long before the elasticity of the wood is seriously tried. Again, the bending moment about the pin of a weight applied to the seat is diminished as the legs bend inwards.



However, I have been making such approach to quantitative experiment as the rough apparatus to be extemporised in a country house, with no particular tools available, allowed of. The material is yellow deal, some slips of which in section $\frac{7}{16}$in. × $\frac{1}{4}$in. I chanced to have at hand. A door weight of 25 lb. and a stable bucket with a can of water furnished breaking weights. First I secured a piece of board some 2ft. long to the window frame so as to project conveniently into the room. To represent a pair of legs of a camp stool two laths are fastened to the board at C by a screw passing tightly through a hole $\frac{3}{16}$in. diameter, and the ends E E are fixed; a string does duty for seat, forming an equilateral triangle 10in. on the side. A lath is tied firmly to the string D D, 1in. from either end of the seat, and the weight is applied to a cord hanging from the centre of this. With a weight of 7 lb. the angle C A D measured scarcely 30 deg.; with 28 lb. it was only 15 deg., the distance A B being reduced to 9$\frac{1}{4}$in. Finally, one leg broke with a weight of 56 lb., the angle C A D being then very small indeed. The other leg was uninjured, and being afterwards tested as a beam fixed at one end, broke through the screw-hole with a weight of 12 lb. at a distance of 10in. This experiment I repeated thrice, obtaining breaking weights ranging from 10$\frac{1}{2}$ lb. to 12 lb. A similar piece without any screw-hole required 15$\frac{1}{2}$ lb. In a second trial with the camp stool arrangement one leg collapsed by bending over to the front under a weight of 48 lb. Having regard to this, I think the arrangement shown in the second sketch would be more satisfactory.



I fear my mathematics are too rusty to formulate these results prettily. Practically I am reassured as to the strength of a camp stool at the pin, and think that most probably if failure occurred at that point, it would be under a pressure passing out of the line of centres, tending to rock the two braced triangles about their apices. W. A. S. B.

Alresford, August 23rd.

SIR,—I venture to answer "Puzzled" by Molesworth's Rule:—Camp stool has 4 legs, held together in the centre by $\frac{1}{4}$in. bolt. Allow said bolt to be the support of a beam fixed at one end and loaded at the other. Let

K equal co-efficient of rupture of English ash = 19 cwt.
L ,, length of beam ... ... = 12in.
B ,, breadth ,, ... = $\frac{1}{2}$in.
D ,, depth ,, minus dia. of bolt-hole 1in.

Then—

$$\frac{K B D^2}{L} = \text{breaking strain of one leg,}$$

Therefore—

$$\frac{19 \times \cdot 5 \times 1 \cdot \times 1 \cdot}{12} = 0 \cdot 7916 \text{ cwt.} =$$

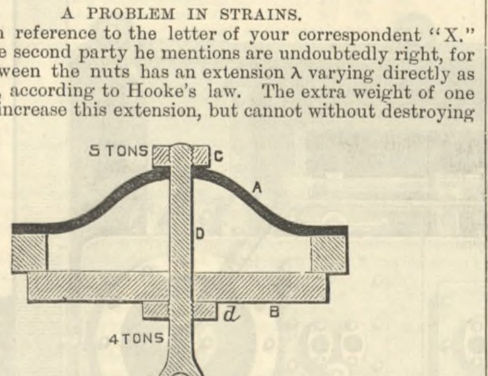
roughly 88 lb. breaking strain of one leg.

Then 88 lb. × 4 legs = 352 lb.—the breaking weight of a camp stool with 4 legs 24in. long. JOHN BATEY.

47, Heytesbury-street, Dublin.
August 29th.

A PROBLEM IN STRAINS.

SIR,—With reference to the letter of your correspondent "X." last week, the second party he mentions are undoubtedly right, for the bolt between the nuts has an extension λ varying directly as the pressure, according to Hooke's law. The extra weight of one ton tends to increase this extension, but cannot without destroying



the pressure of the lower nut. In fact, as long as the extra weight does not exceed five tons, so long does the bolt remain the same length, and so long does the pressure on the upper nut = 5 tons and the pressure on the lower nut = 5 tons, less the extra weight.

August 23rd. T. E. N.

SIR,—Referring to "X.'s" letter in last week's issue, Newton's third law states that to every action there is always an equal and contrary reaction, therefore the strain due to the 5 tons tends to break the bolt across somewhere between the nips of the nuts. This strain is an initial quantity in the machine, and any tensive force acting or pulling on the bolt, whether upwards or downwards, will cause an increment of strain due to the amount of such force. In the case under discussion the amount is 1 ton, therefore the bolt will be strained anywhere below the lower nut by 1 ton, and the bolt will be strained anywhere between the top and bottom nuts to the amount of 5 + 1 = 6 tons. The action is similar to that exemplified in the case of all flanged steam pipes, cylinder covers, &c., connected by bolts; the bolts are firstly strained by the nuts sufficiently to make the joints, and are subsequently further strained by the load due to the steam pressure. The machine is just an eyebolt, and whether the member A is a spring or a girder it matters not, the action is the same—6 tons hangs from the nut C.

If we compare the figure to an external fitted manhole-door and allow the area exposed to the steam pressure, multiplied by the pressure per square inch = 1 ton, then in such case the bolt will be strained as before, *i.e.*, 5 tons due to tightening up, and 1 ton due to the steam pressure, total = 6 tons.

If we compare the figure to an internal fitted manhole-door the area exposed to steam pressure multiplied by the pressure per square inch = 1 ton, then in such case the bolt will be strained as before, *i.e.*, 5 tons due to the tightening up; but the steam pressure will nullify 1 ton, reducing the strain on, say, the outer nut to 4 tons. R. HARTLAND.

Cork, August 23rd.

SIR,—The problem presented by "X." is our old friend the lock-nut in a new guise, and in view of a possibly protracted and more than likely barren discussion, it seems a pity that this should not at once be recognised and treated accordingly. Let those who are anxious for controversy substitute for the upper and lower nuts in this case the outer and inner of the lock-nut question, and turn to and read the recent correspondence. There is here, though, an element peculiar to itself. Only a shortening of the distance between the top nut and the support can produce additional stress on that nut, and this only occurs after a weight of five tons is applied. When the nut is screwed up, the pressure on the spring and the tension on the bolt are due to the screwing alone, but when the weight is applied the tension and pressure remaining constant are due in part to the screwing and the difference to the weight until five tons is reached, when the spring is still further deflected and the lower nut swings clear, and the stresses are due to the weight alone.

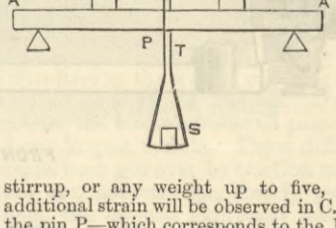
If we suppose that equal increments of load, by screwing or weighting, produce equal increments of deflection of the spring, then the problem is simple. If, however, the $\frac{\text{load on the spring}}{\text{deflection of do.}}$ is a curve, and not a straight line, we must first determine that curve, and this can only be done experimentally.

Glasgow, August 24th. D. S. SINCLAIR.

SIR,—Your correspondent "X." is evidently wrong if he assumes 6 tons to be the weight on top nut of his diagram. The bolt is subject to a strain of 5 tons due to the reaction of the spring. A weight less than 5 tons cannot affect the strain, because any weight applied releases the bottom nut from a portion of its pressure, consequently the condition of the top nut is affected by a pressure of 5 tons, whilst the bottom nut is under a pressure of 4 tons—that is, 5 tons minus the 1 ton added to eye of bolt. JOHN BATEY.

47, Heytesbury-street, Dublin, August 29th.

SIR,—The puzzle offered by your correspondent "X." is readily solved by the methods of the kindergarten. A A is a lath, representing, for the purposes of this experiment, a rigid girder; B B are the halves of a wine cork nailed to the lath, say 3in. apart; C is a common red rubber band put round the nail heads; T is a loop of tape passing over the band and pinned to a scale pan S, made by folding a sheet of note-paper into a stirrup. A few half-ounce weights do duty for tons. Five tons—2$\frac{1}{2}$ oz.—deflects C ·25in.; an additional $\frac{1}{2}$ oz. —six tons in all—lowers it ·05in. more. Then, with five tons in the scale, we put a pin P through the tape loop close under the lath, and, removing the weight, leave the band under a strain of five tons. Now, put one ton in the stirrup, or any weight up to five, and no deflection marking additional strain will be observed in C. The weight merely relieves the pin P—which corresponds to the lower nut in "X.'s" diagram —of so much of the upward pull of the spring. Six tons in the pan again produces a total deflection of ·3in. W. A. S. B.



August 30th.

ACCIDENTS ON TRAMWAYS.

SIR,—In reference to your notice on the above in your last edition, stating "that the accidents are causing an increasing demand to be made by the public for life-saving appliances to be attached to the engines," I beg to state that I studied this question during the time I was in charge of several tram lines at home and abroad. The adoption of a life-saving appliance has, however, to deal with two points—(1) Is it better, in the interest of the public and the company, to risk the danger of accidents and pay heavy damages? or (2) is it better, in the interest of the public and the company, to prevent accidents by providing the rolling stock with life-saving apparatus, causing expenses, but saving the company the payment of heavy damages? According to the views expressed to me, the question of adapting an apparatus to prevent accidents has two sides. The one is moral and philanthropical; the other purely financial and commercial. I consider, belonging to the engineering profession, that it is every engineer's duty to prevent accidents by his work, while it is questioned whether those who represent the financial interest of the company only should adopt the same moral and philanthropical view, or consider only the saving of any expense which is not absolutely and imperatively unavoidable. In short, it is asked, is the public to remain exposed to the proportionate increase of injuries to limb and life, or, perhaps, death, by the considerable increase of tram lines in the United Kingdom of Great Britain, the colonies, and India, by saving the companies the expense of providing the rolling stock with apparatus to prevent or check accidents? or shall the companies adopt life-saving apparatus by saving the expenses of heavy damages?

As to the practical application of lifeguards, may I be permitted to state that practical experience has proved that they are more dangerous than no guards, and assist rather more to increase than to prevent injury. By my studying this question I devised a lifeguard for horse and mechanical tractions, consisting of an elastic cushion, pushing aside any person exposed to the danger of being run over without injuring the same. I was enabled to find out what the requirements of the public service were, and what conditions had to be fulfilled to make such an apparatus practicable. They are manifold, and not so easy as it looks at first sight. After operating privately on a car with the principal parts of such apparatus in full size, a working model was made, which I am prepared to submit for inspection. I thank you beforehand for the space with which I hope you will favour me for the insertion of the above in your valuable paper on account of the importance of the subject under consideration. H. CONRADI.

13, Soho-square, London, August 28th.

IBBOTSON'S LOCK-NUTS AND FISH-BOLTS.

SIR,—Being the sole makers of the Ibbotson's patent steel expansion lock-nuts and special steel fish bolts used on the Great North of Scotland Railway, our attention has this day been drawn to an article under the head of "Railway Matters" at the foot of page 169 of THE ENGINEER, No. 1652, of the 26th inst., containing a quotation from the report of Colonel F. H. Rich on the accident which occurred on the 16th May last between Buckpool and Port Gordon Stations on the above-named line, wherein he questions whether the fish-bolts and nuts used on that railway can be considered safe, because he concluded that they were, to some extent at least, the cause of the buckling or bending of some of the rails discovered there, owing to the excessive tightness with which they were found to grip the said rails at their joints.

We should be greatly obliged if you will permit us to state in your paper that as our lock-nuts do become securely and firmly locked on any part on the bolt up to which they are screwed, there is no necessity whatever that they should be screwed up so tightly as to prevent the expansion of the rails.

The fact that such an extraordinary gripping force can be applied by their use is undoubted, but if so applied, care should be taken when any marked change of temperature sets in to slacken the nuts back a little to permit the rails to expand or contract as the case may be.

No slackening back and re-tightening up of our nuts renders them in any way loose upon their bolts, or diminishes to any appreciable extent their tight gripping hold thereon.

IBBOTSON BROTHERS AND COMPANY,
(ALFRED B. IBBOTSON,
The Patentee and Managing Director.)

Globe Steel Works, Sheffield, August 29th.

THE STRESSES IN THE IOWA BRIDGE.

SIR,—In reply to Mr. Cunningham's letter, I would remark that it depends altogether on the character of the "internal modifications" whether the main truss, which without the "twist" can be adapted to either form, becomes a Warren or a Whipple girder. An American would generally adapt it to the latter type.

I must also maintain that an "arch" is named in virtue of its form and not of its thrust. A thrust is not the exclusive property of an arch; it also belongs to such widely different types as braced iron piers and certain roof trusses. R. H. GRAHAM.

August 31st.

MARINE ENGINE BEARINGS.

SIR,—In your article on "Marine Engines from a Shipowner's Point of View" you speak of the internal friction being 15 per cent. or more. It has often occurred to me that marine engine makers might take a lesson from the makers of a very different sort of machine, viz., the tricycle. The adoption of roller or ball bearings in the tricycle considerably reduces the labour of working it, especially at high speeds, or adds at least 5 per cent. to its speed. Probably some of the advantage derived from these bearings is due to the fact that there can be no cutting or abrasion from dust, but not wholly. J. H. K.

August 30th.

[Roller bearings might be used in a screw tunnel, but we doubt that they could be used in an engine-room, as any slackness of bearing would cause them to be hammered to pieces.—ED. E.]

A CURIOUS EXPLOSION.

SIR,—An explosion recently occurred at a paper mill, the particulars of which are as follows:—During the admission of caustic liquor into the ovens in the process of recovering the caustic soda used for washing esparto, an explosion occurred resulting in the complete demolition of an oven, and serious injury to the man attending same. Two actions have followed, under the Employers' Liability Act, the plaintiff's contention being that the oven was badly constructed, the piers being almost entirely burnt through, that the crown collapsed, allowing the cold air to rush in upon the hot air, thus causing the explosion and injury. On the judge asking one of the plaintiff's witnesses what he thought of the theory, he replied that "he had never heard such nonsense in his life," and with this opinion nearly everybody in court agreed, the judge deciding there was no case to go to the jury, and the plaintiff was non-suited.

As a matter of fact the oven in question was in a perfectly safe condition, constructed of the best fire bricks, the piers being 18in. thick, although, of course, this was reduced in some places by burning.

The theory of the defendant was, that the man allowed the oven to become overheated, and the liquor to enter the oven too rapidly, thus causing a steam explosion; and that the accident happened entirely by reason of the man's neglect and carelessness. Could there be any other cause to account for the explosion? Is there any chemical reason for it? I had some idea of hydrogen caused by the decomposition of steam, but there was not sufficient iron in the oven to account for this. I am not aware that explosions of this character are common in paper mills, but it behoves all mill-owners to pay attention to the matter, or they may find themselves in the position of the defendant referred to.

Being non-suited, the plaintiff appealed, and on the second trial recovered heavy damages. On this occasion the theory of "the cold air rushing on the hot" was abandoned, and no explanation whatever was offered to account for the explosion, other than the collapse of the oven.

Now there is no doubt a violent explosion occurred, the *debris* being carried some distance, and I can find no other cause for it than that mentioned above, viz., a steam explosion caused by the liquor flowing into an overheated oven. The essence of the case seems to be this, Did the crown of the oven collapse previous to the explosion, or was the collapse subsequent to, and the result of the explosion?

As the intelligent British jury gave a verdict for the plaintiff, they of course believe in the curious coincidence that the crown of the oven fell at the precise moment that the liquor was allowed to flow. How they accounted for the explosion that followed I cannot say. The theory, if they had one, was allowed to simmer in the depths of their own imagination.

CHAS. FREDK. FULLER, C.E.

Bow-lane, E.C., August 31st.

FEATHERING PADDLE WHEELS.

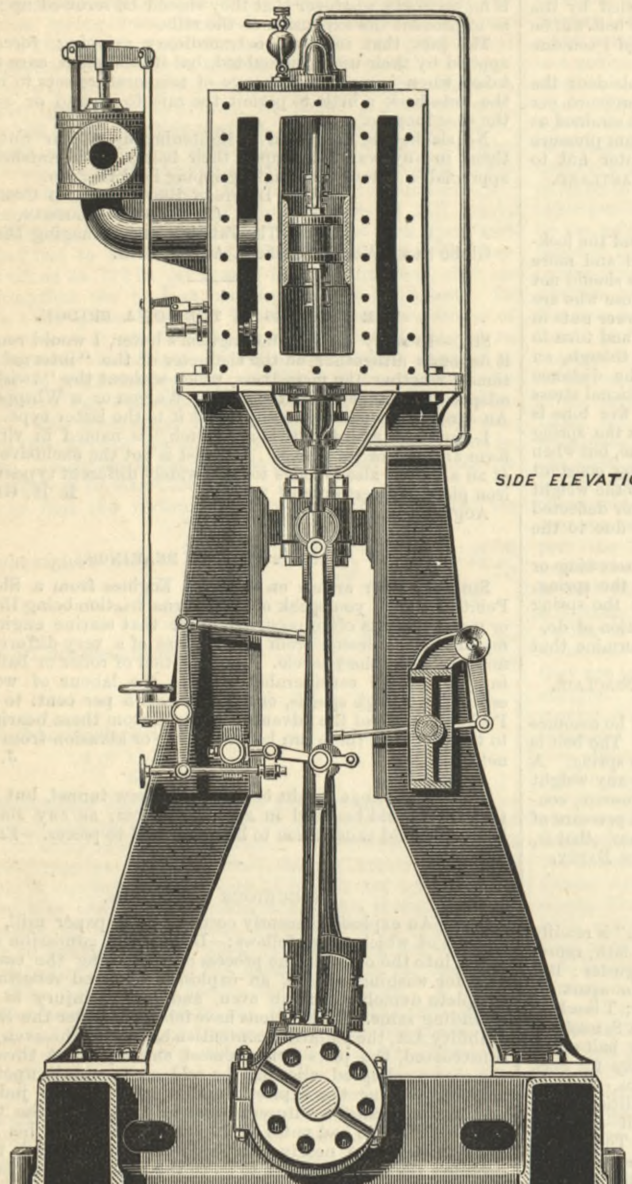
SIR,—Professor Greenhill in his interesting letter in your last impression seems to have overlooked the circumstance that the proper angle of the float varies with the speed and slip. A vessel steaming at a very high speed scarcely needs to feather her floats at all, because the floats move rapidly away from the water. The action is much the same as if a man filled a shovel with sand and then drew the shovel with a jerk towards him. The sand would fall straight down, remaining behind by its inertia. The higher the speed of the ship the greater will be the slip, and this again affects the angle of the float. If there were no slip the float would come up out of the water very nearly at the place where it went in. Professor Greenhill will find a very beautiful copper-plate diagram showing the positions of one float during an entire revolution of one of the wheels of the Kingstown and Holyhead mail steamer Leinster, in Bourne's treatise on the "Steam Engine," which I recommend to his notice. The two vital points are the position of the centre of the excentric and the length of the arm on the back of the float. A complete investigation of the feathering wheel by Professor Greenhill, similar in character to that on the screw propeller, which has already appeared in your pages, would be of much value.

Dieppe, August 31st. M. E.

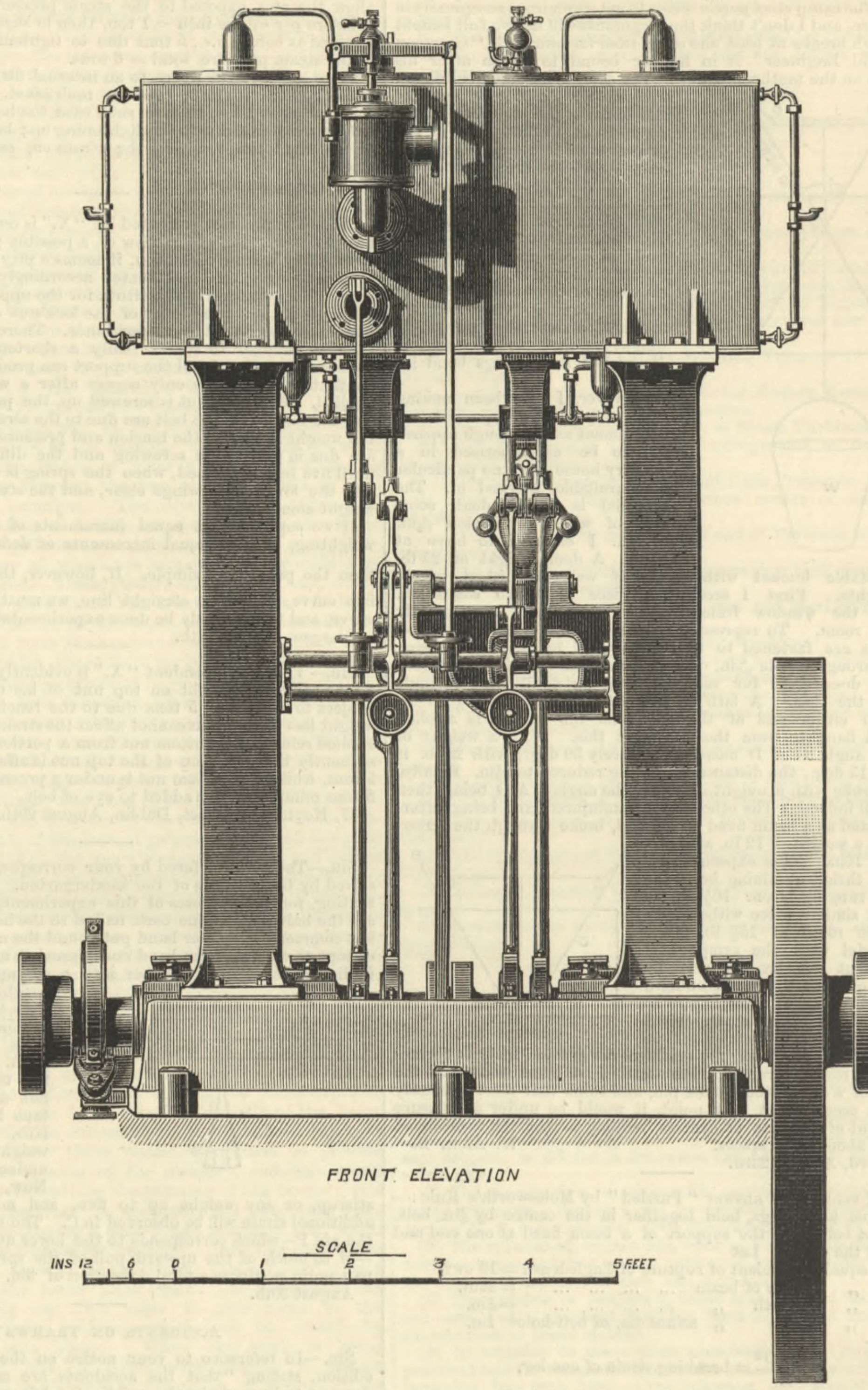
PAPER STENCILS.—M. Garel has invented an electrical method of preparing paper stencils for letters, circulars, &c. In this apparatus a piece of very thin paper rests on a carbon block connected with one pole of a small induction coil, whilst the style, with which the writing is done, is connected with the other pole. On using the apparatus, a series of sparks pass between the style and the carbon block, perforating the paper, which can then be used as a stencil in the ordinary way.

COMPOUND VERTICAL ENGINE, INDIAN STATE RAILWAYS.

(*For description see page* 198.)



