SIMPLE METHODS OF CALCULATING STRESSES IN GIRDERS.

By CHARLES LEAN, M. Inst. C.E.

No. II.

Bowstring girders.—Having had occasion to get out the stresses in girders of the bowstring form, the author was not satisfied with the common formulæ for the diagonal braces, which, owing to the difficulty of apportioning the stresses amongst five members meeting in one point, were to a large extent based on an assumption as to the course taken by the stresses. As far as he could ascertain it, the ordinary method was to assume that one set of diagonals, or those inclined, say, to the right-hand, acted at one time, and those inclined in the opposite direction at another time, and, in making the calculations, the apportionment of the stresses was effected by omitting one set. Calculations made in this way gave results which would justify the common method adopted in the construction of bowstring girders, viz., of bracing the verticals and leaving the diagonals unbraced; but an inspection of many existing examples of these bridges during the passing of the live load showed that there was something defective in them. The long unbraced ties vibrated considerably, and evidently got slack during a part of the time that the live load was passing over the bridge. In order to get some definite formulæ for these girders free from any assumed conditions as to the course taken by the stresses, or their apportionment amongst the several members meeting at each joint, the author adopted the following method, which, he believes, has not hitherto been used by engineers:—Let Fig. 1 page 140, represent a bowstring girder, the stresses in which it is desired to ascertain under the loads shown on it by the circles, the figures in the small circles representing the dead load per bay, and that in the large circle the total of live and dead load per bay of the main girders. A girder, Fig. 1A, with parallel flanges, verticals, and diagonals, and depth equal to the length of one bay, was drawn with the same loading as the bowstring. The stresses in the flanges were taken out, as shown in the figure, keeping separate those caused by diagonals inclined to the left from those caused by diagonals inclined to the right. The vertical component of the stress in the end bay of the top flange of the bowstring girder, Fig. 1, was, of course, equal to the pressure on the abutment, and the stress in the first bay of the bottom flange and the horizontal component of the stress in the first bay of the top flange was obtained by multiplying this pressure by the length of the bay and dividing by the length of the first vertical. The horizontal component of the stress in any other bay of the top or bottom flange of the bowstring girder—Fig. 1—was found by adding together the product of the stress in the parallel flanged girder, caused by diagonals inclining to the right, divided by the depth of the bowstring girder at the left of the bay, and multiplied by the depth of the parallel flanged girder; and the product of the stress caused by diagonals inclining to the left divided by the depth of the bowstring girder at the right of the bay, multiplied by the depth of the parallel flanged girder. Thus the horizontal component of the stress in D=

$$\left(\underset{\text{Stress caused by diagonals leaning to left.}}{15{\cdot}75} \times \underset{\text{Length of right vertical.}}{\frac{1}{4{\cdot}5}} \times \underset{\text{Depth of parallel flanged girder.}}{10}\right) +$$

$$\left(\underset{\text{Stress caused by diagonals inclined to right.}}{24} \times \underset{\text{Length of vertical to left.}}{\frac{1}{8}} \times \underset{\text{Depth of parallel flanged girder.}}{10}\right)$$

= 65; and the vertical component =

$$\underset{\text{Horizontal component.}}{65} \times \underset{\text{Length of bay.}}{\frac{1}{10}} \times \left(8{\cdot}0 - 4{\cdot}5\right) = 22{\cdot}75.$$

In the same way the horizontal and vertical components of the stresses in each of the other bays of the flanges of the bowstring were found; and the stresses in the verticals and diagonals were found by addition, subtraction, and reduction. These calculations are shown on the table, Fig. 1B. The result of this is a complete set of stresses in all the members of the bowstring girder—see Fig. 2—which produce a state of equilibrium at each point. The fact that this state of equilibrium is produced proves conclusively that the rule above described and thus applied, although possibly it may be considered empirical, results in the correct solution of the question, and that the stresses shown are actually those which the girder would have to sustain under the given position of the live load. Figs. 2 to 10 inclusive show stresses arrived at in this manner for every position of the live load. An inspection of these diagrams shows:—(*a*) That there is no single instance of compression in a vertical member of the bowstring girder. (*b*) That every one of the diagonals is subjected to compression at some point or other in the passage of the live load over the bridge. (*c*) That the maximum horizontal component of the stresses in each of the diagonals is a constant quantity, not only for tension and compression, but for all the diagonals. The diagrams also show the following facts, which are, however, recognised in the common formulæ:—(*d*) The maximum stress in any vertical is equal to the sum of the amounts of the live and dead loads per bay of the girder. (*e*) The maximum horizontal component of the stresses in any bay of the top flange is the same for each bay, and is equal to the maximum stress in the bottom flange. Having taken out the stresses in several forms of bowstring girders, differing from each other in the proportion of depth to span, the number of bays in the girder, and the amounts and ratios of the live and dead loads, similar results were invariably found, and a consideration of the various sets of calculations resulted in the following empirical rule for the stresses in the diagonals:—"The horizontal component of the greatest stress in any diagonal, which will be both compressive and tensile, and is the same for every diagonal brace in the girder, is equal to the amount of the live load per bay multiplied by the span of the girder, and divided by sixteen times the depth of girder at centre." The following formulæ will give all the stresses in the bowstring girder, without the necessity of any diagrams, or basing any calculations on the assumed action of any of the members of the girders:—

Let S = span of girder.
D = depth at centre.
B = length of one bay.
N = number of bays.
L = length of any bay of top flange.
l = length of any diagonal.
w = dead load per bay of girder.
w^1 = live load per bay of girder.
W = total load per bay of girder = $w + w^1$.

Then— $\frac{S}{B} = N.$

Bottom flange.— $\frac{W\,N\,S}{8\,D}$ = maximum stress throughout. . . . . (1)

Top flange.—In any bay the maximum stress = $+\frac{W\,N\,S}{8\,D} \times \frac{L}{B} = +\frac{W\,L\,N^2}{8\,D}$ . . . . (2)

Verticals.—The maximum stress = $-$W . . . (3)

Diagonals.—The maximum stress is $\pm\frac{w^1\,l\,S}{16\,D\,B} = \pm\frac{w^1\,l\,N}{16\,D}$ . . . . (4)

These results show that the method generally adopted in the construction of bowstring girders is erroneous; and one consequence of the method is the observed looseness and rattling of the long unbraced ties referred to at the commencement of this article during the passage of the live load. The fact being that they have at such times to sustain a compressive stress, which slightly buckles them, and sets them vibrating when they recover their original position.

Another necessity of the common method of construction is the use of an unnecessary quantity of metal in the diagonals; for, by leaving them unbraced, the set of diagonals which does act is subjected to exactly twice the stress which would be caused in it if the bridge was properly constructed. A comparison of the results of a set of calculations on the common plan with those given in this paper, shows at once that this is the case; for the ordinary system of calculating the stresses, in addition to showing compression in the verticals, gives exactly twice the amount of tension in the diagonals which they should have.

FIG. 1B.

Top Flange Stresses.

		Hor.	Ver.
C	$= 31{\cdot}5 \times \frac{10}{4{\cdot}5} =$	+ 70·00	= 31·50
	$15{\cdot}75 \times \frac{10}{4\,5} = 35$		
D		+ 65·00	= 22·75
	$24 \times \frac{10}{8} = 30$		
E		+ 58·33	= 14·58
	$29{\cdot}75 \times \frac{10}{10{\cdot}5} = 28{\cdot}33$		
F		+ 55·83	= 8·37
	$33 \times \frac{10}{12} = 27{\cdot}5$		
G		+ 54·50	= 2·72
	$33{\cdot}75 \times \frac{10}{12{\cdot}5} = 27$		
H		+ 53·67	= 2·68
	$32 \times \frac{10}{12} = 26{\cdot}67$		
I		+ 53·09	= 7·97
	$27{\cdot}75 \times \frac{10}{10{\cdot}5} = 26{\cdot}42$		
J		+ 52·67	= 13·17
	$21 \times \frac{10}{8} = 26{\cdot}25$		
K		+ 52·36	= 18·33
	$11{\cdot}75 \times \frac{10}{4{\cdot}5} = 26{\cdot}11$		
L	$23{\cdot}5 \times \frac{10}{4{\cdot}5} =$	+ 52·22	= 23·50

Stresses in Diagonals.

		Hor.	Ver.
a	= 70 − 65 =	+ 5·00	= 2·25
b	= ,, ,,	− 5·00	= 4·00
c	= 65 − 58 33 − 5· =	+ 1·67	= 1·33
d	= ,, ,, ,, =	− 1·67	= 1·75
e	= 58·33 − 55·83 − 1·67 =	+ ·83	= ·88
f	= ,, ,, ,, =	− ·83	= 1·01
g	= 55·83 − 54·50 − ·83 =	+ ·50	= ·59
h	= ,, ,, ,, =	− ·50	= ·61
i	= 54·50 − 53·67 − ·50 =	+ ·33	= ·43
j	= ,, ,, ,, =	− ·33	= ·41
k	= 53·67 − 53·09 − ·33 =	+ ·24	= ·28
l	= ,, ,, ,, =	− ·24	= ·24
m	= 53·(9 − 52·67 − ·24 =	+ ·18	= ·20
n	= ,, ,, ,, =	− ·18	= ·16
o	= 52·67 = 52·36 − ·18 =	+ ·13	= ·11
p	= ,, ,, =	− ·13	= ·06

Bottom Flange Stresses.

			Hor.
M	same as	C	= 70·00
N	,,	D	= 65·00
O	,,	E	= 58·33
P	,,	F	= 55·83
Q	,,	G	= 54·50
R	,,	H	= 53·67
S	,,	I	= 53·09
T	,,	J	= 52·67
U	,,	K	= 52·36
V	,,	L	= 52·22

Stresses in Verticals.

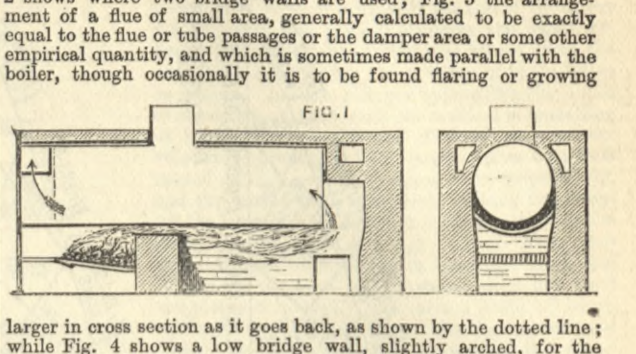
		Ver.
r	= 15 − 4	= − 11·00
s	= 5 + 2·25 − 1·75	= − 5·50
t	= 5 + 1·33 − 1·01	= − 5·32
u	= 5 + ·88 − ·61	= − 5·27
v	= 5 + ·59 − ·41	= − 5·18
w	= 5 + ·43 − ·24	= − 5·19
x	= 5 + ·28 − ·16	= − 5·12
y	= 5 + ·20 − ·06	= − 5·14
z	= 5 + ·11	= − 5·11

HORIZONTAL BOILER SETTING.

THERE is much difference of opinion with boiler setters—masons—and engineers of buildings about the construction of bridge walls and what the size of the "throat" area should be. By the "throat" is meant the area between the boiler shell and the inverted arch of the bridge wall. Most frequently we find that the arch of the bridge wall has the same centre as the cylindrical boiler, and that its radius is but 6in. greater, forming a throat 6in. wide by about 1½in. the circumference of the boiler. This, in many cases, may give an area equal to the tube area or the area of the chimney in its cross section, which to many may appear to at once and forever settle the question, they reasoning that smaller it should not be or it will interfere with the draught, and that should it be larger, and the bridge wall consequently further from the shell of the boiler, heat in some manner will be lost, or that the greatest good will not be obtained from the fire, or some other indefinite quality or quantity will be lost or not brought forth. Others again claim greater efficiency from some peculiar shape of the arch, such as having the arch nearest the boiler at the sides, say 4in. or 5in., and further off at the centre of the bottom, say 7in. or 8in., their theory being that as "heat rises" the sides will get more than their share, unless the passage is contracted so as to force the heat to impinge more strongly on the centre of the bottom of the boiler, from where it is supposed to spread as it goes to the back end, giving all parts of the shell an equal heat; while others think the bridge wall should be closer to the shell at the centre of the bottom for the purpose of forcing the heat and flame to the sides, the bottom getting sufficient heat directly from the fuel, and nearly all agreeing that should the bridge wall be straight and low, and far from the boiler, heat is lost and fuel wasted. Others again go to the trouble of making a second bridge wall to make the heat "hug" the boiler, and a few, not content with that, fill the space between these bridge walls so as to make a flue of equal cross section throughout "to prevent the heat from expanding," so as to force the boiler, as they claim, to take up more heat.

Fig. 1 shows the setting most commonly met with; Fig. 2 shows where two bridge walls are used; Fig. 3 the arrangement of a flue of small area, generally calculated to be exactly equal to the flue or tube passages or the damper area or some other empirical quantity, and which is sometimes made parallel with the boiler, though occasionally it is to be found flaring or growing

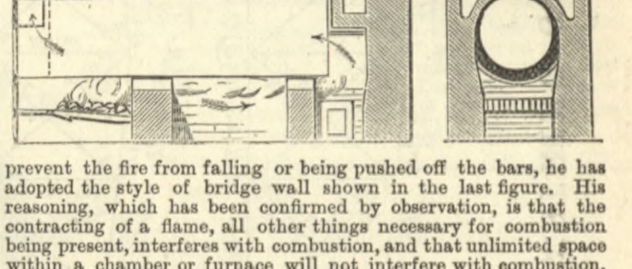
FIG. 1



larger in cross section as it goes back, as shown by the dotted line; while Fig. 4 shows a low bridge wall, slightly arched, for the purpose simply of keeping the bricks in place; the rowlocks of an arch being more staple and less liable to come out than the bricks of a straight-topped wall.

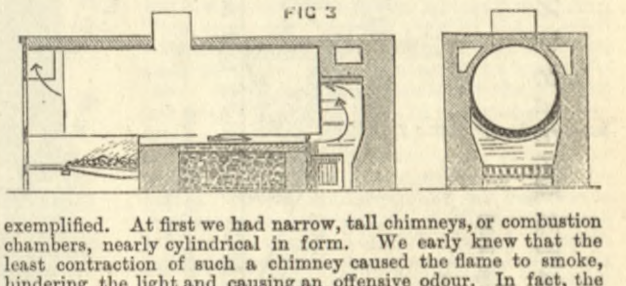
The writer's observations on boilers, which extended over twenty years, go to prove that nothing is gained by bridge walls, as shown in the first three diagrams, nor does he consider any special merit can be granted to the bridge wall shown in Fig. 4; but considering the necessity of a wall at the back end of a grate to

FIG. 2



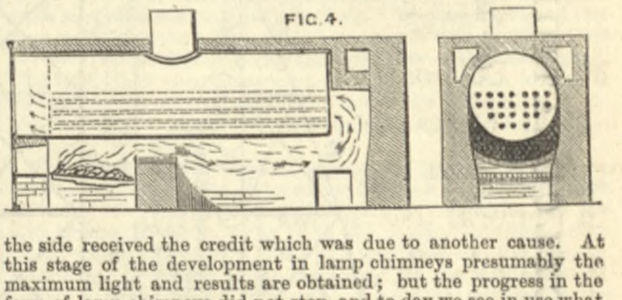
prevent the fire from falling or being pushed off the bars, he has adopted the style of bridge wall shown in the last figure. His reasoning, which has been confirmed by observation, is that the contracting of a flame, all other things necessary for combustion being present, interferes with combustion, and that unlimited space within a chamber or furnace will not interfere with combustion, provided the outlet or chimney bears a proper relation to the amount of air or gas passing off so as to prevent the entering of air by that passage. If we follow the changes in the chimneys of ordinary kerosene lamps we can see the whole principle there

FIG. 3



exemplified. At first we had narrow, tall chimneys, or combustion chambers, nearly cylindrical in form. We early knew that the least contraction of such a chimney caused the flame to smoke, hindering the light and causing an offensive odour. In fact, the early chimneys nearly all had this defect, because combustion was incomplete. Gradually the chimneys were made wider at the base—the furnace part of the chimney—the top remaining about the same as before. These particular kinds of chimneys were given certain names, such as "sun" and "star," and other names which indicated more light and better results, and often some shape of

FIG. 4.



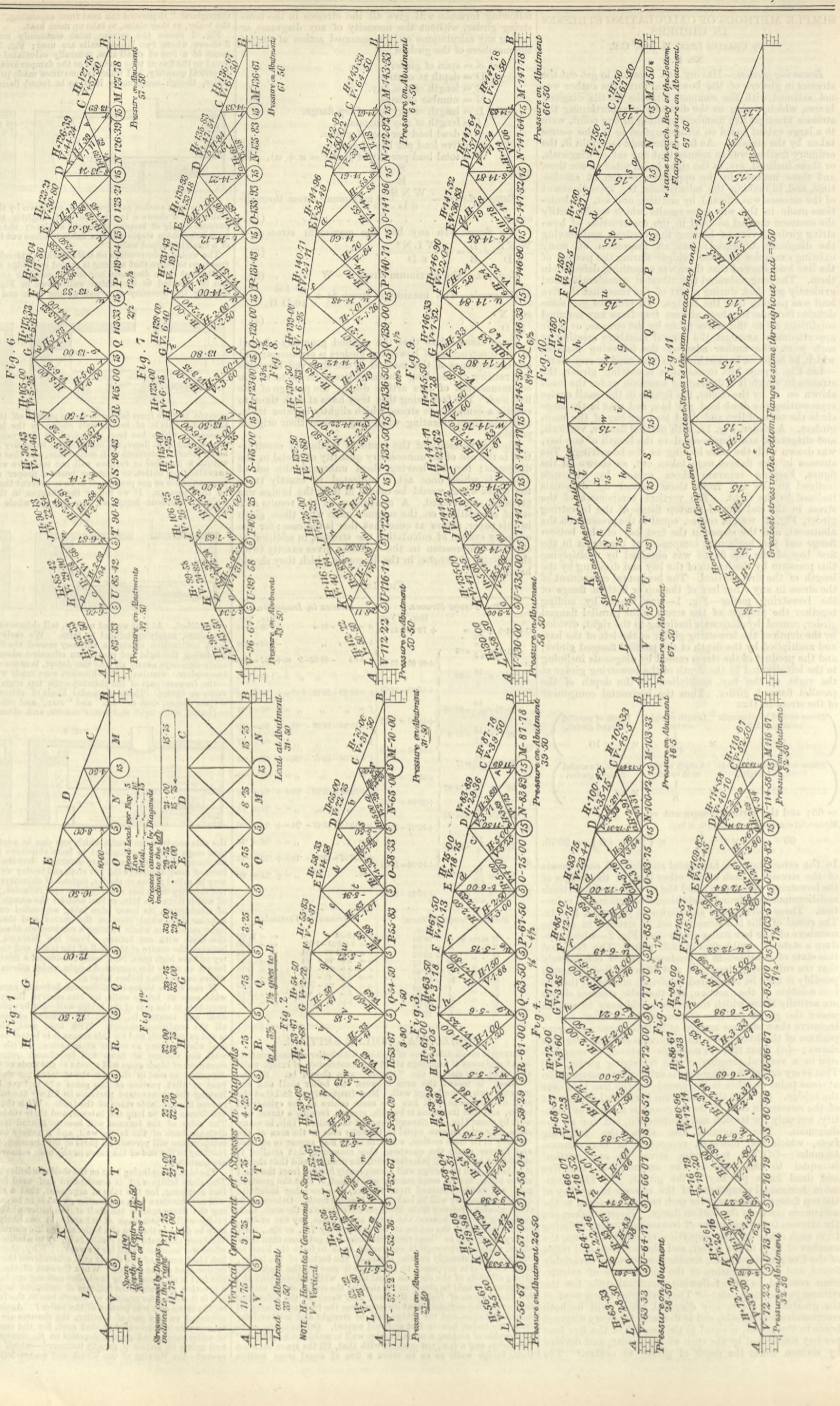
the side received the credit which was due to another cause. At this stage of the development in lamp chimneys presumably the maximum light and results are obtained; but the progress in the form of lamp chimneys did not stop, and to-day we see in use what may be called globes or shades, instead of chimneys, the identity of the chimney being lost entirely in an opal reflector, through the top of which there is a 1½in. or 2in. hole for the escape of the products of combustion, its lower edge being supported on a transparent annular disc, which rests on the burner, and through which the light comes, the whole forming a combustion chamber. And it is the same with our boilers. From low furnaces, 15in. or 16in. between the centre of the shell of the boiler and the grate, we now try to have high ones, 24in. being considered a minimum; and that forced on us by the restricted height under sidewalks or in cellars where our heating boilers must go.