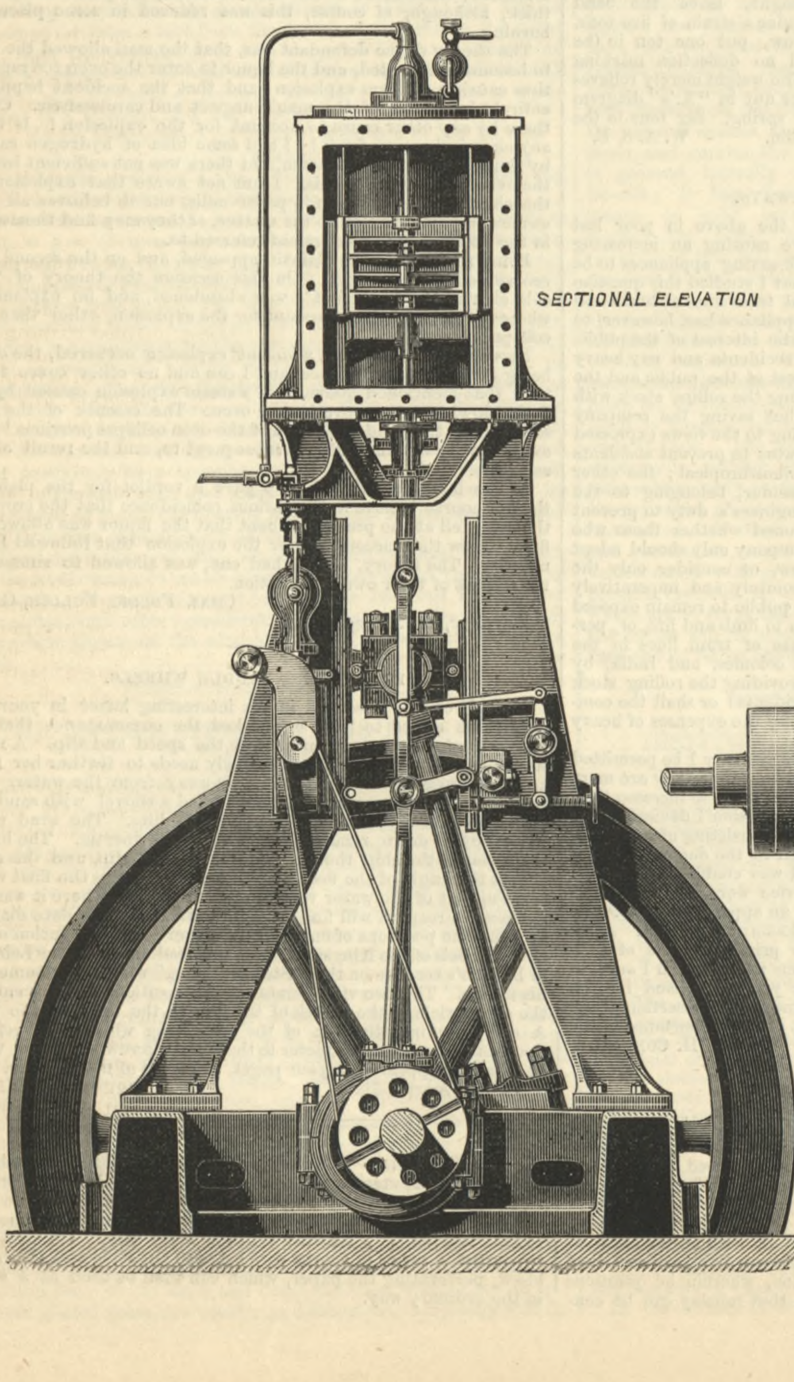
SIDE ELEVATION



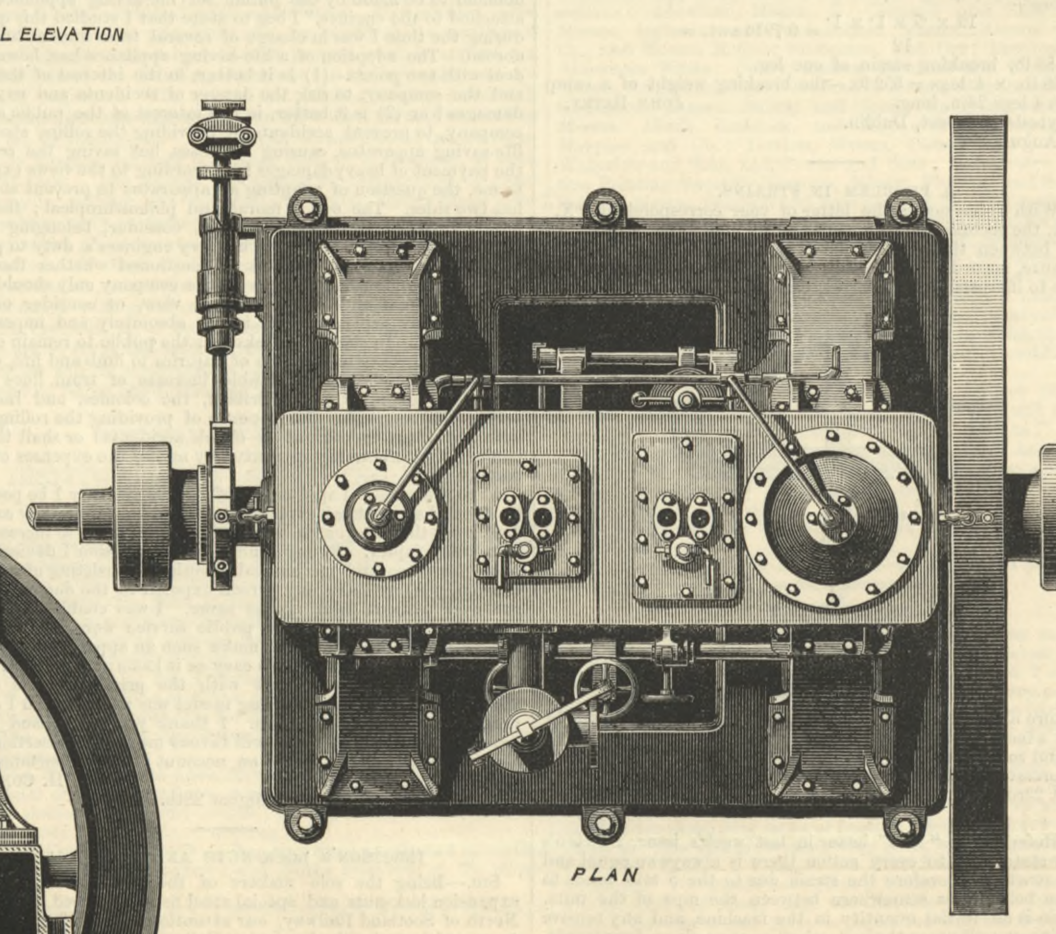
FRONT ELEVATION

SCALE

INS 12 6 0 1 2 3 4 5 FEET



SECTIONAL ELEVATION



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N.—*Write to the Secretary, Lloyd's Registry, 2, White Lion-court, Cornhill, E.C.*

M. A.—*We must refer you to Zeuner's own writings for an explanation which has been found too long to give in English text-books. See the English translation of Zeuner by Müller—in most technical libraries.* (2) *Compression of air, cooling it whilst compressed, and then expanding it.*

RUBBER.—*The harder vulcanised rubber of good quality, prepared for high temperatures, will give you very little trouble. Before making the joint the iron surfaces and the surfaces of the rubber should be well chalked over to prevent sticking. Probably some ordinary thick brown paper would make your joint well, the paper being oiled after being cut to shape.*

MACHINES FOR EXTRACTING GLUCOSE.

(To the Editor of The Engineer.)

SIR,—We are asked for the makers of plant and machinery for extracting or otherwise manufacturing glucose. Can any of your readers assist us? S. S.

London, August 29th.

SAFETY MATCH-MAKING MACHINERY.

(To the Editor of The Engineer.)

SIR,—We shall deem it a favour if you can furnish us with the names of any firms who make machines for the manufacture of safety matches. Awaiting your reply, we thank you in anticipation for your trouble.

London, August 29th. A. G.

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THE ENGINEER.

SEPTEMBER 2, 1887.

SAVING LIFE AT SEA.

THE Select Committee appointed in the early part of the year to investigate the existing laws and regulations regarding the boats, life-buoys, and other life-saving apparatus required to be carried by British merchant ships, have recently handed in their report to Parliament. Following closely upon this, the long-looked for report of the Royal Commission on Loss of Life at Sea, which was appointed more than two and a-half years ago, has been given to the world. Both inquiries had their *raison d'être* in the desire to reduce the heavy loss of life through marine casualty, but the Select Committee have seemingly restricted their attention to the means employed to minimise the fatal effect of such disasters, while the Royal Commissioners have sought to ascertain and provide a remedy for the more radical causes of such occurrences.

With regard to the inquiry on life-saving appliances, it may with propriety be asked how many more such investigations will be considered necessary before definite action is taken in the way of giving effect to what previous inquiries, as well as the present, have shown to be absolutely needful. The questions with which the Committee have been concerned formed the subject of a thorough investigation some time ago by a Departmental Committee of the Board of Trade itself, which, in addition to examining witnesses, visited ships, inspected patent boats, rafts, and life-saving appliances, and finally presented a full report, in which it was abundantly shown that existing arrangements required considerable alteration. The present regulation, by which only two life-buoys are required to be carried by any ship, irrespective of size or of the particular service in which she is engaged, is an ancient absurdity. Not only so, but in regard to lifeboats, life-belts, and other like appliances, the regulations in force are relics of a bygone order of things, and a miserable travesty of what under modern conditions is now indispensably necessary. The most flagrant anomaly is the oft-criticised one respecting the number and capacity of lifeboats. The regulations affecting them, as also the other matters named, were framed at a time when nearly the whole of the passenger traffic was carried on by wooden sailing ships of from 1000 to 1500 tons. The tonnage at that time gave an accurate enough basis upon which to fix the boat capacity, but the changed conditions which obtain to-day, through, among other things, the substitution of steamers for sailing vessels, render the tonnage basis wholly inapplicable. Thus, we find that no vessel over 1500 tons can be compelled to carry more than seven boats, although their cubic capacity may increase somewhat with further increase in tonnage. Under this inadequate and inelastic arrangement passenger steamers and emigrant ships are found traversing the ocean and dangerous channels with hundreds on board for whom there is no boat or other life-saving accommodation, while perhaps cargo vessels are burdened with a plethora of boats, greatly in excess of any use the crew could possibly put them to in an emergency.

The regulating condition with respect to the number and capacity of boats ought clearly to be referred to the maximum number of passengers for which there is carrying accommodation on board. There are, of course, admitted difficulties in the way of carrying and manning a sufficient number of boats of the ordinary description to accommodate the whole number of passengers and crew of many of our largest vessels. These difficulties have not by any means been got over by the Committee's deliberations, but they are, nevertheless, clearly set down, and, in face of them, the opinion expressed that all seagoing passenger ships should be compelled by law to carry such boats and other life-saving apparatus as would in the aggregate best provide for the safety of all on board in moderate weather. Of everything that might be made contributory to life-saving, in the opinion of the Committee, advantage ought to be taken. In passenger ships all seats, chairs, stools, lockers, and other movable articles on the decks suitable for flotation should be sufficiently buoyant to be capable of supporting one or more persons in an emergency. In the same way, rafts might be employed, and prove specially valuable in moderate weather, as a temporary means of flotation. On the whole, the deliverance of the Committee on the subject of boats, buoys, and life-saving appliances is more explicit than usually results from such inquiries, and it is to be hoped the anomalies and imperfections to which attention is once more directed may speedily be removed, or remedied by Parliament.

The part of the report above all others, however, from which tangible good may be hoped for, is that where the recommendation is made that a Committee should be appointed—a permanent one, it is presumed—whose duty it would be from time to time to frame rules on the subject of life-saving measures and appliances. Such rules would require the sanction of the President of the Board of Trade, and would be on the table and be open to challenges in either House of Parliament for a certain period, before acquiring the force of law. Such a Committee might consist of fifteen members; of whom three should be nominated by shipowners, three by shipbuilders, three by persons practically acquainted with the navigation of vessels, three by recognised associations of seamen, and three by Lloyd's Register and kindred societies. In order to enlist the assistance of thoroughly practical men—with whom time generally means money—it is suggested that members should be paid such travelling expenses and other remunerations as the Board of Trade may determine. This proposal is, in effect and principle, the same which has for some years been advocated by many familiar with the peculiar needs of the shipping industry and with the glaring defects in the constitution of the marine department of the Board of Trade. Mr. Chamberlain, it will be remembered, favoured the institution of such a council, or advisory board, while he was connected intimately with the shipping controversy. The Load-line Committee, consisting of Sir E. J. Reed and a body of eminently representative authorities, impressed the same scheme on Parliament in the memorable memorandum to their report. We heartily wish to see a fulfilment of these repeated recommendations; not so much because of the functions such an advisory board would exercise in regard to the hundred-and-one minor life-saving appliances brought into requisition when a vessel gives evidence of going to the bottom, but on account of the powerful influence it would exercise in reducing the chances of a vessel ever getting into such a situation. "The proper placing of bulkheads, so as to enable a ship to keep afloat for some length of time after an accident," says the Select Committee's report, "is most important for saving life at sea, and a matter upon which the full efficiency of life-saving appliances largely depends." The Committee think it only right to state this after having heard the evidence, although the question of construction was not originally referred to them. They might have said while on the subject, that with the proper placing of bulkheads all, or at least a large proportion, of the care and expense implied in the possession and maintenance of a mass of life-saving appliances of the "full efficiency" would be rendered needless. The task of improving and maintaining an increased number of life-saving appliances in disregard of the unsatisfactory state of sub-division may be compared to a nervous regard for the water-tightness of the house roof when the foundations are known to be rotten and open to the assaults of insidious floods. Life-rafts, buoys, and belts, if disposed in such a way about the vessel as to be easily made use of, are certainly not despicable advantages in an emergency; but of what avail are any number of good-conditioned lifeboats and rafts—firmly lashed and difficult of management as they usually are—in emergencies such as that of the Kapunda disaster, where the vessel sank, through lack of water-tight sub-divisions, a minute or two after the colliding vessel had struck?

Sub-division, as an efficient means of rendering both ships and their living freight safe against fatal disaster, has never received the urgent advocacy its vital importance demands. Ever since the repeal in 1862 of that portion of the Merchant Shipping Act of 1854 relating to sub-division by bulkheads, the matter has been left entirely to the caprice of owners, or to the coddling influence of several outside bodies whose functions somewhat overlap those of the Board of Trade. The Admiralty, through the inducements they were enabled to hold out in the way of probable State employment, have been instrumental in furthering to a gratifying extent sub-division of the largest class of merchant steamers, and Lloyds' Register, exercising the power they possess, have stipulated for an increased number of bulkheads in steamers within recent years. The great bulk of merchant steamers, however, and of sailing ships—especially those engaged, like the Kapunda, as emigrant or pilgrim carriers—are still grievously deficient in bulkheads. For this state of matters no Act of Parliament nor Registry regulation affords a remedy. The reason given for the repeal of the provisions relating to bulkheads was that they were found totally inadequate to meet the end in view. Only two bulkheads were required, irrespective of the size of the vessel, and these were to be placed at nearly equidistant points throughout the hull, and were intended to prevent the ship from sinking. In this there was, of course, ample grounds for a revisal of the provision, but none for its total repeal. An enlightened and thorough revision of the enactment to meet the necessities of the time, and framed in such a way as to meet the growing wants and circumstances of the future, would have been infinitely more effective and praiseworthy than the discarding of all responsibility. Doubtless it was thought that self-interest and the influence of the insurance and registration societies would lead to efficiency more than any statutory provisions.

Fortunately, as things have happened, sub-division has been practised, and to a certain extent nurtured, by the bodies already named. Commercial considerations alone have long been the main obstacles in the way of the system reaching thorough efficiency. These objections, however, have been gradually lessened, as experience has been gathered from the measure of sub-division that has existed, and as shipbuilders have been enabled to improve the structure and equipment of vessels. The time now seems to have arrived when vessels must be sub-divided by bulkheads, with reference to life protection, and not alone with regard to structural strength, and the protection of the propelling machinery, when the expenditure for life-saving equipment must be put into strong and tight divisions, and not into the hundred-and-one portable appliances usually advocated. Several things point to the way being cleared for this desirable consummation of life-saving effort. The report of the Royal Commission on Loss of Life at Sea, referred to at the outset, strikes at several of the obstacles lying near the root of the matter. One of these is the admitted facilities for over-insurance, and the consequent carelessness as to the fate of shipping property. If the self-interest of the general body of shipowners can be made more dependent on the efficiency and thoroughness in building and navigating of vessels, the welfare of passengers and crew alike will not be a matter of such uncertainty. On these grounds, the report makes several recommendations regarding marine insurance which it is to be hoped may become law. Of these, the principal one is to the effect that every shipowner insuring his vessel should retain uninsured interest in her to the extent of 3 per cent., and that all claims on the policy, whether for partial or total loss, should be subject to this deduction. Naturally this does not meet with acceptance from the shipowning section of the Commission, and they have protested. But the arguments they employ, as regards being permitted to share the right with all other trades of protecting their property by insurance, are only forcible when used in disregard of the exceptional and hazardous nature of their enterprise.

The Committee or Advisory Board, suggested in the report of the Select Committee, might, with all appropriateness, take up the functions which the Board of Trade discarded at the time of the repeal of the statutory provisions as to bulkheads. The vital subject of sub-division should again appear in the statute book, and in a form calculated to cover future development. The extent of sub-division might be referred to the character of the service in which a vessel is to be engaged, and be regulated according to the number of passengers for which she is fitted, or according to her load displacement. Thus, in the case of a vessel entirely employed in cargo carrying, only the degree of sub-division presently existing might be imposed, or it might simply be left to the care of the insurance and registration societies on the grounds that the boat accommodation would be ample for the use of the crew in an emergency. In the case of a vessel carrying passengers chiefly, and especially when the number is of necessity greater than there is boat accommodation for, sub-division should be regulated by a comparison of the actual with the possible floating displacement. In other words, the sizes of the several compartments into which the vessel would be divided should be regulated—as is at present the case with vessels on the Admiralty List—by the amount of surplus buoyancy of which she is possessed. In no case should there be any two compartments of greater capacity than, if filled, the vessel would sink. Such regulations, however, the Advisory Board, constituted as proposed, would find easy of adjustment. Whatever measure of approval the other recommendations of the two reports may meet with from Government, or the public at large, it is to be hoped that this matter of an Advisory Council will commend itself entirely to all concerned. Its institution would definitely further the cause of live-saving at sea to an extent for which, as experience has already shown, we may look long and vainly from Committees of enquiry merely.

GERMAN COMPETITION WITH BRITISH SHIPPING.

We recently devoted an article to the results now ascertained to have followed from the system pursued by the German Government of granting bounties to those of its subjects who became proprietors of shipping. It was shown in that article that those bounties were insufficient in amount to ensure profitable results to German owners in the fierce competition to which restricted trade and superabundant tonnage had given rise during the last few years. But although such has undoubtedly been the issue to the system, it is impossible to be blind to the fact that the bounty system has worked severely against the British shipowner in this competition. It could hardly be otherwise—at least in some trading directions. German shipowners start well handicapped by the bounties referred to; they are free from restrictions imposed by Government regulations on our own shipowners, and their crews are almost invariably composed of men among whom as yet the evil side of trade unionism has not been developed, while they will accept lower wages than are demanded by the sailors and others of the crews of our own mercantile marine.

It will be of interest to note any facts which tend to show how far in this war of competition the interests of British shipowners have become affected. A single instance—which is typical, however, of some others of similar character—may be quoted in illustration. We have it on official authority that although in 1880 the German tonnage finding employment at the port of Nagasaki, in Japan, was less than one-twelfth of the British tonnage working that port, it had risen in 1886 to one-third of the figures denoting the latter. Moreover, we learn from the same official source that during the interval between the two years named, the German tonnage employed had increased *tenfold*, while that of British nationality had but little more than doubled. Now, looking at this single instance, and regarding it, as we believe we must do, as being illustrative as to what has taken place in the same interval of time at many other places where the British and German mercantile marine are competing, it must be admitted that it opens out ground for much fear for the future. We see that during the years in which British tonnage has been to a large extent laid up as unable to find profitable employment, German vessels have been active in superseding us in the trade that might, had conditions been more favourable to our own ships, have been secured for them. We have before asserted how difficult it is when the course of trade flows towards the ships sailing under one flag for those registered under another to divert it. Prominence was given to that contention in the article above referred to when pointing out how hard must be the conditions under which Germans would have to secure trade already carried by ourselves. We cannot therefore disregard the evidence given by the figures above quoted that, in some degree at least, the Germans have been successful in overcoming that difficulty. The argument we employed against them is, in this instance, turned against ourselves.

Some of the reasons, and those the most patent, which have tended towards obtaining that success we have referred to above, and their potentiality and their certain effect cannot be denied. Nor do we see the least reason to hope that the restrictions which our own advanced civilisation imposes upon us have the least prospect of being soon balanced by other nations following our humanitarian lead with respect to them. They must, therefore, remain for an altogether indefinite period a heavy incubus on the British shipowner in his competition with the foreigner. But the question presents itself to our mind as to how far such disabilities would stultify us in such a competition did they stand alone. We believe in British pluck, energy, and skill being quite equal to counterbalancing them, and must seek, therefore, for some other factor weighing against us in the race. We fear we have not to seek far for it. The same characteristics, which are largely conducing to the ousting of our own countrymen in London, are telling in the department of which we are writing. The foreigner can and will do more, and for less pay, than our own people, and the British shipowner must either ship crews of foreigners or be as worsted in his contest as is the London clerk. We do not write of this matter without experience to warrant our doing so. We have lain alongside of ships in Eastern ports, and have seen that at the striking of the four bells of the evening the British sailor has laid down every load and ceased work, however urgent may have been the demand for the dispatch of his vessel. On the German or Norwegian ships alongside, their crews have pursued their task until it was completed.

How severely this indisposition to meet exigency tells against the British shipowner, may be gauged by a further statement of the official report to which we have made reference. It says:—"Charterers decidedly prefer German to British vessels by reason of the dispatch given by German shipmasters, in a great measure due to the ready and indefatigable assistance of the officers and crew, which compare very favourably with the attitude frequently assumed in other cases. In the case of one large shipping firm, owing to these reasons, it can always afford to give better terms to the Germans." We fear we must not rely too much, while such distinctions are possible between our own and foreign practice, on the failure of the German bounty system to stay the evil effects to ourselves of foreign competition. As a nation, we are possessed of many advantages which are not given to the foreigner. They enable us to make head to some extent against the cheaper labour by which his vessels are worked; but there are moral disabilities, it is certain, which must be removed if we are to cease in the future to see British shipping supplanted by our German friends to the extent that it has been of late years at the Port of Nagasaki and elsewhere.

AEROSTATION AND AERONAUTICS.

Three years ago we had occasion to refer to a balloon voyage accomplished in France by Captain Renard, at that time director of the balloon works at Meudon, and Captain Krebs, his assistant. The voyage was remarkable as being apparently a successful attempt to navigate a balloon, and the rate of travelling was not altogether slow. The account given was that the balloon went seven miles out, travelling against the wind, and then came back again, so as to descend at the point from which the eronauts originally started. This was, therefore, an instance of actual aerial navigation. M. Hervé Mangon presented a report on the subject to the French Academy of Sciences, and declared that August 9th, 1884, the day on which the feat was accomplished, would be "for ever memorable in the annals of discovery." The world has not been much the better for the discovery so far. For land journeys we have still to rely on the railway service, and if we seek to cross the ocean there is nothing superior to a big steamship. A sensational ascent has been recently effected by MM. Jovis and Mallet in the balloon Horla, the object being to reach the greatest practical altitude, which in this instance proved to be 7100 metres, or rather less than 4½ miles, whereas Mr. James Glaisher, accompanied by Mr. Coxwell, ascending at Wolverhampton, in 1863, attained an altitude of about 7 miles, though at the imminent peril of life. But M. Jovis has something yet in store. According to the account of an interview with this gentleman by a representative of a daily contemporary, M. Jovis is going to undertake a balloon voyage from New York to the coasts of Europe. The wisdom of attempting to come rather than to go is evident. The chance of a favourable wind from the west is far greater than one from the east. M. Jovis will wait at New York until a convenient storm presents itself, and will then made his start on the wings of the tempest. "You expect to leave New York in October, I believe?" said his interrogator. "It is impossible to say," was the reply. "We may have to wait till December, or even January, for an atmospheric disturbance which may be expected to cross the Atlantic and pass along our coasts." The utility of all this seems doubtful. To wait for an indefinite period, and yet to be always ready to start, will fail to suit the convenience of an ordinary traveller, however well it may adapt itself to the designs of M. Jovis. Simply to go the way the wind blows implies nothing very scientific. On this plan, at some date inside the next twelve months, M. Jovis may undertake to go anywhere within a range of three thousand miles. What possible good there is in this project for an Atlantic voyage we cannot see. The affair is "sensational," like the recent ascent, and we are at a loss to make anything else of it, supposing the scheme to have any real existence. The balloon is to be called "La France," and is expected to be complete about the end of the present month, when it will be packed up and taken from Paris to New York. It is to have a diameter of 27 yards, but 8477 cubic yards is said to be the extent of the capacity. This would be about 13,500 cubic feet beyond the size of the great balloon in which M. Nadar made two ascents in the autumn of 1863, when he expected to steer by means of a screw. The balloon in which M. Jovis proposes to cross the Atlantic will therefore be the largest yet made. When Professor Wise was intent on an aerial voyage from New York to Liverpool, in 1873, he proposed to employ a balloon yet larger than that which M. Jovis contemplates, the horizontal diameter being 100ft., and the vertical axis 110ft. There was also to be a supplementary balloon, with a diameter of 36ft. Despite the great size of the main balloon, it was reported to be inadequate for the task to which it was to be devoted. If this conclusion were correct, M. Jovis appears to be seriously under-estimating the conditions of success. However, he is said to be busily engaged in superintending aeronautic affairs at the headquarters of the French Balloon Society in the Boulevard Clichy. His assistant, M. Mallet, is to accompany him in his Atlantic voyage, and it is reckoned that the transit from New York to Europe will only occupy from forty-eight to sixty hours. The balloon is believed to be capable of keeping aloft for a period of four days.

But Captain Renard, now Chief of the Military Balloon Service at the camp of Chalons, is once more on the scene, and promises to excel his former achievement. Instead of making headway, as in 1884, against a current having a velocity of five metres per second, he undertakes to resist a current of double that strength. This means that his balloon is to be propelled, in virtue of some self-contained power, at a rate exceeding ten metres per second, or 22 miles per hour. On the former occasion the balloon was said to have travelled 14 miles in about 40 minutes half this distance being accomplished against an aerial current of about 12 miles per hour. Supposing these data to be correct, we reckoned that the inherent speed of the balloon must have been 26 miles per hour. Facing a current of 12 miles per hour, a balloon so propelled would have a geographical velocity of 26 − 12 = 14 miles per hour. It would therefore expend half an hour in going out seven miles; but in returning it would have a geographical velocity of 26 + 12 = 38 miles per hour, and would therefore accomplish the return journey of 7 miles in 11 minutes. The entire trip would accordingly occupy 41 minutes, the time stated being "about 40 minutes." To drive a balloon along at the rate of 26 miles an hour is no small achievement. In commenting on this affair in 1884 we recorded our opinion that the narrative was "extraordinary," and we expressed a desire for some explanation. Now at last we find it stated that Captain Renard is going to travel faster than ever. There is a slight reduction in the velocity of the current which is said to have been encountered three years ago, but the discrepancy is simply 11 miles per hour instead of 12, and the coming feat is to consist in resisting a current equal to 22 miles per hour. So far as mere "resistance" goes, Captain Renard could have coped with such a current as this in 1884. The geographical speed under such conditions would have been 26 − 22 = 4 miles per hour. This would be slow travelling, but still it would be something. But even if Captain Renard has really succeeded in doubling his propelling power, it does not follow that he has practically solved the whole problem. To give a balloon an inherent velocity of fifty-two miles an hour is to do battle with the storm, and to encounter an atmospheric pressure equal to more than 12 lb. on the square foot. If the line of propulsion is below the central line of atmospheric resistance, a balloon propelled with a force equal to this would speedily turn a backward somersault and the car would find its way to earth. If, on the other hand, the line of propulsion coincided with the line of resistance, the balloon would simply be torn to shreds. The fact must be that there is an error as to the speed of the current in 1884, and also the distance travelled over. Fourteen miles in 40 minutes means twenty-one miles per hour, without taking any current into account. This of itself is equivalent to a brisk wind, exercising a pressure of more than 2 lb. on the square foot. The present project is that of facing a current travelling at the rate of twenty-two miles an hour, and if the former affair is to be considered as correctly reported, the forthcoming speed—if it is to be doubled—must be above fifty miles an hour. Possibly something less than doubling the inherent velocity of the balloon is contemplated, although a current of two-fold force is to be overcome. But at least thirty miles an hour must be reckoned upon, and forty would seem more in accordance with the promise given. The latter speed would occasion a pressure of nearly 8 lb. on the square foot of a flat surface struck perpendicularly.

But we may carry this matter a little further. The apparatus employed in 1884 is said to have included the use of certain electric accumulators, capable of supplying the power of ten horses for four hours. According to the account given, the balloon must have been propelled at a velocity exceeding twenty miles an hour. We will simply calculate on this basis, involving a pressure of 2 lb. on the square foot, supposing the surface to be flat and the force perpendicular. From this we will make a reduction, as the balloon presented an oblique surface to the impact of the atmosphere. To give the scheme every chance, we will put the pressure as low as 1 lb. per square foot of the sectional area of the balloon. But if the speed is to be doubled the resistance will be quadrupled, making the pressure 4 lb. per square foot. Discarding the force requisite to raise the balloon, we will simply consider the atmospheric resistance in a horizontal line. The propelling force derived from an engine of 10-horse power is equal to 330,000 lb. per foot per minute, or 1 lb. at the rate of 330,000ft. in a minute. Twenty miles per hour is equal to 1760ft. per minute, which, with 10-horse power, allows a total resistance of 187 lb. At the rate of 1 lb. per square foot this gives an area of 187 square feet, corresponding to the sectional area of a sphere having a diameter of about 15½ft. Captain Renard's balloon is described as elliptical in form. If we take it as equivalent to a cylinder having a length equal to 60ft. on a diameter of 15½ft., the length is as great as symmetry and safety would permit. This would give a cubical content of 11,220ft. The enclosed gas is not likely to have a greater buoyancy than one ounce per cubic foot. Hence the gas would lift 700 lb., from which the weight of the envelope must be deducted. Of course, a much larger balloon must be intended, with a corresponding increase of the sectional area and the atmospheric resistance. The speed, also, is to be doubled, raising the pressure to 4 lb. per square foot. Calculate as we will, we are at a loss to understand how anything like the expected speed can be obtained. Neither can we understand the results said to have been achieved three years ago. That something may be done in the way of propelling and steering a balloon we will admit. The steering is distinctly dependent on the propelling power, and this has to contend with the resistance of the atmosphere to the passage of the balloon, presuming that the gas gives sufficient buoyancy in the first instance. The balloon must be allowed some amount of dead weight, in order for it to be manageable; but this need not be much, and we have favoured the adventure by not taking this load into account.

The prospect of navigating a balloon with a useful velocity through the air seems very remote. But Captain Renard is sanguine, and the fact that he went out and came back again on the same line of route is certainly enough to make a man think that he can do something. His balloon must have possessed some inherent velocity, and, therefore, some steering power, in order for this to be accomplished. But the state of the atmosphere, and the distance traversed in the forty minutes, are elements which require to be carefully and correctly estimated. For the present we cannot conceive how a speed of between twenty and thirty miles an hour could be imparted to a balloon by machinery suspended in a car, or, indeed, attached to the balloon in any way. Still less can we conceive how this speed is to be doubled, involving, as that does, a fourfold increase of atmospheric resistance. Instead of being told that Captain Renard is prepared to resist a current of twenty miles an hour, we should prefer being told what speed he is prepared to attain in a dead calm. This known, we can easily learn all the rest. At present the main points are obscure. Captain Renard is nevertheless so sure of success that he is taking elaborate pains to conceal the exact nature of his invention. His machine is being made in separate parts, distributed over various establishments in France. The construction is to be complete in about a month, when the invention is to be put to a practical test without delay. We may hope that some measure of success will attend the effort, though our expectations are much more moderate than those attributed to Captain Renard. If M. Jovis is to be considered a competent authority, there is very little hope of "forcing a balloon against the wind." In his opinion any such attempt "would probably end in the bursting of the balloon." He may be supposed to know something of what Captain Renard has done, and yet he is described as saying that "little or no progress has been made towards solving the problem of steering the balloon." Hence M. Jovis prudently relies on a special acquaintance with meteorological science, so as to catch the varying currents of the atmosphere and gain the requisite propulsion from the wind. After all, this only amounts to aerostation. The science of aeronautics seems to be, on the whole, still somewhere "in the clouds."

GOODS AND PASSENGERS ON RAILWAYS.

WE are now at the period in the year when the passenger traffic on all the great arterial railways is at its highest, and it is interesting to see how greatly the traffic fluctuates and how difficult it is to arrange economically for so much and so little work. As a general rule, the passenger traffic on railways rises and falls in a somewhat opposite manner to that of the other classes of traffic. If we take, for instance, the Great Western Railway, we shall find in one complete recent year the following facts:—In the first week of the year the passenger traffic averaged £8500 daily. It fell thence until about the end of February, when the takings were on the average £7000 daily. From that time it rose with a regularity only interrupted by holidays and similar causes until a little past the middle of August. At that period of the year the daily takings of the Great Western Railway from its passenger traffic averaged £15,000, so that they were about double the amount of that at the beginning of the year. The goods traffic does not show such variations. It fluctuates between £10,000 daily in August up to about £13,000 in the last month of the year. Whilst the passenger traffic is rising the goods traffic is falling. It may be that this is partly due to the decline in coal receipts; for in the summer and early autumn, when the holiday traffic sets in, the coal requirements are usually at their lowest; whilst in the winter, when travel is more difficult, the coal requirements are usually heavy. Our greatest railway shows the same characteristics. On the London and North-Western the takings from passengers vary from £8000 daily in the early weeks of the year up to £19,000 daily about the middle of August; and the goods and mineral traffic receipts are usually the least in the early autumn, rising as the winter passes on. Local circumstances—the holding of great gatherings in different parts of the country—may at times affect this diverse rule, but it is none the less general in its holding. It furnishes a valuable counterbalance in the revenue of the companies, but it still allows the prevalence of what are emphatically termed "lean" and "fat" half years. Gradually, however, there are sources of railway traffic springing up which are more constant, though their growth is not quite as rapid as could have been desired. The mail traffic is tolerably regularly dispersed, and so is the parcel traffic. Though there is a determination of parcels to particular periods, yet these periods are in the two different halves of the year; and there are other parts of revenue which are growing a little larger—the season tickets and excursions, which are now widely spread over the bulk of the year; but still the passenger traffic as a whole shows the great and general fluctuation to which we have referred. It should teach the managers of railways to cultivate other sources of traffic, so that the two halves of the year may be more uniform in their results. Taking another railway, the total traffic receipts vary from rather under £5000 up to as much as £11,000 per week, and thus the work is unequal on the staff, and the cost of working in the periods necessarily varies. If uniformity could be attained by "levelling up" it would be a benefit.

OPENING OF THE ROATH DOCK, CARDIFF.

WE briefly noted the opening of this dock last week under most favourable circumstances, and now give particulars. The Bill was obtained in 1882, and in the same year the contract was let to Messrs. T. Nelson and Co., Carlisle, who have carried out the undertaking in a most satisfactory manner. The 20th June, 1883, saw the foundation stone laid by Sir W. T. Lewis; the 8th March witnessed the completion by the placing of the last coping stone by Mr. McConnochie. Excluding the lock, which is stated to be the largest in the world, the area of the dock is 33 acres, and the length of quay space, including the jetty, 7520 lineal feet, nearly 1½ mile. The lock is 600ft. in length between the gates, three in number, constructed by Sir W. G. Armstrong and Co. They weigh collectively 900 tons, are worked by hydraulic machinery, and are provided with the latest improvements, and being on the buoyant principle, are moved with the greatest ease. It was evident at the opening that the swinging was perfect. The walls of the dock are 24ft. thick at the bottom, 12ft. 6in. at top, and 50ft. 6in. from foundation to coping in height. The height from the coping to the cill is 43ft. 6in.; height of water over the cill, 36ft. at high water ordinary spring tides, and 26ft. at ordinary neap tides. The sluice machinery is by Tannett and Co., of Leeds, who, with Sir W. G. Armstrong and Co., have also supplied movable hydraulic cranes for iron ore and other imports. A speciality very noticeable are the coaling cranes—Lewis and Hunter's patent. These are placed on the south side, and are creditable to the patentees and to the Leeds firm, Messrs. Tannett and Co., which turned them out. The Roath Dock is so constructed as to admit of the greatest aid being given to a future trade of Cardiff. The old lines are, of course, coal and iron ore; the new ones embrace a prospective import trade. Hence we find accommodation for consignments of live stock, a place for slaughter-houses and refrigerators, and all the many necessities which the new branch may require. On the west side the Wallsend Pontoon Company has leased a portion of the dock for a graving dock. Tyneside will be represented, and we fully expect to see other industries spring up, and there is no reason why, with all the dock and railway facilities, a new impetus should not be given by this dock to Cardiff prosperity.

THE RICHMOND MAIN DRAINAGE BOARD.

THE Royal Assent was given last week to the Bill confirming the provisional order constituting the Richmond Main Drainage Board for the purposes of Richmond, Barnes, Mortlake, Kew, and Petersham. The Richmond Vestry and the Richmond Rural Sanitary Authority can now appoint their representatives on the Board, and the Board will then be able to proceed with the carrying out of the scheme of Mr. Melliss, C.E., to which the Local Government Board have already given their assent. The estimated cost of the works is nearly £100,000. The proposal, it may be remembered, is to collect the sewage of the five parishes upon land on the river-side between Kew and Mortlake, and there to treat it by a scheme of chemical precipitation, allowing only the purified effluent to escape into the river. A lock and weir at Isleworth is an improvement which all interested in the river from Teddington to below Richmond have for many years desired. The objection to its construction hitherto has been that under the existing drainage system a lock and weir would convert the river above, as far as Teddington, into a pool of sewage. One objection will, by the adoption of Mr. Melliss' scheme, be removed; and this incidental advantage of the scheme is considered of much importance in the districts affected.

A YEAR'S MINING BILL.

ONE of the ablest and most energetic of her Majesty's officers who have to deal with the collier and his perilous calling is Mr. Frank N. Waddell, Chief Inspector of Mines for the Yorkshire and Lincolnshire district. In his report for the past year he states that in the whole of the mines of Great Britain the aggregate number of persons employed in 1886 amounted to 561,092, of whom 5568 were females above ground. There were 869 fatal accidents, and the total number of deaths occasioned thereby was 1018, being an increase of three in the number of fatal accidents, and a diminution of 196 in the number of lives lost compared with the totals for the preceding year. The minerals wrought in the different districts weighed 170,006,959 tons, of which 157,518,482 tons were coal, and 8,862,648 tons ironstone, the rest being oil shale, fire-clay, &c., being a total decrease of 3,217,001 tons compared with 1885. Coal has decreased by 1,832,936 tons, and ironstone by 1,245,964 tons; 210,665 tons of mineral were wrought for every fatal accident, and 178,391 tons for every death, as compared with 214,651 tons and 150,629 tons respectively in the preceding year.

AIR BRAKES IN THE UNITED STATES.

"IT is an ill wind that blows nobody any good," must be the sentiment of the Westinghouse Brake Company, which in consequence of the recent collisions on the Baltimore and Ohio Railway, has now to supply its automatic brakes for all trains on this line. The collisions in question were, it seems, caused by the failure of the Loughridge non-automatic air-brakes, and though this company has now shown its good sense, it is an unpleasant reflection that changes of such importance only take place after the spilling of blood, and the quantity required appears to vary in different countries, and on different lines in the same country. We learn that up to June 30th there have now been ordered over 141,000 Westinghouse brakes.

LITERATURE.

Die Schiffsmaschinen, ihre Construction, Wirkungsweise, und Bedienung. Ein Hand-und Nachschlagebuch fuer Ingenieure, Offiziere der Kriegs-und Handelsmarine, Maschinister, Studirende, Technischer Hochschulen, Rheder und allen interessenten der Dampfschifffahrt. Bearbeitet von CARL BUSLEY. Kiel: verlag von Lipsius und Tischer. 1886.

THIS is the second part of a really important specimen of German painstaking minuteness and completeness in the production of a book. The first part was very favourably noticed in THE ENGINEER of 9th May, 1884. The value of an engineering book depends upon the degree to which it fulfils one or other of a set of entirely utilitarian requirements—on the extent to which it supplies information that can be understood and practically employed, whether its intended destination be the college or the office or works. A book may be only descriptive or it may be at the same time suggestive, but we must be satisfied if it conveys to others an intelligent account of the way in which certain things have been done by practical men, although its value is enormously enhanced if it at the same time draws the deductions from what has been done that will enable others in the future to arrive more readily at design and proportions, and produce a better result or similar result in a more economical manner. A book upon a branch of engineering always deals with things that have been initiated and brought to a certain stage of development or success. Things are almost never originated in books, so we must be satisfied if, for the guidance or information of ourselves and those to come, a book is a true chronicle, and if the theories which the author supplies in connection with it are correct.

Herr Busley's book is excellent as a careful and complete description of almost everything in marine engineering machinery and apparatus that is worth either illustration or description. There is no other book published which presents with anything like completeness the machinery and apparatus of a ship, the coloured lithograph plates being both full, accurate, and very clear; in fact, the book is valuable for the lithographs alone, almost all of which may be looked upon as working drawings. The descriptions are clear, though in some cases lengthy. It is very evident that the author has made full use of his double position as engineer in the Imperial German Navy and professor in the Royal Academy at Kiel, for English marine engines, boilers, propellers; torpedo boats, engines and boilers; the results of trials with English engines, vessels, torpedo boats, screws, and the British experiments with models to ascertain the resistance of ships and the efficiency of propellers are all dealt with.

This second volume deals with the size, practice, and strength of the steam cylinders and their various parts and connections, the motive parts outside the cylinders; condensers and condensation; air pumps, circulating and other pumps, steam jet apparatus, including ejectors, injectors, and water raisers, and so on; the miscellaneous apparatus of marine engines; the erection or fixing of marine engines, including the size and strength of the frames and bed-plates; specifications of engines up to 4000-horse power, the indicator and indicator diagram, the working and management of the marine engine, and at great length the screw propeller and screw propulsion; the whole forming an especially well-illustrated book worthy of high commendation.

STEEL-FACED ARMOUR TRIALS IN RUSSIA.

WE have received photograph, of which we give copies on p. 198, of a result recently obtained with a St. Chamond steel projectile and a steel-faced plate, manufactured on Wilson's method, at Kolpino, in Russia. The trial took place in July last. The plate measured 12ft. by 8ft. by 16in. The gun was the Obuchoff 12in. breech-loader, 35 calibres long. The projectile was forged steel, weighing 794 lb. Russian and 714½ lb. English. The charge was 245 lb. Russian or 220½ lb. English. The range was 350ft. The shell struck normally with a velocity of 1700ft. This implies a striking energy of 14,320 foot-tons and a perforation figure of 20·2in. of unbacked iron. The plate, being of considerable area, probably weighed 27½ tons, so that the shock per ton of plate is only 522 foot-tons. This, however, does not affect the problem in the usual way, because the blow is very near the edge. The object was not the testing of the plate, but rather the projectile. It may be seen that the latter broke up and failed to get through, but fractured the plate as shown in the photograph, chiefly towards the near edge of the plate. We understand that the makers of the projectile were anxious not to fire any more shells until they had made some change in the quality. This is only an example of what, we think, we must be prepared to expect in England. The steel projectiles have been greatly improved, and their makers expect to get them through our plates as they did in certain individual cases of Firminy, Holtzer, and Hadfield's projectiles, and notably in the samples of a lot of Holtzer's shells, which constitute the first regularly passed into the service. We do not expect that this success can be repeated often. The plates are being now made with harder faces, if not backs also; consequently they will stop the projectiles much more effectually, though at the expense of increased fracture in the plate. The case before us is an example of what we have before stated we expected. This is likely to be repeated at Shoeburyness. At present we do not know how such plates would be regarded at Portsmouth, but we think that the Admiralty will probably accept more cracking as a necessity if the new steel shells are to be kept out.

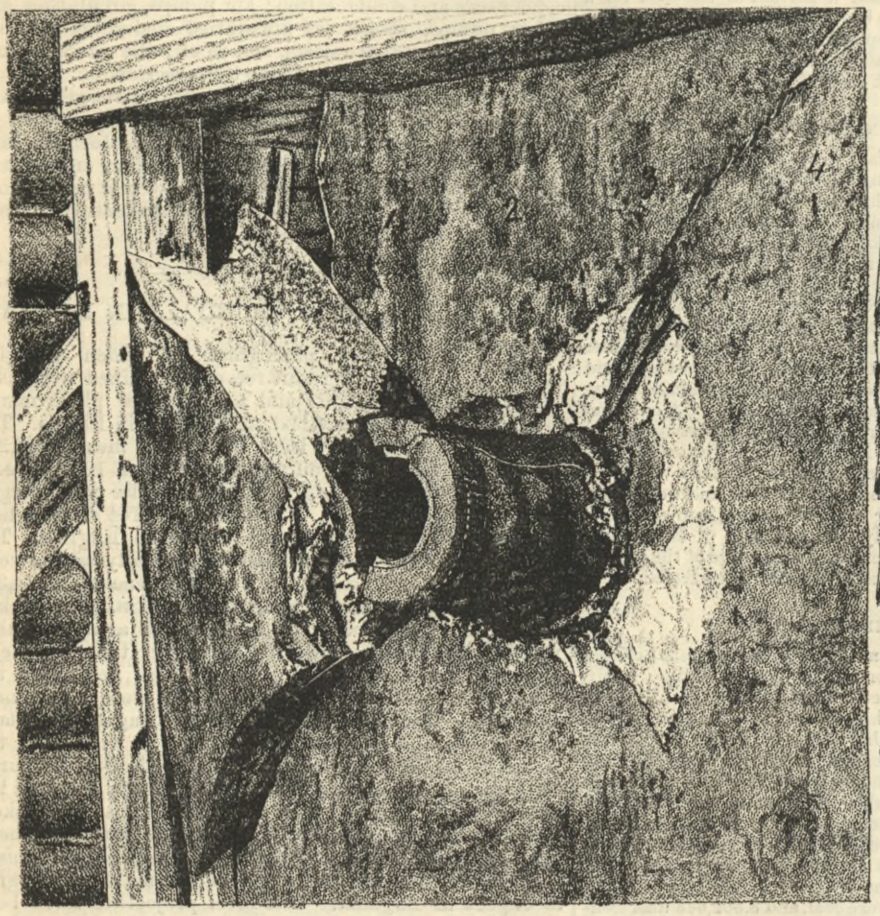
The shell was cracked all over and broken as shown in the illustration above mentioned. The point of it just got through the back of the plate. The base stands out a considerable distance from the face. The result before us ought to keep up the name of steel-faced plates in Russia.

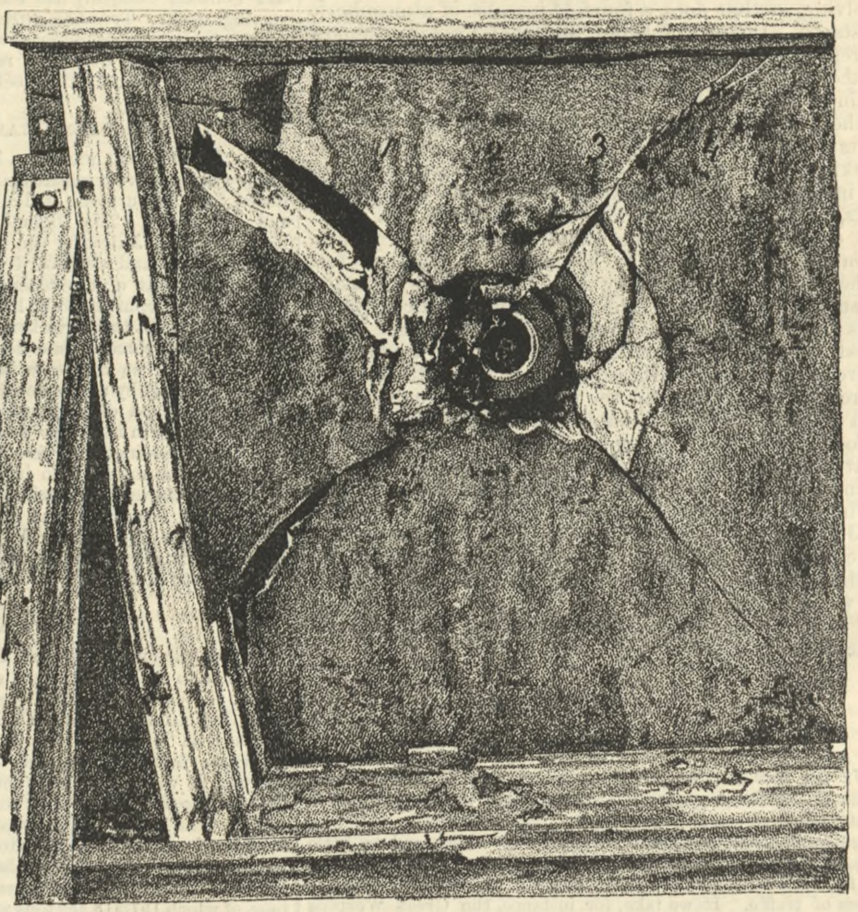
LIMPSFIELD AND OXTEAD WATERWORKS.

ON Friday, July 29th, the waterworks of the above company, situated at Pain's-hill, Limpsfield, Surrey, were formally opened by the Hon. Mrs. Leveson-Gower, wife of the chairman of the company. The company has been formed for the supply of the villages of Limpsfield and Oxtead, Surrey, and the adjoining neighbourhood with water from the celebrated springs at Pain's-hill, Limpsfield, the sole right to use the water having been granted by G. Leveson-Gower, Esq., the owner. The district of Limpsfield and Oxtead, one of the most beautiful parts of Surrey, is twenty-one miles from London, and is becoming a residential neighbourhood, the joint railways of the London, Brighton and South Coast Railway and South-Eastern Railway running through it. The water supply of Limpsfield and Oxtead has hitherto been obtained from wells, some of which have been condemned as unfit for use, while upon the high ground of the district the inhabitants have to depend upon rainwater tanks; or failing these, upon water carted from open ponds. In 1885 Mr. W. Barns Kinsey, M. Inst. C.E., F.G.S., was consulted as to the possibility of the springs at Pain's-hill, situated 370ft. above Ordnance datum, being made available for the supply of the high-level portion of the district up to 600ft. above Ordnance datum, and whether water-power could be used for pumping to the required height. Mr. Kinsey having taken gaugings of the springs, and trial borings having been made by Messrs. G. F. Baker and Son, contractors, Southwark, reported favourably, and a company was formed to carry out his suggestions. Pain's-hill Dell, the site of the company's works, is a natural hollow at the foot of the lower greensand escarpment which has been formed by the action of the spring water. At this point the Atherfield clay, resting upon the weald clay, has been thrown into a fold or ridge due to a local anticlinal, which has caused a dip of the lower greensand beds in a direction opposite to that of the general down-throw in this locality. Strong springs are consequently thrown out which had converted Pain's-hill Dell into a swamp, the water flowing away through a deep channel formed in the clay bed. The geological formation of the ground is peculiar, the junction beds of the lower greensand and Atherfield clay forming alternate bands of sand and marl, each having a water level peculiar to itself. Taking advantage of these conditions, a puddle wall was formed across the dell in the form of a crescent, the foundations resting on solid clay at a depth of 27ft.; the ground within the puddle wall was excavated and deposited outside to form the embankment, the excavation from which the clay had been taken to form the puddle, as well as the old water channel at the head of the valley, being filled in with the excavated material. The formation of the puddle trench was a work of considerable difficulty, owing to a vein of water-bearing sand having been met with between the upper and lower clay bed. This necessitated constant pumping, but the water from the various springs above the level of the top of the bank was

EFFECT OF A ST. CHAMOND PROJECTILE ON A STEEL-FACED PLATE.

(*For description see page* 197.)





carried past the excavation in temporary channels, there being a difference of 18ft. in the levels of the highest and lowest springs within the dell. This enabled two wells to be sunk on the high ground above the reservoir, in which the water stands 15ft. higher than in the reservoir itself. The wells are discharged by means of 4in. cast iron syphons, arranged so as to be self-charging. These are connected to the suction main leading to the pumping-engines, and by means of byepass-valves can either or both deliver to pumps or reservoir. The water of the various springs below the level or the wells is conducted into the reservoir below the water-line, and is stored to give power for working the pumping-machinery.

During the time the pumps are working the water of one well is sufficient to supply them; the syphon of the second well therefore discharges into the power reservoir, and when the pumps are shut off both wells are so available. The necessary working pressure is obtained by placing the pumping machinery at a distance of 900ft. from the power reservoir, there being a fall of 65ft. in that distance. The driving water is conveyed from the power reservoir in a 6in. cast iron pipe, which passes through the embankment above a 9in. cast iron wash-out pipe with stand-pipe overflow within the reservoir, and are surrounded with cement concrete. The valves from the power and wash-out pipes are worked from a bridge in the usual manner. The suction pipe to the pumps is laid beneath the footpath on either side of the power reservoir, and after leaving the embankment is laid in the same trench as the power pipe, and has an available head of 70ft. above the pumps. The power reservoir contains 400,000 gallons, and the wells are capable of yielding about 120,000 gallons per day. The pumping machinery has been specially designed for these works, and was manufactured at New York, U.S.A., by the Worthington Pumping Engine Company, of New York and Queen Victoria-street, London, and is the first water motor of that company's manufacture erected in England, although their steam pumps are well known here, and several waterworks in the United States are supplied by their water motors. In these works two motors are used, one for high level and the other for low level duty, space being left in the engine-house for duplicate sets. The duty required is 45,000 gallons per day to be delivered 220ft. and 320ft. above the pumping station. The high-level motor has two motor pistons, each 5in. diameter by 9in. stroke, with two pumps each 2$\frac{1}{4}$in. diameter and 9in. stroke, with an average piston speed of 20ft. per minute. The low-level motor has two motor pistons, each 9in. diameter by 9in. stroke, with two pumps each 4$\frac{1}{4}$in. diameter by 9in. stroke, and having an average speed of 22ft. per minute. The motors are arranged side by side, and are in appearance similar to a horizontal steam pump. The power pipe enters at the centre of the engine-room, and delivers right and left to each motor. The suction pipe is brought in above the power pipe, and similarly delivers right and left to the pumps. The pumps deliver into a 4in. cast iron main for the low level and 3in. main for the high level, a byepass being arranged so that either or both can deliver into either main. Owing to the special arrangements of the valve motion, there is an entire absence of shock, noise, or vibration.