If one wants to see the difference between narrow throats and wide ones at bridge walls, let him observe the result through a peep-hole in the rear of the bridge wall—not by opening the furnace door and looking in, as at the moment of opening the door all the conditions change. With hard coal, also, the change is not so marked, and for this reason it is better to use a little soft coal when making an ocular examination. With the close bridge wall the volume of flame will be almost quenched, and long streamers of black gases will appear at the ends of the flames, to be deposited as soot in the tube the moment the water seizes on the heat of that portion of the gases which have been consumed, leaving the unconsumed particles to fill up the tubes and further reduce the available value of the fuel. With the low bridge wall the flames will be long and intense, and their volume will be large. The sides of the furnace will become heated for a considerable distance back of the bridge wall, and a nearly uniform glow and temperature will pervade all parts of the chamber, the flames often reaching to the end of the tubes in the back connection before they are quenched.

The idea of impinging heat on the shell of a boiler is also a mistake. The close bridge-wall is constructed and used for this purpose. But assuming, for the sake of argument, that a close bridge-wall will not interfere with combustion, what is to be gained by impinging the flame against the shell of the boiler at the part over the bridge-wall or just back of it? and is it not likely that an injury may be done to the iron of a boiler and its life shortened by so doing? We know that hard firing results in injury to a boiler, as in "forcing" when the boiler is small for its work. Why, then, do we make a hot blast nozzle of the throat and concentrate the heat of the fire on one spot of the boiler? When the sum of the heat evolved by the fuel is all absorbed by the boiler nothing can be gained by such a practice, and when the boiler is of sufficient length to absorb it all, is it not better practice to absorb less in the furnace and more in the tubes and rear portion of the boiler? Again, when flame is impinged on any part of a boiler, the chances are that very little more water is evaporated at that spot, for the reason the amount of water evaporated greatly depends on its motion—circulation—and unless its motion is greatly increased—which practice has not proved—the burning of the plates and seams follow, particularly

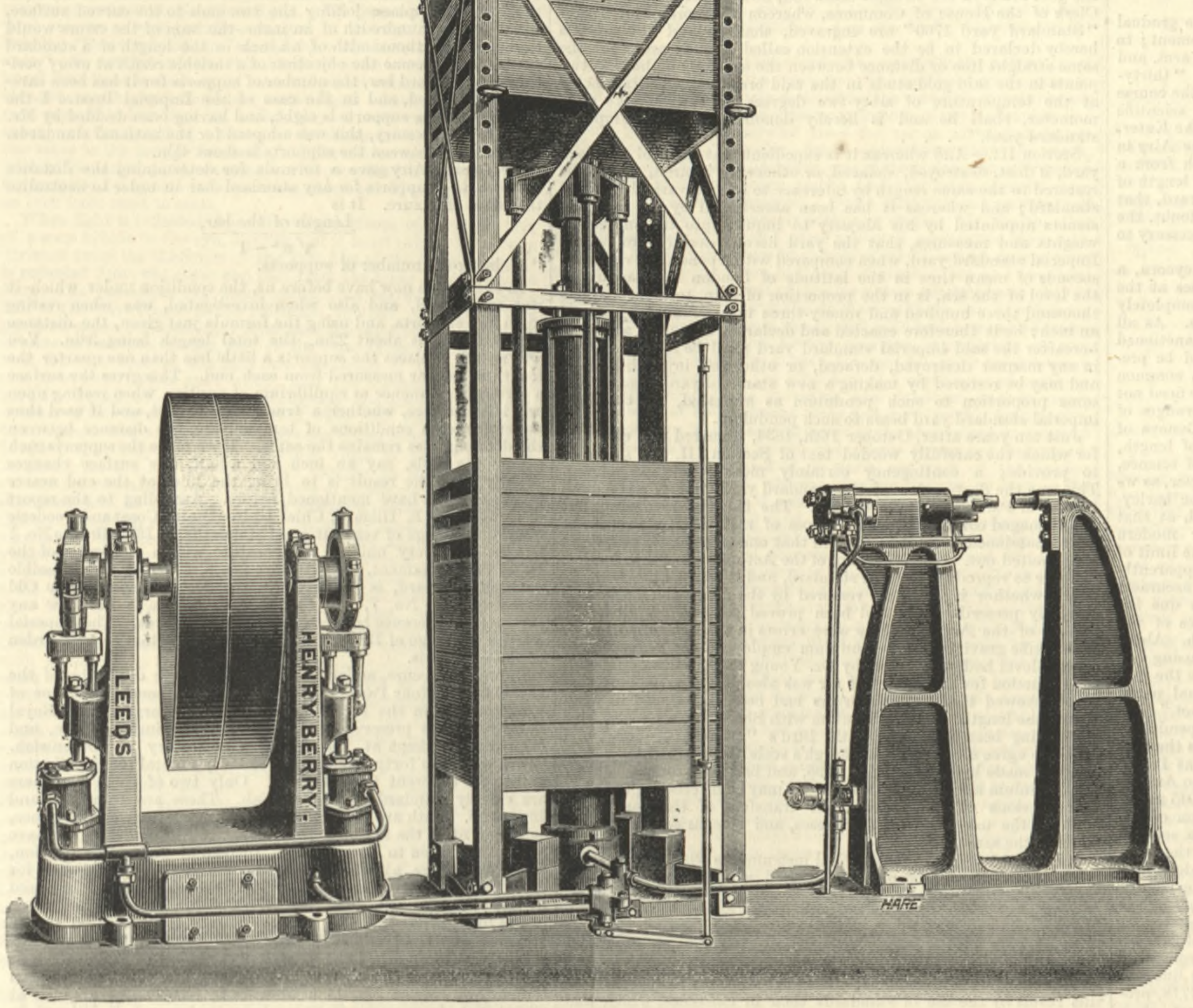
DIAGRAMS FOR THE CALCULATION OF STRESSES IN BOWSTRING GIRDERS.

(For description see page 139.)



HYDRAULIC RIVETTING PLANT.

MR. HENRY BERRY, CROYDON WORKS, HUNSLET, LEEDS, ENGINEER.



the latter, which crack from the rivet holes to the edge of the sheet on the fire side of the plate.

The observing engineer will notice that flame never enters the tubes of a boiler. With some conditions of fire, and particularly with short boilers, this may be seen when the flame reaches the backhead. Could the flames pass straight on in a large chamber there is every reason to suppose they would reach 3ft. or 4ft. further, with many boilers; but the moment they strike the back head-sheet and divide to pass into the tubes, each division is quenched as with an extinguisher. Beyond this point combustion cannot and does not go on. The reasons for it are several. It had nearly reached the point where, for want of air—oxygen—the remaining carbon could not be consumed, or else consumption was about completed, then the cooling due to passing in a subdivided state through the tubes—water—placed it beyond all hope of ignition. But as this takes place at the rear end of the boiler, and when combustion is nearly, if not altogether, complete, much heat is not lost; but if, instead, we choke it at the bridge-wall, where the fuel decomposed on the grates should spring into the most active form of combustion—flame—we are destroying one of our most potent elements of heat; the radiant heat of the coal and the heat of the decomposed or distilled—not the consumed—elements being the only ones remaining to us.

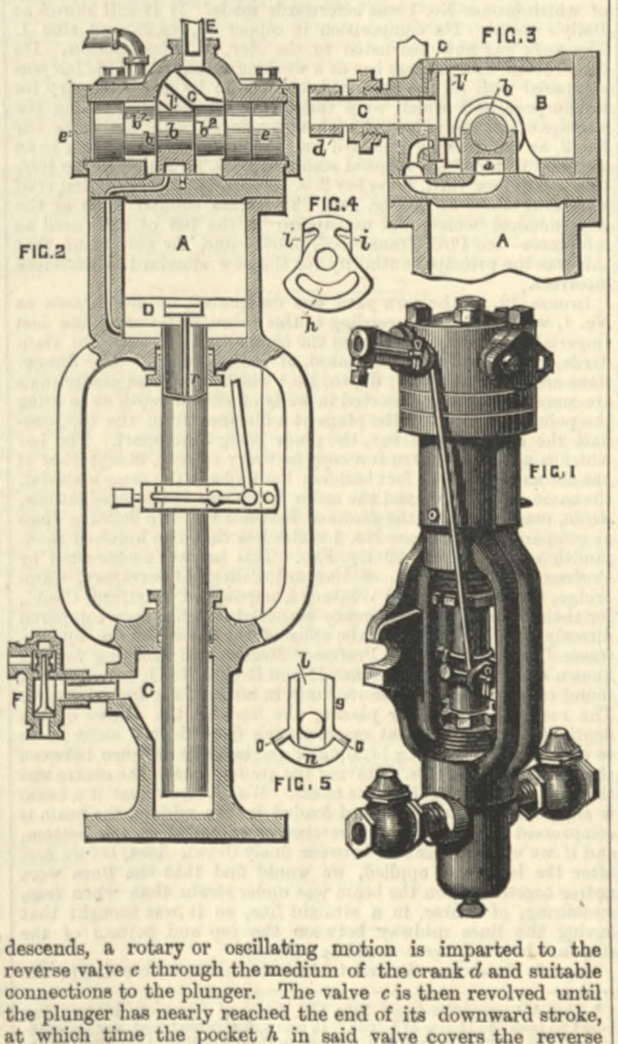
The admission of fresh air at or back of the bridge-wall is of no service with a narrow throat. Some may question the good it will do in any case, but to be of service at all it must be admitted into a large and highly-heated chamber. When admitted without increasing combustion, a loss results, as the mingling cool air cools the mass; though the loss is not as serious as some may reason, on account of the restricted areas of the contrivances used. When combustion properly follows the gain is marked, but to be of any real service the addition of air must be made to the flame either before it is quenched or in a chamber whose side-walls are sufficiently hot to reignite the gases.—*The Sanitary Engineer.*

HYDRAULIC RIVETTING PLANT.

THE engraving above illustrates a compact self-contained rivetting plant made by Mr. H. Berry, of Leeds. It does not require much description, as the illustration shows the plant very clearly. The chief points of novelty are the hydraulic pumps, which are made very simple, and driven direct by large pulleys without the intervention of gearing. The pump valves are all very easily got at without having to take the pumps off when they require examination. The accumulator is of an improved self-contained type, requiring no wall or wooden posts to fix it; the pressure per square inch is also very readily varied, as by inserting the bars shown on the illustration, one-half or less as required of the weights can be released from the ram. The illustration shows four of the weights taken off the ram. The rivetter is of the flush top type, and both the hob and cylinder sides are made of cast steel, requiring much less foundation, and costing a great deal less for carriage than the heavy cast iron machines, especially on machines for foreign countries.

THE SINTZ BOILER FEEDER.

THE annexed engravings represent a new donkey known as the Sintz boiler feeder. We take our engravings from the *Age of Steel*. The valve gear is positive, being connected directly to the plunger. The valves are flat, and the pumps can, it is said, be run at any speed from one to three hundred strokes per minute. They will pump hot or cold water, nor be injured by the failure of water supply, as the piston cannot strike the cylinder heads. The plunger is of brass tubing. The operation of the pump is as follows:—The steam enters the steam chest at E, and passing through the normally open ports, enters into the chambers *e e* 1 at the respective ends of the piston *b*. The said piston thus has an equal pressure on each end, and is completely surrounded by live steam, which keeps the chambers of the ends of the piston *b* always hot, and thus prevents condensation. The main valve *a* being in a position shown in Fig. 2, the steam enters the cylinder A and forces the piston D to descend. As the plunger



descends, a rotary or oscillating motion is imparted to the reverse valve *c* through the medium of the crank *d* and suitable connections to the plunger. The valve *c* is then revolved until the plunger has nearly reached the end of its downward stroke, at which time the pocket *h* in said valve covers the reverse ports, and the chamber *e* at one end of the supplemental piston *b* is exhausted through the reverse ports. The supplemental piston is then relieved from pressure at one end, and the pressure at the other end immediately forces the piston into the exhausted chambers, thus changing the position of the main valve *a* and admitting the steam to the lower end of the cylinder A. The plunger is now forced upward until near the end of the upper stroke, when the pocket *h* covers the other exhaust port, thus exhausting the steam from the chamber *e* 1, changing the position of main valve as before. As the plunger approaches the limits of its stroke at either end, the crank *d* is travelling at that portion of its arc of travel at which its velocity is greatest. The reverse valve *c* is thus moved quickly over the reverse ports respectively, and the main valve *a* reversed almost instantly. At the same time the pocket *h* covers either of the reverse ports, one of the lugs *o o* 1 on the reverse valve engages with the lug on the main valve, and in case the pressure of the steam does not start the piston *b* instantly, the valve *a* is moved longitudinally by the said lugs. The last mentioned feature is of great utility in starting the pump after it has been standing idle for some time, under which circumstances the piston may have become rusted or stuck fast in the chambers and will not readily move by the pressure of the steam. By having the reverse ports nominally open, and thus keeping the pressure equal at both ends of the reverse piston, except at the moment of reversing the position of the main valve, the chance of leakage by blowing past the piston is confined to the short space of time consumed in reversing the valve. The chambers at the end of the piston are also thus kept heated by the live steam therein, the opening to the air through the exhaust port being closed immediately after the valve is reversed, thus preventing condensation of steam. The pumps are made by the Blakeney Foundry Company, Springfield, O.

SOUTHAMPTON WATERWORKS.

THE improvement of the Southampton water supply is a subject which has occupied the attention of the inhabitants of that town for nearly fifty years. The difficulty of obtaining a good supply cheaply seems at last to have been solved. On the chalk hills of Otterbourne, situate eight miles north of Southampton, springs rise to the surface and flow southward until they join the river Itchen. These springs are but the overflow from a great watershed created in the extensive outcrop of the chalk formation which reaches far up into Wiltshire. After careful examination of the district, and with a full knowledge of the geological features, a spot was selected by Mr. W. Whittaker, of H.M. Survey Department, as suitable for obtaining the very large quantity of water required. Mr. W. Matthews, C.E., the engineer to the Corporation Waterworks, then had the ground between Southampton and Otterbourne surveyed, and prepared the scheme which has just been unanimously sanctioned by the Town Council, and also approved at a town meeting of ratepayers.

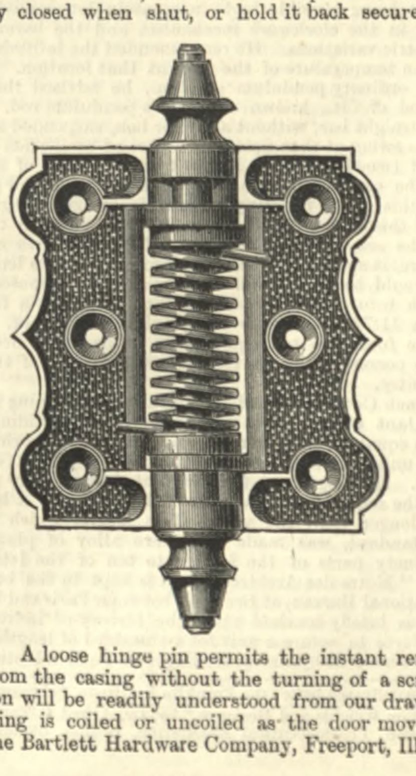
The Abyssinian tube well system is that adopted for procuring the water, and Messrs. Le Grand and Sutcliff, of London, have already completed two of 12in. diameter and 100ft. deep. Powerful centrifugal pumps worked by portable engines have been attached to these tube wells. Working night and day for a week, with the pumps throwing between 400 and 500 gallons per minute, has demonstrated the suitability of the site selected. The total daily supply required is 4,000,000 gallons, and it is calculated that six additional 12in. tube wells will easily provide this quantity of water without unduly lowering the head of the springs at any one spot.

The quality of the water is pronounced upon analysis to be particularly pure. The permanent hardness is only 2·4. The softening process known as Atkin's will be employed, and the lime necessary will be made from the chalk on the spot. The water will flow from the tanks at Otterbourne to the existing reservoirs on Southampton-common. In the parliamentary powers applied for, other districts have been included in the schedule.

The pumping station has been visited by the Mayor, Town Council, and several well-known engineers and geologists who are interested in the results so rapidly obtained, the time occupied over the works having been only about six weeks.

WILES' SPRING HINGE.

THE Wiles spring hinge, which we illustrate, is reversible, *i.e.*, either right or left-hand, and has a loose pin. It will keep a door tightly closed when shut, or hold it back securely when



wide open. A loose hinge pin permits the instant removal of the door from the casing without the turning of a screw. Its construction will be readily understood from our drawing. A helical spring is coiled or uncoiled as the door moves. It is made by the Bartlett Hardware Company, Freeport, Ill.

STANDARDS OF LENGTH AND THEIR SUBDIVISION.*

By GEORGE M. BOND, Hartford, Conn.

WE are all, no doubt, familiar with the old table of English measures of length beginning "three barleycorns make 1in." I, for one, can remember having vague ideas in regard to barleycorns in general, and their exact size in particular, though I imagined I knew exactly what constituted an inch. Later in life I began to doubt my knowledge in this respect, having had considerable difficulty in reconciling the differences between two separate inches not exactly alike, one or both evidently not one-thirty-sixth part of a standard yard.

It may be of interest to glance over the history of the gradual development of the modern science of minute measurement; to notice how such crude standards as the human foot or arm, and standards called cubits, fathoms, or the foot made up of "thirty-six barleycorns, round and dry, placed end to end," in the course of time grew into the more exact determinations of scientific research, as shown in the results of the labours of men like Kater, Baily, Bessel, Sheepshanks, Shuckburgh, and Sir George Airy in the great problem of establishing a standard of length from a natural unit. They gave us so closely the relation of the length of a pendulum beating seconds of time to the length of a yard, that it was thought they had determined, beyond further doubt, the means for restoring a lost standard should it become necessary to do so from any cause.

However good these crude standards, such as a barleycorn, a human arm or foot, may have been for practical purposes at the time they were adopted, they certainly are in our times completely out of the question and useless for precise determinations. As all measures derived from them are purely arbitrary, and sanctioned by law, no reference made to any of these sources could be presumed to restore a lost original standard, even such as a common yard-stick, except within a very liberal margin of error, we need not be surprised then to find that there happened such wide ranges of value for a foot as that of the Pithic of 9¾in. to that of Geneva of 19in. The adoption of an invariable unit as a standard of length, while seemingly only applicable to the refined methods of science, really becomes a necessity in our ordinary workshop practice, as we shall see later. The arm of King Henry the First, or the barleycorn, though possibly furnishing a standard good enough at that time, would hardly satisfy the requirements of our modern mechanics or tool makers, who work very often within the limit of a thousandth of an inch, and even one-tenth of this apparently minute quantity, with surprising unconcern and no less accuracy. To the celebrated philosopher and scientist Huyghens is due the honour of having demonstrated the fact that the times of the vibrations of pendulums depend entirely upon their length. About the year 1670 his inventive genius conceived the plan of using this fact to establish the length of a standard which should be the unit for measures of length. This he divided into three equal parts, each of about 13in., calling this third part the "horary foot."

Picard, in 1671, also proposed using the length of a pendulum beating seconds of mean time, which should be adopted as the unit of length, thus endorsing the plan of Huyghens. It was Picard who first measured the arc of the meridian from Paris to Amiens in 1669, deducing from it the value of a degree to be 68·945 miles. Picard was the first to suggest that the diurnal revolution of the earth necessarily affected the times of oscillation of a seconds pendulum, and that it ought to vibrate more rapidly at the poles than at the equator. His experiments at different latitudes, however, failed to confirm this fact, probably owing to the lack of sufficiently accurate apparatus for his work, and it was left to Richer in the same year, 1671, to prove that at the equator, or 4 deg. 56′ north, where the observations were made, the difference of the length of a seconds pendulum at that place, as compared with the length at Paris, or 48 deg. 50′ north, was about a line and a quarter, or nearly one-tenth of an inch. Cassini, in 1718, proposed a unit which should be one six-thousandth part of a minute of a degree of a great circle of the earth, and which would be nearly equal to a third part of our yard.† M. de la Condimine, who had measured a degree at the equator in Peru, in a memoir read before the Academy of Sciences at Paris, advocated the use of a pendulum as the unit of length, proposing that it should beat seconds at the equator, a place least likely to cause prejudice that might follow from national jealousy, were the latitude of any particular place selected. Talleyrand, in 1790, proposed to the Assembly of France that a commission be appointed to consult with a similar commission from the English Government, to consider the subject of a uniform international system of metrology. He favoured the length of a pendulum as compared with the unit obtained by the subdivision of a quadrant of the earth's meridian, but after a careful consideration of the three plans proposed, the pendulum, a quarter of the equator, and a quadrant of the earth's meridian, they concluded to recommend the latter method.