The water used for driving is about four times the quantity lifted, thus comparing favourably with the hydraulic ram, while the slight attention required is a valuable feature. Pressure gauges are arranged upon the pumping mains, so that the attendant can at once tell what portion of the district is being supplied, and the motors automatically govern themselves according to the duty required of them. They have been run as a test for 120 hours without attention or inspection, doing continuous and regular duty during the period. The low level main delivers the water into a storage reservoir containing 27,000 gallons. The reservoir is excavated in the ground at the top of the hill above the pumping station. It is 27ft. 6in. diameter by 8ft. deep, constructed of 9in. brickwork in cement with 9in. concrete backing, and is covered by three 4$\frac{1}{2}$in. brick arches springing from wrought iron girders supported by two cast iron columns. The arches are covered with concrete and finished with 18in. of earth. The service pipe is arranged so that the pumps can deliver into the mains independent of the reservoir. As the high level reservoir is not yet constructed, the district above the 500ft. contour is supplied by continuous pumping against a valve fixed within the low-level reservoir, into which any surplus water is delivered. The length of water mains, 5in., 4in. and 3in. diameter, at present laid is about 6$\frac{1}{2}$ miles of cast iron $\frac{1}{2}$in., $\frac{7}{16}$in., and $\frac{3}{8}$in. thickness, and coated with Dr. Angus Smith's composition. Eighty per cent. of the joints are turned and bored, the unbored portion of the socket being filled in with Portland cement. A large area can yet be supplied by gravitation only. Where lead joints are made no yarn has been used, the joint being first caulked with drawn lead wire and afterwards run and caulked. The mains have been tested to a pressure of 150 lb. per square inch, and the pumping mains to 220 lb. per square inch in the open trench as the work proceeded. The working pressure upon the mains varies according to locality from 140 lb. to 50 lb. per square inch. The works have had the advantage of Mr. Kinsey being a resident of Oxtead, and his consequent personal supervision, in which he has been assisted by Messrs. John T. Sample and G. Van Notten Pole, Studts. M. Inst. C.E., as clerks of works. Each line of main is provided with a district meter, a royalty being payable to Mr. Gower upon the quantity of water consumed. Messrs. G. F. Baker and Sons, Southwark-bridge-road, London, are contractors for the entire works. Messrs. Stone and Co., Deptford, supplied the valves and fittings, and Messrs. J. Tylor and Sons, Newgate-street, London, the meters. The cost of the works has been about £5000. As an illustration of an economical and effective arrangement for the supply of small districts from their own watershed, these works are interesting, and show how readily the springs which in many localities are wasted may be made a source of power and a benefit to the inhabitants.

COMPOUND VERTICAL ENGINES, INDIAN STATE RAILWAYS.

The engravings on page 194 illustrate a vertical compound engine for which tenders were recently invited for the Indian State Railways. The engines are to have cylinders 10in. and 16in. diameter, and 24in. stroke, the revolutions to be 90, the steam pressure 90, and is to be tested and indicated up to 50 indicated horse-power. We shall in future impressions publish detail drawings of this engine fully dimensioned, which will, we think, be found useful and instructive by our student readers.

DESCRIPTION OF THE NEW TAY VIADUCT.[1]

By Mr. Fletcher F. S. Kelsey, M. Inst. C.E.

Site.—The new viaduct across the Tay near Dundee, which has once more established direct railway communication between the counties of Fife and Forfar after an interval of nearly eight years, is situated throughout the extent of the straight portion, which forms four-fifths of its total length, at a distance of 60ft. centre to centre from the old structure. At the north end of the straight a curve of 21 chains radius gradually reduces the distance between them until they join in a common centre line at the point where they cross the esplanade at Dundee. Unlike the old viaduct, the new one carries a double line of railway, and consequently gains enormously in stability from the greatly increased width of the piers.

Dimensions.—The chief dimensions of the new work are as follows:—

South end of Wormit arching to high girders	3585ft.
High girders	3156ft.
North end of high girders to north end of viaduct	3786ft.
Total length = 23ft. short of 2 miles =	10,527ft.

	ft.	in.
Width between parapets	25	6
Maximum with of piers at base..	55	0
Minimum " "	36	0
Maximum headway above high water	77	0
Maximum height of rails above high water	83	0
Minimum " " " "	25	0
Maximum height of piers from foundations to top	141	6

There are in all eighty-six spans, five of which consist of brick arches and the remainder of girder work. Of the brick arches, four of 50ft. span are situated at the southern end of the viaduct, and one of 25$\frac{1}{2}$ft. at the northern end.

Piers.—Seventy-three of these have cylinder bases and may be divided into two groups thus:—Group 1, comprising forty-nine constructed with wrought iron cylinder bases; Group 2, comprising twenty-four constructed with cast iron cylinder bases. The former are in the straight and the latter in the curved portion of the viaduct.

Cylinders.—The portion of the pier below low water consists of two of these cylinders, which, in the case of the piers for the thirteen large spans in the centre of the river, are placed at a distance from each other of 32ft., and in the rest of the piers 26ft., centre to centre. Except in the case of those for piers Nos. 5-14, the cylinders are all splayed at the base, and have a base diameter varying from 10ft. up to 23ft. The 10ft. cylinders which form the bases of twenty-four of the piers in the curve are of cast iron, all above this size being of wrought iron, and made of such a lengtn that when sunk to the required depths the tops might project slightly above low-water level. They are all lined with brickwork filled in with concrete.

Blue-brick shafts and connecting-piece.—From low-water up to high-water level the piers in Group 1 consist of two circular blue-brick shafts of 12in. less diameter than the cylinders. They are filled in with concrete and joined together at high-water level by means of a strong connecting-piece, which also consists of blue brickwork filled in with concrete, the portion between the shafts resting on cast iron girders. In the cast iron cylinder piers —Group 2—the cylinders are continued up to the connecting piece, and cast iron segments of cylinders and plates take the place of the blue brickwork in the connecting-piece itself.

Base of pier superstructure.—On the top of the brickwork, and forming part of the connection, a wrought iron framework made chiefly of channel irons is placed, and securely attached to the shafts below by means of sixteen holding-down bolts of 2$\frac{1}{2}$in. diameter and 20ft. length, which are embedded in the masonry. This framework forms the base for the upper portion or superstructure of pier, which is rivetted to it.

Superstructure of piers.—In the case of piers Nos. 5-64, the superstructure consists of two wrought iron octagonal shafts, as shown in the engraving joined together near the top in the form of an arch; and is composed of plates connected at the angles by means of two splayed channel irons on the outside, and an obtuse angle iron on the inside. Outside and inside T-irons cover the other vertical joints, and serve to stiffen the structure, which is furthered strengthened by means of bracings and horizontal diaphragms placed at intervals inside the shafts. Short cross girders near the top support the cast iron bed-plates for the main girders. The height of these pier superstructures varies from 20ft. to 68ft. In piers Nos. 65-77 the superstructure and connecting piece are combined, on account of the reduced height of the piers, and assume the form of a tapered box, stiffened with channels and tees in the same way as the rest of the piers.

Cylinder sinking.—In sinking the cylinders down to their several depths below the bed of the river, pontoons specially designed for the purpose were used. They were constructed with two apertures in them, of sufficient size to admit of the pair of cylinders passing through them at their proper distance from each other; and were also provided with four cylindrical legs capable of being lowered down to the bed of the river or lifted off it by hydraulic power. During the greater part of the time that cylinder sinking was going on four of these pontoons were employed, the dimensions of the largest being 80ft. × 67ft. × 7ft. deep. The work of cylinder sinking was carried out as follows:—A pontoon having been floated into position and its four legs lowered down to the bed of the river, the two cylinders for the pier were suspended in the apertures; and after having been lined with brickwork were gradually lowered down to the bed of the river by means of hydraulic jacks. The excavation for the cylinders was then proceeded with by means of a subaqueous digger worked by a crane on the pontoon. Owing to the nature of the strata through which the cylinders passed, it was necessary to weight them in order to force them down as the excavation proceeded; in some cases as much as 400 tons were placed upon the cylinder for this purpose. Where silty sand was met with, the use of a centrifugal pump was found to be of great assistance; the continual pumping of the water from inside the cylinder caused the sand beneath the cutting edge to be scoured towards the centre of the cylinder, where it could be more readily got at by the digger. When sunk to their required depths, the cylinders were filled with concrete; and the pontoon was then floated away to the next pier.

Depths of foundations.—The depths of the foundations vary from 6ft. to 38$\frac{1}{2}$ft. below the river bed as the average for the pair of cylinders. The shallowest foundations are at piers 7 and 8, where the cylinders rest on red sandstone; and the deepest at pier 20, which is founded on sandy clay. Thirty-three of the piers, including those for the thirteen large spans, rest on sand foundations,

[1] Paper read before the Institution of Mechanical Engineers, Edinburgh.

nd the average depth to which these cylinders are sunk below he river bed is 26½ft. The work of sinking the seventy-three pairs of cylinders occupied nearly three years and a-half, having been commenced on February 1st, 1883, and completed on July 20th, 1886.

Testing of foundations.—All the foundations of the cylinder piers have been subjected to a weight 33 per cent. heavier than that which they will be required to carry. The test load, consisting of iron blocks weighing half a ton each, was applied at the level of the tops of the cylinders before building the blue-brick shafts upon them. The load on the pair of cylinders varied from 608 up to 2438 tons. Under the gross weight of the test load and the cylinders themselves, the minimum pressure per square foot on the foundations was 3·80 tons, and the maximum 6·80 tons. The subsidence of the cylinders in the latter case was only 1½in. The labour in carrying out these testing operations was very considerable, involving as it did the shifting of about 180,000 tons of weights.

Girders.—Including the wrought iron arches near the north end, there are eighty-one girder spans. The following are the lengths of the girders, taking them in the order in which they are placed in the viaduct from south to north :—

	No. of spans.		Length of girders.
South end	1	of	113ft.
	10	,,	129ft. continuous in sets of 4 and 2
	13	,,	145ft. ,, ,, 3
High girders, 13 spans	5	,,	245ft.
	1	,,	227ft.
	2	,,	245ft.
	1	,,	227ft.
	4	,,	245ft.
	1	,,	162ft.
	11	,,	129ft. continuous in sets of 4 or 3
	24	,,	71ft.
	1	,,	56ft.
	2	,,	85ft. wrought iron arches
	4	,,	66ft. continuous over the 4 spans
North end	1	,,	108ft. high girder

From piers 4 to 28, 41 to 78, and 80 to 84, each span consists of four lattice girders with top and bottom members parallel, the roadway being carried on the upper members. The outside girders, excepting for six of the spans, are those which carried the roadway in the old viaduct. From piers 28 to 41 and 84 to 85, where additional headway is required, two girders only are used in each span, having curved top members, and the roadway is carried on the lower members.

Transferring girders from old to new viaduct.—In the four-girder spans the first operation, after completing the piers, was to transfer the girders from the old to the new viaduct. This was effected by means of two large pontoons, 80ft. by 27½ft. by 8½ft. deep, securely attached to each other at a distance of 20ft. apart by means of connecting girders. Each pontoon was provided with two wrought iron columns, the upper parts of which were telescopic and capable of being raised or lowered about 13ft. by means of hydraulic rams attached to the fixed portion of the columns. These two adjustable parts were connected together at the top by a cross girder, upon which the girders of the old viaduct rested while in the act of being transferred to the new one. The operation of transferring them was carried out in the following manner :—About the time of low water the pontoons were placed immediately beneath the pair of girders to be transferred; and the telescopic portions of the columns having been adjusted to the required height, the pontoons gradually rose with the tide, and lifted the two girders, with their cross bracing and roadway above, clear of the piers. The pontoons with their load were then floated in between the new piers, upon which the girders were let down by lowering the columns. In this position, and with rails laid along the top booms, the old girders formed a roadway, upon which the new girders, slung between two travellers, were run out, and were then lowered down between them on to the tops of the piers. All four girders were then opened out to their respective positions in width on the piers, and the cross bracing and decking above were proceeded with.

Floating out the high girders.—The work of floating out the girders for the thirteen large spans near the centre of the river, and of lifting them to the tops of the piers, was still more interesting. All these girders, with their deck-plating and top cross bracing, thus forming completed spans, were erected and rivetted on a jetty constructed for the purpose on the south side of the river, Fig. 1. The jetty was of sufficient size to allow of two of these complete spans being constructed simultaneously and side by side, and was provided with two openings or docks extending across it, at right angles to the direction in which the girders were built. Upon the completion of a span, the piers for which it was intended having also been finished up to the level of the top of the blue-brick connections, the same pontoons which had been used in transferring the old girders, as just described, were again made use of, but stripped of their columns and connecting-piece, and thus made independent of each other. These pontoons having been floated into the docks at low water, and placed in position immediately beneath the girders about to be floated out, rose with the tide, and lifted the girders clear of the blocks upon which they had been built. They were then towed out on the east or lower side of the viaduct by four steam-tugs; and when opposite to and parallel with the position they were to occupy, were allowed to drift slowly up with the flowing tide until the centre line of the decking was exactly in the centre line of the viaduct. In this position the ends of the girders were made fast to the piers, and were allowed to take their bearings with the fall of the tide.

Lifting the high girders.—The girders having been placed on the piers at this level, the next proceeding was to erect round and over their end posts the wrought iron pier superstructures, in which the plates that would interfere with the lifting operations were only temporarily bolted in their places, so that they might be removed when necessary. For erecting these superstructures, a crane of sufficient height to command the whole work was fixed on the decking between the girders. As soon as the erection of the superstructures was completed, the next operation was to construct inside each of the four shafts a temporary column, composed of steel angles ($8 \times 4\frac{1}{2} \times \frac{7}{8}$ in.) braced together, the four columns being of sufficient strength to carry the whole weight of the span, about 520 tons. The raising of the girders up these columns was performed by means of four 13½in. hydraulic rams, attached to the columns, and placed one under each of the end posts of the girders; and as the whole span gradually rose in 7½in. lifts, the bolted plates in the pier superstructure immediately above the girder end were removed, to allow of their passing up the shafts, while those below were at the same time replaced and riveted up. On arriving at their full height, the riveting of the piers having also been completed the ends of the girders were transferred from the lifting columns to the piers themselves, and the lifting columns were taken down and removed. The raising of the thirteen large spans occupied nine months, or an average of three weeks per span.

Decking.—The decking or flooring is of the ridge and trough type. In the case of the high girders, where there are only two girders to the span, it is constructed with plates and channels; the troughs are 16in. deep and 30in. from centre to centre. In the rest of the viaduct, where the decking has the support of four girders, the depth is reduced to 8in., and the troughs are formed of corrugated plates, shaped in a hydraulic press and connected on the ridges by cover strips. The whole decking is of steel, and forms a continuous flooring from end to end of the viaduct, excepting at the expansion joints.

Expansion.—The allowance for expansion is divided over thirty-two different places in the whole length, the sum of the calculated allowances amounting to 3ft. 8in. As a matter of fact, however, the spaces provided admit of a much greater variation than this. Where provision is made for expansion, the girder ends est upon rockers.

Parapets.—The parapets or wind screens are of lattice work, made of $3 \times 5\frac{5}{16}$in. bars, with standards about every 16ft., and finished off at the top with an oak coping. The effect they have in breaking up the force of the wind and thereby protecting the roadway is very remarkable.

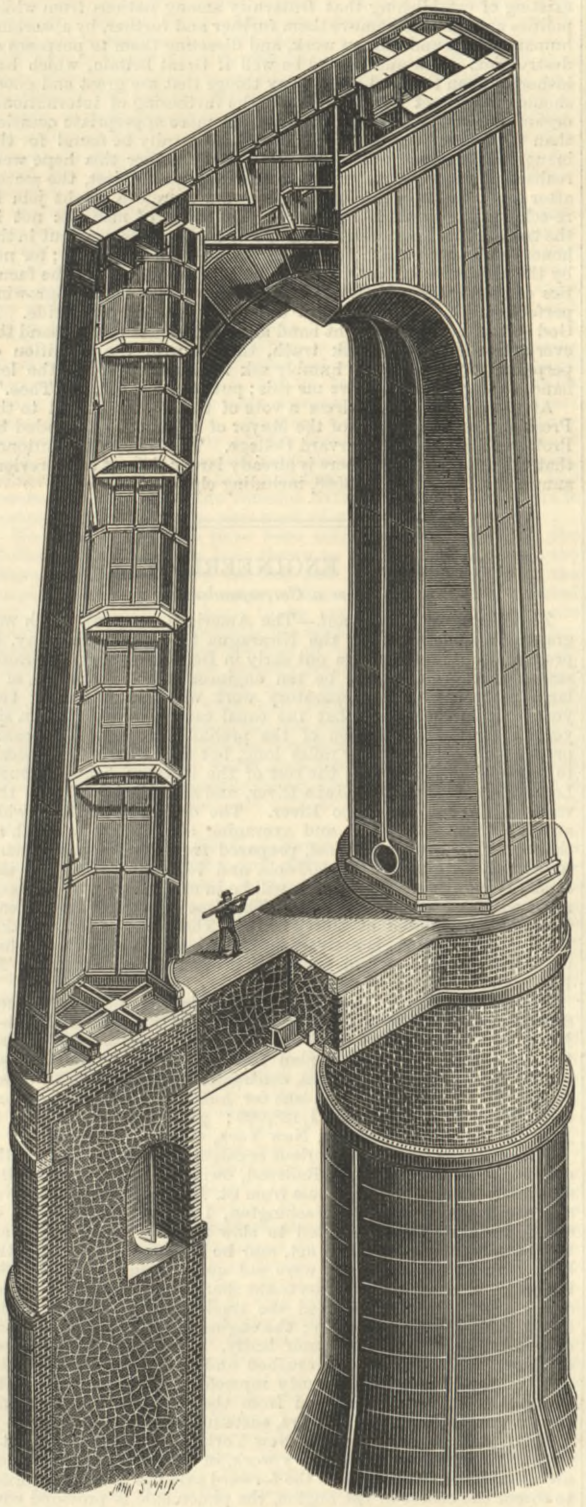
Permanent way.—The permanent way is laid with cross sleepers, which are bedded in ballast in the troughs of the flooring; and is provided with special expansion joints placed over those piers where the girders rest upon rocker bearings. The gradients are as follows :—

From south end to commencement of high girders at pier 28	1 in 762 falling.
From pier 28 to pier 32	Level.
From pier 32 to north end	1 in 114 falling.

Materials.—The various materials used in the construction were subjected to frequent testing throughout the work. In the case of the wrought iron, the test was that it should withstand a tensile strain of 22 tons per square inch with an extension of 6¼ per cent. The following are the amounts of material used :—

Wrought iron in girders and piers	19,337 tons
Steel in flooring	3,540 ,,
Cast iron	2,470 ,,
	25,347 ,,
Concrete (cement)	37,000 cub. yds.
Brickwork	25,700 ,,

Wind pressure.—The calculations for wind pressure are based on a pressure of 56 lb. per square foot; and in estimating the area



SECTION OF PIER.

exposed to the wind, the bevelled ends of the piers are considered as flat surfaces, the wind screen as a solid surface, and 50 per cent. is added to the area of the outside girders. Until this pressure is brought to bear on the structure, the holding-down bolts in the base of the pier superstructure do not come into play.

Testing of Viaduct.—The viaduct has recently been subjected to very severe tests by the Board of Trade inspectors, the result being highly satisfactory. The tests were made with sixteen heavy locomotives, the aggregate weight of which amounted to 955 tons. The maximum deflection of the high girders was 1⅝in., when the span was loaded with engines close together on both roads from end to end.

Time occupied in construction.—The construction of the viaduct was commenced on June 22nd, 1882, and it was opened for passenger traffic on 20th June in the present year, the work having thus occupied exactly five years. The engineers for the work were Messrs. W. H. Barlow and Son, Westminster; and the contractors Messrs. Arrol and Co., Glasgow; the author being resident engineer.

STATISTICS OF THE PRODUCTION OF PIG IRON.—The statistical report of the British Iron Trade Association has just been issued. The result may be thus summarised :—The stock of pig iron—makers' stocks in Scotland not included, being unknown—on December 31st, 1886, was 2,491,506 tons; the production of pig iron during the first half of 1887, was 3,668,115 tons; total, 6,159,621 tons. Deduct stock at June 30th, 1887, 2,238,670 tons; total consumption of pig iron to June 30th, 1887, 3,920,951 tons; against a consumption to June 30th, 1886, of 3,338,443 tons; increase of consumption, 582,508 tons.

THE BRITISH ASSOCIATION.

SIR H. ROSCOE'S ADDRESS.

THE fifty-seventh annual meeting of the British Association was opened on Wednesday evening at Manchester by an address from the president, Sir H. E. Roscoe, M.P. This was delivered in the Free Trade Hall. The chair was occupied by Professor Williamson, who was supported by the Bishop of Manchester, Sir F. Bramwell, Professor Gamgee, Professor Milnes Marshall, Professor Wilkins, Professor Boyd Dawkins, Professor Ward, and many other distinguished men. A telegram was read from the retiring president, Sir Wm. Dawson, of Montreal, congratulating the Association and Manchester on this year's meeting. The new president, Sir H. Roscoe, having been introduced to the audience, was heartily applauded.