In 1790, one year before the International Commission had adopted the ten-millionth part of the quadrant, as settling the question of a natural unit for a standard measurement of length, and before any steps had been taken by them in the matter, Thomas Jefferson, then Secretary of State, in obedience to a resolution of Congress calling upon the Secretary to propose a plan for establishing a uniformity in the currency, weights, and measures, for the United States, recommended, in his report, a decimal system of metrology, and that the unit be derived from a natural and invariable standard of length. Jefferson considered that though the globe or its great circles might be invariable, the means to be employed to obtain an accurate subdivision of a quadrant, from previous trials, had showed their unreliability, and promised too great a degree of uncertainty; he also objected to the ordinary form of the pendulum as "not without its uncertainties," the length not being possible to be accurately determined, owing to variations in the clockwork mechanism and the barometric and thermometric variations. He recommended the latitude of 45 deg. and a mean temperature of the year at that location. Instead of using the ordinary pendulum of 39in., he advised the use of a seconds rod of 5ft., known as Leslie's pendulum rod. This was a simple straight bar, without a disc or bob, suspended at one end, and free to swing at that point, its centre of oscillation being at a distance of two-thirds of its length from the point of suspension. It would be one-half longer than the ordinary loaded pendulum. A rod of this kind, vibrating seconds, is 58·72in. long. He proposed that this rod be made of iron, of such a length that at the level of the sea, at a latitude of 45 deg., and with a constant temperature, it should beat seconds of mean time; its length, given exactly, would be 58·72368in. Jefferson then proposed dividing this length into five equal parts, calling each part a foot, which would give 11·7449in. as the length of the new foot. He then divided the foot into ten equal parts, affording a decimal subdivision to correspond with the decimal character of the coinage of the country.

The French Commission, after carefully determining the length of a quadrant of the earth's meridian, and dividing it into ten million equal parts, presented science and the world with the metre as a universal standard to which posterity might ever afterward refer. Its length, as they computed it, is very nearly the length of the seconds pendulum, or 39·370788in., or a little more than 3in. longer than the yard. This metre, which is an end measure standard, was made of a pure alloy of platinum and iridium, ninety parts of the former to ten of the latter. It is called the "Mètre des Archives," and is kept in the buildings of the International Bureau, at Breteuil, between Paris and Versailles. Having thus briefly touched upon the history of individual and national efforts to secure a unit for a standard of length, covering a period of about 200 years preceding the legal adoption of our standard yard, it may be interesting to know that just 500 years after the statute of 17th Edward II., A.D. 1324, which enacted that "three barleycorns, round and dry, make an inch, and 12 inches make one foot," it was, by Act of 5th George IV., cap. 74, 1824, that a legal definition of the yard was made, and by it was declared that the yard-bar, made by Bird in 1760, should be the standard beyond any question or doubt.* It may be in place to quote here an abstract of the Act of June 17th, 1824, legalising this standard, and which reads as follows:—

Section I.—Be it enacted . . . that from and after the first day of May, one thousand eight hundred and twenty-five, the straight line or distance between the centres of the two points in the gold studs in the straight brass rod, now in the custody of the Clerk of the House of Commons, whereon the words and figures "Standard yard 1760" are engraved, shall be and the same is hereby declared to be the extension called a yard; and that the same straight line or distance between the centres of the said two points in the said gold studs in the said brass rod, the brass being at the temperature of sixty-two degrees by Fahrenheit's thermometer, shall be and is hereby denominated the "Imperial standard yard." . . .

Section III.—And whereas it is expedient that the said standard yard, if lost, destroyed, defaced, or otherwise injured, should be restored to the same length by reference to some invariable natural standard; and whereas it has been ascertained by the Commissioners appointed by his Majesty to inquire into the subject of weights and measures, that the yard hereby declared to be the Imperial standard yard, when compared with a pendulum vibrating seconds of mean time in the latitude of London in a vacuum at the level of the sea, is in the proportion of 36in. to 39in. and one thousand three hundred and ninety-three ten thousandth parts of an inch; be it therefore enacted and declared, that if at any time hereafter the said imperial standard yard shall be lost or shall be in any manner destroyed, defaced, or otherwise injured, it shall and may be restored by making a new standard yard, bearing the same proportion to such pendulum as aforesaid, as the said imperial standard yard bears to such pendulum.

Just ten years after, October 16th, 1834, occurred the calamity for which the carefully worded text of Section III. was intended to provide; a contingency certainly most wisely considered. This was the destruction of the standard yard by fire, when both Houses of Parliament were burned. The bar was recovered, but in a damaged condition, and all hopes of restoring its usefulness were abandoned when it was found that one of the gold plugs had been melted out. The provisions of the Act now came into service, in order to reproduce the lost standard, and it became necessary to decide whether it could be restored by the use of the method so carefully prescribed. It had been proved conclusively since the passage of the Act that there were errors in the determination of the specific gravity of the pendulum employed; the reduction to the sea-level had been shown by Dr. Young to have been doubtful, the reduction for the weight of air was also proved erroneous, and Kater showed that sensible errors had been introduced in comparing the length of the pendulum with Shuckburgh's scale, this bar having been compared with Bird's "Standard, 1760," and found to agree closely. Shuckburgh's scale was marked 0 — 36in. and was made by Troughton in 1798, and had been compared with the pendulum and with the metre. It may be interesting to know, that previous to Shuckburgh, all transfers of the yard were made by the use of beam compasses, and comparisons were also made in the same way.

It was not until 1798 that optical instruments were used for this purpose, and Troughton must be credited with having introduced this wonderfully improved manner of dealing with minute measurements, and which afterward, no doubt, led to the discovery of the errors found to have crept in when the relation of the yard to the length of the pendulum was established. All attempts, therefore, to use the pendulum for the purpose of reproducing the lost standard were abandoned. The next step was to approximate this result by the use of standards then in existence, which had been compared with the original yard. The bars used for this purpose were: (*a*) Shuckburgh's scale (0 – 36in.). (*b*) Shuckburgh's scale, with Kater's authority. (*c*) The yard of the Royal Society, constructed by Kater. (*d*) Two iron bars, marked A_1 A_2, and belonging to the Ordnance Department, and kept in the office of the Trigonometrical Survey. To Sir Francis Baily was intrusted the work of the restoration of the yard. His death occurred in 1844, before the work was completed. He had then only completed the provisional or preliminary investigations necessary for this most important undertaking. He had, however, made a great many experiments to determine the proper material for the new standard, and finally decided upon the alloy of which bronze No. 1 was afterwards made. It is still known as Baily's metal. Its composition is copper 16, tin 2½, and zinc 1. The work was now entrusted to the Rev. R. Sheepshanks. He constructed first a brass bar as a working standard. This bar was compared with all the standards considered by him necessary for the purpose, and which were those just mentioned. Taking the average of all the values of each as compared with the brass bar No. 2, as the working standard was designated, and reducing to an assumed value of the original standard yard, he found as the relation of the new yard, brass bar 2 = 36·00025in. of the lost Imperial standard, taken at 62 deg. Fah. The brass tubular scale of the Astronomical Society did not appear in the list of bars used as references—see Phil. Trans. 1857, p. 661—and the statement that this was the principal authority for the new standard is therefore incorrect.

Bronze 19, as the new yard was designated, or now known as No. 1, was graduated according to this value, in terms of the lost Imperial standard, found from the comparison of these five standards, and is made, as just stated, of Baily's metal. The dimensions are: Length, 38in.; depth, 1in.; width, 1in. The graduations are upon gold plugs inserted in wells of such a depth as to bring the polished surface of the plugs at a distance from the top, one-half the depth of the bar, the plugs being 36in. apart. The bar which is now before you is a copy in every respect, except that it has the subdivision of feet besides; but we have the same material, the same dimensions, and the same conditions in the graduations, while, more than all, the distance between the two defining lines as compared with Bronze No. 1 varies less than one hundred thousandth of an inch at 62 deg. Fah. This bar was constructed by Professor W. A. Rogers, of Harvard College Observatory, Cambridge, for the Pratt and Whitney Company, of Hartford, Conn., for their use as a final reference standard. It has been compared directly with Bronze 11, at the office of the Coast Survey, by Professor J. E. Hilgard and Professor Rogers, and allowing for the known relation between Bronze 11 and Bronze No. 1, its value was found to be within this minute limit, in terms of the Imperial yard. The reason assigned for placing the lines at the centre of the depth of the bar was that errors arising from flexure were liable to occur; that is, by the bending of the bar, the distance between the lines becoming less. Having the graduations at the centre was thought would neutralise this effect. We all know that if a beam is supported at the ends and loaded in the middle, the beam is compressed at the top, and stretched or extended at the bottom, and if we were to measure between finely drawn lines, before and after the load was applied, we would find that the lines were nearer together when the beam was under strain than when free, measuring, of course, in a straight line, so it was thought that having the lines midway between the top and bottom of the standard bar, this error would be reduced.

Captain Kater was the first to discover the variations due to the flexure of standard bars upon which graduations were traced, and he first proposed a neutral plane, which would have the effect, within certain limits, of reducing this error to zero. He first located this plane in the centre of the bar, as was done in the case of the Imperial yard, but from further investigations he concluded that it was not quite one-third the thickness of the bar below the graduated surface.

He found that the errors from the effect of flexure depended upon the thickness of the bars compared with each other, and when resting upon a surface which is not plane—Phil. Trans. 1830. He also found that this error far exceeds that which would arise from the difference of the length of the arc and its chord under the same circumstances; so much so that in a bar 1in. thick, with the versed sine—that is, the distance at the centre of the bar from the horizontal plane joining the two ends to the curved surface, equal to one hundredth of an inch—the sum of the errors would be nearly one thousandth of an inch in the length of a standard yard. To overcome the objection of a variable result at every position of a standard bar, the number of supports for it has been carefully determined, and in the case of the Imperial Bronze 1 the number of these supports is eight, and having been decided by Mr. Baily to be necessary, this was adopted for the national standards. The distance between the supports is about 4½in.

Sir George Airy gave a formula for determining the distance between the supports for any standard bar in order to neutralise the effect of flexure. It is

$$\frac{\text{Length of the bar,}}{\sqrt{n^2 - 1}}$$

"n" being the number of supports.

In the bar we now have before us, the condition under which it was transferred, and also when investigated, was when resting upon two supports, and using the formula just given, the distance between them is about 22in., the total length being 38in. You will notice it places the supports a little less than one quarter the length of the bar measured from each end. This gives the surface a certain permanence or equilibrium of position when resting upon any level surface, whether a true plane or not, and if used thus under the same conditions of temperature, the distance between the defining lines remains the same. If we move the supports each nearer the ends, say an inch and a-half, the surface changes slightly, and the result is to bring the lines at the end nearer together, as we have mentioned before. According to the report of Professor J. E. Hilgard, Chief United States Coast and Geodetic Survey, in charge of verification of standards, in 1877, Bronze No. 1 is kept at a very uniform temperature within the walls of the Houses of Parliament, while Bronze No. 6, which is the accessible national standard, is preserved in the Strong Room of the Old Treasury, now No. 7, Old Palace-yard. There is not now any perceptible difference between these two standards. The Imperial Yard is in charge of Dr. Chaney, his official position being Warden of the Standards.

In order to secure, as far as possible, accurate duplicates of the new standard, four Parliamentary copies were constructed, one of which is kept in the Royal Mint, one is in charge of the Royal Society, one is preserved in the new Westminster Palace, and the other is kept at the Royal Observatory at Greenwich. There were also forty copies made of Baily's metal for distribution among the different Governments. Only two of these forty bars are exactly standard at 62 deg. Fah. These are Bronze 19 and Bronze 28. Both are kept at the Royal Observatory for reference, as representing the national standards. All the other copies have a certain relation to Bronze 1, and, instead of giving this relation, the temperature at which they are standard is established for each. The standards prepared by Mr. Sheepshanks were legalised by Act of Parliament, June 30th, 1855, and in 1856 Bronze 11, one of the forty copies made of Baily's metal, was presented to the United States Government by the British Board of Trade, and was standard at 61·79 deg. Fah. This bar is deposited in the office of the United States Coast Survey at Washington. It has since been found that Bronze No. 11 is shorter by 0·000088 of an inch at 62 deg. Fah. from comparisons made by Professor J. E. Hilgard, in charge of the Bureau of Weights and Measures, United States Coast Survey, who, in 1878, compared it directly with the Imperial yard at the British standard office in London, and consequently, to be standard, must be considered so at 62·25 deg. Fah. Previous to 1856, the distance between the twenty-seventh and sixty-third line of the brass scale made by Troughton was taken as standard; though never having been legalised by Act of Congress, it had an indirect authority, as it was adopted by the Treasury Department, and copies of it were made for distribution among the different States under the charge of Mr. Joseph Saxton. The fact is noticeable that all the copies of the Imperial yard are made of the same material as that of the original Bronze 1. This is no doubt owing to the greater uniformity in the coefficient of expansion for each standard bar, admitting of comparisons at any temperature. This would not be possible, except for bars of other metals whose coefficient or rate of change for each degree of temperature was definitely known, and this would make it an exceedingly nice operation.

To illustrate this in a few words, if a steel bar or a platinum standard be compared with one made of brass or Baily's metal, and each were standard only at 62 deg., if we should compare them at 72 deg. we would find them not alike in length, because brass expands more for each degree of rise of temperature than does the steel or the platinum; the difference would be greater in the comparison of platinum with the brass standard, as steel and brass have a coefficient more nearly alike.

Let us now briefly refer to what has been done to fix permanently the metric standard of length. The metric system is represented in Great Britain by two bars made of platinum, one being a line measure and the other an end measure standard. These bars are of the following dimensions:—

Line metre	Length	41·000	inches
	Breadth	1·000	,,
	Thickness	0·211	,,
End metre	Length	39·37 +	,,
	Breadth	1·000	,,
	Thickness	0·287	,,

The defining lines nearly traverse the face of the bar for the line metre, and arrows, arbitrarily placed, indicate the position on the lines when measurements are to be made. The line metre has the words "Royal Society, 45" engraved on the under side. The end metre, being made of so soft a material as platinum, is at present not in a condition to use as a standard for very accurate work, the edges of the end surface being indented and other signs of change in the surface being visible. The end metre has the words "Mètre à Bouts" engraved on one side, and "Fortin à Paris, Royal Society, 44," on the other. These bars, together with the original standard prepared by Hassler in 1832, are the only recognised standards which have been compared directly with the "Metre of the Archives," as the French standard is called. The Metre of the Archives is also made of platinum, the dimensions being about the same as the metric standard in London, and this bar was made a legalised standard after all attempts to make it conform to a natural unit were abandoned. It is standard only at 0 deg. Cent., or 32 deg. Fah. Thus, we see, that, after all, the actual use of a natural unit for creating and reproducing a standard of length was not realised; and standards, made standard by law, were really the final result.

It has been said that "a mystery is a truth hid behind some other truth, and about which the latter throws a veil," and it would seem as if this definition might apply to the great difficulties met with in the attempts to obtain a standard of length from natural laws, and natural conditions, using the grand truths which are known and accepted, but which seem to throw just enough uncertainty around the truth sought, as to make the results doubtful for the purposes for which they are intended. Truth is exacting, it allows for no "errors of observation" or of "personal equation," and in no other kind of investigation does this requirement seem more difficult to be fulfilled, as so many "variables"—

* A lecture delivered before the Franklin Institute, February 21st, 1884.

† "Report on Weights and Measures," by Dr. Alfred B. Taylor, Eighth Annual Session, Pharmaceutical Association, Boston, September 15th, 1859.

* This Act was introduced into the House of Commons in 1822, but failed to pass the House of Lords. It was again introduced, with modifications, in 1823, but was not passed until June 17th, 1824, to go into effect as stated, May 1st, 1825. This was, however, postponed to January 1st, 1826.

["Weights and Measures," by Professor F. A. P. Barnard, Johnson's New Cyclopædia p. 1787, Appendix. See also Encyclopædia Britannica, eighth edition, vol. xxi. p. 803 and 807.]

to use a mathematical term—enter into the problem; variations of temperature, internal strain, due to position of the bar; errors of curvature, errors of observation in using optical instruments; differences in material or of density, thus affecting the rate of expansion or contraction, and a score of other variables, all tending to make the problem a complicated one. We cannot fail to realise—at least, partially—the wonderful skill and patience necessary to conduct the experiments which gave us, as English-speaking people, the standard Imperial yard, and which fifty years ago were engaging the attention of some of the greatest minds the world has ever known. There is still another natural unit that has been proposed as a standard of length. This is the length of a wave of monochromatic or single-colour light. We have all seen the beautiful colours so wonderfully arranged in the thin film of a soap bubble. These colours are caused by what is termed "interference." To briefly explain this kind of interference, we should know that light is made up of seven distinct coloured rays, which blended together produce clear white light. Each of these separate rays of colour has an undulatory or wave motion through space, and the length of a wave, or the distance from the crest of one wave to the top of the next, is different for each as compared with unlike colour, but constant for its own, that of the green ray, for instance, being computed as being about one fifty thousandth of an inch from crest to crest.

When light is reflected from the two surfaces of the thin film of a soap bubble to the eye, a portion of it must evidently travel a distance twice the thickness of the thin film of the bubble, as part is reflected from the outer and part from the inner surface of the film. The particular ray which must thus travel farther loses a half of the wave length in the reflection, so that when these two portions of the reflected light come into the same path again, there is more or less interference, and if the retardation has been such that the wave crest of one falls into the trough of the other, they completely neutralise each other, and the corresponding colour rays are destroyed. Without attempting the mathematical discussion of this subject, we know that when this relation happens to be more or less coincident, the rays are either deadened or are so blended that they form the beautiful rings or bands so often noticed. As the film of the bubble changes in thickness, these colours are rearranged, as different sets of colour rays or waves are deadened and as different colours disappear from the reflected light. This unit, no doubt, could be relied upon to produce a standard within certain small limits, but the addition or multiplication of such minute units for the purpose of obtaining a practical standard of length might introduce errors in the total greater than would be likely to result from either of the methods already mentioned. The use made of this unit seems to confirm the theories in regard to the limit of divisibility of matter, and these same soap bubbles which are such a delight to children—and we might include some of the older people too—have shown a way in which to estimate, in a purely scientific manner, the dimensions, approximately, of a molecule, a form of matter so minute that the smallest object visible under a powerful microscope is made up of countless numbers of them. It has been demonstrated that the mechanical energy required to pull apart the molecules of water in forming steam is no greater, according to the theory of capillary action, than is required to reduce the thickness of a film of water to the one five hundred millionth of an inch; a force quite large when compared with the small amount of water which we are considering. The measurement of this minute thickness is based upon the varying colours, using the length of any given wave. Probably before this extreme tenuity could be obtained, there would remain only a single layer of molecules held together by their mutual attraction, giving as the estimated average diameter of a molecule the one five hundred millionth of an inch, a dimension so infinitely minute as to be quite beyond our ability to realise.

Sir William Thomson, from a comparison of these phenomena, has estimated the limits or range of size of these minute molecules to be between one two hundred and fifty millionth and one five thousand millionth of an inch, and in order to give some conception of the "coarse-grainedness," as he calls it, thus indicated, he has said, "that if we conceive a sphere of water as large as a pea, magnified to the size of the earth, each molecule being magnified in the same proportion, the magnified structure would be coarser grained than a heap of small lead shot, but less coarse grained than a heap of cricket balls." We can thus faintly begin to grasp the idea of the infinite divisibility of matter, and the science of exact measurement of length must stop far short of this limit, as it does far short of the limit of infinite extension. We have now seen how difficult has been the work of obtaining a standard for final reference, and as it must certainly be supposed to remain an invariable or fixed length after having been once established, great care must be taken to preserve this standard from injury, caused either by wear or oxidisation, or change of form. The materials available for standards of length, taken in the order of their rate of expansion under the same conditions of temperature, are wood, glass, platinum, gold, silver, iron, brass, and copper. Wood may be rejected at once for our purpose, though it does very well for yard-sticks and pocket rules for everyday use. Glass has been, and is now, used in certain cases, though its great brittleness makes its use restricted, and the changes going on within its structure are now the subject of rigid investigation, requiring time to prove its value as a material for standards. Platinum, alloyed with about 10 per cent. of iridium, is used for the Metre of the Archives, and also for the bars representing the line and end metre standards in Great Britain, to which reference has already been made. Gold and silver may be said to be excluded for various reasons, that of cost in the case of gold, and its extreme softness; and silver, because of its great affinity for sulphur, which is always present in the atmosphere of cities, forming the dark sulphide that would soon ruin it for use as a standard. There is, however, a silver centimetre scale, ruled by Brunner, of Paris, subdivided into 100 parts, in the office of the Coast Survey at Washington.