The President, in his inaugural address, said Manchester, distinguished as the birthplace of two of the greatest discoveries of modern science, welcomed the visit of the British Association for the third time. Those discoveries were the atomic theory of which John Dalton was the author, and the most far-reaching scientific principle of modern times—namely, that of the conservation of energy, which was given to the world about the year 1842 by Dr. Joule. While the place suggested these reminders, the time, the year of the Queen's Jubilee, excited a feeling of thankfulness that they had lived in an age which had witnessed an advance in our knowledge of nature and a consequent improvement in the physical, moral, and intellectual well-being of the people hitherto unknown. A sketch of that progress in the science of chemistry alone would be the subject of his address. The initial point was the views of Dalton and his contemporaries compared with the ideas which now prevail; and he—the President—examined this comparison by the light which the research of the last fifty years had thrown on the subject of the Daltonian atoms, in the threefold aspect of their size, indivisibility and mutual relationships, and their motions. As to the size of the atom, Loschmidt, of Vienna, had come to the conclusion that the diameter of an atom of oxygen or nitrogen was the ten-millionth part of a centimetre. With the highest known magnifying power we could distinguish the forty-thousandth part of a centimetre. If, now, we imagined a cubic box each of whose sides had this length, such a box, when filled with air, would contain from sixty to a hundred millions of atoms of oxygen and nitrogen. As to the indivisibility of the atom, the space of fifty years had completely changed the face of the inquiry. Not only had the number of distinct, well-established elementary bodies increased from fifty-three in 1837 to seventy in 1887, but the properties of these elements had been studied, and were now known with a degree of precision then undreamt of. Had the atoms of our present elements been made to yield? To this a negative answer must undoubtedly be given, for even the highest of terrestrial temperatures, that of the electric spark, had failed to shake any one of these atoms in two. This was shown by the results with which spectrum analysis had enriched our knowledge. Terrestrial analysis had failed to furnish favourable evidence; and, turning to the chemistry of the stars, the spectra of the white, which were presumably the hottest stars, furnished no direct evidence that a decomposition of any terrestrial atom had taken place; indeed, we learned that the hydrogen atom, as we know it here, can endure unscathed the inconceivably fierce temperature of stars presumably many times more fervent than our sun, as Sirius and Vega. It was therefore no matter for surprise if the earth-bound chemist should for the present continue to regard the elements as the unalterable foundation stones upon which his science is based. Passing to the consideration of atoms in motion, whilst Dalton and Graham indicated that they were in a continual state of motion, we were indebted to Joule for the first accurate determination of the rate of that motion. Clerk-Maxwell had calculated that a hydrogen molecule, moving at the rate of seventy miles per minute, must, in one second of time, knock against others no fewer than eighteen thousand million times. This led to the reflection that in Nature there is no such thing as great or small, and that the structure of the smallest particle, invisible even to our most searching vision, may be as complicated as that of any one of the heavenly bodies which circle round our sun. How did this wonderful atomic motion affect their chemistry? Lavoisier left unexplained the dynamics of combustion; but in 1843, before the Chemical Section of the Association Meeting at Cork, Dr. Joule announced the discovery which was to revolutionise modern science, namely, the determination of the mechanical equivalent of heat. Every change in the arrangement of the particles he found was accompanied by a definite evolution or an absorption of heat. Heat was evolved by the clashing of the atoms, and this amount was fixed and definite. Thus to Joule we owe the foundation of chemical dynamics, and the basis of thermal chemistry. It was upon a knowledge of the mode of arrangement of atoms, and on a recognition of their distinctive properties, that the superstructure of modern organic chemistry rested. We now assumed on good grounds that the atom of each element possessed distinct capabilities of combination. The knowledge of the mode in which the atoms in the molecule are arranged had given to organic chemistry an impetus which had overcome many experimental obstacles, and organic chemistry had now become synthetic. Liebig and Wöhler in 1837 foresaw the artificial production in the laboratories of all organic substances so far as they did not constitute a living organism; and after fifty years their prophecy had been fulfilled, for at the present time we could prepare an artificial sweetening principle, an artificial alkaloid, and salacine. We know now that the same laws regulate the formation of chemical compounds in both animate and inanimate nature, and the chemist only asked for a knowledge of the constitution of any definite chemical compounds found in the organic world in order to be able to promise to prepare it artificially. Seventeen years elapsed between Wöhler's discovery of the artificial production of urea and the next real synthesis, which was accomplished by Kolbe, when in 1845 he prepared acetic acid from its elements. Since then a splendid harvest of results had been gathered in by chemists of all nations. In 1834 Dumas made known the law of substitution, and showed that an exchange could take place between the constituent atoms in a molecule, and upon this law depended in great measure the astounding progress made in the wide field of organic synthesis. Perhaps the most remarkable result had been the production of an artificial sweetening agent, termed saccharin 250 times sweeter than sugar, prepared by a complicated series of reactions from coal tar. These discoveries were not only of scientific interest, for they had given rise to the industry of coal tar colours, founded by our countryman Perkin, the value of which was measured by millions sterling annually. Another interesting application of synthetic chemistry to the needs of everyday life was the discovery of a series of valuable febrifuges, of which antipyrin might be named as the most useful. An important aspect in connection with the study of these bodies was the physiological value which had been found to attach to the introduction of certain organic radicals, so that an indication was given of the possibility of preparing a compound which will possess certain desired physiological properties, or even to foretell the kind of action which such bodies may exert on the animal economy. But now the question might well be put, was any limit set to this synthetic power of the chemist? Although the danger of dogmatising as to the progress of science had already been shown in too many instances, yet one could not help feeling that the barrier between the organised and unorganised worlds was one which the chemist at present saw no chance of breaking down. True, there were those who professed to foresee that the day would arrive when the chemist, by a succession of constructive efforts, might pass beyond albumen, and gather the elements of lifeless matter into a living structure. Whatever might be said regarding this from other standpoints, the chemist could only say that at present no such problem lay within his province. Protoplasm, with which the simplest manifestations of life are associated, was not a compound, but a structure built up of compounds. The chemist might successfully synthesise any of its component molecules, but he had no more reason to look forward to the synthetic production of the structure than to imagine that the synthesis of gallic acid led to the artificial production of gall-nuts. Although there was thus no prospect of effecting a synthesis of organised material, yet the progress made in our knowledge of the chemistry of life during the last fifty years had been very great, so much so indeed that the sciences of physiological and of pathological chemistry might be said to have entirely arisen within that period. He would now briefly trace a few of the more important steps which had marked the recent study of the relations between the vital phenomena and those of the inorganic world. No portion of the science of chemistry was of greater interest or of greater complexity than that which, bearing on the vital functions both of plants and of animals, endeavoured to unravel the tangled skein of the chemistry of life, and to explain the principles according to which our bodies live, and move, and have their being. If therefore in the less complicated problems with which other portions of our science have to deal, we found ourselves often far from possessing satisfactory solutions, we could not be surprised to learn that with regard to the chemistry of the living body—whether vegetable or animal—in health or disease, we were still farther from a complete knowledge of phenomena, even those of fundamental importance. Liebig asked if we could distinguish, on the one hand, between the kind of food which goes to create warmth, and, on the other, that by the oxidation of which the motions and mechanical energy of the body are kept up. He thought he was able to do this, and he divided food into two categories—the starchy or carbo-hydrate food was that, said he, which by its combustion provided the warmth necessary for the existence and life of the body. The albuminous or nitrogenous constituents of our food, the flesh meat, the gluten, the casein out of which our muscles are built up, were not available for the purpose of creating warmth, but it was by the waste of those muscles that the mechanical energy, the activity, the motions of the animal are supplied. Soon after the promulgation of these views, J. R. Mayer warmly attacked them, throwing out the hypothesis that all muscular action is due to the combustion of food, and not to the destruction of muscle. What did modern research say to this question? Could it be brought to the crucial test of experiment? It could; but how? In the first place, we could ascertain the work done by a man or any other animal; we could measure this work in terms of our mechanical standard, in kilogramme-metres or foot-pounds. We could next determine what was the destruction of nitrogenous tissue at rest and under exercise by the amount of nitrogenous material thrown off by the body. And here we must remember that these tissues were never completely burned, so that free nitrogen was never eliminated. If now we knew the heat value of the burned muscle, it was easy to convert this into its mechanical equivalent, and thus measure the energy generated. What was the result? Was the weight of muscle destroyed by ascending the Faulhorn or by working on the treadmill sufficient to produce on combustion heat enough when transformed into mechanical exercise to lift the body up to the summit of the Faulhorn or to do the work on the treadmill? Careful experiment had shown that this was so far from being the case that the actual energy developed was twice as great as that which could possibly be produced by the oxidation of the nitrogenous constituents eliminated from the body during twenty-four hours. That was to say, taking the amount of nitrogenous substance cast off from the body, not only whilst the work was being done, but during twenty-four hours, the mechanical effect capable of being produced by the muscular tissue from which this cast-off material was derived would only raise the body half-way up the Faulhorn, or enable the prisoner to work half his time on the treadmill. Hence it was clear that Liebig's proposition was not true. The nitrogenous constituents of the food did doubtless go to repair the waste of muscle, which, like every other portion of the body, needed renewal, whilst the function of the non-nitrogenous food was not only to supply the animal heat, but also to furnish, by its oxidation, the muscular energy of the body. We thus came to the conclusion that it was the potential energy of the food which furnished the actual energy of the body, expressed in terms either of heat or of mechanical work. But there was one other factor which came into play in this question of mechanical energy, and must be taken into account; and this factor we were as yet unable to estimate in our usual terms. It concerned the action of the mind on the body, and although incapable of exact expression, exerted none the less an important influence on the physics and chemistry of the body, so that a connection undoubtedly existed between intellectual activity or mental work and bodily nutrition. What was the expenditure of mechanical energy which accompanied mental effort was a question which science was probably far from answering; but that the body experienced exhaustion as the result of mental activity was a well recognised fact. The phenomena of vegetation, no less than those of the animal world, had, however, during the last fifty years been placed by the chemist on an entirely new basis. Liebig, in 1860, asserted that the whole of the carbon of vegetation was obtained from the atmospheric carbonic acid, which, though only present in the small relative proportion of four parts in 10,000 of air, was contained in such absolutely large quantity that if all the vegetation on the earth's surface were burned the proportion of carbonic acid which would thus be thrown into the air would not be sufficient to double the present amount. That this conclusion was correct needed experimental proof, but such proof could only be given by long-continued and laborious experiment. It was to our English agricultural chemists, Lawes and Gilbert, that we owed the complete experimental proof required, and this experiment was long and tedious, for it had taken forty-four years to give a definite reply. At Rothamsted a plot was set apart for the growth of wheat. For forty-four successive years that field had grown wheat without the addition of any carbonised manure, so that the only possible source from which the plant could obtain the carbon for its growth was the atmospheric carbonic acid. The quantity of carbon which on an average was removed in the form of wheat and straw from a plot manured only with mineral matter was 1000 lb., whilst on another plot, for which a nitrogenous manure was employed, 1500 lb. more carbon was annually removed; or 2500 lb. of carbon were removed by this crop annually without the addition of any carbonaceous manure. So that Liebig's prevision had received a complete experimental verification. Touching us as human beings even still more closely than the foregoing, was the influence which chemistry had exerted on the science of pathology, and in no direction had greater progress been made than in the study of micro-organisms in relation to health and disease. In the complicated chemical changes to which we gave the names of fermentation and putrefaction, Pasteur had established the fundamental principle that these processes were inseparately connected with the life of certain low forms of organisms. Thus was founded the science of bacteriology, which in Lister's hands had yielded such splendid results in the treatment of surgical cases; and, in those of Klebs, Koch, and others, had been the means of detecting the cause of many diseases both in man and animals; the latest and not the least important of which was the remarkable series of successful researches by Pasteur into the nature and mode of cure of that most dreadful of maladies, hydrophobia. The value of his discovery was greater than could be estimated by its present utility, for it showed that it might be possible to avert other diseases besides hydrophobia by the adoption of a somewhat similar method of investigation and of treatment. Here it might seem as if we had outstepped the boundaries of chemistry, and had to do with phenomena purely vital. But recent research indicated that this was not the case, and pointed to the conclusion that the microscopist must again give way to the chemist, and that it was by chemical rather than biological investigation that the causes of diseases would be discovered, and the power of removing them obtained. For we learned that the symptoms of infective diseases were no more due to the microbes which constituted the infection than alcoholic intoxication was produced by the yeast cell; but that these symptoms were due to the presence of definite chemical compounds, the result of the life of these microscopic organisms. So it was to the action of these poisonous substances formed during the life of the organism, rather than to that of the organism itself, that the special characteristics of the disease were to be traced; for it had been shown that the disease could be communicated by such poisons in the entire absence of living organisms. Had time permitted, he would have wished to have illustrated the dependence of industrial success upon original investigation, and to have pointed out the prodigious strides which chemical industry in this country had made during the fifty years of her Majesty's reign. As it was, he must be content to remark how much our modern life, both in its artistic and useful aspects, owed to chemistry, and therefore how essential a knowledge of the principles of the science was to all who had the industrial progress of the country at heart. The country was now beginning to see that if she was to maintain her commercial and industrial supremacy, the education of her people from top to bottom must be carried out on new lines. The question how this could be most safely and surely accomplished was one of transcendent national importance, and the statesman who solved this educational problem would earn the gratitude of generations yet to come. In welcoming the unprecedentedly large number of foreign men of science who had on this occasion honoured the British Association by their presence, he hoped that that meeting might be the commencement of an international scientific organisation, the only means now-a-days existing of establishing that fraternity among nations from which politics appeared to remove them further and further, by absorbing human powers and human work, and directing them to purposes of destruction. It would indeed be well if Great Britain, which had hitherto taken the lead in so many things that are great and good, should now direct her attention to the furthering of international organisations of a scientific nature. A more appropriate occasion than the present meeting could perhaps hardly be found for the inauguration of such a movement. But whether this hope were realised or not, they all united in that one great object, the search after truth for its own sake, and they all, therefore, might join in re-echoing the words of Lessing:—"The worth of man lies not in the truth which he possesses, or believes that he possesses, but in the honest endeavour which he puts forth to secure that truth; for not by the possession of truth, but by the search after it, are the faculties of man enlarged, and in this alone consists his ever-growing perfection. Possession fosters content, indolence, and pride. If God should hold in his right hand all truth, and in his left hand the ever-active desire to seek truth, though with the condition of perpetual error, I would humbly ask for the contents of the left hand, saying, 'Father, give me this; pure truth is only for Thee.'"

At the close of his address a vote of thanks was passed to the President, on the motion of the Mayor of Manchester, seconded by Professor Asa Gray, of Harvard College. The President mentioned that the number of members is already larger than at any previous annual meeting, namely, 3568, including eighty foreigners.

AMERICAN ENGINEERING NEWS.

(*From a Correspondent.*)

The Nicaragua Ship Canal.—The American company which was granted a concession by the Nicaragua Government in May, is prepared to send engineers out early in December, when the rainy season ends. There will be ten engineers, each in charge of a large party, and the preparatory work will occupy one or two years. It is estimated that the canal can be in operation in six years after the completion of the preliminary work. The canal proper will be about forty miles long, but the distance from ocean to ocean will be 170 miles, the rest of the distance being through Lake Nicaragua, the San Juan River, and an artificial lake in the valley of the San Francisco River. The canal will be 120ft. wide at the bottom, 28ft. deep, and averaging about 288ft. in width at the top. The estimated cost, prepared from careful preliminary surveys, is between 60,000,000 dols. and 75,000,000 dols. Of the canal, about twenty-seven miles will be in excavation, and thirteen miles will be made by dredgers. The time for transit from ocean to ocean is calculated at thirty hours. There will be seven locks. A. G. Menocal, C.E., is actively interested in the project, and has made surveys, plans, and estimates of cost of the work. R. E. Peary, C.E., is also interested.

The new war ships.—The contracts for the new ships have been awarded as follows by the Secretary of the Navy:—Cruiser No. 1—Newark—Cramp and Sons, Philadelphia, Pa., department's plan for hull, and contractor's plan for machinery, 1,248,000 dols.; cruiser No. 4, Cramp and Sons, contractor's plans, 1,350,000 dols.; cruiser No. 5, department's plans for hull and machinery, Union Ironworks, San Francisco, 1,428,000; gunboats Nos. 3 and 4, N. F. Palmer, Jun., and Co., New York, 490,000 dols. each.

Failure of air brakes.—A serious accident occurred, August 17th, on the Baltimore and Ohio Railroad, owing to the failure of the automatic brakes. The express from St. Louis and Cincinnati was approaching the yard at Washington, D.C., at a rapid rate of speed, and the engineer started to slow down as usual. The air brakes, however, refused to act, and he whistled sharply for the hand brakes; the brakemen were not quick enough to apply the brakes, and the train dashed on to the sharp curve of the Y at such a speed that the first car jumped the track and went into a signal tower, wrecking it completely; the engine was derailed and turned over in the mud, wrecking itself badly. A number of cars were derailed. The engineer was crushed and scalded to death, and a number of persons were seriously injured. Two men were in the tower at the time; one jumped from the window, the other was caught and buried in the timbers, sustaining serious injuries.

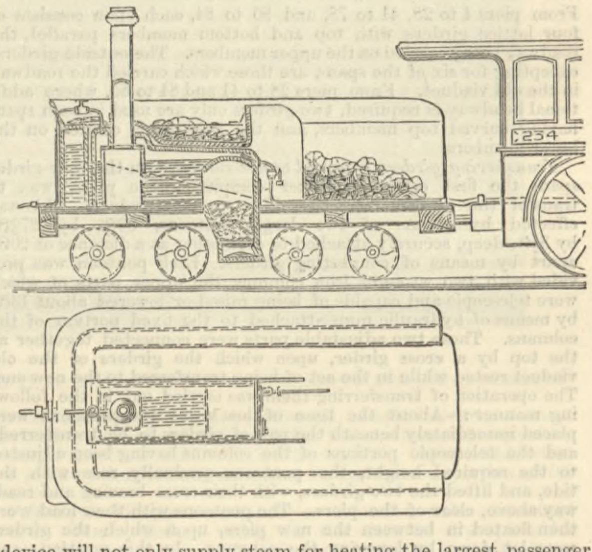
Traction engine.—A firm in New York State has brought out a type of traction engine for heavy work, in which all the four wheels are utilised for traction. As the forward axle has to swivel in order to direct the course of the engine, the pinion axle is provided with a universal joint. The power is communicated between the fore and rear main spur wheels by a series of gear wheels. The performance of this type of engine is said to be satisfactory. The same engine, which has the cylinder on top in the usual way, may also be used for a portable or stationary engine. The wheels are of the "bicycle" type, of light appearance but ample strength.

A Central American steamship line.—The Southern Pacific Railroad Company will put two large and powerful steamers in the Central American trade to test the advantages and profit of such a line, with a view to the establishment of a permanent line. The vessels will run from New Orleans, and if the experiment proves successful, two others will be added. It is generally thought that the enterprise will prove a benefit to the promoters and to the commerce of New Orleans.

The Chenango Canal.—This canal, connecting the Erie Canal at Utica, N.Y., with the Susquehanna River at Binghamton, N.Y., was authorised in February, 1833, commenced July, 1834, and finished October, 1836, at a cost of 2,782,134 dols. The canal is ninety-seven miles long, exclusive of 13·75 miles of feeders, none of which were navigable. It was carried over the high divide between the waters of the Mohawk and Susquehanna, having 1015·3ft. of lockage up and down. The locks were built of rubble stone, and cost on an average 8000 dols. each. There were 116 locks, 15ft. by 90ft. The canal was calculated for boats of from 50 to 70 tons; the ditch was 40ft. wide at the surface and 24ft. at the bottom. It is now proposed to fill up the canal in West Utica, and by a recent Act of the Legislature the city of Utica was authorised to fill it up and sell the property to pay off the bonds raised for funds to carry out the work. Lots will be staked off and sold, the city giving title to the purchasers. Many people are in favour of making a public park of the land, but this is not thought practicable under the provisions of the Act.

Irrigation in Colorado.—Mr. Orange Judd, the scientist, practical agriculturist, and expert in irrigation, spent several months last year in investigating the resources of Texas, New Mexico, Arizona, Utah, Colorado, and other far-western States. The system and laws of irrigation in Colorado are generally accepted as being the best in the country, but there are very considerable differences in opinion and practice. Mr. Judd thinks that much more of the soil is capable of profitable cultivation if irrigated, than is understood by people in the State, or by "Eastern people who have only thought of Colorado as consisting of mining mountains or sterile plains." There are hundreds of thousands of acres now ready for immediate and profitable occupancy, where irrigating canals and ditches are already provided, but these constitute a comparatively small part of what may yet be brought into profitable cultivation. Mr. Judd believes in the establishment of a system of reservoirs on a large scale, and thinks the national as well as the State Government should investigate the matter, and establish such a system of reservoirs to preserve the quantities of water which annually run to waste. At the head waters of the great agricultural rivers—the Colorado, Rio Grande, Arkansas, and the two great branches of the Platte—a system of dams across the gulches could be constructed at comparatively small expense. There has been trouble recently between an English company controlling an irrigation ditch and the farmers and others below the company's land. The company has illegally diverted a greater quantity of water to its own use than it is entitled to, and the matter is now before the court.

Auxiliary steam generator for locomotives.—A new device has been invented for supplying steam to aid locomotives. It consists of a steam boiler, with furnace and appurtenances, placed in the tender between the water tanks, being covered by a boiler iron hood, which forms the floor of the coal space and a shoot for bringing the coal down handy to the fireman. The furnace door is towards the engine cab, and the smoke-box and smoke-stack at the rear of the tender. The furnace door is above the floor of the tender, and the fire-grate and ashpit below. The sides of the tender are raised so as to give the regular fuel capacity. It is claimed that this



device will not only supply steam for heating the largest passenger trains, and heat the feed-water in the tender tanks by means of an arrangement of pipes, but that it may also be made a valuable auxiliary to the locomotive as a source of additional power. As a steam heater it may be used in connection with the locomotive or independent of it, and as the tender is of iron, the danger of causing fire in case of accident to the train is claimed to be reduced to a minimum. When in cold weather the engine requires all its steam to haul the train the auxiliary boiler will heat the cars. The cost and operating expenses would be small. For heating the train by steam such an auxiliary boiler may have its value, although for heating feed it is not necessary if arrangements now in use in England are adopted.

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

(*From our own Correspondent.*)

THE attendances on the Wolverhampton and Birmingham Exchanges yesterday and to-day suffered from the opening of the shooting season, but there was no decline in the more cheerful nature of ironmasters' reports of current trading. That other branches besides sheets are getting somewhat busier is the best feature of the market, but at present too much must not be argued from this premise. More confidence is, however, beginning to be expressed in the future of the market, particularly as regards the autumn shipping trade.

American orders, it was this afternoon reported, are adding to the activity of the mills and forges in the sheet, hoop, and sectional iron branches. The United States demand is assuming proportions that entitle it to rank as important. Sheets are in largest call, but too much stress must not be laid upon this circumstance. The baling hoop orders are, it is noteworthy, this season finding their way to different local works than those which executed them a season ago. This circumstance is due in much part to the retirement from the trade of Messrs. John Dawes and Sons, of the Bromford Works, Tipton. The price quoted this—Thursday—afternoon for hoops cut to 11ft. lengths for the American market, and finished in accordance with buyers' requirements, was rather over £6 per ton f.o.b. Liverpool.

Messrs. Hingley and Smith, of the Hart's Hill Ironworks, Brierley Hill, have booked a considerable order for iron for America. It is of "sectional" description, being punched, &c., and is required for an overhead tramway. It is satisfactory that business between Staffordshire and the United States in iron is still possible, notwithstanding the very high tariffs. Orders are also under execution at these works for hoops for the United States.

Platemakers are not yet in a position to report a share in the greater activity which marks some of the other departments. Iron boiler-plates, in particular, are suffering from the competition of the steelmasters; there are consumers who will still have nothing but iron plates, but these are getting fewer every day, and are the decided exceptions. Plates for foreign railway wagon work are in pretty brisk request, and some makers are doing well at them. The number of producers in this particular line is small, so that better prices are obtained than in most other branches. Tank plates are £6 10s., easy, at works, and boiler sorts about £7 to £9.

The marked bar trade does not show much alteration on the week, but compared with a few weeks ago, the tone is certainly better. The orders coming to hand are for rivet and horseshoe iron, the latter largely for Australia. The Admiralty is giving some work to Earl Dudley's Round Oak Mills. Prices remain at £7, with £6 for second branded qualities. General merchant bars are £5 10s.; ordinary, £5; and common, £4 15s. to £4 17s. 6d. per ton. Gas tube strip is becoming rather more active with the advance of the tube season, and £4 15s. is quoted for ordinary sizes. Hoops for Australia and other markets are most £5 for common sorts at makers' works.

Of the sheet makers it may be said that they are busier than at any previous time this year. The only limit to their activity is their capacity of production. They are full of work, and inquiries continue to arrive in greater numbers than can be satisfied. One local consumer who a few days ago attempted to place an order for 2000 or 3000 tons in a line is reported to have been unsuccessful, makers being so well placed ahead that they would not accept the business. Probably, however, the date of delivery and the price offered had much to do with deterring producers to whom the work was tendered. Merchants are buying for export as well as the galvanisers, and some firms are filled with orders to the end of the year.

Sheet prices are very strong again this week, and firms who are filled up are asking almost prohibitive rates. Still there is amongst most a feeling against allowing orders to pass if they can be in any way executed at a profit, and a wise caution is being exercised not to advance too rapidly. We have had so many re-actions of late that a fairly profitable and steady market is regarded as better than an unduly high one with the risk of a sudden rebound. Galvanising sheets of 20 w.g. keep at £6 to £6 2s. 6d.; 24 g., £6 5s. to £6 7s. 6d.; and 27 g. at £7 5s. per ton.

The galvanisers this afternoon repeated their former excellent reports. The demand is in advance of the past few months, and some firms who are their own black sheet makers are unable to turn out sufficient material to keep all the galvanising hands as busy as orders will allow. Cablegram accounts of the condition of the Australian markets are, it is satisfactory to note, favourable as regards some improvement in the extent of current sales, but no revival yet appears in colonial prices. This is the great difficulty which galvanisers have to contend against. South African, South American, and Indian orders are being received as supplementary to the Australian trade. The larger exports which are recorded in this branch month by month are of very gratifying augury.

Competition amongst home makers for the orders on the market continues severe, and although "Association prices" are supposed to rule, yet there is a good deal of underselling in the matter of extra sizes. The quotations to London merchant firms for work of this class differ greatly. While some makers offer supplies at £10 12s. 6d., other firms require for the same size £11 2s. 6d. f.o.b. London. It cannot be said that attempts to regulate prices by associated action have met with much success. The productive capacity at the different works is not yet all employed, and until this is the case the present underselling is sure to continue.

In the native pig trade new business is somewhat quiet, and there is at the moment a tendency to stock production. One or two furnaces have been damped down. Nevertheless, from other of the furnaces deliveries continue to go steadily away. All-mine hot-blast iron is in tame sale, at about 50s. to 52s. 6d.; part-mine, at about 40s.; and cinder pigs at 28s. 6d. to 30s. Most buyers of native pigs seem to have satisfied their wants to the end of the quarter.

Foreign pigs show more life than natives, though new sales are not for large lots. Inquiries, however, are coming to hand rather more freely, and sellers anticipate a quickened trade when September has set in. Prices show no quotable change on the basis of 36s. for Northamptons, 37s. for Derbyshires, and 40s. for Lincolns.

Steel is rapidly ousting iron in the steam boiler business. A local firm of boilermakers are just now building eight or ten boilers for China, the whole material for which, including the plates and rivets, is of steel. The boilers are intended for the mint which is being erected by Messrs. Ralph Heaton and Son, Birmingham, for the Chinese Government. The cost of the steel plates being used is considerably under the price of iron plates of corresponding strength and size.

A good contract for cast iron pipes has just been placed in this district. It is one by the Wolverhampton Corporation for a new waterworks main, 18in. diameter, to convey water from the pumping station at Cosford to the storage reservoir at Tettenhall—a distance of some nine miles. The new main is to be supplementary to the existing 24in. main, which is at the present time subject to undue strain. The present main will convey 1¾ million gallons per day under a pressure of 138 lb. to the square inch; but when double that quantity is forced through, as in seasons of prolonged drought, it has to be done against a pressure of 205 lb. to the inch. Such a pressure the engineer to the works considers undesirable. The contract has just been divided between Messrs. C. E. Firmstone and Co., Brettle-lane Foundry, Brierley Hill, who have taken 700 tons; Messrs. J. and S. Roberts, Swan Village Foundry, West Bromwich, 400 tons; and Messrs. Cochrane and Co., Brierley Hill, also 400 tons. I understand that the average contract price leaves about £3 3s. 9d. per ton to makers at the works. Execution is to commence at once. The total cost of the new main is estimated by the Corporation at £10,000. Powerful new pumping plant is also required in connection with the same works, but these contracts have not yet been let.

The works of the Birmingham Compressed Air Power Company are being pressed forward with all reasonable despatch. According to the report presented at the half-yearly meeting of the shareholders last week, it was found impossible, owing to the severity of the weather, to commence operations until early in March. Since then the foundations, retaining walls, and roadway, the gas and boiler flues and drainage, the chimney and the fitting shop, were all nearly completed. The materials for the gas generators were on the ground, and were in course of erection. One tubular boiler was completed in its place, and others were in a forward state. Three steam engines and compressors, each of 1000-horse power, were in a forward state, one being nearly ready for delivery, and the engine-house ready to receive it. The mains were in hand. Notwithstanding the forward state of all the parts, it was not possible to fix a definite time for commencing to deliver power.

With a view to expediting work on the Birmingham cable tramway, the contractor, who wishes to finish the whole system by October, has completed an electric light installation that will allow of the men working at night.

The steel-rope will be supplied by Messrs. J. and E. Wright, of Birmingham and London, whose contract has been accepted in preference to ten other tenders. This firm made the first Atlantic cable, and the iron wire-rope which is used on the London and North-Western Railway between Edge Hill and Lime-street stations, Liverpool. The cable to be supplied is to be 3⅝in. in circumference.

The cars which have been made by the Falcon Company, Loughborough, have several new features. Most important of all is a novelty in the gripper, which will diminish friction and lengthen the life of the cable. This consists of a couple of pulleys, which, being raised by a spring when the gripper is loosened for the purpose of stopping the car, will support the cable without subjecting it to a dragging action.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—What with the British Association and the Manchester and Liverpool Agricultural Society's meetings, the Jubilee of Phonography, and the British Pharmaceutical Conference, all held in Manchester this week, with the Manchester Royal Exhibition serving in addition as the central point, there are certainly attractions sufficient and varied enough to afford a pleasant temporary diversion from the present depressing surroundings of ordinary trade, in which there is no specially new feature to record beyond what I have already dealt with in my recent notes. An extremely dull tone still characterises the iron market generally, and prices remain much the same as those last quoted. Except that there is some activity in shipments of finished iron, there is a prevalent indifference about buying, which gives a discouraging aspect to the immediate outlook, and indicates a general want of confidence in any early improvement in the branches of trade connected with the iron and engineering industries.