Iron bars were used by the French Commission, four standards being made of this material, with polished ends. From one of them was constructed the platinum Metre of the Archives. One of these bars, the only one known to be in existence, bearing the stamp of the Commission, is now in the possession of the United States Coast Survey at Washington. The Russian standard of length, used for geodetic surveys, was constructed of iron, using conical pieces of tempered steel in each end. This bar has a length of 7ft. We have already noticed how largely brass, or Baily's metal, has been used for our standard yard, and for the numerous copies made of it. There remains only a brief mention of standards made of copper. M. Tresca, acting director of the Conservatory of Paris, constructed a copper line metre of a form which he proposed. This bar is X shaped, very light and strong, and has the lines ruled on a plane midway between the top and bottom edges. The method adopted at the Conservatory in Paris for comparing the platinum line metre bar with the end "Mètres des Archives" is the use of a plate having the same thickness as the metre, to which is attached a thin piece of platinum terminating in a sharp point. As a statute law forbids contact of any kind whatever in the use of this platinum end metre, the reflection of this sharp point upon the surface of the end of the standard gives the means of observing the instant of contact without contact being actually made. It is the opinion of M. Tresca that the error can be in this way reduced below 1 mikron = ·001 mm., or about one twenty-five thousandth of an inch, in the transfer to line measure.

(To be continued.)

The Tin Trade.—The Cornish smelters yesterday advanced tin standards £2 per ton. The standards now are—common, 71s.; superior common, 78s.; refined, 75s. per cwt.

Naval Engineer Appointment.—The following appointment has been made at the Admiralty:—William H. White, chief engineer, to the Indus, for service in the Racer.

LEGAL INTELLIGENCE.

JUDICIAL COMMITTEE OF THE PRIVY COUNCIL.

Present:—Lord Blackburn, *Sir* Barnes Peacock, *Sir* Richard Couch, *and Sir* Arthur Hobhouse.

WASTENEYS SMITH'S PATENT "STOCKLESS" ANCHOR.

This was a petition for the extension of the term of letters granted in 1871 to Mr. William Wasteneys Smith, of Newcastle-upon-Tyne, civil and consulting engineer, for his invention of improvements in the construction of anchors.

Mr. Webster, Q.C., and Mr. Lawson appeared for the petitioner; the Attorney-General and Mr. R. S. Wright for the Crown.

The petition stated that about the year 1870 the attention of Mr. Wasteneys Smith, the petitioner, who had been an engineer in the Navy, was particularly devoted to the study of improvements in anchors with the aim of making an anchor of great strength and holding power and otherwise fitted for use in all circumstances without a "stock," he—Mr. Smith—conceiving that the stock, besides being useless for stability, was in itself dangerous by reason of its liability to get broken and to foul the cable, in both cases rendering the anchor valueless. Up to that date no anchors had been designed to act efficiently without a stock. Mr. Smith, after numerous experiments and great personal application and cost, invented the improvements in respect of which letters patent were granted, and the invention had been of great utility and beneficial to the public. The merit of the invention consisted not only in dispensing with the stock in the ordinary anchors, but in obtaining an anchor which would hold the ground with both arms at the same time. Such holding was always obtained immediately on any strain being put upon the anchor, through the cable, which was a point of importance in the efficiency and usefulness of anchors. The construction of the invention also rendered anchors more easily capable of being stowed away and more readily transported than heretofore. The steadying power of the anchor was transferred from the shackle to the crown end, where it was not only much more effective, but remained so while any part of the anchor remained on the ground, whereas in other anchors, as soon as the cable was tightened, or if sufficient cable was not paid out, the stock was raised off the ground, and immediately its efficiency was lost and the anchor would drag. In 1871 various successful public tests and experiments of the anchor were made, and Mr. Smith devoted great time and expense to the development and furtherance of the invention; but there being a pressure in the anchor and chain trade at the time he experienced much difficulty in getting his anchors made. In 1872 he made an arrangement with Messrs. J. Spencer and Sons, of Newburn Steel Works, Newcastle, by which, in consideration of their putting down the necessary plant for the manufacture of the anchors and of their paying him certain royalties on the sales, he conveyed to them the sole and exclusive right of making the anchors during the term of the letters patent. Messrs. Spencer had accordingly continued to the present time to manufacture anchors for the petitioner to his satisfaction. Mr. Smith had used his best endeavours to introduce the invention to the public, but inasmuch as the advantages of his anchor were obtained at an increased first cost of the anchor, owing to the peculiarities of its construction, he had found considerable difficulties in inducing shipowners and others to adopt it. At length its value had been thoroughly appreciated, and Mr. Smith had sold during the term of the patent nearly 700 anchors. He had supplied them for the Royal Navy for her Majesty's ships Collingwood, Garnet, Agamemnon, and others, and for the Cunard Steamship Company, and he would be able, owing to an important concession made by the Committee of Lloyd's in regard to the use of high-class annealed steel instead of forged iron, to make a reduction to the public of about 20 per cent. in the price of such anchors. Both Mr. Smith and Messrs. Spencer had done all in their power to get the anchors used, and the demand had considerably increased in the last four years, but until then the patent had been almost wholly unproductive, and now, when the patent was about to expire, the real value of the invention was becoming well understood, and its use established and extending. For these reasons, among others, the petitioner asked for a prolongation and extension of the term of his letters patent.

Mr. Wasteneys Smith, the petitioner, was examined in support of his petition, and produced full accounts of the cost of manufacture, the sales, and other incidents of the invention. Captain Inglis, the marine superintendent of the Cunard Line, was also called, and spoke in high terms of the value and merit of the invention. There were other scientific and practical witnesses in attendance but they were not called. A number of interesting models, showing different kinds of anchors, old and new, were also brought to the notice of the Committee.

The Attorney-General, on the part of the Crown offered, no objection to the patent being extended if their lordships should consider, from the accounts, that inadequate remuneration had been received.

Their Lordships, in the result, gave judgment expressing themselves satisfied as to the meritorious and valuable nature of the invention, and as to the petitioner not having received adequate remuneration in respect of it, and they stated that her Majesty would be humbly advised to grant new letters patent to the petitioner for a term of seven years from the expiry of the original term.

THE FORCE OF HYDRAULIC RAMS.

At a meeting of the American Society of Civil Engineers, November 19th, 1884, a paper was read by Edmund B. Weston, M. Am. Soc. C.E., giving a description and the results of some experiments that were made to ascertain the force of water ram that could be generated above the static pressure in water-pipes under various conditions. The experiments were made at Providence, R.I. A combination of iron pipes of different sizes and various lengths were used in making the experiments. An air chamber, 2½in. in diameter, and 42in. in height, that could be used or thrown out of service at pleasure, was connected to a 2½in. pipe of the combination. The water used was taken from a distribution pipe, which was supplied by two 24in. mains. The quantity of water that flowed through the pipes was measured in each instance. The force of the ram was ascertained at the different points in the pipes by the aid of a Richards steam engine indicator. The force of the ram was produced by suddenly closing a valve in the outlet pipe, and it was regulated by screwing orifices of different sizes to the outlet pipe. The results of some of the experiments are as follows:—

Force of Ram Generated in a Line of Pipe consisting of 111*ft. of* 6*in.,* 58*ft. of* 2*in.,* 99*ft. of* 1½*in., and* 4*ft. of* 1*in., which was the Outlet Pipe.*

Orifice of discharge in inches.	Velocity in the 1in. pipe.	Ram in pounds per square inch.						
		1in.	1½in. Distance from 2in.			6in.	Dead end.	
			32ft.	49ft.	67ft.		2½in.	The same with air chamber.
3/16	2·57	72·8	72·4	70·8	70·3	—	—	—
¼	5·36	129·3	125·9	127·0	128·8	14·5	18·8	—
⅜	10·05	—	—	—	—	23·5	42·2	16·8
½	19·23	—	—	—	—	51·7	88·3	49·3

The dead end referred to in the above table was a continuation of the pipe beyond the point in the 6in., where the 2in. was connected, and consisted of 70ft. of 6in., 66ft. of 4in., and 4ft. of 2½in., which was at the extremity, and located, measuring on the line of pipe about 322ft. from the orifice of discharge.

Force of Ram Generated in a Line of Pipe consisting of 111*ft. of* 6*in.,* 58*ft. of* 2*in.,* 48*ft. of* 1½*in.,* 3*ft. of* 3*in.,* 48*ft. of* 1½*in., and* 4*ft. of* 1*in., which was the Outlet Pipe.*

Orifice of discharge in inches.	Velocity in the 1½in. pipe.	Ram in pounds per square inch.		
		1½in. 16ft. from 3in.	Centre of 3in.	1½in. 16ft. b'y'd 3in.
3/16	1·19	75·3	64·5	61·2
¼	2·37	126·4	120·8	113·8
5/16	3·00	150·2	150·5	138·9
⅜	4·47	203·3	206·8	195·3

Force of Ram Generated in a Line of Pipe consisting of 182*ft. of* 6*in.,* 66*ft. of* 4*in.,* 4*ft. of* 2½*in.,* 1*ft. of* 2*in.,* 7*ft. of* 1½*in., and* 6*ft. of* 1*in., which was the Outlet Pipe.*

Orifice of discharge in inches.	Velocity in the 1in. pipe.	Ram in pounds per square inch.					
		1in.	1½in.	2½in.	6in.	With air ch'mb'r.	
						2½in.	6in.
¼	5·39	66·7	49·4	22·2	4·8	—	—
5/16	6·71	76·1	61·5	35·6	6·6	—	—
⅜	10·02	106·3	81·8	52·0	15·8	14·0	12·3
½	20·94	177·5	121·5	99·0	36·8	38·7	25·6
1	43·9	—	—	183·0	80·1	105·8	65·6

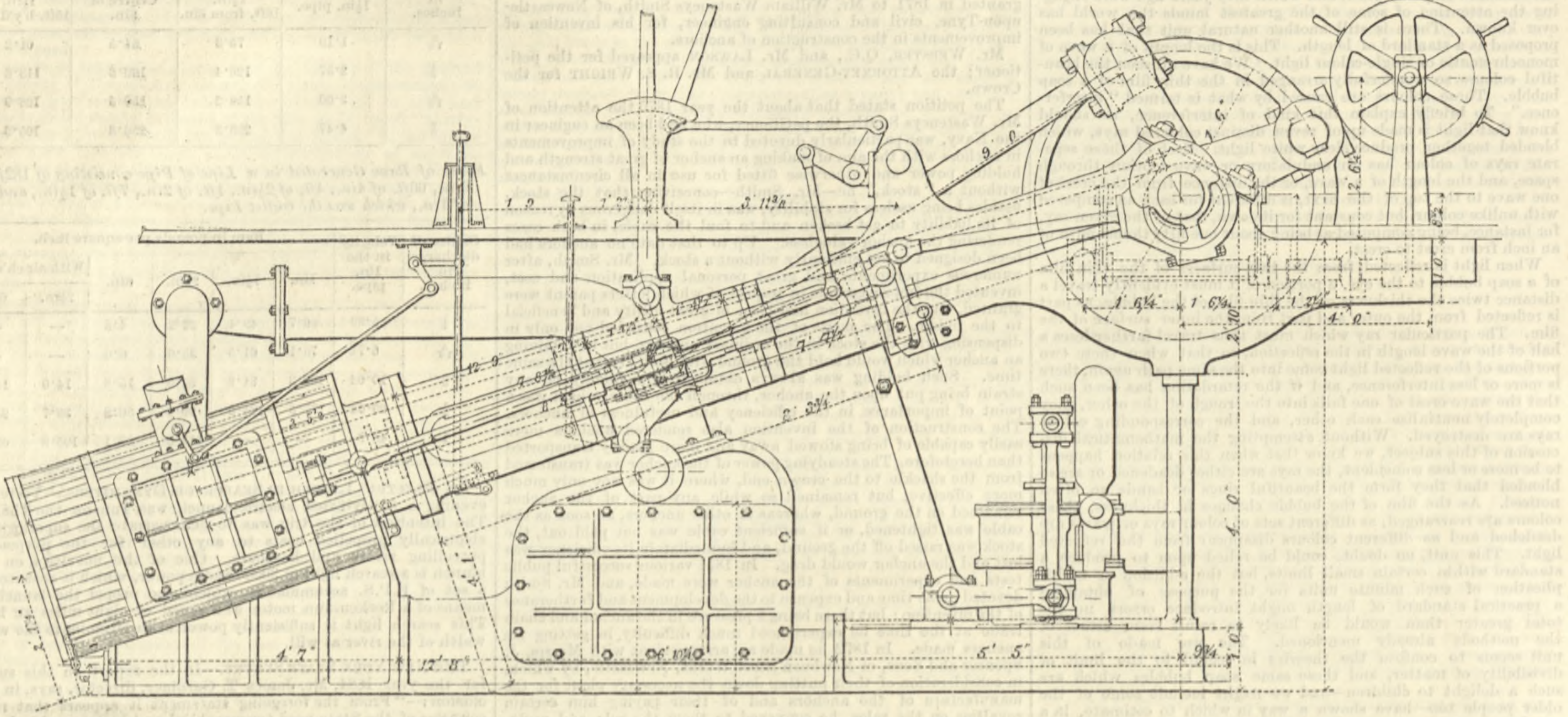
An Electric Launch in Search of Dynamiters.—Yesterday evening a newly-fitted electric launch was run on the Thames. The intention of the trip was to demonstrate the superiority of electrically propelled boats to any other for the purpose of patrolling rivers and harbours. One of the novelties on this launch is a search light of 3000-candle power, which is actuated by a set of E.P.S. accumulators, which also propel the launch by means of a Reckenzaun motor at a speed of eight miles an hour. This search light is sufficiently powerful to illuminate the whole width of the river at will.

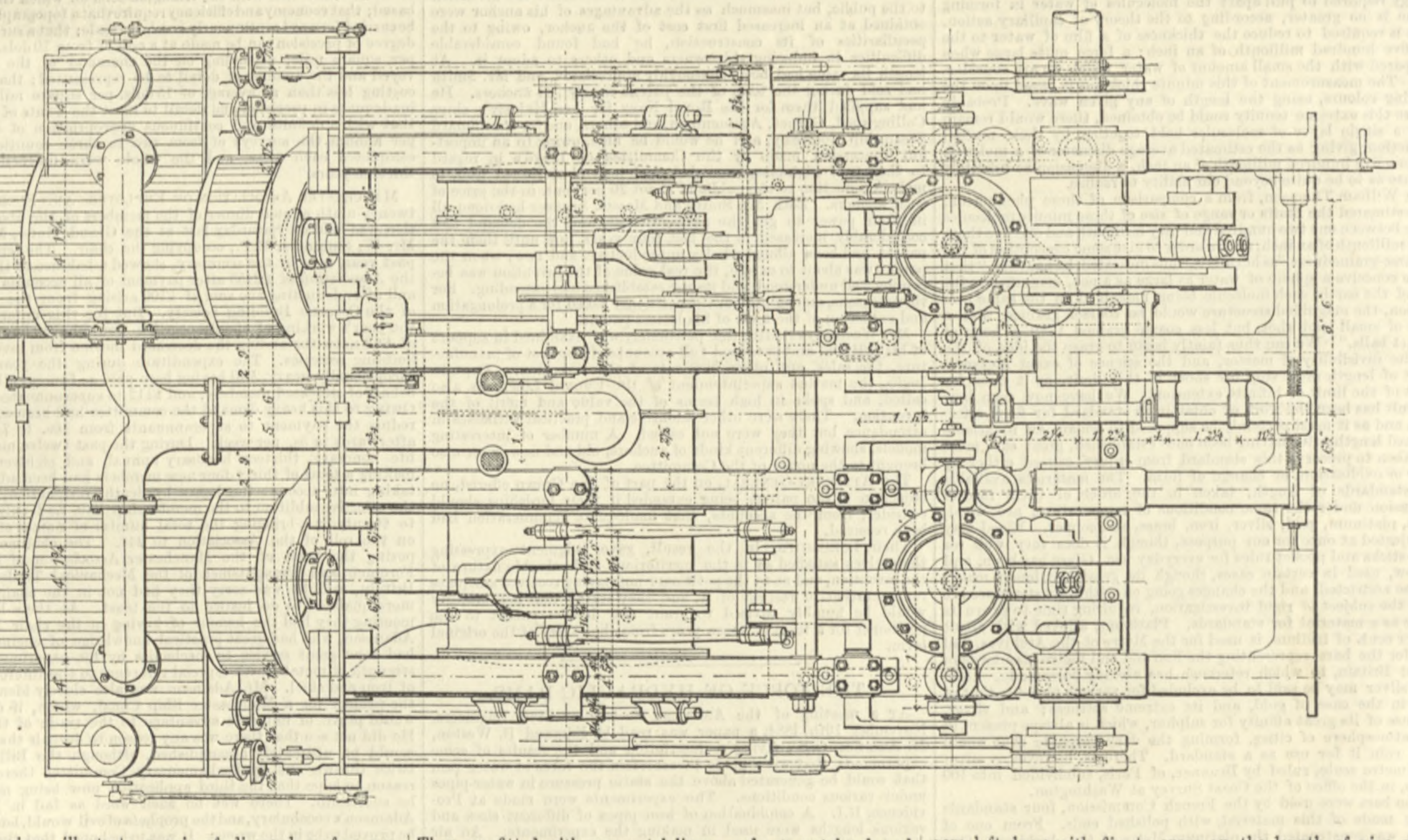
The New York State Survey.—In the report on this survey for the year 1884, Mr. James T. Gardiner, director, says, in conclusion:—"From the foregoing statement it appears that many counties of the State need topographical and hydrographical maps and need them now, that such extensive surveys must be made by State or Federal authority, and have never been executed in any other way; that these surveys and maps can be most economically made in connection with the triangulations on which they must be based; that economy and efficiency require that a topographical survey be carried forward continuously on a large scale; that a survey of a fair degree of precision can be made at a cost of from 10 dols. to 20 dols. per square mile, depending on the character of the region surveyed and the amount of detail to be represented; that a survey costing less than an average of 15 dols. per square mile would be inadequate in precision and detail to meet the wants of this State; that with a definite and continuous appropriation of 40,000 dols. per annum the surveys of from two to three counties could be completed each year, and the whole work finished in about thirteen years."

Manchester Association of Employers and Foremen.—The twenty-ninth annual dinner of the members of the above Association was held on Saturday last at the Grand Hotel, Manchester, Mr. W. Summers, M.P., occupying the chair. The report for the past year, read by the secretary, showed a balance to the credit of the Association of £2455 after payment of all accounts up to date, and after deducting the sum of £100 arising from the winding up of the Osborne Building Society. But for this unfortunate loss the year's working of the Association would have shown a balance of £63 notwithstanding the decreased income from investments in building societies. The expenditure during the year had been exceptionally heavy, £40 having been paid as funeral allowances on behalf of deceased members, and £112 to superannuated members. Owing to this heavy demand the committee had been compelled to reduce the payment to superannuants from 10s. to 7s. 6d., and afterwards to 5s. per week. During the past twelve months three life honorary, thirteen honorary annual, and eighteen ordinary, making a total of thirty-four new members had been admitted, but taking into account the losses by death, resignation, or erased, the effective addition to the membership lists had only amounted to twenty-one, bringing the total number of names of all classes on the roll of the Association to 244. The chairman, in proposing the toast of the Manchester Association of Employers, Foremen, and Draughtsmen of the Mechanical Trades of Great Britain, said he was sorry they had not in the chair some one more qualified to do justice to the toast. At their last annual meeting they had the honour of having in the chair Mr. Daniel Adamson, who had great practical knowledge of engineering, and had done great service to mechanics by his experiments on the strength of metals, with especial reference to the different varieties of iron and steel. Mr. Adamson was also closely identified with the project for a Manchester Ship Canal, which, if once made, would prove of immense advantage to the trade of the district. He did not see that there was any reason to despair that this work would be ultimately accomplished, although the Bill had been twice thrown out by Parliamentary Committee there was good reason to hope that the third application now being made would be successful. There was no such word as fail in Mr. Daniel Adamson's vocabulary, and the prophets of evil would, let them hope, be proved to be in the wrong. It was to be hoped that the promoters of the Manchester Ship Canal would triumph over the various obstacles that still stood in the way, and that Association, he was sure, most heartily wished them success. That Association was based on the principle of uniting together masters and men, and proved that employers and employed could work harmoniously together. During the twenty-nine years it had been in existence, it had gradually grown, until it had attained its present flourishing condition. In addition to the pecuniary assistance which it afforded to its members, when this was required, the Association had for one of its principal objects more frequent exchange of opinions on interesting questions constantly arising from the professional nature of the mechanical trades. This object had been admirably carried out in a series of papers and addresses delivered in the lecture hall of the Manchester Technical School. A great change had recently come over the engineering world. Formerly it was the custom to preserve the utmost secrecy with regard to improvements in mechanical science; now the utmost frankness prevailed, and with this change of policy there had been a rapid development of the trades connected with the iron, steel, and allied branches of industry. A change had also come over the mind and feelings of the working classes with regard to improvements and inventions which resulted in the saving of human labour. The inventor was now recognised as the friend of the working man, and the effect of the improvements in machinery was seen to have been not only to cheapen the cost of production, but also to increase the wages while lessening the hours of labour. The progress of mechanical science, which had been so rapid and astonishing in recent years, had conferred the greatest blessings on the human race. In this great work that Association had borne no inconsiderable part; he congratulated it on what it had already accomplished, and confidently predicted for it a future yet more glorious than its past had been. Alderman W. H. Bailey, the President of the Association, briefly responded to the toast,

DIAGONAL SURFACE CONDENSING PADDLE-WHEEL ENGINES

MESSRS. ALEXANDER SHANKS AND CO., ARBROATH, N.B., ENGINEERS.





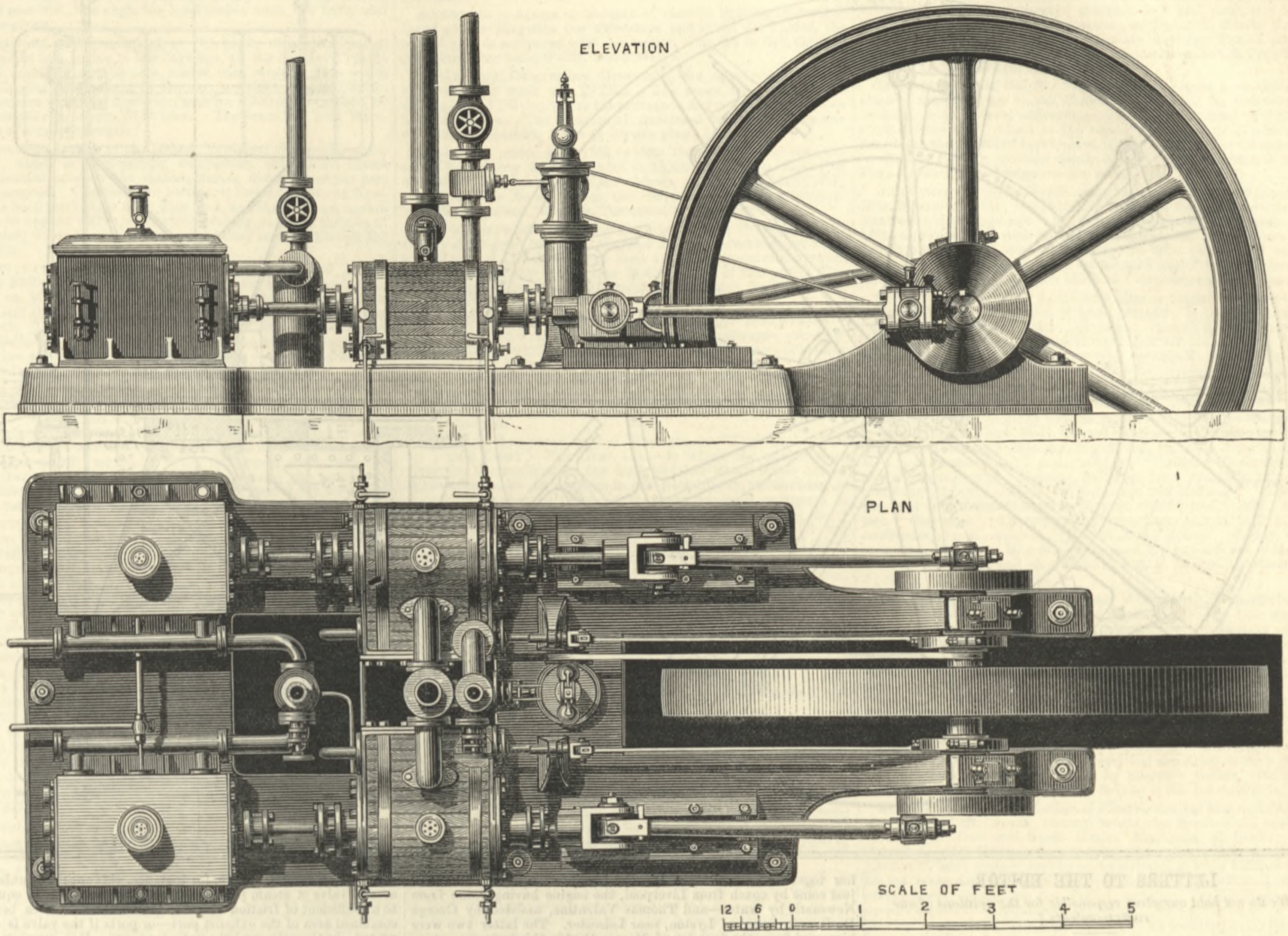
Our engravings illustrate a pair of diagonal surface-condensing, disconnecting engines and boilers made by Messrs. Alex. Shanks and Sons, Dens Ironworks, Arbroath. They were for a paddle tug, fitted up complete, marked, and taken to pieces, and delivered on board ship with all connections for fixing in a wooden vessel abroad. In describing these engines we shall closely follow the specifications to which they were made. The engines have two cylinders 30in. diameter by 4ft. 6in. stroke. The piston-rods are of steel, 4in. diameter, secured to the crossheads by a steel key and to pistons by a nut. The slide valves are arranged on the sides of the cylinders so as to avoid weigh shafts, and the expansion valves work on the backs of the main slides. There are four excentrics, two for main slides and two for expansion valves, the former being loose and fitted with steps properly balanced. The intermediate shaft is 8¾in. diameter in bearings, 10in. long, and 9½in. diameter in sliding crank. The paddle shafts bearings are 8¾in. diameter by 10in. long in engine frames, and outer bearings 9¼in. by 12in. The disconnecting crank is of wrought iron on the port engine, and is made to slide on four steel keys by means of levers, and a clutch ring of wrought iron, faced with brass, and fitted with gun-metal cod pieces in the crank eye. The connecting-rods are of wrought iron, with 9ft. centres. They have brasses, caps, and bolts at both ends, and brass liners to facilitate adjustment. The condenser is placed below the shaft and forms part of the framing. It is fitted with solid drawn brass tubes ¾in. diameter outside, and secured in Muntz metal tube plates by wooden ferrules. The total tube surface is 750 square feet, the tube plates being 1in. thick. There are two air pumps worked by beams, as shown above. They are fitted with gun-metal liners, and gun-metal rods and valve seats, glands, and neck bushes, and brass valves are used. There are two each of feed and bilge pumps, one to each engine; they have gun-metal plungers, valve seats, glands, and neck bushes. The circulating pump is centrifugal, worked by a separate engine, taking steam direct from the boilers and exhausting into condenser. The starting gear is arranged so as to work from the deck. The paddle wheel shafts are overhung from the bearing, resting on strong brackets on the ship's side. The excentric is attached to a spring beam. The wheels, illustrated on page 142, are 12ft. 6in. diameter to centres of floats, each wheel having nine floats, 7in. by 2ft. 6in. by 2½in. thick, of black birch. The eyes are bushed with lignum vitæ, and pins cased with gun-metal. All the bolts on the wheels have square heads, and each bolt two square nuts. Each boss is one solid casting secured to shaft by three keys. The boilers, see page 148—two return tube—are of Siemens steel, each 8ft. 9in. diameter by 10ft. 9in. long. Each boiler has two furnaces, 2ft. 9in. diameter by 6ft. length of bar = 33 square feet. They each have seventy-eight iron tubes, 3½in. diameter outside, 4¾in. pitch, and 8ft. long over the tube plates, giving 571 square feet tube surface. From the top of the combustion chambers to the top of boiler inside it is 2ft. 11in.; and there is a separate combustion chamber to each furnace. These have flat tops and girder stays. The stay tubes screwed into both plates, and no nuts used. Each boiler has a vertical steam chest, 3ft. 6in. diameter and 4ft. high. They were tested to 90 lb., and have to work at 45 lb.

The pipes are all of copper, except for the bilge, which are of lead, and in most cases flanges were brazed; but in other cases they were left loose with 6in. to spare on the length of pipe, and each steam pipe was fitted with a Mollerup's impermeator. Chadburn's repeating telegraph has been adopted. Brass save-alls are fitted so as to prevent oil getting into bilges.

Floods in the Midlands.—Mr. Tarbotton reports as follows as to floods in the neighbourhood of Nottingham:—"I am strongly of opinion that the great damage by floods in the neighbourhood of Nottingham is caused by the Colwick and Beeston weirs. These weirs being constructed of solid material, are very serious obstructions to the passage of flood waters; they also tend to the silting up of the river, necessitating a large amount of constant dredging. Colwick Weir: I was unable to get the exact fall at the Colwick Weir, but I found the fall at the lock, at the lower end of the Holme Cut, was 8ft. 10in. Now, the main object should be the assimilation of the two levels in times of flood. This can be obtained most efficiently by introducing a new tilting weir near to the lock, but not necessarily upon the site of the Colwick Weir. Beeston Weir: I found the fall at this weir to be nearly 5ft., but I noticed a considerable fall in the bed of the river immediately below the weir, and down to the Trent Bridge. The flood relief works required above Colwick Weir would be mainly between the Trent Bridge and Beeston, comprising the dredging of the river, and the introduction of a tilting weir in substitution of the fixed weir at Beeston. The effect of this would be to give the river its full dynamic power from Beeston Weir to Colwick Weir, which at this moment it cannot exercise. The dredging might be executed gradually, and spread over a few years. The gravel dredged would be largely remunerative if dredged according to demand for use in Corporation works and for sale. The alteration to the weirs is imperative, and admits of no delay, as you may have a flood at any time which might do such damage in one day as would amount to more than the total cost of improvement.

AIR COMPRESSING ENGINES.

MESSRS. W. NEILL AND SON, ST. HELEN'S JUNCTION ENGINEERS.



THE accompanying engravings illustrate a pair of engines and air compressors manufactured by Messrs. Neill and Son, Bola Ironworks, St. Helen's Junction, Manchester. The arrangement is compact and the machinery well finished. About a dozen similar sets are at work, and have, we understand, given great satisfaction. With steam at 50 lb., they will give an air pressure of 100 lb. The steam cylinders are 12½in. diameter, and the air cylinders 10¾in. The stroke is 18in.

THE STILES AND PARKER PRESS COMPANY'S PRESSES.

THE accompanying engravings illustrate the details of two presses for sheet metal work, made by the Stiles and Parker Press Company, Middletown, Conn., and described in the *Age of Steel*. These machines are made in a variety of sizes, and for a great variety of work, from the finest work of the jeweller and watchmaker up to heavy ordinary work. Fig. 1 represents the new graduated adjustment of the Stiles press. This provides

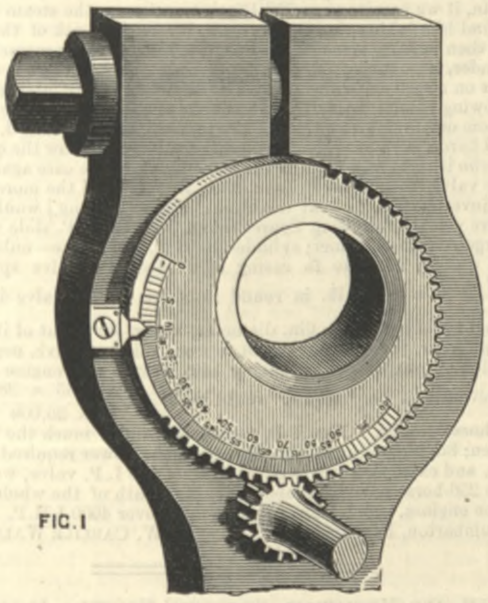


FIG. 1

for the rapid and certain adjustment of the downward travel of the punch without consulting tables, or making any calculations whatever. Thus, supposing it is required to lower the stroke of the punch one-hundredth of an inch. The single bolt at the top is loosed, and by means of the hand pinion shown the graduated circular wedge, or excentric, is moved one division of the graduated scale; an operation, as will be seen, that can be very quickly performed. While the scale is graduated for advances by hundredths of an inch, it is evident that by setting between two graduations finer adjustments can be made. The graduations being numbered, a record can be kept for any particular dies used on regular work, and when again used these dies can be accurately set without loss of time. These features would appear to be valuable, and particularly when a variety of work is done with a single press, must result in a large saving of time. In setting the dies in this machine the shaft can be turned to bring the slide to the lowest point of stroke while the

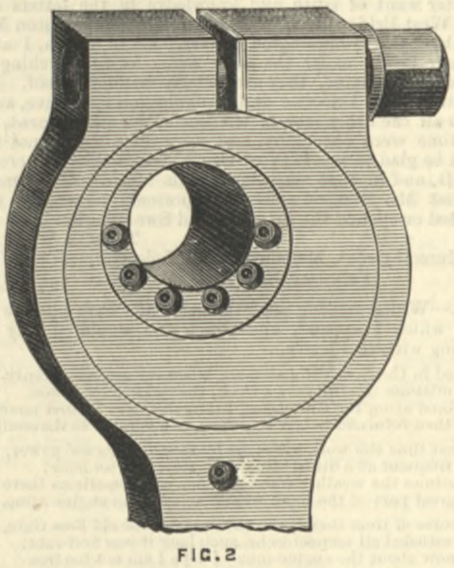


FIG. 2

wheel is in motion, as the press cannot be started by accidental pressure upon the treadle, being prevented by self-actuating mechanism. The wheel can be turned backwards to release a punch that becomes fast in its die, or in fitting punches to dies,

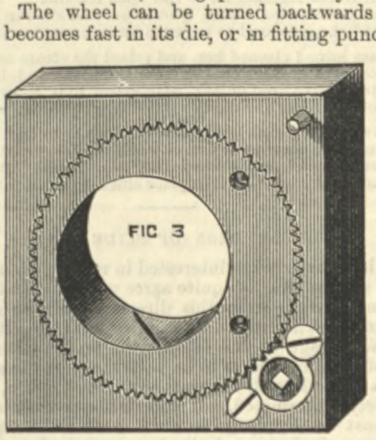


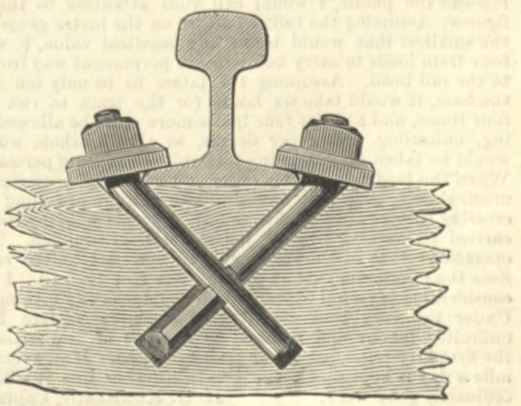
FIG 3

a feature the value of which will be recognised by those accustomed to use such machines.

The clutch-pins, three in number, are arranged to lock at three different points in a revolution; consequently there can never be more than one-third of a revolution lost between the depression of the treadle and the starting of the press. The three clutch pins will manifestly last three times as long as a single one. A positive stop is provided, which can be used or not, at will. This stop, when used, prevents the possibility of a second stroke, even if the foot is not removed from the treadle. Fig. 2 represents the arrangement for changing the stroke of the slide, in addition to the adjustment previously referred to. The excentric disc is secured to and revolves with the crank shaft. The stroke is adjusted by changing the position of the disc by means of a pin that enters the holes shown. This pin can be changed from hole to hole, thus accomplishing the desired end. Fig. 3 represents the slide adjustment of the Fowler press. In this the adjustment is made by turning the excentric ring. The crank pin revolves in the hole in the excentric block, and imparts motion in a way that will be clearly understood. To adjust the punch a wrench is supplied to the bolt head shown, and the excentric brought into position to be moved by a wrench fitting the holes on the face. By means of this the excentric can be turned to vary the position of the punch by the finest gradations. In the Fowler, as well as in the Stiles press, the thrust between crank and punch is received by solid unyielding metal, affording no chance for variation while in operation.

THE BUSH INTERLOCKING RAIL BOLT

THE accompanying engraving illustrates an ingenious bolt which has been, we understand, well tested on American railways. It is obvious that the system is applicable in many situations to many purposes besides those to which our illustration shows it applied. It is claimed for it that the spreading of

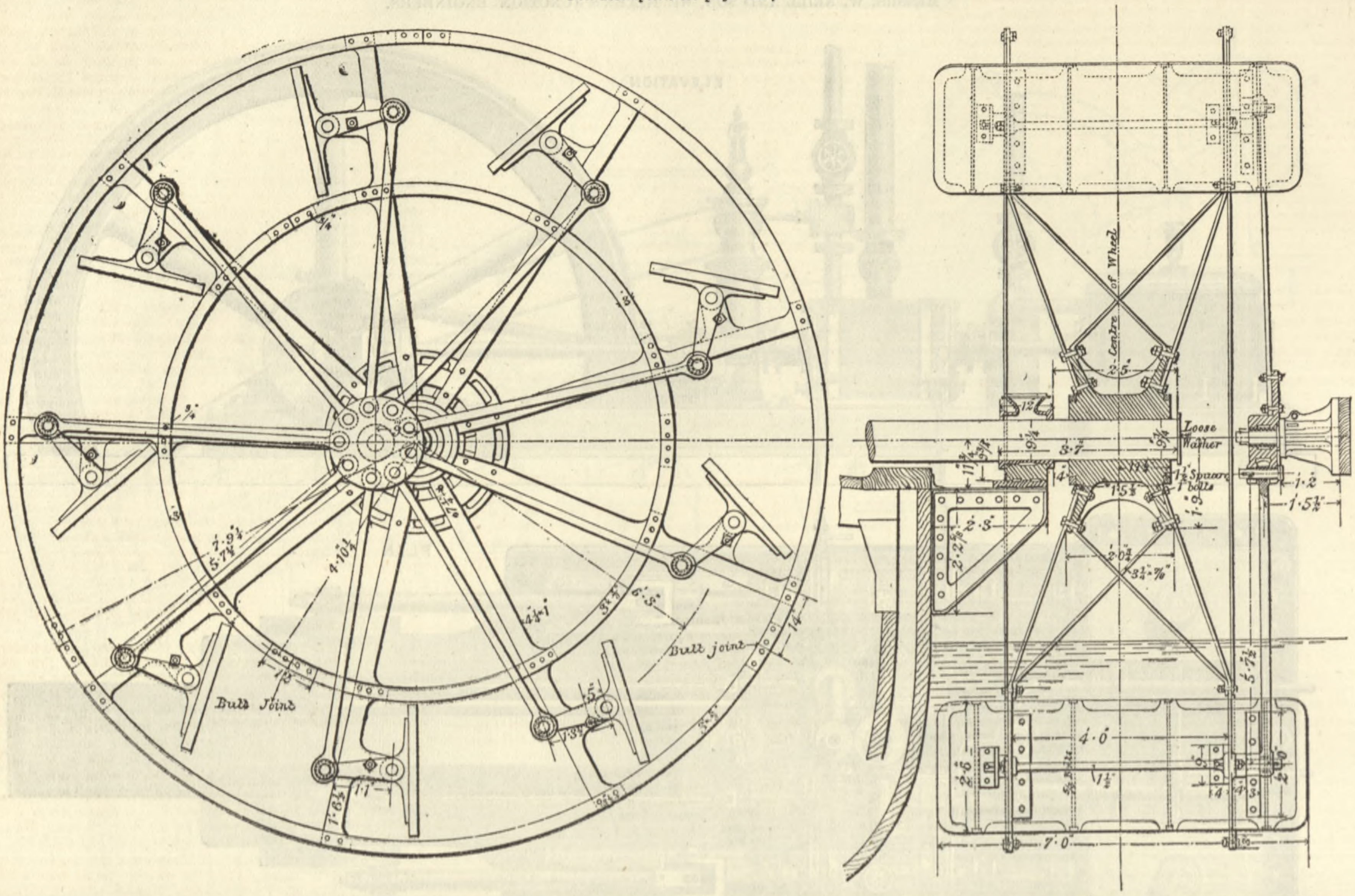


rails is entirely obviated, and that it can be applied at all seasons without delaying traffic. The bolts are manufactured in the United States by the Bush Interlocking Bolt Company, South Forth-street, Philadelphia.

PUBLIC HEALTH.—The deaths registered during last week in 28 great towns of England and Wales corresponded to an annual rate of 20·9 per 1000 of their aggregate population, estimated at 8,906,446. The six healthiest places were Birkenhead, Derby, Salford, Brighton, Huddersfield, and Bradford. In London 2913 births and 1525 deaths were registered. During the first six weeks of the current quarter the death-rate of London averaged 22·6 per 1000, against 24·7, the mean of the rates in the corresponding periods of the five years 1880-4.

TUG-BOAT PADDLE-WHEELS.

(*For description see page* 144.)



LETTERS TO THE EDITOR.

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

COOPER'S HILL COLLEGE.