There was again only a very slow business doing in the Manchester iron market on Tuesday. So far as quoted prices are concerned, a general firmness is maintained, but this is not backed up by any weight of actual trade, and, as I have pointed out in previous reports, it is due more to the fact that makers are really not in a position to accept lower prices than to any real firmness in the market. There is business offering for pig iron, but this is mostly at under current rates, which sellers do not care to entertain, and as a result the actual transactions reported are only very small in weight. For Lancashire pig iron makers still hold to 38s. 6d. for forge and 39s. 6d. for foundry, less 2½, as their quoted rates for delivery equal to Manchester, and they are not disposed to sell at anything materially under these figures. They are able to find a market amongst their regular customers who have a preference for the local brands or are favourably situated with regard to delivery for pretty near all of the small quantity of iron they have at present to offer, and are consequently under no absolute necessity to compete with the much lower-priced Lincolnshire brands to which most of the trade, so far as the open market is concerned, is just now practically confined. For Lincolnshire iron quotations for delivery equal to Manchester remain at 37s. for forge and 37s. 6d. for foundry, less 2½ per cent., but it is questionable whether the full prices are being obtained, where active business is being done, and to effect sales 3d. and 6d. per ton under the above figures is reported to have been taken in some instances. Derbyshire foundry iron delivered equal to Manchester is still quoted at 40s., less 2½, and although very little business is practicable at this figure, makers generally are firm. In outside brands comparatively little or nothing is being done in this market beyond occasional small sales for special requirements, and prices, if anything, are rather easier; sellers of Middlesbrough iron show more disposition to meet buyers, and good-named foundry brands could now in most cases be bought at a little under 43s. per ton net cash delivered equal to Manchester, whilst the Scotch iron merchants are prepared to sell at quite 1s. per ton under what may be termed the makers' nominally quoted rates. The continued activity in steel making centres maintains a firm tone in hematites, and although the actual business doing in this market is only small, 52s. 6d. to 53s., less 2½, represent about the minimum figures for good No. 3 foundry qualities delivered into the Manchester district.

In the manufactured iron trade shipping orders are for the present keeping most of the makers full of work, but the home trade is still only indifferent, and this operates as a check against any actual advance in prices. Makers are, however, firm at their current list rates, and delivered into the Manchester district prices are steady at £4 17s. 6d. per ton for bars, £5 5s. for hoops, and £6 5s. to £6 10s. per ton for sheets.

The condition of the engineering branches of industry remains practically the same as I reported last week. There is more work stirring in some departments, but no better prices are obtainable owing to the continued keen competition for any new orders coming upon the market. Machine tool makers and stationary engine builders are fairly off for orders, boiler makers are kept busy, and some of the leading machine shops are well off for work, whilst there are concerns here and there that are very slack. The locomotive building trade remains extremely quiet, and there is comparatively little or no new work of any weight in prospect.

No further attempts have been made at a settlement of the Bolton strike. The men have shown no disposition to submit the dispute to arbitration on the fair and open terms to which the employers were willing to agree, and, as I have all along pointed out, the struggle will have to be caried on until the men are thoroughly beaten. Gradually the shops are being filled with men obtained from other districts, and at two of the works, I understand, the employers have already obtained as many men as they require. The strike has been most stubbornly fought out by the men, who have so far been well supplied with funds; but the decreased allowances now being made by the trades union societies to their members is causing an increasing drain upon the resources of the strike committee, which cannot fail to tell before long; and with the employers gradually filling up their shops with men, the practical end of the atruggle may be regarded as not very far distant.

Messrs. Kendal and Gent, of Manchester, have just patented a new motion for their boiler shell drilling machine by which a very considerable improvement has been effected, the main feature being that the machine, whilst operating with six drills all pointing to the centre of the boiler, is enabled to withdraw all the drills simultaneously, and the whole of the six drills can be used either on circular or longitudinal seams as required. This new motion, which has been introduced by Mr. Dixon, one of the members of the firm, and is an improvement upon his patent releasing motion applied to the drilling machines previously made by Messrs. Kendal and Gent, consists essentially in each drilling tool having an entirely independent feed motion, this being necessary, owing to the two drills which are carried on each headstock having an adjustment varying with the pitch of the rivets; the feed is so arranged that the drill is advanced by a kind of differential motion, and when withdrawing the whole of this differential feed goes to rest, and the drills are withdrawn in four to six revolutions. The operation of the whole of the drills, which are carried on three headstocks, so arranged that they can be applied to boilers with either three or two laps, is under the control of a single attendant, who remains in one position, a simple movement of a hand lever being all that is required to withdraw simultaneously and rapidly, and to any required distance, the whole of the six drills. In the same manner the drills can also be fed any required distance. One great advantege of this arrangement is that the workman can rely with the utmost certainty upon all the drills being withdrawn simultaneously, and there is no necessity for going round the boiler to ascertain whether all the drills are clear of their work before the boiler shell can be moved for the next set of holes. I had an opportunity this week of inspecting the first of the new machines that have been made by Messrs. Kendal and Gent, and this is constructed for drilling boiler shells up to 9ft. diameter, and constructed of plates 6ft. wide. The central table fitted with three jaws forms a concentric chuck for fixing and holding the rings, and can be turned round by power when setting seams, and by hand when pitching the circular seams, and in addition to the new motion already described, the machine is fitted with Scott's patent dividing arrangement, whereby the circular seam can be pitched for any number of holes without the use of change wheels. The three drilling saddles are carried by three standards which are adjustable for different diameters of shells, and firmly bolted on three radial beds, thus forming a rigid support even when drilling at the top of the standards on plates six feet wide.

In the condition of the coal trade there is no material change to report. There has been no quotable alteration in prices with the commencement of the month, and although there is perhaps rather more doing in house fire coals, with a fair inquiry for forward contracts, business generally is still only extremely dull, and there are very few collieries that are as yet working more than four days a week, and a good deal of coal is still going into stock. The lower classes of round coal for iron-making and steam purposes, and engine classes of fuel, continue in but very indifferent demand and very low price. At the pit's mouth best coal averages 8s. to 8s. 6d. per ton; seconds, 6s. 6d. to 7s.; common coal, 4s. 9d. to 5s. 6d., according to quality; burgy 4s. 6d. to 4s. 9d.; good ordinary qualities of slack, 3s. 3d. to 3s. 9d.; and common sorts, 2s. 6d. to 3s. per ton.

For shipment there is only a moderate demand, with good qualities of steam coal delivered at the high level, Liverpool, or the Garston Docks, averaging about 6s. 9d. per ton.

Barrow.—The iron trade is busy and orders are freely offering all round for both Bessemer and ordinary qualities of hematite. The market shows increased firmness in most departments, and the business doing in Bessemer is especially good, and is showing evidences of expansion. The trade with local makers of steel is brisk, and a large tonnage is finding its way, not only to the Continent and the colonies, but some little to America, although the demand from that country is not nearly so good as it used to be. Prices are remarkably steady, and 45s. 6d. per ton is firmly quoted for parcels of mixed Bessemer iron, net f.o.b. or f.o.t. at makers' works. No. 3 forge and foundry iron are still quoted at about 44s. 6d. per ton net, and white and mottled as well as other inferior samples at from 42s. per ton net. Stocks of iron are not large and are not increasing. Deliveries are considerable both by rail and by sea. The output is large and the make per week is again very regular, as makers are not compelled now to damp down their furnaces owing to scarcity of water. Sales are noted at from 44s. 3d. to 44s. 9d. per ton, but some of the largest makers are holding firmly for full prices, in the belief that better rates will soon exist. It is certain that the requirements in the steel trade will increase, and that the general consumption will be fully maintained. It is therefore probable that the make of iron will soon be increased by the relighting of some furnaces now standing idle. Here again makers are slow to take so important a step until it is more certain that prices will improve. There is a brisk demand for all classes of steel, and it is evident that the business doing in rails is not only exceptionally brisk, but that many more orders could be booked if makers were able to complete deliveries. The business doing in billets, bars, and blooms is very satisfactory, and the market for shipbuilding steel is improving every day. The demand for merchant steel is very steady. Rails remain firm at from £4 to £4 5s. per ton net f.o.b. The value of other classes of steel is very steady. Next year the steel works in the district will be capable of a largely increased output by reason of the new mills and other machinery which are being put down. Finished iron remains a very quiet trade, and with steel so cheap as it is at present it is obvious that the market for finished iron will remain poor and the trade unprofitable. It remains to be seen how far finished iron works can be altered so as to be adapted for the superior class of metal. The business doing in iron ore is very large, so far as deliveries are concerned, but these are mainly on account of orders booked some time ago. Sales at present are from 8s. 6d. to 11s. 6d. per ton net at mines, and the trade is greatly confined to the better qualities which are scarce. Coal and coke steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

A LARGE quantity of railway material is still ordered, the Indian States Railways being leading customers at present. In addition to work now in hand for that market, tenders have been issued for 1384 pairs and 1600 pairs, respectively, of wheels and axles, also 3200 and 2900 springs. The Bengal Nagpur Railway is asking for 1430 pairs of wheels and axles.

Though the larger orders for armour-plates are being worked off, there is yet a goodly amount of work on hand, and further requirements are anticipated. It would seem as if the War-office had made up their minds to lay in stocks of cast steel shells, while conducting the experiments for which they have ordered another lot of fifty plate blocks. They are inviting tenders for 11,000 common 6in. cast steel shells. Three local firms have been interesting themselves in this speciality, and two of them are now engaged in making steel projectiles, the third having finished their order, which was like the rest, purely experimental. 11,000 is a quantity, however, which looks like business, and Sheffield manufacturers are in hopes the work may be placed here.

A local company, which has a large rail plant on the coast, is, I hear, contemplating the increase of its productive power to 6000 tons of steel rails per week. This would be about doubling its present output. A stronger indication of faith in the future of the export rail trade could scarcely be given.

A trade which has shown some signs of once more resuming its former importance is the manufacture of saws. Several years ago the redoubtable Harry Disston, of the Keystone Works, Philadelphia, took a big bite out of the Sheffield saw trade, and two or three firms thought Sheffield would find its days numbered as a saw-producing town. Of late years, however, the orders for saws have greatly increased, and the business has quietly assumed something like its former dimensions. Messrs. Wm. Jessop and Sons, Brightside Steel Works, have for years supplied the huge sheets from which the American firm make their large circular saws, while the appliances for speedy and effective production of band and circular saws have been greatly improved. On Abbeydale Valley a large establishment is being erected for the saw business, which is another sign that capitalists have not lost faith in the continuance of Sheffield as the chief seat of the saw industry.

Mr. Frank N. Wardell, Chief Inspector of Mines for the Yorkshire and Lincolnshire districts, has issued his report for 1886. During the year 100 separate fatal accidents caused the loss of 131 lives, being an increase, as compared with 1885, of sixteen accidents and forty-six deaths. Accidents at Altofts, Houghton Main, and Aldwarke Main involved a loss of thirty-four lives, the remaining ninety-seven accidents producing in each case one death. Mr. Wardell, whilst regarding the fatality for the year as disappointing and much to be regretted, points out that the output of minerals has increased considerably, which exhibits the tables of proportions in a much more satisfactory light than would otherwise be the case. In the year he was appointed to the district the output was 9,850,000 tons, and the number of persons employed 37,000, and the number of deaths 131. There were therefore 502 persons employed and 150,710 tons raised per life lost. Now the number of persons employed has risen to 65,734—an increase of 28,734—and the output in the same time has advanced from 9,850,000 tons to 19,742,990—an increase of 9,892,990 tons; that is to say, it has more than doubled.

An extraordinary accident on the Midland Railway, near Wath-on-Dearne, in the Sheffield district, last Saturday, caused much alarm and great destruction to railway material, mainly in rolling stock, though, singularly enough, only two persons were seriously injured. The 12.20 p.m. Midland express, from St. Pancras to Glasgow and Edinburgh, due at Sheffield at 3.50, left a minute or two late. It proceeded in safety as far as Wath sidings, where a coal train had broken down through the failure of a draw-bar on one of the trucks. The signals, it is said, were set at danger the moment the draw-bar failed. The driver of the express—a trustworthy man with a twenty years' experience—did not see the signals, and dashed into the rear of the coal trucks. There was a terrific smash. The engine, tender, and leading carriage mounted five of the trucks, the engine toppled over and fell down the embankment, the tender remaining partly on the line. The coupling snapping, the leading carriage remained up-ended on the coal truck, and the passengers had to be assisted down by ladders, while others crawled along the foot-board. The driver and fireman, when within a short distance of the trucks, saw a collision was inevitable, and manfully stuck to their posts. The fireman was flung off as the locomotive went over the embankment, but the driver clung to his post even then. The driver, though shaken severely, had not a scratch; the fireman had two fingers broken, his face and arm lacerated, and was badly shaken. All the passengers were able to proceed on their journey, the most seriously shaken being an elderly lady from London, who was travelling to Ilkley. The loss to the company in damaged rolling stock is estimated at over £3000, and two break-down gangs of 150 men required thirteen' hours incessant labour to clear the wreckage. An inquiry will no doubt be instituted as to how the driver, supposing the signals were set against him, did not see that they were at danger. Equally important would be an inquiry why a coal train should be on the main line so perilously near the time for an express on the same metals. Three-fourths of all the serious accidents which happen are due to goods trains picking their way from station to station close on the time for fast trains to follow. Wath-on-Dearne narrowly escaped being an appalling disaster, the marvel being that a great loss of life did not ensue.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

A CONSIDERABLE amount of business has been done in Cleveland pig iron during the last few days. The improvement recently reported continues, and has received an accession of strength from the increased shipments and the good reports emanating from Glasgow. At the market held at Middlesbrough on Tuesday last no actual advance took place in prices; but buyers gave what was asked by merchants more freely than they have done for some time. There is therefore every probability of higher prices being demanded next month, when exports on foreign account are usually at a maximum. For delivery in September the price of No. 3 g.m.b. is firm at 34s. 4½d. per ton, and for delivery over the last quarter of the year 34s. 6d. is quoted. Most makers have orders to last to the end of October, and so they continue to quote 35s. per ton. One or two firms, however, who are not so well off, are accepting a little less. The demand for forge iron is somewhat better than it was a week ago, and the price is firm at 32s. 3d.

Stevenson, Jaques, and Co.'s current quotations are:—"Acklam hematite," (mixed nos.), 45s. per ton; "Acklam Yorkshire," (Cleveland) No. 3, 35s. per ton; "Acklam basic," 36s. per ton; refined iron, 48s. to 63s. per ton, net cash at furnaces.

There is but little enquiry for warrants, neither buyers nor sellers seeming at all anxious to do business just now. The price quoted both at Middlesbrough and at Glasgow is the same as last week—namely, 34s. 4½d. per ton.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store on Monday last was 332,334 tons, being a decrease of 1037 tons for the week. At Glasgow they hold 915,229 tons.

Shipments are this month proceeding at a very satisfactory rate. The quantity of pig iron exported up to Monday night was 69,521 tons, as compared with 64,516 tons for the entire month of July. The manufactured iron and steel shipments amounted to 41,530 tons.

The construction of the new bridge at Stockton-on-Tees, and the removal of the old one, has enabled the Conservancy Commissioners to turn their serious attention towards deepening the upper reaches of the river, and supplying the long-felt wants of the shippers and shipowners, who carry on business there. Mr. John Fowler, the engineer to the Commission, has been for some time engaged in considering a scheme, whereby a much greater depth of water would be secured between Middlesbrough and Stockton, together with certain works designed to strengthen the banks on either side. This scheme would also include a turning place for large vessels, and a good deep water berth at Stockton. But to carry out all these improvements an expenditure of nearly £50,000 would have to be incurred. The Commissioners are hardly prepared in the present state of trade to sanction such an expenditure as this, and they have therefore requested Mr. Fowler to prepare a revised scheme to include the turning place and deep-water berth, and an extra depth between Stockton and Middlesbrough of 2ft. over and above the present minimum. This would be sufficient to permit very large ships to proceed as far as Stockton Bridge at high water spring tides, and to be safely berthed when there. In connection with the river, further improvement has been resolved upon by the Stockton Corporation. They are the owners of a considerable extent of quay property, which is not in a very satisfactory condition. They have just come to the conclusion to rebuild it at a cost of £17,500. This, together with the Commissioners' improvements, will, when carried out, give a great impetus to the shipping trade at Stockton-on-Tees.

On the 23rd inst. the directors of Messrs. Bolckow, Vaughan, and Co. issued a circular to their shareholders, wherein they say that they are glad to be able to report a decided improvement in the prospects of the company, as compared with a twelvemonth since. Nevertheless, they deem it wise not to declare any immediate dividend of the balance of profit for the last six months, but to carry the same forward to the end of the financial year. This decision, though naturally disappointing to the shareholders, is undoubtedly a wise one under the circumstances.

The London Lead Company appears to have discovered a valuable vein of galena, at a place called Blea Gill, near Middleton-in-Teesdale, where it has been exploiting for a considerable time. The discovery is regarded, both by the company's officials and by the workmen, as exceedingly opportune, as the old industry has for long been suffering from general depression of trade.

An upright, plain cylinder, spherical-ended boiler, belonging to the South Stockton Iron Company, exploded on the night of the 22nd, doing considerable damage to the brickwork surrounding it, the furnaces connected with it, and the roof above it. Fortunately no one was killed or seriously injured, although numbers of workmen were employed near it. The steam pipes were broken, and bricks are said to have been flying in all directions. The noise of the explosion and rush of steam were heard a long way off, and crowds of people assembled in the streets adjoining the works. The boiler is said to have been inspected only a few days before, it being insured by one of the Manchester Associations. The cause of the explosion has not yet been definitely ascertained. It is believed, however, that the boiler was an old one, and had been locally repaired with new plates. The probability therefore is that the old and new parts had not taken the strain equally together. This might have had the effect of starting a crack in the older part. The water used by the company is from the mains of the Stockton and Middlesbrough Corporations Water Board, and is very pure and good for the purpose.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

TOWARDS the close of last week the Glasgow pig iron warrant market became somewhat easier, and there was a certain back turn in prices. In the early part of the present week, however, the market was strong, and steadily recovered the lost ground. Although not so large as those of the preceding week, the shipments of pigs were above the average. They amounted to 9997 tons, as compared with 8952 in the corresponding week of 1886. The shipments had a strengthening effect on the market, and the feeling was still further enhanced by the statistics issued by the British Iron Trade Association for the first half of the year. There was a pretty general opinion on 'Change in Glasgow that had the Scotch ironmasters' stocks been included in the returns, they would have appeared still more favourable. Ironmasters are now more fully employed supplying the current home consumption and export demand, and the quantity of iron being made for the store is accordingly much reduced. Since last report an additional furnace has been put in blast at Carron, and the total now in operation is 85, as compared with 81 at this date last year.

The market values of makers' pigs are firm, and in a few cases higher, as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 48s. 6d.; No. 3, 44s.; Coltness, 53s. 6d. and 44s.; Langloan, 49s. 6d. and 45s. 6d.; Summerlee, 51s. 6d. and 43s.; Calder, 49s. and 42s.; Carnbroe, 44s. and 40s. 3d.; Clyde, 46s. 6d. and 41s. 6d.; Monkland, 43s. 6d. and 39s. 6d.; Govan at Broomielaw, 43s. 6d. and 39s. 6d.; Shotts at Leith, 48s. 6d. and 45s.; Carron at Grangemouth, 52s. and 44s. 6d.; Glengarnock at Ardrossan, 49s. 6d. and 41s. 6d.; Eglinton, 43s. 6d. and 39s. 6d.; Dalmellington, 44s. and 40s. 6d.

The past week's arrivals of Middlesbrough pigs at Grangemouth are 10,349 tons against 3935 in the same week of last year.

In the malleable trade there is considerable activity, although the recent improvement is not quite so well sustained as could be desired. Merchant bars are quiet, the extra business being chiefly in unbranded iron for India.

The iron and steel goods shipped from Glasgow in the past week embraced locomotive engines and tenders worth £7200, for Calcutta; a steamer and engines for Portugal, £3000; a steamer and engines for Egypt, £7300; machinery, £1260; sewing machines, £6310; steel goods, £8500; and general iron manufactures, £11,500.

In the coal trade there is a fair business doing, although the shipping department would have been busier but for a strike of quay labourers at Glasgow, and the observing of annual holidays in certain districts of Ayrshire. The total coal shipments were 87,498 tons, as against 83,591 in the same week of last year.

The colliers are in many localities restricting the output, but the supply is still fully equal to the demand, and the prices are therefore easy.

During the month of August the output of new shipping from the Clyde has been very satisfactory in amount, being the greatest that has been launched in the same month for many years, with the exception of August, 1882, when the out-turn was slightly greater. In the past month nineteen vessels were put into the water, with an aggregate tonnage of 35,575, as against 10,171 tons in the same month of last year. The production of the eight months is now the largest since 1884, amounting to 131,641 tons, and comparing with 110,469 in the first eight months of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE great work of the Cardiff Corporation—the reservoir in the Cwmtaff Valley—is proceeding well. At a recent visit I was much interested in the progress and the good work being done. Land has been taken for other reservoirs in case of need, and a farm bought lately. The laying of the pipes continues, and a length of nearly twenty-five miles, with a slight exception, completed. The excavation in the Taff Valley, thirty miles in length, has shown that the vale was an arm of the sea, the rolled stones—"old red," granitic, and conglomerate—having been subject to the action of tides as violent as any on the roughest coast.

I note that the Stock Exchange Committee appointed September 1st as a special settling day in Cardiff Corporation Stock—further issue—£300,000, 3½ per cent.

The New Roath Dock at Cardiff is beginning work in earnest. I saw on the day of opening a fine train of coal ready for shipment; trucks and coal came from "Lewis, Merthyr." On Monday the first cargo of deals came in, brought by the William Tapscott, 1593 tons register, Boston, Mss. On Monday the first vessel was despatched with a cargo of coals for St. Nazaire. This was the St. Aubyn, which came in with 1600 tons of iron ore from Bilbao, so the St. Aubyn had the honour of discharging first ore and shipping first coal cargoes. The True Briton, with damages, was the first vessel to be repaired in the new dock. The Tyneside Engineering Company is now engaged upon her.

The coal trade is tolerably brisk, Cardiff foreign shipments were in excess of late averages, and prices are well maintained as regards steam coal. Present quotations, best coal, Cardiff, 9s. to 9s. 6d.; Newport, 8s. 3d. to 8s. 6d. In Cardiff Monmouthshire coals and seconds are offered as low as 8s. Swansea quotation for best coals f.o.b. is 9s. 6d. to 10s.

Generally, house coal is flat. There are some exceptions amongst favoured collieries, especially near Maesycwmmer. I am glad to see that a fine piece of the famous vein known by that name has been won by Mr. Stewart, of the Gwerna, which will yield 1000 tons weekly for a considerable time.

The colliers of Mountain Ash, at a meeting last week, approved of the eight hours' movement.

On Saturday, under the presidency of Sir W. T. Lewis, the Sliding-scale Committee directed the books to be audited. I hope that the result may be to declare an advance, but fear not.

An ex-engineer, Cardiff, tells us that changes are creeping in at this seaport, and large sailing vessels coming into favour instead of steamers, as a less expensive medium, where time is not of first consideration. The large steamer, with its high-salaried master, three engineers, or two and an assistant, and its consumption of coal, entails a figure which is larger than outsiders dream of.

There is an encouraging sign or two in the iron trade: rails are in better demand. America is putting in more briskly for blooms, and the necessities of the tin-plate works cause a full demand for steel bar. Rails, too, are in steady requirement.

Now that the drought is ended, business will get more active. Dowlais is expected to make a slight start soon, though the poor watershed it has does not promise much yet. When it does start fairly good work may be expected. For some time repairs and additions have been extensive, and a new Bessemer mill is preparing.

It is in machinery, the best engineering appliances, and the cheap labour rate current in the Welsh districts, consequent upon low rents, &c., that Wales can compete favourably with the North of England. The North get their foreign ore almost at the seaboard, here there is about a 2s. rate, and the northern coke may be said to make it imperative for Welsh ironmasters to obtain the latest and best ovens, such as the Evance Coppée.

I note one or two works still without, and in consequence they are handicapped. The steel works at Treforest will soon be in action again. An early date is named for the restart.

A large despatch of blooms took place from Newport this week for Philadelphia. Blooms are quoted at £4 5s. This, too, is the figure for rails, heavy sections; light are being quoted up to £5 5s.

At the Swansea Exchange this week prices varied little from last. Pig, Glasgow, commanded, 42s. 9d. to 43s. Middlesbrough, No. 3, 34s. 6d.; Bessemer, 44s. 8d., f.o.b.; local hematite Bessemer, 48s. 6d. This is one of the manufactures showing an advance from last week.

Bessemer bars, steel, are quoted at £4 15s.; Siemens bars, £5 2s. 6d. Bar iron, £4 10s.; sheet iron, £6 15s.; steel sheets, £7 10s.

The tin-plate trade remains about the same. Prices are maintained, but there is not a very large sale going on, though as makers are well booked this is not considered as of great consequence, as makers have the whip hand of buyers. Even wasters are selling at only 6d. per box less than primes. Cokes are quoted at 13s. 3d. to 13s. 6d.; Bessemers, 13s. 6d. to 13s. 9d.; Siemens, 14s. to 14s. 6d. coke finish; best go up to 18s. 6d.; ternes, 28s. double box.

The news from America, from whence large orders are continually coming, indicates uneasiness, as stocks are getting less, and there is a confident impression prevailing that higher prices must rule, and that in a short time. Clearances have been large, make is still somewhat restricted, and booking for future delivery at market price is not approved by makers.

The Gadlys plant, Aberdare, tin-plate, is announced for sale. The position of these works, with good water power and railway communication, should command attention.

A strike is threatened amongst the steel smelters at Swansea; the men are acting in unison with one of the trade societies—the British Steel Smelters' Amalgamated Association. The cause of the difference is resistance to an adjustment of the tonnage rate of wages consequent upon the increased make of a large improved furnace at Landore.

One would think that as the increased make meant increased pay, eventually, at least, that this would be a fitting subject for arbitration.