SIR,—I have read with great interest the many articles and letters published in your paper; and, not being personally acquainted with any engineers sent out by the College, so it would not do for me to express any opinion as to their ability in carrying out works; but what I do have a good deal of experience in is with the so-called engineers with diplomas, as they call themselves, coming from colleges on the Continent, as Belgium, Germany, Italy, &c., and I have no doubt that it is about the same as the Cooper's Hill engineers, not the slightest idea of carrying out work and less of managing men, and an enormous amount of pride in parading before the public a fine looking instrument, which, in many cases, they do not know how to set up. But to come back to the articles and letters referred to, I see that Cooper's Hill turns out engineers exclusively for India, and naturally I ask the question why that College is not transferred to India itself, because it could supply there at once what I see by the letters is greatly wanted, knowledge of works—special for India—country, and climate. Having the College in India, the engineers actually engaged there, with their practical acquired knowledge, could be the teachers and the pupils, have the advantage of seeing the works where they have to be engaged on, get acclimatised, and get also a practical knowledge of the country, people, and customs they are so much in want of. JOHN I. DE JONGH, C.E.

San Jose, Costa Rica, January 14th.

A SOUDAN RAILWAY.

SIR,—I was astonished to read in an extract taken from THE ENGINEER a statement that a line of railway might have been made across the desert from Korti to Shendy at the rate of ten or twenty miles a day. As such an astounding assertion is likely to mislead the public, I would call your attention to the following figures: Assuming the railway to be on the metre gauge, which is the smallest that would be of any practical value, it would take four train loads to carry two miles of permanent way from the base to the rail head. Assuming the latter to be only ten miles from the base, it would take six hours for the train to run to and fro four times, and at least four hours more must be allowed for loading, unloading, and other delays, so that a whole working day would be taken up in sending forward two miles of permanent way. When the lead gets to fifty miles and more the operation becomes much slower, even with an unlimited amount of rolling stock and crossing sidings at every five miles. The plate laying itself can be carried on as fast as ever the material is supplied. The latter operation—that is, the running up of material to the rail head—fixes the maximum rate at which a line can be laid. I talk from considerable personal experience in rapid railway making in India. Under the very best conditions—a simple surface line, with unlimited labour and money—an average of two miles a day for the first fifty miles has never been exceeded. If an average of one mile a day is kept up on the Suakim-Berber line it will be extraordinarily good work. H. G. KUNHARDT, Captain R.E.

Chatham, February 13th.

THE ROCKET.

SIR,—I am an old man, not fond of display, and not much accustomed to writing, but have, I hope, a sincere regard for the truth; and having seen several letters in your paper on the Leicester and Swannington first engine, and one in your last week's impression signed by "Old Swannington Driver," I cannot stand by any longer and see the truth go to the wall. I, too, am an old Swannington driver, the oldest living, my connection with the Leicester and Swannington Railway dating from its commencement, and I should be considered to know something about it. My memory is, thank God, as fresh as the bright June day of 1832 when I saw the first engine unloaded, the same that did the ballasting, and afterwards opened the line. The men who put her together were Robert Weatherbourne—the driver who had just come by coach from Liverpool, the engine having come from Newcastle by water—and Thomas Valentine, assisted by George De Boarde—now of Lyston, near Leicester. The latter two were borrowed from the foundry of Messrs. Cort in this town.

The engine, Sir, was an inside cylinder one and had a crank axle, of course. There never was an outside cylinder engine at West Bridge, at any rate for a great number of years after the opening, and I do not ever remember seeing one there at all.

Now, Sir, it is high time the bubble burst. I am surprised at the utter want of truth and knowledge in the letters signed by "Old West Bridge Man," "Another Old Swannington Man," and lastly by "Old Swannington Driver," all of whom, I am afraid, put their heads under the same hat. As to searching of books and price of engine, they are utterly without proof. Now, Sir, being the oldest Leicester and Swannington man alive, and having known all the other men in the locomotive department, which at that time were not many, and were all my personal friends, I should be glad to meet any of the old hands should there really be any left, and in that way expose this affair. Allow me here to say that Mr. Stenson's sketch represents no engine that ever ballasted or opened the Leicester and Swannington line.

THOMAS WEST SMITH.

4, Murcell-street, Melbourne-road, Leicester, February 16th.

P.S.—Whilst musing upon the subject, I have put the facts into verse, which I append, and which you would greatly oblige by inserting with this letter.

I lived in the North of Leicester, when my age was twenty-three,
And ofttimes used to take a stroll, the railway for to see.
I walked along the Groby-road to the Glenfield Tunnel mouth,
And then returned to Old Foss-lane, and bore off to the south.

At that time the work was done by men and horses' power,
And frequent at a dinner-time they rested for an hour;
Sometimes the weather was quite fine, and sometimes there was rain,
But great part of the work was done before an engine came.

In course of time they landed her beyond the old Foss Gate,
And satisfied all seemed to be, such luck it was first-rate;
But now about the engine-man—I hope I am not too free—
His name was Robert Weatherbourne; the fireman's, John McCree.

A fitter there was sent from Cort's; one, Thomas Valentine;
To put her limbs together for to run upon the line;
And when some wagons were hooked on, and she ran upon the rail,
A "Comet" she appeared to be, with joints along her tail.

Many times have I cleaned her, and raised the steam as well,
And so you see I had the chance these tidings for to tell;
I many times have fired on her, with driver Rob. McCree,
And so you see I had the chance this "Comet" for to see.

We all have sprung from mother earth in every monarch's reign,
And when we've served our day on earth she takes us back again.
Of the young men as we worked with then, there's left but very few.
What changes there hath taken place since eighteen thirty-two.

THE FRICTION OF SLIDE VALVES.

SIR,—I have been much interested in reading your article on the friction of slide valves, and quite agree with you that if Mr. Towers would turn his attention in this direction, with as good results as in his late experiments on friction of bearings, it would be of immense advantage to the engineering world. It appears to me that one of the first things to be arrived at is the actual pressure tending to force the valve against the cylinder face, and until this is accurately determined, all calculation connected with valve gearing must be simply guess-work. As an example, I would refer to your calculations of the force required to move the slide valve of a marine engine having cylinders 46in. and 86in. diameter, in which you assume that the pressure on the back of the valve is only that due to the area of the exhaust port in the valve multiplied by the pressure in the casing, this again multiplied by an assumed coefficient of friction 0·3, gives you the force required to move the slide. Now, if this is true, surely much of the existing valve gear is much heavier than there is any need for, as the rules used by some well-known firms of marine engineers give much larger results. Take, for instance, this one: The unbalanced area of valve × steam pressure in casing ÷ 3, which is equivalent to a coefficient of friction of 0·33, the unbalanced area being the combined area of the exhaust port—or ports if the valve is double-ported—in the valve and the cylinder ports. If in connection with this rule I take the following, that the exhaust port in the cylinder face = steam port + half travel of valve − one bridge, assuming a loss of 2½in. and a steam opening of 2½in., we get a travel for valve of 10in., and exhaust port = 3in. + 5in. − 1½in. = 6½in., and allowing an inside lap of ½in. on lower side of valve, we get exhaust port in valve = 6½in. + 3in. − ½in. = 9in., and an unbalanced area = (9 + 3 + 3) × 37 = 555, and the force required to move the valve = 555 × 70 ÷ 3 = 12,950, so that making all allowance for your taking minimum figures for your exhaust port, you make the force required to move the valve only half that usually allowed in practice. Now, if we turn to Seaton's book on marine engineering, we find on page 240 the following:—"Since it is possible for a slide valve to be exposed to the pressure of steam on its whole area, without any relief due to the ports, &c., and this may occur even when the valves are fitted with relief frames, it is better to assume this in making all calculations for determining the sizes of the parts to move it.

"If L be the length of the valve, and B the breadth in inches, p the maximum absolute pressure to which it is exposed in lbs. per square inch, then pressure on valve = $L \times B \times p$. The coefficient of friction should be taken at 0·2, or that of metallic surfaces rubbing together dry, strain on valve rod = 0·2 ($L \times B \times p$) lbs." This gives a result very little greater than the first-mentioned rule. Again, if we turn to page 103 Rigg's treatise on the steam engine, we find him taking the pressure on the entire back of the valve, and then making some deductions due to the back pressure in the cylinder, amounting only to 10 per cent., and basing his calculations on actual experiments with a locomotive valve, arrives at the following results, namely, that the force required to move a valve is from one-fourth to a third of the pressure taken as stated. This I need hardly say would give the largest result of all. Now the question is, who is right? I have made out a much worse case against the slide valve than even you have done, therefore all the more reason for investigation in that direction. In concluding I would place before you the following figures taken from the L.P. slide valve of a large Atlantic steamer; cylinder 102 dia., 5ft. stroke—unbalanced area = 3652, pressure in casing 23 lb., load on valve spindle = $\frac{3652 \times 23}{3}$ = 28,000 lb. in round numbers. This valve is fitted with a relief frame 2ft. 6in. diameter, but in the event of its being out of order, the power required to work this one valve, neglecting friction of gear, the valve having 14in. travel, and engine making 65 revolutions per minute, would be $\frac{14'' \times 2 \times 65 \times 28{,}000}{12 \times 33{,}000}$ = 128-horse power. The L.P. valve is usually much the hardest driven; but supposing in this case that the power required for the H.P. and expansion valves equal that of the L.P. valve, we would have 256-horse power, or about one-sixteenth of the whole power of the engines, which indicated something over 4000 I.H.P.

Dumbarton, Feb. 10th. W. CARLILE WALLACE.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—An ordinary meeting was held on the 11th inst.—the president, Mr. Cole, M.I.C.E., in the chair—when Mr. Haughton, C.E., read a paper entitled "Indian Railway Network, 1884." The principal points taken up by the author were—(1) The physical geography of India as it applies to the rivers and mountain ranges, which in every country affect its railway network; (2) the general character of the railway network; (3) an Indo-European railway, and its connection with the Indian lines; (4) the Indian railway gauges; (5) financial position of the railways. A discussion followed, and the proceedings terminated with a vote of thanks to Mr. Haughton for his paper. The next meeting will be held on the 25th inst., when Mr. Nelson Boyd, M.I.C.E., will read a paper on "The Petroleum Fields of Europe," in lieu of the paper previously announced by Mr. Burge, M.I.C.E.

RAILWAY MATTERS.

THE Mersey Tunnel has been completed.

SPEAKING of an accident on the Great Southern and Western of Ireland, Colonel F. H. Rich, contradicting the evidence of the firemen, says that where the accident occurred "the gradient is level." We may perhaps be allowed to say that when a level incline is met with, the angle the level makes with the horizontal should be given.

AN American contemporary says: "A heavy wheat train pulled into Fargo by one engine, a few days ago, on the Northern Pacific Railroad, consisted of 110 cars loaded with wheat. This would make, allowing 550 bushels to the car, a weight of 3,630,000 lb. while the cars weigh 2,729,000 lb., making 6,359,000 lb. pulled by one locomotive, or about 3180 tons. The train was over three-quarters of a mile in length."

THE southern section of the Didcot, Newbury, and Southampton Railway, which is approaching completion, will afford direct communication between the manufacturing districts and the port of Southampton. The northern section, between Didcot and Newbury, has been worked for some time past, and the southern section about to be opened will carry the undertaking as far as the city of Winchester, where there has been some heavy cutting through the chalk hills.

A SINGULAR accident happened on the London and North-Western Railway, at Whalley Bridge, between Buxton and Manchester, on Wednesday. A goods train was leaving the station when it left the rails, and the engine fell over a stone bridge into the street. The driver and the guard, who was on the engine, were killed, but the stoker escaped by jumping off the engine. The engine and tender were smashed, and considerable damage was done to the permanent way and to the bridge.

AT the half-yearly meeting of the North London Railway Company on the 19th inst. the report of directors and statements of account to be presented will show that the continued depression in the trade and industries of the country has affected the revenue from all sources of traffic, the reduction on passengers being £481; merchandise, £1225; minerals, £723; live stock, £169; and yet the number of passengers increased 420,666, and the number of season tickets 1069. The total train mileage was 1,021,555 miles, and the total cost of locomotive power was £43,474 11s. 7d.

REPORTING on a collision which occurred on the 17th December near West Croydon Station, on the London, Brighton, and South Coast Railway, Major F. A. Marindin says:—"The desirability of distinguishing in some way between distant and home signal lamps at night, which is often felt, is shown by this accident; for the fireman, who saw the Waddon advance signal at danger, would probably have called his driver's attention to it had he not thought it was a distant signal, having himself little experience of this part of the line. A recent invention of revolving or flashing lights at distant signals would seem worthy of trial."

ACCORDING to the *Railroad Gazette*, the miles of railway completed in the United States during the last seven years were:—1878, 2916; 1879, 4570; 1880, 7174; 1881, 9789; 1882, 11,506; 1883, 6753; 1884, 4350. The total mileage completed at the close of each of the last seven years was, on the same authority:—1878, 81,774; 1879, 86,497; 1880, 93,454; 1881, 103,242; 1882, 114,838; 1883, 121,592; 1884, 125,942. "Since 1879," remarks the *Gazette*, "the increase has been 39,445 miles, or 45½ per cent.; and here we have a sufficient explanation of anything that may be unsatisfactory in the present condition of railroad business."

WRITING in the American *Machinist*, Mr. Angus Sinclair says: "The most reliable official figures that can be found show that there are 29,227 locomotives of all kinds belonging to the railroads of North America. Reckoning the life of a locomotive at twenty-five years, it ought to require the construction of 1169 locomotives annually to maintain the stock of engines. A great many locomotives kept on the motive-power list are doubtless out of service; but, making free allowance for this, the figures indicate that in the last year the renewals of locomotives have been far below the necessary requirements. Many of the engines built do not represent maintenance of stock, but were called for by new roads and extensions. Renewals must be made sometime to fill the blanks left by wear and tear; and those who delay longest in getting their motive-power put in order will pay heaviest for the work when it can be delayed no longer." Taking the American railway mileage as 125,000 miles, there are over four miles open to each locomotive, including all kinds of locomotives.

THE superintendent of construction on the Canadian Pacific Railway in the Rocky Mountains states that since the work was commenced at Laggan last spring, eighty miles of the road has been completed. The road follows the valley of the Kicking Horse, until the Columbia river is reached, which stream it follows for a distance of eighteen miles. At this point the first crossing is made, and the road is continued westward to Beaver Creek, where track-laying ceased for the winter. There 5000 men were engaged on construction during the past summer, and out of this number 3000 have been retained to work on grading, tunnelling, and making preparations for next season's work. Three saw mills are kept constantly at work and eighteen million feet of lumber have been cut during the season. The largest mill will cut 60,000ft. of lumber in twenty-four hours. During the season seven tunnels were also made and nine bridges built, together with a large temporary bridge across the Columbia river. The massive iron bridge across the latter river is rapidly reaching completion. Track-laying will, it is stated, be commenced early in March, and the through line be completed in August.

VICE-CONSUL TREHERNE, reporting on the condition of the State of Minnesota in a Blue-Book just issued, refers to the work of railway construction, and mentions that the following are the various lines now operating in the State: Burlington, Cedar Rapids, and Northern; Chicago and North-Western; Chicago, St. Paul, Minneapolis, and Omaha; Minneapolis and St. Louis; Northern Pacific; St. Paul and Duluth; Chicago, Milwaukee and St. Paul, &c. The Chicago and North-Western Railway, with its branches and leased lines, traverses the State from east to west, and plays a most important part in the railway system of Minnesota. The Chicago, Milwaukee, and St. Paul operates the largest number of miles of road in the State; both of the last-mentioned lines are pushing construction very rapidly in all directions. The St. Paul, Minneapolis, and Omaha Railway, starting from St. Paul, extends through the south-western portion of the State into Iowa, with branches to Dakota, its objective point being some yet undecided-upon spot in the far west. The total number of miles of railway now in operation in the State of Minnesota exceeds 4000.

A PROJECT for a railway on the Fell system between Oulx and Briançon has recently been laid before the Italian Minister of Public Works. It is proposed that this line should commence at the station of Oulx—47 miles from Turin—on the line from Turin to Modane, and crossing the torrent Dora Riparia, to follow the course of this torrent on its right bank as far as Cesana, then the line would again cross the Dora, and then following the national road over the Monginevro pass, would descend at La Vachetta to Briançon. The total length of the proposed line is 19½ miles, of which 11½ miles will be on Italian territory and 8 miles on French. The total difference of level to be overcome in the crossing of this pass is 2422·77ft. The maximum gradient will be 7 in 100—1 in 14·28—and this on the Italian side for a distance of a little more than 3½ miles. The permanent way will consist of steel rails weighing 70 lb. per yard, fixed to ordinary cross sleepers, and on these sleepers in the middle of the track will be bolted a longitudinal one carrying the central rail, which will weigh 80 lb. per yard. This line, if approved, will be a most important one for Turin, as it will shorten the distance to Marseilles considerably.

NOTES AND MEMORANDA.

THE horizontal component in absolute measure of the terrestial magnetism at Paris is in C. G. S. units, $H = 0{\cdot}19414 \pm 0{\cdot}00012$.

IN Greater London 3994 births and 1955 deaths were registered last week, equal to annual rates of 37·1 and 19·6 per 1000 of the population.

ACCORDING to figures on the cost of electric lighting in Paris as found at the Magasins des Printemps and Hotel des Pastes, the cost of gas, as compared with electricity, is as 431 to 344, the cost per carcel hour being 0·431f. and 0·344f.

AT the Royal Observatory, Greenwich, the mean reading of the barometer last week was 29·72in. The mean temperature was 46·2 deg., and 7·0 deg. above the average in the corresponding week of twenty years. The duration of registered bright sunshine was 8·6 hours, against 6·6 hours at Glynde place, Lewes.

DURING the period from 1855 to 1883, the gold received for coinage at the Sydney Mint amounted to 13,633,504 ounces, valued at £51,943,991; of which 6,703,357 ounces, valued at £25,657,357, came from New South Wales, and the remainder from Queensland, New Zealand, Victoria, Tasmania, and elsewhere.

THE deaths registered during the week ending February 7th in twenty-eight great towns of England and Wales correspond to an annual rate of 21·8 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The six healthiest places were Birkenhead, Blackburn, Salford, Sheffield, Bradford, and Huddersfield.

IN London during the week ending February 7th 2806 births and 1592 deaths were registered. The annual death-rate per 1000 from all causes, which had been 23·1 and 24·1 in the two preceding weeks, fell to 20·3. During the first five weeks of the current quarter the death-rate averaged 23·2 per 1000, against rates declining from 30·3 to 20·4 in the corresponding periods of the five years 1880-84. In Greater London 3624 births and 2018 deaths were registered.

ACCORDING to a paper by J. J. Roelants, on "The Sea-level on the Dutch Coast"—Proc. Inst. C.E.—in which the author compares the observations of the high and low-water levels during eighteen years, at six stations in the Netherlands, no tendency is shown for the rising or falling of the mean sea-level, compared to the elevation of the coast above the sea during the period under observation; so that, so far, no confirmation is found for the opinion of some writers, who hold the theory of a gradual subsidence of the east coast of the North Sea.

THE smoke from the charcoal works at Elk Rapids, Mich., which was formerly wasted, is now manufactured, the *Engineering and Mining Jounal* says, into chemicals by being blown by immense fans into a purifier, from which it eventually comes in the form of an acid—pyroxilic—that is as clear as amber. From the acid are produced acetate of lime, alcohol—wood spirit—tar, and gas. Each cord of wood contains 28,000 cubic feet of smoke; 2,800,000ft. of smoke handled every twenty-four hours is said to produce 12,000 lb. of acetate of lime, 200 gallons of alcohol, and 25 lb. of tar.

SYMPATHETIC ink for writing on postal cards, the *Paper World* says, is made of diluted sulphuric acid, one part by measure of acid to seven of water. When this ink is used the card will at first show roughened traces of the writing, but after being allowed to dry for a short time these disappear, and it is as invisible as if done with water. Of course, only a gold pen or a quill must be used. If it is desired to avoid the suspicion of using sympathetic ink, it may be written upon, across the first writing, with tincture of iodine, which will entirely fade out when the heat is applied to develope the invisible ink.

ACCORDING to the annual statistical report of the secretary of the British Iron Trade Association, the home production of iron ores in 1884 was considerably less than in 1883, as is evident by the diminished production of pig iron; but to what extent the output was reduced there are no official figures yet available to show. In the Cleveland district, however, the total output of iron ore has been ascertained by the Cleveland Mineowners' Association to have been 6,005,000 tons, against 6,700,000 tons in 1883, and 6,326,000 tons in 1882. The output of 1884 therefore showed a decrease of 695,000 tons on 1883, and of 321,000 tons on 1882.

M. PLANTAMOUR is continuing his observations on the periodic movements of the ground as indicated by spirit-levels, as described by us some time since. The sixth year—1st October, 1883, to 30th September, 1884—of these investigations—see also "Minutes of Proceedings" Inst. C.E., vols. liv., lx., lxiv., lxviii., lxii., lxxv., and lxxix.—presents features almost identical with those of the preceding one. The curve, traced by the east end of the level oriented east-west, shows a gradual fall of 15 seconds to the end of December, 1883; it then fluctuates up and down till the middle of May, having reached its greatest depression, viz., 21·59 seconds, on 24th, 27th, and 29th of April. Its subsequent maximum summer rise—reached on 21st-22nd September—was only 19·39 seconds.

A LEICESTER contemporary says:—"The Midland Railway Company has just fitted two new trains with a new or improved form of vacuum brake. To fully and fairly test the appliance under all circumstances it has wisely been decided to try it on a fast and slow train alternately. One train left Bradford at 7.50 a.m., and ran the fast express, *viâ* Nottingham and Melton, to London, and then the 6.30 p.m. slow train to Bedford, where it remained the night. The second train left Bedford at 8.20 on Monday morning, and passed Leicester at 10.22 a.m. on its way to Bradford. A number of officials and others interested in the brake question rode with the trains. We understand that several ordinary easy station stops were made from speeds of 40 miles an hour in 25 seconds."

SPEAKING of the lasting properties of gold leaf used as an outdoor protection, and its economy in spite of first cost, the *Scientific American* says:—"The gilder of the dome of the Capitol at Hartford, Conn., Captain Thomas F. Burke, states that his principal trouble in doing the work was from currents of air, the altitude being more than 200ft. from the ground, and the site of the building itself being one of the highest in the city. To do the work properly he constructed a movable canvas shield, made to fit the curvature of the dome and its twelve radial ribs, not so much to shield the workmen as to prevent the leaf from being blown away. To cover this dome—an area of 4100 square feet—there were used 87,500 leaves of gold, each 3⅜in. square, weighing in the whole 3 lb. avoirdupois. The total cost of the gold and the labour was 1600 dols."

THE bulletin of the Association Scientifique de France says:—Lightning has killed 4609 persons in France alone since 1835, when a record of such deaths was first kept. The following figures show the number killed each year, but there were the same number seriously wounded, though not fatally, and five times as many struck. The maximum years have been 1874, 178 killed; 1868, 156; 1880, 147; 1883, 143; 1865, 140. During these five years the summer was very hot, and it is a curious fact that they were remarkable as excellent wine years. The minimum years have been 1843, 48; 1853, 50; 1860, 51; 1854, 52; 1851, 54; and these years were all more or less cold. The lightning proved most destructive in those departments which have a high situation, such as Le Puy-de-Dôme, La Haute Loire, Saone-et-Loire, &c., while the low-lying districts, such as the departments of La Manche, La Calvados, and l'Eure were nearly, if not quite, exempt. The victims of lightning, killed or wounded, may be classed as follows: (1) Those struck while taking shelter under trees; (2) those in open country, particularly if they hold any metal object or any animal in their hands; (3) those in isolated houses; (4) those in churches; (5) those in towns. In Paris, and in the Department of the Seine, there has not been a single death from lightning since 1864, although many violent storms have broken over the city and district since.

MISCELLANEA.

THE manufacture of paper from sugar-cane refuse is said to be successfully carried on in America, and if this is true, the process should be of importance to West India and America.

THE extensive improvement works now under execution at Dunkirk include an additional seven acres to the floating basins, extended quays, enlargement of entrance lock and dock, and improvement of railway communication, so Dunkirk stands some chance of regaining that leading position amongst French ports which she anciently held. To secure this improvement M. Peyotte-Beyaert worked hard for many years.

THE completion of the St. Petersburg ship canal now enables ships of large tonnage to sail direct to the port of St. Petersburg without, as heretofore, undergoing transhipment of goods at Cronstadt. The canal, which is 26½ versts in length, or 17·4 miles, runs from the Island of Goutouiew, in the Neva, to the Cronstadt roads, and has an average depth of 22ft., and a portion of the Neva has also been dredged to the same depth.

A NEW screw dredger of 800 tons, built and engined by Messrs. Wm. Simons and Co., was launched complete from their works at Renfrew a few days ago. Its dimensions are 200ft. by 35ft. by 12ft., and it is fitted with compound engines and steel boilers of 750 indicated horse-power, to dredge to 40ft. depth, and raise 800 tons per hour. It has been constructed under the direction of Sir John Coode, C.E., for the Harbour Commissioners, Melbourne.

SOME time ago it was announced that a French engineer had introduced a refractory brick of pure graphite, by perfectly agglomerating the powder of that substance. Graphite being nearly infusible at the highest temperatures that can be produced, this new brick was expected to prove very serviceable in metallurgy, where the want of linings which are wholly infusible has long been felt. We have not, however, heard anything of this brick since.

THE Society of Architects will hold a general meeting and Architectural and Building Trades' Exhibition during the first week in March, in the Floral Hall, Covent Garden. The following is a general programme:—Monday, March 2nd, hall open from 10 a.m. to 6 p.m.; conference, 2 p.m., subject, "Internal Decoration;" conversazione, 8 p.m. Tuesday, hall open from 10 a.m. to 10 p.m.; conference, 2 p.m., subject, "Ventilation and Heating." Wednesday, hall open from 10 a.m. to 10 p.m.; conference, 2 p.m., subject, "Clayware." Thursday, hall open from 10 a.m. to 10 p.m.; conference, 2 p.m., subject, "Health in the House." Friday, hall open from 10 a.m. to 10 p.m.; conference, 2 p.m.; subject, "Metal Work." Saturday, hall open from 10 a.m. to 10 p.m.; conference, 2 p.m., miscellaneous papers.

THE South Staffordshire and East Worcestershire Institute of Mining Engineers held their annual meeting at Dudley this week. Professor John Brown was elected president for the ensuing year, and in his address impressed upon the members the necessity for original papers. Speaking of boring operations in mining, he said that the appliances had been improved by having free falling tools rather than the rigid rod. The Americans had tried the old Chinese system of boring with success, and Messrs. Mather and Platt had been successful with their method, while Colonel Beaumont, with the diamond borings, had done excellent work at a depth of 4000ft. The Danish system of hollow rods through water had done good in certain strata, and the deviation from a true vertical line had been corrected by magnetic means. He condemned cheap steel ropes as likely to lead to serious accidents.

A PAPER upon "The Action of Phosphorus on Iron and Steel" was read by Mr. A. H. Hiorns before the South Staffordshire Institute of Iron and Steel Works' Managers, at Dudley, on Saturday. Mr. Hiorns recommended that the hearth should be lined with basic matter, and be so constructed as to be independent of the body, and that dephosphorisation should be effected by an arrangement similar to the Perrot motion. The addition of a certain amount of nitrate of soda would be an advantage. Phosphorus increased the fusibility of iron, and its tendency to crystallise when heated; and if an iron rich in phosphorus had acquired a coarsely crystalline texture by exposure to a strong heat, and not sufficiently stretched afterwards to bring the component crystals together and elongate them so as to develope fibre, it might still prove hard in wear, although neither very extensile nor strong when stretched. The influence of phosphorus in steel was still more prejudicial, and the metal deteriorated with repeated heatings, and soon became incapable of being tempered.

THE Alexandrine, launched a few days ago as already mentioned, is like the Oldenburg, launched about two months ago, an important addition to the navy of Germany. She is constructed of iron and steel throughout; her iron skin having a double teak planking, sheathed with copper. Her displacement is 2370 tons; her length between perpendiculars, 68 metres—223ft.; breadth of beam, 12·5 metres—41ft.; draught of water when fully equipped, 5 metres—16½ft. forward, 5·5 metres—18ft. aft. The stern-post and rudder-post are of bronze. Cross bulkheads divide the vessel into eight watertight compartments, the two largest ones of which contain the engines and boilers. The corvette will be fitted with two independent compound engines, placed side by side in the direction of the keel, and capable of developing together 2400-horse power. Steam will be supplied to each of the two engines by four cylindrical boilers placed in two separate boiler-rooms. It is estimated that her engines will propel the vessel at a speed of between 14 and 15 knots—16 to 17 miles—an hour. Her screw may be lifted, and, being barque rigged, the corvette will be able to proceed under sail. The Alexandrine is to receive an armament of ten 10·5 centimetre—4·1in.—guns, a bow and a stern gun, four revolving guns, and a torpedo-launching apparatus.

A CORRESPONDENT has at last called attention in the *Times* to a really degrading and harmful London railway grievance. When London railways were projected it was supposed that the districts passed through by the lines would be opened up, air and light let into them, and people enabled to live in the suburbs by an easy ride. But this is far from being the case. The London, Chatham, and Dover Railway traverses arches "let out" in a manner to injure the health of the travellers above and add to the "mysterious illnesses" of those who live near. Close to the Walworth-road Station, a thickly populated district, the body absurdly called the Newington "Health Authority" converts the refuse of the houses and streets of a locality in which there is an enormous amount of epidemic disease into a manure for transport along the line in open trucks to Kentish hop gardens. This abominable factory is always in work, and in summer the stench from these central town works of a so-called sanitary authority is simply indescribable on the railway, and there seems to be no attention paid to any of the foulnesses of this and other places by sanitary inspectors. And then some of the arches, for about a couple of miles, are let out for workshops, and in some instances are converted into dwellings. The correspondent referred to says, chimneys from these underground dwellings are brought out above the line to a level with the carriage windows, and one can tell when the train is passing by a shoemaker's kennel by the burning of refuse leather and wax ends. At Camberwell the arches are made the store places of road refuse, dead animals, and other like evils. It was here—so neglected is the spot—that Margaret Walters threw the infants murdered in her fearful trade. But Loughborough Junction is the central spot of all for sordidness and misery. No fewer than 10,000 persons pass through this station twice a day, and as it is open from four o'clock in the morning until past one the next—that is, for nearly twenty-two of the twenty-four hours—it is to all intents a public thoroughfare. The "sanitary authorities" of Lambeth, in which district this unhappy station is situated, have been appealed to, but they can do nothing to cleanse this disease trap. "The place is private," says the sanitary inspector, and with regard to the filthy road, "that is untaken to" by the parish; hence the vegetable and animal refuse left there to fester from month to month can have no benefit of parish scavenger.

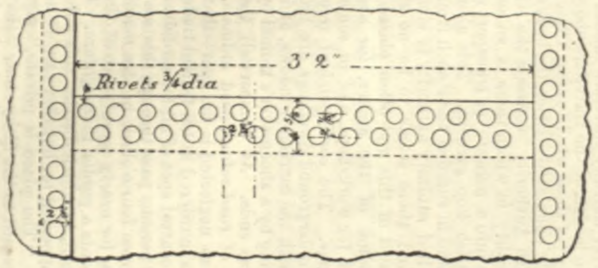
BOILERS FOR PADDLE-WHEEL TUG BOAT.

MESSRS. ALEXANDER SHANKS AND CO., ARBROATH, N.B., ENGINEERS

(For description see page 144.)

PLAN OF LONGITUDINAL SEAMS OF BOILER SHELL

Scale 1½ to a ft.



NOTE

To be made of steel throughout

Shell 7/16 thick double rivetted in longitudinal seams with ¾ rivets 2½ pitch

Screw Stays 1¼ diar over the thread 9" pitch & nuts at both ends Roof Stays 10" pitch with 1⅜ bolts in each and made from two 4" x ¾ bars give 1½ clearance

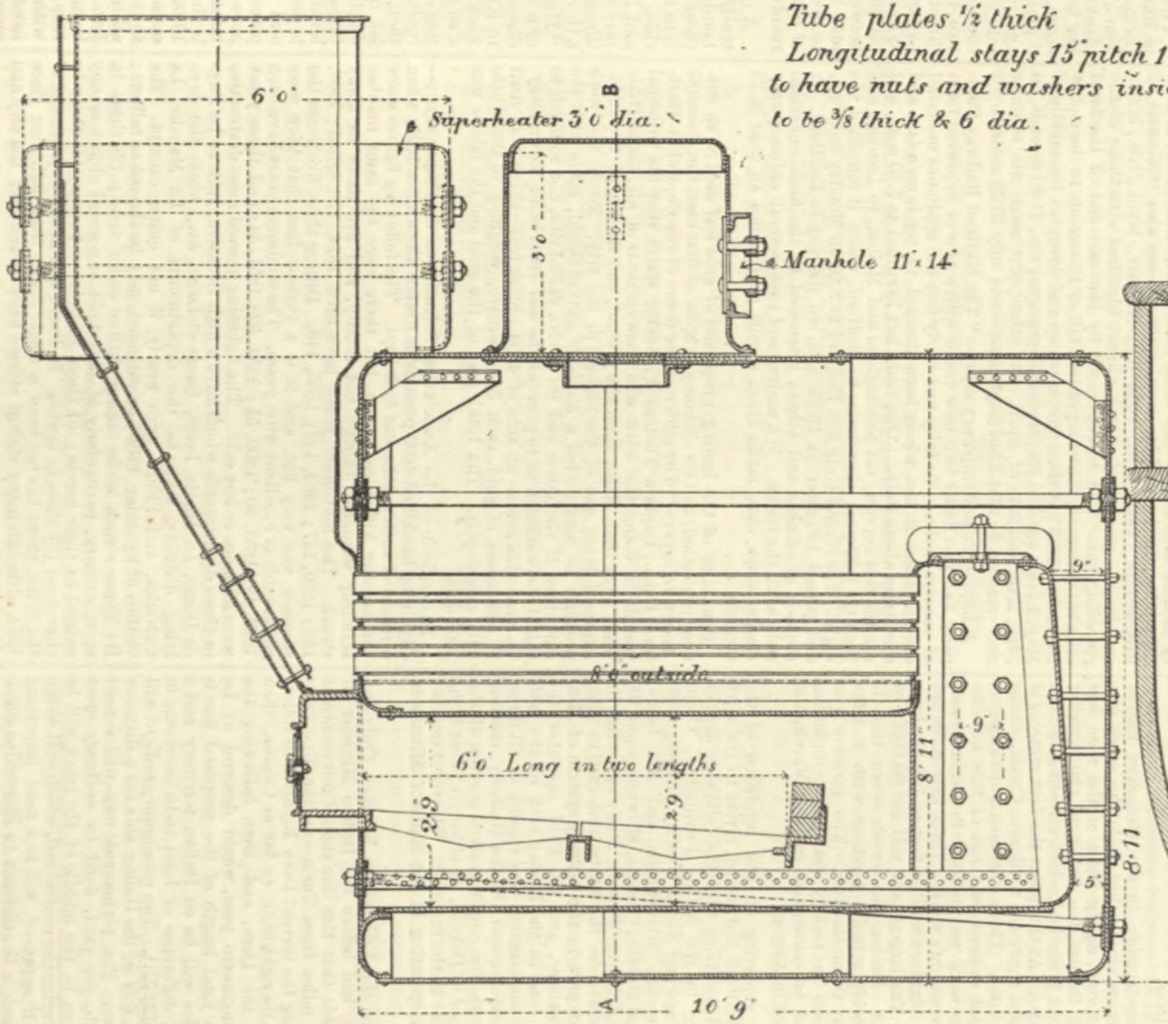
Furnaces ⅜ thick

Combustion chambers ⅜ thick

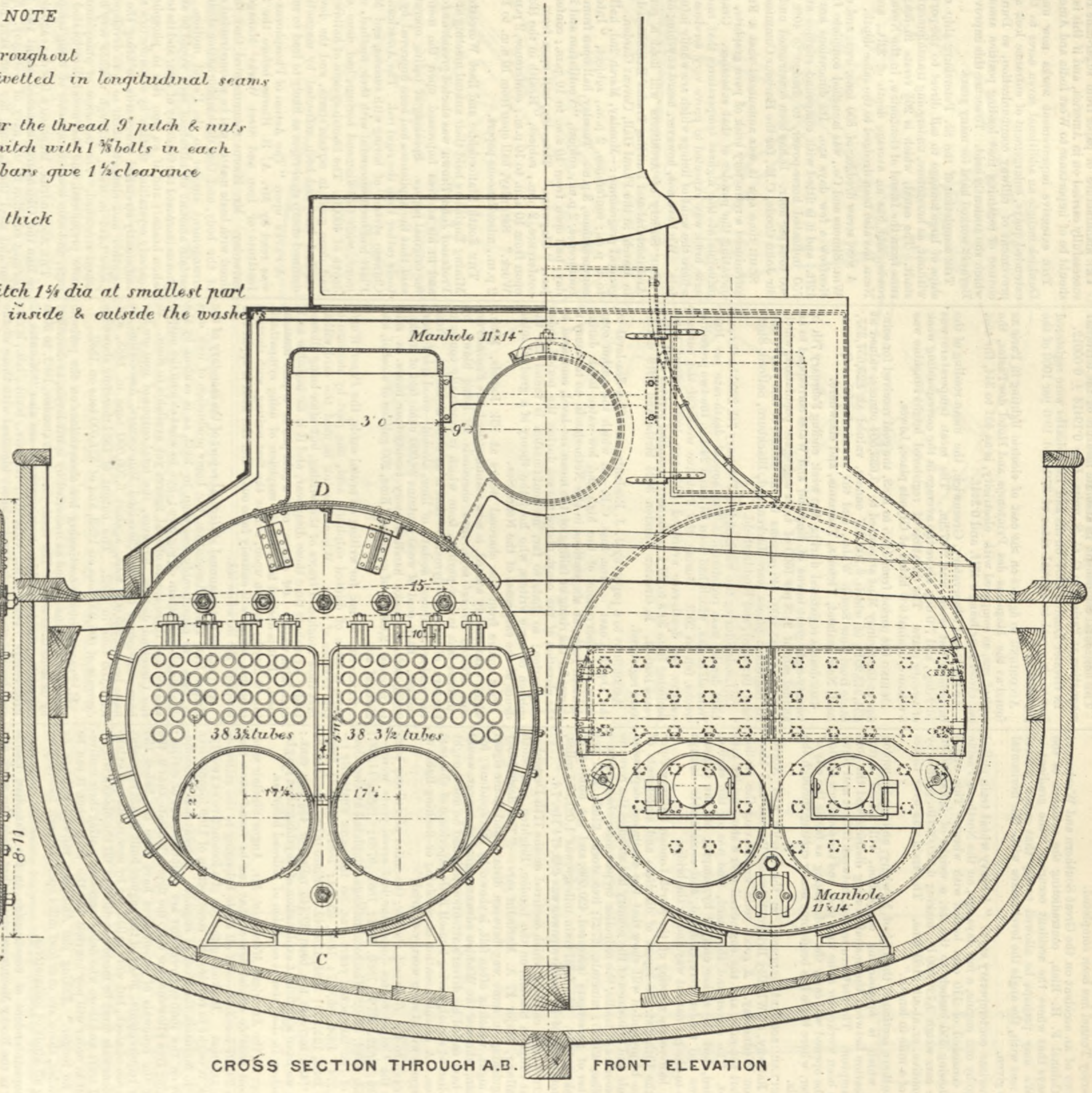
Ends ½ thick

Tube plates ½ thick

Longitudinal stays 15" pitch 1¼ dia at smallest part to have nuts and washers inside & outside the washers to be ⅜ thick & 6 dia.



LONGITUDINAL SECn THROUGH C.D.



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TO CORRESPONDENTS.