The Rhondda and Swansea Bay Railway Co. had a meeting this week, and good progress was announced with the tunnel. It is now half through. Another year will see the completion under ordinary circumstances. It is stated that some of the walling at Milford Docks has given way; this, if true, will delay the opening of the dock.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE position of the Rhenish-Westphalian iron market improves from week to week, and this more cheerful condition of it is founded on a healthy basis, in the opinion of those best able to form a judgment. The conventions and syndicates have taken a wise and moderate course in accommodating their prices to the actual conditions of the trade, which has given confidence, and as yet there has been no reaction on the part of buyers. The Silesian iron market, too, continues to exhibit great firmness. It was at first prophesied that the establishment of conventions, &c., would cause a reaction on the part of buyers, but quite on the contrary, the large merchants and dealers have rather aided than opposed the works in their endeavour to raise prices, which would indicate that the former exceptionally low ones were unnatural and unnecessary; and as a proof of the good will of buyers, they have filled the works with orders at the syndicate prices—indeed, M. 1 p.t. above this for bars is being given to get promptly served, and all this quarter's output has already been contracted for. For the fourth quarter no contracts are being entered into by sellers, because a further rise is anticipated for that period. Last August the base price of bar iron was M. 90 p.t., now it is 132·50; best sorts, 140 to 145; and plates are 160 to 165. The steel works continue satisfactorily employed.

The ore markets of the Western districts remain favourable to sellers, and prices in the Siegerland have not only been well maintained, but have somewhat advanced again, and the same may be recorded of those of Luxemburg, which are being sent in such large parcels into Westphalia that stocks are quickly becoming reduced, and the prices of minette are now M. 1·85 to 2·40 p.t. On the whole the position of the pig iron market is also favourable, the demand is brisk, and prices still have an upward tendency.

The railway freights on German pig iron into Holland are shortly to be lowered, which will be of importance to the Westphalian works. This has already taken place with regard to steel wire rods, and will soon come into operation. Belgium had almost pushed Germany out of the Dutch market through cheap freights, so now the tables are to be turned and Belgium ousted. Such is the rivalry now going on on the Continent. The export of high quality spiegel iron is again in full swing, and as the rolling mills are all full of work, it keeps forge pig in continued brisk demand at firm prices; and the same is the case with foundry sorts, as the foundries are much better employed, and now again in a position to lay in fresh stocks of crude iron. Basic pig goes off well at tighter prices, and Bessemer well, but not quite so much so as the former. The prices are very nearly the same as quoted last week. In the month of July, 326,075 tons of pig iron, including Luxemburg, were produced, 149,413 tons of forge pig and spiegel, 42,491 tons Bessemer, 91,075 tons basic, and 43,096 tons foundry pig. From January 1st to July 31st, 2,174,556 tons, against 1,983,515 tons last year.

The wrought iron branches keep steadily and, if possible, increasingly well employed, and the syndicate prices, which have only gradually followed the rise in pig iron, are cordially paid by buyers. It is reported that the syndicate has laid an extra M. 3 p.t. on to small lots under 10 tons in favour of merchants. It appears that the base price of M. 115 is for the limited home area, whilst that up to the Elbe and Saar is 113, and east of the two named rivers 108 per ton, which is also the price to the south of Aix-la-Chapelle-Coblence-Hof. The output of the twenty-two combined rolling mills was for July 25,229 tons. The Saar rolling mills, in sympathy with the rising pig iron market, are contemplating a speedy rise in girders, the present price of which is M. 113 p.t. The good demand for thin sheets keeps up, and M. 135 is paid readily, but the base price has been again raised M. 5 to 140 p.t. The wire rod trade, both for home consumption and especially for export, has greatly increased. Prices are firmer, and if a profit is to be realised on their sale prices must, and will, be raised a little in proportion to the advanced notations for pig iron and steel billets. Added to this, the steel works are almost all sold out till the end of the year, so that it is not possible, or at any rate only at very enhanced prices, to contract for the requisite supply of billets. As regards steel rails, the lowest offer for 3000 t. at Bromberg for the State Railway was M. 1 p.t. higher than at the last tendering. The tenders ranged between M. 109 and 115 p.t. Cockerill and Co. offered at M. 116·45 free at Colberg, but this port is out of the way, so the offer did not avail them. The wagon works are extremely quiet just now. There is nothing new to note regarding the machine and constructive workshops beyond what was said last week. The wrought iron and steel notations continue the same as last reported, always with a tendency more to a rise than a fall in them.

The Belgian iron trade continues very firm, and most works are very busy, but more especially those rolling girders, which are going in very large lots to North and South America and Italy; also the steel works are satisfactorily employed. The Cockerill Company, it is announced, has taken an order for 6000 tons of steel rails for the Danish State Railways, at M. 82 p.t. at Seraing. Indeed, the Liége works are best engaged in the rail branch, whilst other districts are busy on billets. The Liége small-arms makers have obtained orders for 300,000 rifles on the Schulhof system. The machine shops complain of want of orders. It will be in recollection that Baron Sadoine was deputed by a syndicate of Belgian Industrials to proceed to China, in the hope of securing enterprises or trade for the country. He has just returned, but his mission appears to have almost entirely failed of success.

The French iron trade is beginning to rise out of the deplorable condition it has remained in for some time back, and demand at the works is increasing.

An extensive factory for the manufacture of scythes, large enough to supply all the wants of Russia, has just been put into operation at Wilna. Till now the country was supplied from abroad, chiefly from Styria, which will now lose a great portion of its once flourishing, celebrated trade, which has existed hundreds of years.

It is reported that an English company is about to establish a large factory at Nüremberg for the construction of bicycles. It has already acquired several acres of land on which to erect the works, to which a riding school, or covered circus or ring, is to be attached. As there are but 25,000 cycle riders in Germany, where this sort of sport has only of late years attracted the attention it deserves, against 500,000 in England, the company no doubt has a good prospect of success, which it is to be hoped it will obtain. It is further stated that the proprietors in this country of the "Roburite" patents have sold the rights to manufacture this explosive in England and France for £50,000, but this statement requires confirmation

A YEAR'S RAILWAY ACCIDENTS.—The total number of persons returned to the Board of Trade as having been killed in the working of the railways in the United Kingdom during the year was 938, and the number of injured 3539. Of these, 95 persons killed and 1342 persons injured were passengers, but of these only 8 were killed and 615 injured in consequence of accidents to or collisions between trains; the deaths of the remaining 87 passengers and the injuries to 727 are returned as due to a variety of other causes, and especially to want of caution on the part of the individuals themselves. Of the remainder, 425 killed and 2010 injured were officers and servants of the railway companies or of contractors. Of suicides there were 80; of trespassers, 205 were killed and 91 injured; of persons passing over the railway at level crossings, 81 killed and 25 were injured; and of other persons, from miscellaneous causes, 52 were killed and 71 injured. In addition to the above, the companies have returned 51 persons killed and 3868 injured from accidents on their premises not connected with the movement of railway vehicles. The total number of passenger journeys, exclusive of journeys by season ticket-holders, was 725,584,390 for the year 1886, or 28,371,359 more than in the previous year. Calculated on these figures, the proportions of passengers killed and injured during the year from all causes were, in round numbers, one in 7,637,730 killed, and one in 540,674 injured. In 1885 the proportions were one in 6,385,421 killed, and one in 617,549 injured.

NEW COMPANIES.

The following companies have just been registered:—

Cheadle Railway, Mineral, and Land Company, Limited.

This company proposes to construct, equip, and work a railway intended to extend from the town of Cheadle, in Staffordshire, to or near the Cresswell station of the North Staffordshire Railway; also to carry on mining operations. It was registered on the 18th inst., with a capital of £250,000, in £10 shares. The subscribers are:—

	Shares.
H. M. H. Rumball, 4, Stone-buildings, Lincoln's-inn, barrister	1
John Lewis Dean, 47, Moorgate-street, fencing manufacturer	1
W. F. N. Clappison, 294, Cold Harbour-lane, Brixton, contractor's agent	1
J. A. Graham, 4, St. Andrew's-terrace, Plaistow, surveyor	1
Thomas Bird Leaver, 2, Newman's-row, Lincoln's-inn-fields, law stationer	1
Thomas Baker, 422, Mansion House-chambers, land agent	1
Charles Dickie, Bernard House, High Barnet	1

The number of directors is not to be less than five, nor more than nine; the subscribers are to appoint the first, and are to act *ad interim*. The company in general meeting will determine remuneration.

Height Measuring Apparatus Company, Limited.

This company was registered on the 18th inst., with a capital of £15,000, in £10 shares, to acquire certain provisional specifications and patents at home, in the colonies, and abroad, obtained by Mr. William Porritt Ingram, of Middlesbrough, for a height-measuring apparatus. The subscribers are:—

	Shares.
*W. E. Walker, Middlesbrough, ironmaster	1
W. P. Ingram, Middlesbrough, engineer	1
J. Gilchrist, Middlesbrough, accountant	1
*G. Benjamin Jackson, Middlesbrough, solicitor	1
T. H. Jackson, Middlesbrough, solicitor	1
John Moses, Middlesbrough, clerk	1
W. M. Hopkins, Middlesbrough, clerk	1

The number of directors is not to be less than three, nor more than seven; the first are the subscribers denoted by an asterisk, and Mr. Thomas Walker, of Saltburn-by-Sea. The purchase is regulated by an agreement of 13th inst., the consideration being £500 cash and 950 fully-paid shares.

Santa Marta Railway Company, Limited.

On the 22nd inst. this company was registered, with a capital of £600,000, in £10 shares, of which 40,000 are 7 per cent. preference shares, to purchase from Don Manuel J. de Mier and Robert A. Joy certain contracts or concessions made with the Republic of Colombia, for the construction of a railway from the city of Santa Marta to Banco, upon the river Magdalena, and for certain harbour works, wharves, quays, and other works at the Port of Santa Marta. The subscribers are:—

	Shares.
Robert Griggs, 17, Crescent-road, Bromley, Kent	1
Alexander Henderson, 28, Austinfriars, stock-broker	1
H. W. Burnside, 21, Kempsford-gardens, South Kensington	1
J. de Mier, 12, Rue de Lubeck, Paris	1
J. White Todd, 33, Eaton-place	1
C. J. Whitaker, 12, Waldegrave-road, Teddington	1
E. P. Farish, 24, Coleman-street, solicitor	1

The number of directors shall not be less than three, nor more than seven; the subscribers are to appoint the first, and are to act *ad interim*; qualification, 250 shares. The company in general meeting will determine remuneration.

Leete, Edwards, and Norman, Limited.

This company was registered on the 27th ult., with a capital of £20,000, in £5 shares, to trade as general, mechanical, mining, and consulting engineers, tool and boilermakers, electricians, indiarubber, and vulcanite manufacturers. The subscribers are:—

	Shares.
*A. Leete, 366, Euston-road, engineer	1
*W. Edwards, 366, Euston-road, engineer	1
*H. C. Norman, 366, Euston-road, engineer	1
*A. R. Reeves, Hendon, engineer	1
J. Leete, 11, Ashchurch-terrace, Shepherd's Bush, engineer	1
E. Mansell, Grassington, Beckenham, secretary	1
C. W. Ray, 366, Euston-road, engineer	1

The number of directors is not to be less than three, nor more than seven; qualification, £500 in fully-paid shares; the first are the subscribers denoted by an asterisk; remuneration, £200 per annum.

London Electric Supply Corporation, Limited.

This company was registered on the 26th ult., with a capital of £1,000,000, in £5 shares, to supply electricity for lighting and other purposes within the City of London and the area included in the London Postal District. An agreement with Sir Coutts Lindsay and Co., Limited, will be adopted. The subscribers are:—

	Shares.
*The Hon. R. T. D. Brougham, C.E., 15, Hans'-place	1,500
*The Earl of Crawford, 2, Cavendish-square	3,000
*Francis Ince, St. Benet-chambers, solicitor	2,000
*Sir Coutts Lindsay, Bart., 11, Grosvenor-square	12,000
*Joseph Pike, Devonshire-place House	6,000
*A. F. Wade, 9, Albert-mansions, Victoria-street, S.W.	10,000
*Lord Wantage, 2, Carlton-gardens, S.W.	7,500

The number of directors is not to be less than seven, nor more than twelve, the subscribers being the first; qualification, £5000 of share capital; remuneration, £2000 per annum, and, in addition thereto, one-tenth of the annual surplus profits after providing for a reserve fund and paying 5 per cent. dividend to the shareholders, provided that the total remuneration shall not exceed £5000 per annum in respect of each £1,000,000 capital.

Northern Electrical Engineering Company, Limited.

This company was registered on the 26th ult., with a capital of £25,000, in £1 shares, to take over the business of scientific apparatus manufacturers and electrical engineers, carried on by F. H. Perry and Co., Limited, in Victoria-street, Liverpool, and also the business of H. J. Marshall and Co., of Custom House-arcade, Liverpool. The subscribers are:—

	Shares.
Thomas M. Bigley, C.E., 19, Castle-street, Liverpool	1
J. E. Banks, 23, Balmoral-street, Liverpool, solicitor	1
R. H. Anderson, Wavertree, engineer	1
H. Ingham Marshall, 5, Custom House-arcade, Liverpool, electrical engineer	1
F. W. Witter, 18, Water-street, Liverpool, general broker	1
F. H. Perry, 70, Chatham-street, Liverpool, electrical engineer	1
R. F. Johnson, 77, Stoke Newington-road	1

The number of directors is not to be less than three, nor more than seven; qualification, 300 shares; the subscribers are the first. The company in general meeting will determine remuneration.

Beersheba Gold Mining Company, Limited.

This company was registered on the 26th ult., with a capital of £30,000, in £1 shares, to carry on mining operations in the Transvaal, and will adopt an unregistered agreement, dated 22nd ult., between James Kent, of 55, Basinghall-street, and F. W. Smith. The subscribers are:—

	Shares.
R. J. Smith, 23, Moorgate-street, engineer	1
H. W. Macdona, 20, Finsbury-pavement, accountant	1
J. T. Bedborough, 44, King's-road, Brownswood Park, N.	1
J. H. Goodwin, 74, Coleman-street, wool broker	1
B. H. Bloxham, 41, Doughty-street, clerk	1
H. L. Dixson, Castle Tavern, Gresham-street	1
W. J. Beard, 66, Basinghall-street, auctioneer	1

The number of directors is not to be less than three, nor more than seven; qualification, £50 in shares or stock; the first are Messrs. W. Gordon Bagnall, Castle Engine Works, Stafford; G. F. Griffin, St. Helen's Wood, Hastings; W. Bevitt, Romford; Major Donald Cameron, of Cape Town; and Edward Jones, M.E., of Johannisberg, the latter being appointed local director in South Africa; remuneration, £500 per annum, and 5 per cent. of the net profits after payment of 20 per cent. dividend.

Bridgewater Spinning Company, Limited.

This company was registered on the 27th ult., with a capital of £100,000, in £5 shares, to acquire from the Patricroft Spinning Company, Limited, the Springfield Mill, Barton, in the parish of Eccles. The subscribers are:—

	Shares.
*W. Hargreaves, Bolton, engineer	1
C. T. Wolfenden, Heaton, Bolton	1
*J. K. Glazebrook, Swinton Park, near Manchester	1
*D. Marriage, Chorley, cotton spinner	1
*M. Settle Daray, Lever, colliery proprietor	1
*T. H. Rushton, Bolton, machinist	1
*R. Walker, Southport	1

The number of directors is not to be less than three, nor more than five; qualification, twenty shares; the first are Messrs. J. Crompton, T. Grundy, J. J. Grundy, William Entwistle, and the subscribers denoted by an asterisk. The company in general meeting will determine remuneration.

Oaxaca Mining Company, Limited.

On the 25th ult. this company was registered, with a capital of £100,000, in £1 shares, to acquire the mining properties and reduction works belonging to Mr. Constantine Rickards, at Oaxaca, Mexico, and to work gold, silver, and other mines. The subscribers are:—

	Shares.
L. Long Maudsley, Stanger-road, South Norwood, solicitor	1
A. Gilbert, St. Michael's-road, Stockwell	1
C. Bogler, 6, Great St. Helen's, merchant	1
Mrs. Jane Sadler, 2, Gloucester-terrace, Regent's Park	1
W. Brougham, 6, Copthall-court, clerk	1
R. R. Gibbs, 7, Fenchurch-buildings	1
J. H. Smeed, 16, Mountford-road, Dalston	1

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

THE UPSETTING OF A RAILWAY TRAIN BY WIND.[1]

During the night of the 11—23 of June, 1886, on the South-Western Railway, near the Novo-Oukrainik station, a portion of a train, consisting of an engine and forty-five wagons, was blown over by a terrific gale of wind accompanied by a severe thunderstorm. The train was made up in the following manner:—Next the engine, an empty covered wagon; next, four smaller wagons, each loaded with a little more than 3 tons of miscellaneous goods; next, sixteen empty covered wagons; then twenty empty flat trucks; next, two coal trucks; and lastly two empty flat trucks. The line was on sidelong ground, and was formed for a double track, but the permanent way was laid only for a single one.[2] At the spot where the accident occurred, the wind, which was blowing from the S.S.W., was nearly at right angles to the line, and came down a valley some miles long. On the lee side of the line, on the portion destined to receive a second pair of rails, was a spoil bank, against which two loaded and sixteen empty covered wagons fell, remaining in an inclined position and forming a curve, the centre of which was about 4ft. from the rails, while the ends abutted upon them. The hinder parts of the train remained on the rails, though the couplings were broken away. This short paper is illustrated by a cross section showing the position of the wagons after the accident, and a map illustrating the peculiar features of the country. The estimated force of the wind is given at 25·2 lb. per square foot.

[1] "Proceedings" Institution of Civil Engineers.

[2] The gauge is not stated, but it is presumably the normal Russian gauge of 5ft.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

23rd August, 1887.

11,451. Automatic Fire Alarm, L. Nievsky and B. Humphreys, London.
11,452. Atmospheric Oil Burner, E. Horton, Birmingham.
11,453. Stopper for Bottles, J. Brocklehurst, Manchester.
11,454. Photographic Print Washer, E. H. B. Lyne, London.
11,455. Driving a Reaper Knife, G. P. Cooper, Beverley.
11,456. Separating Solid Matters from Liquids, W. S. Squire, London.
11,457. Shaft Keys, W. N. Woodruff, London.
11,458. Winding Shuttle Cops, H. H. Lake.—(*M. V. Palmer, United States.*)
11,459. Rock-drilling Machines, R. P. Elmore and G. G. Tillotson, London.
11,460. Cartridge Cases, H. H. Lake.—(*J. W. Frazier, United States.*)
11,461. Knitting Machines, &c., J. M. Sellers, Keighley.
11,462. Artificial Teeth, J. Macdonald, Manchester.
11,463. Printers' Galleys, R. C. Ross, Manchester.
11,464. Advertising Puzzle, C. Lee, London.
11,465. Isochronal Clock, H. Conant, London.
11,466. Gas Motors, C. T. Wordsworth, London.
11,467. Correspondence Card, W. H. D. Caple, Roath.
11,468. Call Whistles, A. C. Farrington, Shelfanger.
11,469. Repeating Attachments to Watches, J. G. Tongue.—(*P. Nordmann, United States.*)
11,470. Duplicate Telegram Book, G. Harrison and Sons, Bradford.
11,471. Lathes, P. Shellenback and S. E. Swayne, London.
11,472. Spinning Worsted Yarns, H. H. Tankard and H. W. Broadbent, London.
11,473. Taps, C. Kasefang, London.
11,474. Ingot Iron, P. C. Gilchrist, London.
11,475. Tricycles, P. M. Justice.—(*P. M. Pearne and E. M. Tower, United States.*)
11,476. Drawing Boards, H. H. Lake.—(*N. W. Salsbury, United States.*)
11,477. Ironing and Drying Fabrics, E. Hesketh, London.
11,478. Crystallised Metal, L. L. Lefevre, jun.—(*C. Payen, United States.*)
11,479. Boot Stretcher, F. Roeder, London.
11,480. Towel Rack, H. H. Lake.—(*W. T. Mersereau, United States.*)
11,481. Lubricators, J. Y. Johnson.—(*D. D. MacMullen, United States.*)
11,482. Indicating Apparatus for Railways, J. W. Hilles, London.
11,483. Adjusting the Seats of Music Stools, G. Clulow and J. Loader, London.
11,484. Adjusting the Seats of Music Stools, G. Clulow and F. Stevens, London.
11,485. Treating and Purifying Sewage, J. H. Barry, London.
11,486. Securing Doors of Railway Carriages, F. G. G. Lines and J. Kendal, London.
11,487. Reducing Cereals, A. H. Reed.—(*J. S. Hall, United States.*)
11,488. Stand for Carrying Teapots, W. Soar and H. Parkins, London.
11,489. Indicating the Weight of Human Beings, E. Parr and E. Edwards, London.
11,490. Syphonic Apparatus, P. Winn, London.
11,491. Exhaust Arrangements for Engines, J. Atkinson, London.
11,492. Caustic Alkali Carbonates, H. H. Lake.—(*A. Kayser, H. Williams, and A. B. Young, United States.*)
11,493. Producing Silicate of Sodium, H. H. Lake.—(*A. Kayser, H. Williams, and A. B. Young, United States.*)
11,494. Producing Muriatic Acid, H. H. Lake.—(*A. Kayser, H. William, and A. B. Young, United States.*)
11,495. Starting Tramcars, S. Reeve, C. E. Ratcliffe, and J. B. Davis, London.
11,496. Decorating Ceramic Ware, A. J. Boult.—(*F. Czech, Austria.*)
11,497. Dyeing Yarn in Cops, A. Graemiger, London.
11,498. Glove, &c., Fastening, G. Brockhaus, Liverpool.
11,499. Attaching Candlesticks to Standards, W. P. Thompson.—(*A. H. A. Landwehr, Forst on Lans.*)
11,500. Compounds of Fluoride of Antimony, &c., C. J. E. de Haën, Liverpool.
11,501. Belting Pulleys, A. J. Boult.—(*H. R. Leichsenring, Germany.*)
11,502. Dynamo-electric, &c., Machines, E. F. H. H. Lauckert, London.
11,503. Motor Engines, C. D. Abel.—(*The Gasmotoren Fabrik Deutz, Germany.*)

24th August, 1887.

11,504. Steam Pumps, P. E. Hodgkin, London.
11,505. Varying a Burning Gas Jet, J. D. Cocker, Manchester.
11,506. Warp Letting-off and Treadle Motions of Looms, C. Catlow, Halifax.
11,507. Grinding Flats of Carding Engines, J. Bullough, Halifax.
11,508. Opening, &c., Fanlights, &c., R. R. Harrison, Birmingham.
11,509. Bricks, &c., H. Warrington and W. W. Howlett, Hanley.
11,510. Plant and Furnaces for Extracting Metallic Ores, &c., F. Fenton and R. J. Partridge.—(*J. Woolford, France.*)
11,511. Healds for Looms, C. Hahlo, C. E. Liebreich, and T. Hanson, Halifax.
11,512. Stoppering Bottles, M. Sutcliffe and W. Brocklehurst, Manchester.
11,513. Frosting the Surfaces of Flint and Glass Ware, J. S. Williams, Staffordshire.
11,514. Releasing and Locking Machinery, W. Sunderland, Selly Park.
11,515. Shaping the Teeth of Bevel Wheels, J. Lindsay and R. Allan, Glasgow.
11,516. Hollow Steel Shafting, E. Cope and A. Hollings, Liverpool.
11,517. Controlling Steam Engines, H. W. Cook, London.
11,518. Perambulators, C. A. Rollason, Birmingham.
11,519. Consuming Smoke in Furnaces, P. Hodkinson, London.
11,520. Opening and Cleaning Fibres, J., R., and J. Greenhalgh, London.
11,521. Utilising Old Horseshoes, A. Leggoe, Sheffield.
11,522. Watch Chains, N. C. Reading, Birmingham.
11,523. Perambulators, C. A. Rollason, Birmingham.
11,524. Pencils, R. E. Green, London.
11,525. Bleaching Materials, J. Farran, Manchester.
11,526. Shoes for Hoofed Animals, C. J. Jutson and F. A. Poupard, London.
11,527. Car Couplings, J. L. Rankine, London.
11,528. Casting Rollers, J. A. Drayton and M. P. McCoy, London.
11,529. Lamps, L. Cornélis, London.
11,530. Steel Sleepers, J. Cabry and W. H. Kinch, London.
11,531. Bottles for Aerated Liquids, W. W. Macvay, R. Sykes, and W. Wainwright, London.
11,532. Treatment of Ores, G. Gathereal, London.
11,533. Fastenings for Boxes, G. W. Palmer and W. J. Stock, London.
11,534. Treatment of Sewage, T. M. J. and J. N. Truchelut, London.
11,535. Pneumatic Bells and Signals, H. F. Joel, London.
11,536. Signal Gun, E. Drinkwater, London.
11,537. Charcoal, O. Bowen and A. S. Tomkins, London.
11,538. Velocipedes, F. Wilkins, London.
11,539. Pocket Filter, S. W. Silver and W. S. Bennett, London.
11,540. Hydro-carbon Oil Carriers, A. F. Stone and J. Black, London.
11,541. Propulsion of Ships, E. Griffon, London.
11,542. Clocks, A. J. Boult.—(*P. Amiel, Spain.*)
11,543. Electrodes for Electric Accumulators, H. Tudor, Liverpool.
11,544. Ships for War, &c., J. W. White, Manchester.
11,545. Hooks and Eyes for Wearing Apparel, M. W. Alcock, Manchester.
11,546. Shaping, &c., Files, R. Eggert and E. A. aus'm Weerth, London.

25th August, 1887.

11,547. Fish Hooks, J. E. Gold, London.
11,548. Protectors for Boots, &c., O. Tilley, Leicester.
11,549. Water Tuyere with a False Nose, G. Large, Wolverhampton.
11,550. Winding Yarns to be used as Warps, J. Morrison, Glasgow.
11,551. Coal Vases, A. Lowe, Birmingham.
11,552. Sand Blast Apparatus, J. E. Mathewson, Sheffield.
11,553. Self-measurement System for Boots, C. J. Smith and H. E. Howe, Northampton.
11,554. Making Bicycle, &c., Wheels, J. L. Berry, Aberdare.
11,555. Stretching, &c., Trouser Bottoms, G. Browning, Farnworth-in-Widnes.
11,556. Blocks and Tuyeres connected with Blast Furnaces, J. McCann, Millom.
11,557. Ploughs and Plough Coulters, H. W. Robinson, Northampton.
11,558. Self-acting Mules, J., W., and S. France, and T. Smith, Manchester.
11,559. Rectifying at Sighttall Error in the Mariner's Compass, W. O'Keeffe, Douglas, Isle of Man.
11,560. Injectors, A. Budenburg.—(*Schäffer and Budenburg, Germany.*)
11,561. Buckles and their Attachments, J. M. Fletcher, Cheadle.
11,562. Revolving Car for Gravitation Railways, &c., R. Mansell and R. Flanagan, Manchester.
11,563. Corrugated or Spring Washer, W. C. Lockwood and H. Carlisle, Sheffield.
11,564. Washing Dolly or Plunger, H. Watson, Steeton.
11,565. Adjustable Tool Holder, J. J. Carr, London.
11,566. Door Furniture, R. W. Brenmehl, Birmingham.
11,567. Hydro-carbon Engines, P. Niel and J. M. Bennett, Glasgow.
11,568. Electrically-driven Sewing Machines, J. David, London.
11,569. Cooling Stokeholes, &c., L. McIntyre, London.
11,570. Separating Wool, &c., from Animal Fibre, S. S. Bromhead.—(*U. C. Allen, United States.*)
11,571. Hardening or Chilling the Face of Armour and other Plates, R. E. Shill and A. Martin, London.
11,572. Engines, Steam or otherwise, as Motors or Meters, J. J. Miller, G. J. Tupp, and H. G. A. Rouse, London.
11,573. Boots and Shoes, B. B. Nicholls, London.
11,574. Motor, H. P. Fenby, London.
11,575. Fire Bar, W. Wilkie, Glasgow.
11,576. Sewing Machines, R. Fryer, London.
11,577. Musical Instruments, E. Parr, London.
11,578. Determining the Range of Guns, &c., G. Shepheard and H. F. Holman, London.
11,579. Baling of Peat, &c., H. C. Capel, London.
11,580. Fastening Materials Together, L. Wilson, Manchester.
11,581. Securing, Locking, or Fastening Materials Together, L. Wilson, Manchester.
11,582. Solenoids, R. Harrison, London.
11,583. Automatic Extinguishers for Oil Lamps, F. W. Durham, London.
11,584. Testing Alcohols, A. J. Boult.—(*B. Bruel.*)
11,585. Printing Presses or Machines, J. Jordan and E. Howard, London.

26th August, 1887.

11,586. Roller Bearings for Shafts of Wringing Machines, A. Clark, Halifax.
11,587. Latches and Bolts for Doors, J. Holt, Manchester.
11,588. Automatic Machinery for Cutting-up Card-board, L. Myers, Birmingham.
11,589. Upright and other Pulleys, W. H. Rooke, Birmingham.
11,590. Presses, W. Gaskill, London.
11,591. Sunk-slide Flush Bolt for Doors, R. R. Harrison, Birmingham.
11,592. Life-saving Apparatus for Steam Trams, &c., J. Cheshire, Birmingham.
11,593. Beam Scales and Weighing Machines, W. Farnall, Bristol.
11,594. Electric Fire-alarm Telegraph, W. Blenheim, Egham.
11,595. Lamp Extinguisher, J. Blos, Berlin.
11,596. Steam Boilers, J. Barker, Oldham.
11,597. Automatic Cigar, &c., Supplying Machines, E. E. Atkins, Birmingham.
11,598. Wire Chain, R. A. Breul, London.
11,599. Footballs, A. J. Altman, London.
11,600. Water Heating and Automatic Gas and Water Regulator, W. J. Righton, London.
11,601. Box or Sad Iron Heated by Liquid Fuel, L. Strakosch, London.
11,602. Fire-arms, H. C. Walker and H. C. Heffer, London.
11,603. Safety Dropping and Sprinkling Cork, H. W. Lancashire, Felpham.
11,604. Facilitating Delivery of Prepaid Goods, A. Steer and E. O. Eaton, London.
11,605. Indicator Block for Springs of Carriages, R. Jones, London.
11,606. Burner for Gas Lamps, G. Downing.—(*N. Schaeffer and J. Elsner, France.*)
11,607. Ball Bearings, J. L. Herckenrath and H. W. van Raden, London.
11,608. Height-measuring Apparatus, W. P. Ingham, London.
11,609. Filtering Water, &c., J. E. Warren, London.
11,610. Recovering Chemicals from Spent Liquors, J. E. Warren and F. A. Cloudman, London.
11,611. Steam, &c., Boilers, G. Paxton, Glasgow.
11,612. Textile Fabrics, H. Martinz, London.
11,613. Cupola Smelting Furnaces, F. A. Herbertz, London.
11,614. Making Cop Tubes, J. B., G., J. B. Swailes, London.
11,615. Twist Lace Fabrics, I. Elliott, London.
11,616. Lantern Pinions for Clocks, A. E. Hotchkiss, London.
11,617. Steam Engines, J. F. Thompson, London.
11,618. Heels for Boots and Shoes, J. B. Tilley, London.
11,619. Foot-warmers, &c., W. Farquhar, London.
11,620. Cleaning Foreign Sheepskins, A. Granville, London.
11,621. Kaleidoscopic Effects, W. S. Simpson and W. S. Oliver, London.
11,622. Furnaces, N. Petersen, London.
11,623. Extractor Mechanisms for Drop-down Small-arms, H. W. Holland and J. Robertson, London.
11,624. Stoves, J. A. Hanna and T. F. Shillington, London.
11,625. Making Calculations, A. J. Boult.—(*A. T. Thomas.*)

11,626. Combined Cane and Umbrella, W. P. Thompson.—(*C. E. Vail, United States.*)
11,627. Generating Steam, J. F. Walker, Farnham.

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11,628. Generating Secondary Steam, C. Howe and B. and J. H. Beckwith, London.
11,629. Double-cuff Glove, H. Caston, London.
11,630. Stopping Looms, F. T. Schmidt, Bradford.
11,631. Governor for Engines, W. F. Bowen, Bolton.
11,632. Expansive Vessels of Steam Traps, A. Bradshaw, Accrington.
11,633. Washing Machines, J. C. Balmforth and H. Hutchinson, Nottingham.
11,634. Medals of Cardboard, &c., W. H. Watts, Birmingham.
11,635. Winding Machines, W. and L. Tolson and J. Adams, Halifax.
11,636. Atmospheric Injector, R. Robson, Leeds.
11,637. Bicycles, &c., W. H. S. Aubin, Bloxwich.
11,638. Internally-stoppered Bottles, D. Rylands, Barnsley.
11,639. Loading and Unloading Coal, W. E. Kochs, Cardiff.
11,640. Kindergarten Spelling-box, C. Hossfeld, London.
11,641. Boilers, J. Peake, Manchester.
11,642. Beer Pumps, S. Smith, Sheffield.
11,643. Shooting Game, J. Hope, Liverpool.
11,644. Self-closing Ball Valves, J. S. Walford, Birmingham.
11,645. Storing and Automatic Supply of Oil for Lamps, C. W. Clarkson and F. Burnard, Newport.
11,646. Issuing and Registering Apparatus, D. R. O'Sullivan, London.
11,647. Respirator and Inhaler, S. F. Smith, London.
11,648. Paring, &c., Vegetables and Fruit, D. Clan-Alpine Thatcher, London.
11,649. Shop-window Stands or Brackets, A. C. Marlow, Worcestershire.
11,650. Compound Donkey Pumps, S. C. Harris, London.
11,651. Boxes or Cases, A. Hood, Glasgow.
11,652. Hydraulic Motors, W. Fletcher, London.
11,653. Caustic Soda and Potash, F. P. E. de Lelande, London.
11,654. Permanent Cramp Bottle Stopper, S. H. Musgrave, Acton.
11,655. Double-grooved Neck Glass Bottle, S. H. Musgrave, Acton.
11,656. Steering Gear, J. Robinson, London.
11,657. Stoppers for Bottles, &c., J. Hands, London.
11,658. Explosives, E. Edwards.—(*R. Sjöberg, Sweden.*)
11,659. Revolving Rubber, L. Gillon, France.
11,660. *Re-numbered* 9256a.
11,661. Bung Bushes and Valves, W. P. Thompson.—(*M. Duhr, Prussia.*)
11,662. Sieving Apparatus, P. van Gelder, Liverpool.
11,663. Fasteners for Scarves, &c., A. J. Boult.—(*A. Löwy, Austria.*)
11,664. Colouring or Staining Wood, J. Munier and N. Salvaire, London.
11,665. Machine for Drying Wool, W. Nelson and E. Bowen, London.
11,666. Metallic Plates or Plating, S. Robertson, Glasgow.
11,667. Extinguishing Fire, H. Christie, London.
11,668. Balling Machine, W. B. Lee, Bradford.
11,669. Gas Lamps, H. W. and A. F. Cole, Stourport.
11,670. Steam Engines, W. G. Strype, London.
11,671. Window Fasteners, G. H. and A. A. E. Needham, London.
11,672. Volatilisation of Lead, &c., M. M. Bair, London.
11,673. Swaging and Welding the Ends of Wrought Metal Tubes, &c., J. P. and E. S. T. Kennedy, London.
11,674. Suspending, &c., Electric Lamps, M. Bailey and J. Warner, London.
11,675. *Re-numbered* 4135a.

29th August, 1887.

11,676. Stand Pipes for Fire-extinguishing, J. W. Hearfield, Hull.
11,677. Warp Machines, A. Paget, Loughborough.
11,678. Mincing Machine and Gas Motor Engine, G. McGhee and P. Burt, Glasgow.
11,679. Anchors, W. P. Strawson, Birmingham.
11,680. Coupling, &c., Shop Shutters, Doors, &c., E. Jones, London.
11,681. Brush, W. H. Sellwood, London.
11,682. Self-acting Mules, W. Dyson and T. Fisher, Halifax.
11,683. Packing for Cylinders, &c., J. Taylor, Manchester.
11,684. Safety Riding Stirrups, J. Harrison, Stamford.
11,685. Land Tilling Machine, W. Gordon, Cullen.
11,686. Attachment of Door Knobs to their Spindles, J. Tomkys, Codsall.
11,687. Lace and Fabrics on Twist Lace Machinery, W. Gadd, Manchester.
11,688. Reel to Hold Sewing Cotton, &c., R. Wright, Redditch.
11,689. Treatment of Oil or Tar obtained from Blast Furnaces, A. H. Allen and R. Angus, Sheffield.
11,690. Ball and Wheel Castor Frame, J. Cheshire, Birmingham.
11,691. Artificial Supports for Spinal Weakness, D. Kennedy, Glasgow.
11,692. Conveying Pure Air into Cities, &c., H. D. Child, London.
11,693. Fixing Beads upon a Foundation Thread, G. Stein, London.
11,694. Rocking Chair and Horses, J. Simpson and S. T. Fawcett, London.
11,695. Extracting Joint Pins, &c., J. J. Hayhurst, St. Leonard's-on-Sea.
11,696. Taking Measurements, &c., for Garments, J. Couteau, London.
11,697. Covers to Vessels for Preserving Perishable Articles, S. R. Stevenson, London.
11,698. Gas Lamps, E. Stein.—(*T. Gordon, United States.*)
11,699. Valves for Liquid Meters, C. C. Barton, London.
11,700. Pump or as a Motor Engine, G. de Montrichard, London.
11,701. Burning Gas for Cooking and Heating Purposes, Q. S. Backus, London.
11,702. Wire Ropes, H. R. I. Webster, London.
11,703. Safety Fasteners for Window Sashes, A. Rose and R. Hunter, Glasgow.
11,704. Insulators, W. E. Langdon, J. C. and G. Fuller, London.
11,705. Electric Lamps, E. B. Burr and E. Böhm, London.
11,706. Cans or Jars for Liquid Blacking, &c., H. J. Allison.—(*S. M. Bixby, United States.*)
11,707. Wind Gauge Sight for Fire-arms, H. J. Allison.—(*W. Lyman, United States.*)
11,708. Horizontal Bill or Letter File, F. Planner, London.
11,709. Metal Cans or Cases, J. A. Lloyd, London.
11,710. Spring Saddle for Hobby Horses, J. H. Howson, Sheffield.
11,711. Actuating Brakes on Bassinettes, &c., R. Ashton, Manchester.
11,712. Watches, H. Hammarlund, London.
11,713. Radiators, B. Russell, London.
11,714. Connecting Carriage Lamps to Lamp Irons, H. Rogers, W. Howes, W. Burley, and W. Howes, London.
11,715. Machines for Mincing Meat, &c., F. J. Gardner, London.
11,716. Enriching Pitch, M. L. Honnay, London.
11,717. Gas Motor Engine, D. Embleton, London.
11,718. Actuating Mechanism for Electrostatic Generators, H. Gläser, London.
11,719. Water Circulating, &c., Apparatus, &c., R. Fraser, Liverpool.
11,720. Safety Locking Devices, A. B. Pickard, London.
11,721. Rolling Tea Leaf, W. Jackson, London.
11,722. Telephone Apparatus, J. Stewart.—(*J. Hutinet, France.*)
11,723. Registering Automatically the Number of Articles Weighed by a Weighing Machine, P. G. Shadbolt, London.
11,724. Magazine Repeating Fire-arms, F. Passler and F. Seidl, London.
11,725. Blank Ammunition, P. Thaine.—(*T. Nordenfelt, Sweden.*)
11,726. Sealed Lock and Label-case Combined, J. Verney, Wolverton.

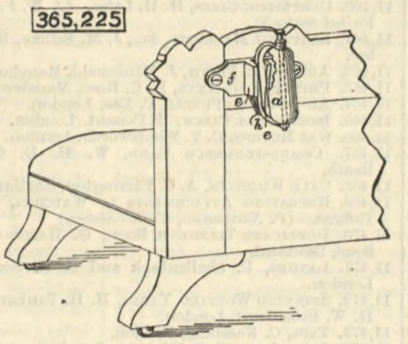
SELECTED AMERICAN PATENTS.

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

365,225. Wall-protecting Attachment for Furniture, *Frederick Barrows, Haverhill, Mass.—Filed April 5th*, 1887.

Claim.—(1) As a new article of manufacture, a device of the character described, consisting of a bracket carrying a roller and a spring, the latter being arranged to maintain the roller in the vertical plane, essentially as specified. (2) As a new article of manufacture, an attachment for sofas and other articles of furniture, consisting of a roller mounted in a supporting arm, and a bracket in which the said supporting arm is pivotted, substantially as described. (3) The combination, with a bracket *f*, and the pivotted arm *c*, carrying a roller *a*, of a spring *h*, at the back of said supporting arm, substantially as described. (4) The combination, with the bracket *f*, formed with lugs *e* of an arm *c*, pivotted between said lugs and carrying a roller *a*, and a spring *h*, secured to the bracket *f* between the lugs *e e*, substantially as described.

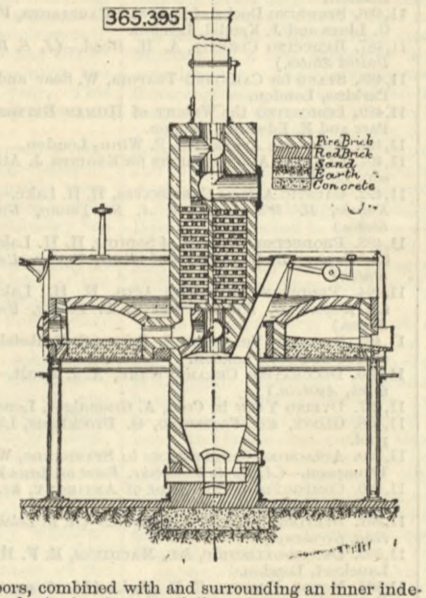
365,225



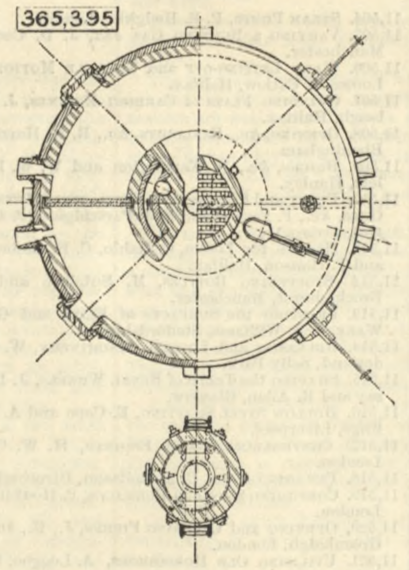
365,395. Gas Furnace, *H. W. Loss, Edge Moor, Del.—Filed June 7th*, 1886.

Claim.—A continuous hearth of a circular, elliptical, or polygonal outline with two removable partition doors, combined with and surrounding an inner independent structure consisting of an upper partition regenerator with a reversible valve and a lower gas producer with a similar valve, the inner structure being connected with the outer hearth by two diametrically opposite situated openings or throats, substantially as and for the purpose specified.

365,395



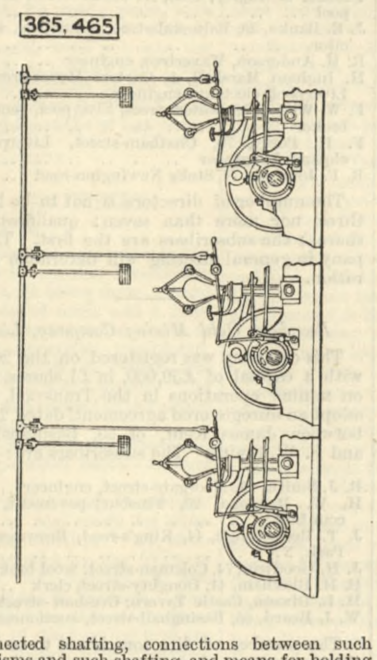
365,395



365,465. Valve Gear, *T. A. Edison, Menlo Park, N.J.—Filed October 12th*, 1882.

Claim.—(1) The combination, with two or more engines having centrifugal governors, of connections between such governors causing them to act in unison, substantially as set forth. (2) The combination, with two or more steam engines, each operating one or more dynamo or magneto-electric machines, all of such machines being connected with the same conductors or systems of conductors, of a line or lines of connected shafting, and connections from said shafting to the throttle valve or cut-off mechanism of each engine, whereby variations in such mechanism in one engine are transmitted to the corresponding mechanism of both or all the other engines, substantially as set forth. (3) The combination, with the throttle valve or cut-off mechanisms of two or more engines and the line or lines of connected shafting, of removable and adjustable connections between them, substantially as set forth. (4) The combination of the valve or cut-off mechanisms of two or more engines, the line or lines of connected shafting, connections between such mechanisms and such shafting, and means for holding such shafting in any position to which it is moved, substantially as set forth. (5) The combination of two or more steam engines, one or more dynamo or magneto-electric machines driven by each of said engines, all such machines being connected in multiple arc, and means for regulating the speed of both or all said engines simultaneously, substantially as set forth.

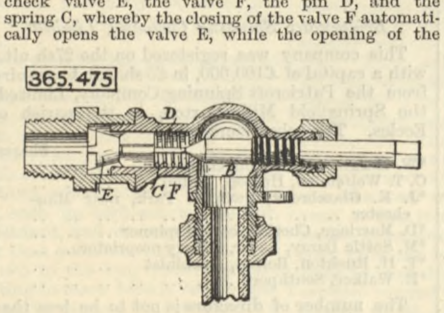
365,465



365,475. Automatic Water-gauge Valve, *J. Kayser, New York, N.Y.—Filed February 3rd*, 1886.

Claim.—(1) The combination of the automatic check valve E, the valve F, the pin D, and the spring C, whereby the closing of the valve F automatically opens the valve E, while the opening of the valve F does not close the valve E, substantially as described. (2) In an automatic gauge-cock, the combination of the valve E and its seat F with the screw-stem B, having the pin D and the spring C surrounding the spring D and bearing against the outer portion of the valve E, substantially as described.

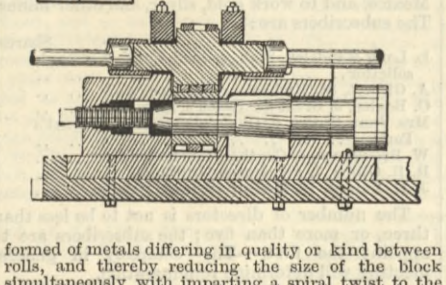
365,475



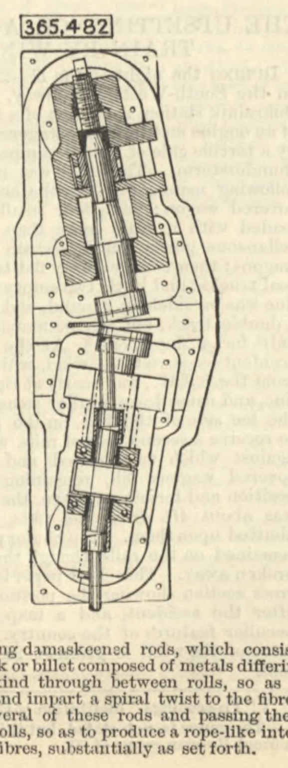
365,482. Process of Rolling Damaskeened Rods, *R. Mannesmann, Remscheid, Prussia, Germany.—Filed January 31st*, 1885.

Claim.—(1) The process of forming damaskeened rods, which consists in passing a block or billet formed of metals differing in quality or kind between rolls, and thereby reducing the size of the block simultaneously with imparting a spiral twist to the fibres of the metal, substantially as set forth. (2) The process of forming damaskeened rods, which consists in rolling a block or billet composed of metals differing in quality or kind through between rolls, so as to reduce the size and impart a spiral twist to the fibres, then uniting several of these rods and passing them again through rolls, so as to produce a rope-like intertwisting of the fibres, substantially as set forth.

365,482



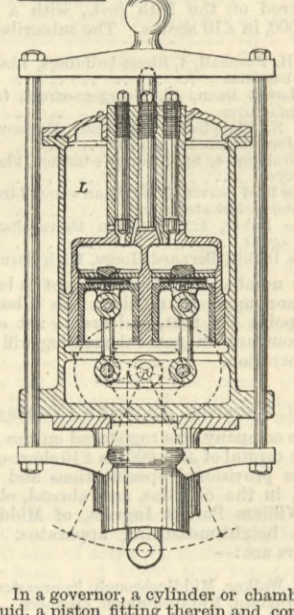
365,482



365,508. Engine Governor, *G. E. Dove, San Francisco, Cal.—Filed September 7th*, 1886.

Claim.—(1) A governor consisting of a cylinder containing liquid, a main piston moving vertically therein and connected with the supply valve of the engine, and the smaller alternately reciprocating pistons operating in corresponding chambers in the main piston, in combination with the upwardly-opening outlet valves in said pistons and the escape-passages through the main piston, substantially as herein described. In a governor, a cylinder or chamber containing liquid, a piston fitting therein and connected with the supply valve of the engine, and smaller alternately reciprocating pistons operating in corresponding chambers in the main piston, and by which means the reactive force of the governor is sustained and controlled, in combination with the inlet valve K and passage L^1, communicating with the reservoir-space L and return passage W, substantially as herein described.

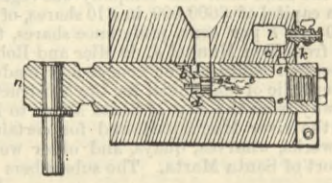
365,508



365,701. Gas-motor Engine, *N. A. Otto, Deutz-on-the-Rhine, Germany.—Filed February 17th*, 1887.

Claim.—(1) Igniting apparatus for gas-motor engines, consisting of a slide *n* having a channel *b* communicating by a small hole *c* with a chamber *d* that in its turn communicates by an annular opening d^1 with a passage *e* having opposite lateral openings e^1 e^2, the passage *e* being made to communicate with the firing port of the engine by a passage *h*, substantially as described. (2) In combination with the passage *e* e^1 e^2 of the igniting slide *n*, the chamber *l*, communicating with the outer air by a regulating cock *g*, and with the said passage by an opening *k*, substantially as herein described.

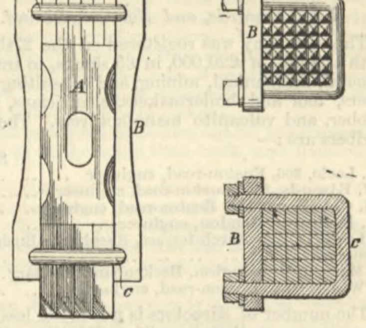
365,701



365,707. Stone-dressing Hammer, *J. S. Squires, Jordan.—Filed December 4th*, 1885.

Claim.—The combination of the head or body A, the plate B, secured to said body on one side, removable points or chisels supported by the body-plate, and the stirrup clamps C C, clasping said points or chisels and secured in holes formed in the plate near its ends substantially as described.

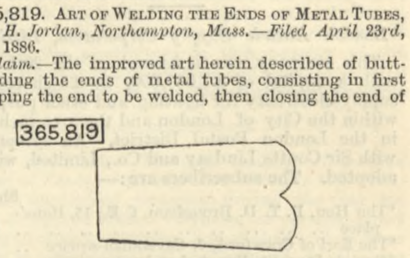
365,707



365,819. Art of Welding the Ends of Metal Tubes, *H. Jordan, Northampton, Mass.—Filed April 23rd*, 1886.

Claim.—The improved art herein described of butt-welding the ends of metal tubes, consisting in first shaping the end to be welded, then closing the end of the tube sufficiently to bring the edges each opposite to the other, and then heating and welding between dies shaped to force the inwardly-bent portions of the end of the tube together and form a butt-weld, substantially as and for the purpose set forth.

365,819



Railway Extension in Ceylon.—In his first report on the Uva Province, issued by Government, Mr. King urges that a decision should be come to very soon as regards the extension of the railway by some route and on some gauge. Ceylon people were glad to learn by last mail from Mr. T. N. Christie, the chairman of the Ceylon Planters' Association, that on the day after the mail left England he was to have an interview with Sir Henry Holland on this subject, and they hoped tha at length the extension would be sanctioned.