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

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

D. W. (Clonmel).—*Messrs. Chance Bros., of Birmingham, or Messrs. Edmundson, of Capel-street, Dublin, can supply the information you want.*

E. B. S. M'D.—*If you like to send a description and sketch of your invention, in confidence, we shall be happy to give you an opinion concerning its merits. This will not prevent you from subsequently taking out a patent if you see fit.*

R. H. A. (Preston).—*We do not quite understand your question. The order is quite definite, and means rectangular pieces of india-rubber of the sizes stated and* 1in. *thick. Why any other construction should be put on such an order we are at a loss to say.*

W. W.—*The highest safe speed for a sound cast iron fly-wheel rim is* 200*ft. per second. The circumference of the rim of your fly-wheel is about* 33*ft., so that your wheel would be safe at six revolutions per second, or* 360 *revolutions per minute. The dimensions of the rim do not affect the question in any way, because the bursting strain is a function of the weight, and the stronger the rim is the heavier it is, so that the two influences balance each other.*

R. C. (Hayward's Heath).—*The simplest and cheapest arrangement will be to put up a small vertical boiler near the bath, and blow steam directly into the bath by means of a pipe dipping a couple of feet below the surface. This will make some noise when at work, but it does not appear that that would be objectionable, as the bath could be heated before it was used. Hot water pipes may be employed, but the cost will be greatly augmented thereby. We shall be happy to supply further information if you want it.*

M. S.—*If your cover be made of uniform thickness, then the necessary thickness, according to the formula commonly used for small covers, will be* $t = \frac{l}{120}\sqrt{p}$, l *being the shorter dimension or width of the cover, and* p *the pressure. This will give a large margin of safety, and will make your cover about* 2·5*in. in thickness; but if you rib the cover, then the thickness may be decreased by an amount corresponding to the strength at the ribbed parts taken as beams. Assuming your cover to be split up into a series of bars* 1in. *wide, and of the depth you propose for your thickness, namely,* 1⅛, *we have as the breaking weight of each bar, considered as a rectangular beam fixed at end with distributed load,* $W = \frac{B\,D^2\,C}{l} = \frac{1{\cdot}0 \times 1{\cdot}125^2 \times 61824}{31} = 2475$ *lb., while the load due to steam pressure of* 80*lb. on the unsupported part of the assumed bar in your cover will be* 31 × 80 = 2480*lb. There is, as it happens, thus a very close balance between the strength of your cover and the load. You may, however, assume the cover strengthened by the two ribs as two separate beams* 1in. *wide and* 2in. *deep, which, as calculated by the above, would carry* 7652 *lb., and thus aid materially in strengthening the cover. You will, however, see that the cover should have either a considerably increased thickness, or the ribs should be deeper than* 2in. *and at least four in number. For the strength of circular cylinder covers, see* THE ENGINEER 15*th March*, 1867. *See Unwin's "Mechanics of Machine Construction."*

ENGRAVING BRASS.

(*To the Editor of The Engineer.*)

SIR,—Can any of your correspondents tell me the best and quickest method of engraving brass name-plates with acids? J. P. M.
February 17th.

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Feb. 24th, at 8 p.m.: Ordinary meeting. Papers to be discussed, "The Metropolitan and Metropolitan District Railways," by Mr. B. Baker, M. Inst. C.E. "The City Lines and Extensions (Inner Circle Completion) of the Metropolitan and District Railways," by Mr. J. Wolfe Barry, M. Inst. C.E. Friday, Feb. 27th, at 7.30 p.m.: Students' meeting. Paper to be read and discussed, "The Gauging of Flowing Water," by Mr. H. Turner, Stud. Inst. C.E. Professor Unwin, B.Sc., M. Inst. C.E., in the chair.

KING'S COLLEGE, LONDON, ENGINEERING SOCIETY.—Tuesday, Feb. 24th: Paper by Mr. Duncan, "On Recent Marine Engineering."

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Discussion on Mr. Illius A. Timmis's paper "On the Working of Railway Signals and Points by Electro-magnets, &c." "On Constant Electro-motive Force in an Electric Light Circuit," by Sir David Salomons, Bart., Member.

SOCIETY OF ARTS.—Monday, Feb. 23rd, at 8 p.m.: Cantor Lectures. "The Chemistry of Pigments," by Mr. J. M. Thomson, F.R.S.E., F.C.S., Lecturer on Chemistry at King's College, London. Lecture I.—Introductory—nature of colour—division of colours—white pigments—deleterious actions on such pigments—methods of counteracting such actions. Tuesday, Feb. 24th, at 8 p.m.: Foreign and Colonial Section. "The Spanish Gold-fields and the Mines of Rio Sil," by Mr. William Sowerby. Wednesday, Feb. 25th, at 8 p.m.: Twelfth ordinary meeting. "Past and Present Methods of Supplying Steam Boilers with Water," by Mr. W. D. Scott Moncrieff, M. Inst. M.E. Thursday, Feb. 26th, at 8 p.m.: Applied Chemistry and Physics Section. "Tempered Glass," by Dr. Frederick Siemens. Sir Frederick Bramwell, F.R.S., Pres. Inst. C.E., will preside.

DEATH.

On the 9th inst., in Buenos Ayres, Argentine Republic, J. G. CRUICKSHANK, C.E.

THE ENGINEER.

FEBRUARY 20, 1885.

THE SOUDAN RAILWAY.

THE fall of Khartoum has at last driven the Government to make a railway from Suakim to Berber. Of course, the arguments used last year against the construction of such a line were that it would divert commerce from better known Egyptian towns, and that as we were not going to remain in the Soudan, the construction of a railway would be mere waste of money. It may be shown, however, that, to say nothing of the saving of life, the formation of a line of railway across the desert would have been economically right even though we handed it over to the Arabs twelve months after it was made. Every question of the kind must be discussed with a full knowledge of all the conditions which control or influence it; and we have no hesitation in admitting that it would have been possible—and is, indeed, possible now—to waste money to a deplorable extent on railway works in the Soudan. On the other hand, it is perfectly practicable to make such arrangements that the proposed railway will be in all senses an economical work, to which every one, even the British taxpayer, may look with satisfaction. The first point to be considered is, are we or are we not going to retain possession of Khartoum, Suakim, Berber, and so much of the desert as will suffice to render the subsequent use of the railway safe? or is it to be a temporary affair, merely laid down for strategical purposes? On this point, of course, as we do not pretend to know the minds of the members of the Cabinet, we can give no information. The indications are, however, that the line is intended to be a permanent structure. If we do not mean to keep it and use it, it ought not to be anything of the kind, and information ought to be elicited as soon as possible as to the reasons which have induced the Government to adopt a 4ft. 8½in. gauge, while something much less important would have answered every purpose of getting troops to the front. Before criticising further, however, it will be well to give here all the information that is at present available concerning the Soudan railway.

Suakim is a seaport on the Red Sea, distant as the crow flies 240 miles east from Berber, and Berber is 160 miles north from Khartoum. The engineering obstacles are worth consideration. For some distance inland the desert is comparatively flat and sandy. The ground then begins to rise, and in the first 27 miles it is stated that an altitude of 1800ft. has to be attained. This represents a regular gradient of about 66ft. to the mile, or 1 in 80; but inasmuch as the gradients will not be diffused over 27 miles, inclines much steeper than 1 in 80 will probably be met with. Tambouk may be regarded as the first station from Suakim. Es Sibil, twenty miles further inland, is the next point of importance, and the country rises here to a nearly level gravel plain, 2700ft. above the sea—that is to say, Es Sibil is 900ft. higher than Tambouk. The gradient is therefore equal to 45ft. to the mile, or about 1 in 117. Twenty-two miles from Es Sibil is Haratri, 2850ft. high, so that this part of the route is fairly level. Here there is a very difficult pass to be dealt with. After this has been crossed, the line descends to a broad gravelly plain, 2300ft. above the sea. Another mountain pass is encountered at Wady Kokref, 33 miles from Haratri; from thence it falls to Arieb 27 miles further on; thence to Berber, 110 miles, is nearly level, Berber being 1250ft. above the sea. The total length of the proposed railway is, on this statement of distances, but 239 miles, which is too little even for what Americans term an "air line." The probable total length of the Suakim-Berber Railway may be taken at about 260 miles, when allowances have been made for curves and deviations. The precise nature of the engineering difficulties to be overcome are, we believe, pretty well known to Messrs. Lucas and Aird, who have taken the contract for making the road. Whether they are formidable or not depends on the way in which they are dealt with.

It is above and beyond all other considerations essential that the railway shall be made as quickly as possible. Its quality is a matter of secondary consideration—any conceivable kind of railway must be better, immensely better, than the rough surface of the desert. It may be taken that ten miles a day is the maximum rate at which any considerable body of troops with their baggage and impedimenta can advance from Suakim to Berber. We are of course assuming that they are not interfered with by the enemy. This means a march of at least 25 days. Now that must indeed be a wretched railway on which a speed of 5 miles an hour cannot be maintained; and this, assuming that the troops travelled but ten hours a day, would mean that Berber could be reached in three days instead of in twenty-four. The return train would make the trip in two days, and it would thus be possible, if sufficient rolling stock was provided, to put a force of 500 men into Berber in three days after they reached Suakin, and 500 in five days more, so that in one week we might have 1000 men there. How many more is simply a question of rolling stock. Trains enough to carry 20,000 men might be dispatched one after the other as fast as they could be loaded, but it is far more probable that men will be sent on a few at a time. We are here making the worst of the railway, but with a speed of 8 or 10 miles an hour, sufficient rolling stock, and crossing places, there would be no difficulty in placing 3000 men in Berber in a week. The line required for this purpose would be of very light rails, say 20 lb. to the yard, carried on light iron sleepers laid on the surface of the ground, very little levelling up or down being resorted to. The gauge should be narrow, not more certainly than 2ft. 6in., because the transport of sleepers will constitute a heavy item, and the shorter they are the better. The mode of propulsion to be used presents some difficulties, as comparatively long distances will intervene between the watering stations, and enough coal must be carried by the engines for a run of about 500 miles in the first instance, because we do not assume that it would be safe to reckon on finding coal in Berber, or indeed any kind of fuel likely to serve for locomotive purposes, and some time would be lost in hauling coal to depôts, which time could be ill spared. If we suppose that the little engines employed burned 20 lb. of coal per mile, then each would have to carry about 5 tons of coal, and it would certainly not be safe to reckon on less. The vehicles used for the conveyance of the troops, &c., would weigh about 2 tons 10 cwt. empty, and each would carry about twenty men, weighing with light baggage say 1 ton 15 cwt., or a gross load of 4 tons 5 cwt. A train of twenty-five wagons would suffice for 500 men, and the weight would be about 106 tons, to haul which an engine weighing about 10 tons would suffice; and it seems likely that some form of geared engine, such, for example, as the type of contractor's locomotive at one time made by Messrs. Aveling and Porter, of Rochester, would answer better, in the first instance at all events, than engines of the normal form. It must be understood that we are speaking, not of a regular railway in the received sense of the term, but of what may be termed an emergency track, and here a fresh point for discussion arises. Is it possible to make such a track in time to be of any real service? Short lengths of line can be laid on the surface at a great rate, provided everything is ready. Possibly some miles might thus be laid from Suakim out at the rate of 20 miles a day, although we do not believe that 20 miles could be laid in 24 hours. If, however, we assume that the utmost possible diligence is used, it does not seem probable that the proposed emergency track could be laid from Suakim to Berber at greater speed than two miles a day, so that the line would not be completed in less than 130 days, or over four months. Whether this would or not render the proposed line quite useless for Lord Wolseley's purpose we cannot pretend to say, because neither we nor anyone else in England knows what he may be compelled to do by the Mahdi. It at least seems certain that, if the water and provision difficulty can be got over, troops would move across the desert by marching long before the line could be opened. It has been urged that once any part of the line is complete, it can be used by troops. This is an error. The line will be wholly occupied in carrying rails, sleepers, &c., to the front, and if troops avail themselves of it, then the work of construction must stop.

So far we have discussed the Soudan railway as an emergency track, but if the road is to be of 4ft. 8½in. gauge, it is to the last degree unlikely that it can be of any but the most limited service for military purposes for at least eight months; on this point there ought to be no doubt. We regret to find, however, that not a few persons seem to think that the whole affair can be finished in a week or two, and that it will play a most important part in the war. Such a belief is wholly fallacious as far as the time of construction contemplated is concerned. Of course, as no one can say when military operations will cease in the Soudan, we cannot tell whether the line will be ultimately of service for strategical purposes or not. It is quite certain, however, that it can be of no immediate or proximate utility whatever, simply because it will not exist. In a word, Messrs. Lucas and Aird can in no way modify the military situation now, and it must not be supposed that this railway can be of any immediate use to the expedition leaving our shores. Khartoum, it is to be hoped, will be in our hands long before Messrs. Lucas and Aird have completed their task. The engineer is all powerful in modern warfare, but he cannot work miracles; short of this he can perhaps do anything, but he demands a little time. Even an English firm of contractors with unlimited means cannot, Aladdin-like, build a palace in a night or make 260 miles of railway in a month.

We said at the outset of this article that it might be shown that even had we made a railway last year, and given it up to the Arabs, such a proceeding might have been economically right. The cost of a narrow-gauge railway, under all the adverse circumstances that can operate, cannot exceed £10,000 a mile; in all probability they will not exceed one-half this sum, because there is no land to be bought, and no parliamentary expenses—no bridges, or cuttings, or heavy earth works; but at £10,000 per mile, the line from Suakin to Berber would have cost not more than £2,600,000. If this is compared with the sums expended in taking troops up the Nile as we have done, with the fact that having spent about £15,000,000 as it is, and failed in our object, we shall now have to spend about £15,000,000 more; when we bear in mind the circumstance that all the forces which the Mahdi could collect could not have taken either Berber or Khartoum had this railway existed, and that without Berber or Khartoum he would have had practically no base from which to operate, and that he could not possibly attack Egypt proper, leaving Khartoum behind him in the hands of the English, without courting utter ruin—when, we say, these things are borne in mind, it becomes obvious that an outlay of even two millions and a-half on a Soudan railway might have been the wisest economy ever practised by any Government.

LONDON MAIN DRAINAGE.

CAPTAIN DOUGLAS GALTON, in a paper read before the Society of Arts, has reviewed the report of the Royal Commission on Metropolitan Sewage Discharge. On the score of experience, Captain Galton is well qualified to deal with the subject; and to some extent he finds a confirmation of his original views in the recommendations of Lord Bramwell and the other distinguished authorities appointed on the Commission. The main drainage question is certainly growing old, and has worn out several of the early combatants who have been concerned in the controversy. Captain Galton is himself the sole survivor of the three Referees who were appointed by Sir Benjamin Hall in 1857 to consider the plan prepared by the Metropolitan Board for the drainage of London. Sir B. Hall became Lord Llanover, and died. The first chairman of the Metropolitan Board, Sir John Thwaites, has also passed away; and it seems quite possible that years will yet elapse, and other notables disappear, before the sewage problem, as it affects the metropolis, will be finally settled. Captain Galton pronounces the report of the Royal Commission a "model report." But his grounds for saying so are not very encouraging. He considers the report to be thus worthy of approval for the reason that it is drawn up with great skill and care, "and forms the most valuable survey of the state of the question on water-carried sewage disposal which has ever yet been issued." "The state of the question" is not necessarily satisfactory, neither was the Royal Commission appointed for this much. We want the Royal Commission to show us how the question is to be brought into a better state. What progress are we really making in regard to "water-carried sewage disposal?" If only we could find a new point of departure there would be some hope. The first result is for the Royal Commissioners to tell us that the Thames is in a disgraceful and scandalous condition. It took Lord Bramwell and the rest of the Commissioners a long time to find this out. They suspected things were bad when they signed their first report. But it was not until they prepared their second report that they were so convinced as to speak strongly on the point. Henceforth there need be no doubt that the sewage of London is making the Thames exceedingly foul. So far as the water of the river is concerned, Captain Calver has his reputation vindicated, and perhaps Captain Galton almost regrets that, as one of the arbitrators appointed under the Thames Navigation Act, he joined in the verdict which in 1880 exonerated the outfalls from the production of mudbanks. But as for getting rid of the sewage, the Royal Commissioners in their second and final report, in a chapter devoted to "the general aspect of the question of the disposal of town sewage," quote largely from the report of the Referees in 1857, and give as a reason for so doing that "little real advance has been made in the modes of viewing and treating the subject since that date." The second report of the Royal Commission, which thus pays homage to the wisdom of the Referees as displayed more than a quarter of a century ago, is that which is designed to tell us what to do now. After examining a multitude of witnesses, and overhauling a mass of parliamentary and other documents, the Commissioners say they are compelled to express their regret at the obscurity in which, after so many years' study and discussion, and after the large experience that has been gained, the subject of sewage treatment appears still to be involved. Hence it was that the Commissioners considered their duty would be best performed by stating and explaining the various plans that had been proposed or suggested as possible remedies for the existing evils, adding such remarks as seemed most useful in forming a judgment upon them.

There is no doubt that the Royal Commissioners carefully weighed the various proposals brought before them, and endeavoured to avoid committing themselves rashly to any untried conclusion. They felt the difficulties of the situation, and proceeded cautiously. It is well that the question should not be tied up too tightly, and if we trace hesitation in their conclusions, there is this advantage—that those authorities who will have to deal finally with the question will find themselves the more free to adopt that which may prove to be the better course. A certain outline is drawn, which other hands will have to fill up. We do not know that the Royal Commissioners could be expected to go farther than this. There is no magic in the powers possessed by individuals so appointed. They can but collect evidence, supplemented by a limited amount of personal observation, and it is desirable that they should recognise their own inevitable deficiencies. As it is, with all the caution that has been displayed, we are presented with a scheme, or set of schemes, sufficiently bold and portentous. On the whole, the Commissioners have been wiser than the Government Referees of 1857. These gentlemen sat in judgment on the present main drainage works when the project existed only on paper. Captain Galton and his two colleagues prove to have been correct in many of their criticisms, but we cannot undertake to say that they were right in the plans which they themselves proposed. The scheme which they evolved was to convey the southern sewage to the Lower Hope, and the northern sewage to Sea Reach, the mode of conveyance being an open channel on each side of the river, the northern channel extending twenty miles from the metropolitan boundary, and the southern rather more than sixteen miles, the former being 39ft. broad, and the latter 37ft., each having a depth of about 16ft. There was something very formidable in the aspect of these sewage channels, but in order to mitigate their offensiveness it was proposed that tidal water should be admitted to the head of the channels by means of reservoirs. The sewage was thus to be "diluted," and the requisite flow secured. It is almost impossible to avoid associating a plan of this kind with the fact that one of Captain Galton's colleagues was an engineer to two of the London water companies, and the other was engineer to the Kennet and Avon Navigation. These two gentlemen being thus in the majority, it seems perfectly natural that the plan proposed should consist mainly of reservoirs and canals. We feel sure that such a proposal, made in the present day, would stand no chance of adoption. Excluding the reservoirs, and converting the canals into regular sewers, there would be some approximation to the plan recommended by the Royal Commissioners; but the latter have gone beyond the proposals of the Referees, by introducing the question of sewage purification. No part of the Thames, not even in proximity to the sea, is to be desecrated by the introduction of crude sewage. The doctrine of physical purity had not advanced so far as this in 1857, and it must be owned that there is a vast difference between the diluted sewage of that date and the refined effluent proposed in 1884.

The history of the metropolitan main drainage has a very peculiar financial aspect. The Referees estimated the cost of their scheme at £5,437,265—a tremendous sum in those days, when the rateable value of the metropolis was less than half what it is now. Messrs. Bidder, Hawksley, and Bazalgette, to whom in their turn the Metropolitan Board submitted the report of the Referees, considered that the expense would be far in excess of the estimate, their idea of the cost being that it would probably amount to £9,000,000. Against this they set the plan which the Metropolitan Board had adopted, which they estimated as involving only "a reasonable cost"—namely, £2,300,000—the works also to be completed in "a reasonable period"—namely, five years. It is due to the late Lord Beaconsfield that the Metropolitan Board, previously trammelled by a Government veto, was ultimately left free to follow its own devices with regard to the main drainage. Lord Beaconsfield—then Mr. Disraeli—was Chancellor of the Exchequer at the time, and he argued that, as the metropolis paid for the main drainage, so the Metropolitan Board had a right to construct it in any way it pleased, providing the works were not a nuisance. The privilege of paying has certainly been largely developed. The £2,300,000 originally contemplated has been exactly doubled. To this has to be added the cost of relief works and extensions decided upon in 1881, the estimate for which being £1,500,000. Further still we have the proposed enlargement of the sewage reservoirs at Barking and Crossness, estimated at £160,000, making up the grand total to £6,260,000. Captain Galton may fairly point to these figures as showing that the Referees were right when they pronounced the main drainage works proposed by the Metropolitan Board in 1856 as inadequate, especially in view of the prospective increase of the population. It is right to remember that some of the extensions necessarily awaited the time when they were required, and could not have been properly established in the first instance. The enormous growth of the metropolitan suburbs has been more marked in some directions than in others, and the requisite works could not, in all cases, have been forecast. Still it may be contended that the works were unduly cramped at the outset, and that more ample provision ought to have been made when the intercepting sewers were first constructed. Concerning the locality of the outfalls, Captain Galton finds strong support in the recommendations of the Commissioners, the latter advising that the sewage should be discharged in a part of the river virtually the same as that recommended by the Referees. The latter also spoke approvingly of a plan for uniting the northern and southern sewage into one channel.

The next stage in this question has reference to the attitude of the Metropolitan Board. As yet no formal announcement has been made by that body as to the course which it contemplates taking in consequence of the report of the Royal Commissioners. The Home Secretary has requested the Board to inform him as to its intentions, and for that information Sir W. Harcourt is waiting—very probably with some degree of impatience. As far as active measures are concerned, the Board may claim credit for having anticipated the proposals of the Royal Commissioners concerning the first step which is to be taken. With regard to the chemical treatment of sewage, the Commissioners say the proper method to be employed "should be a matter for careful experimental investigation." The scientific officers of the Board took this matter in hand some months before the Royal Commissioners gave their advice, and important results have already been arrived at. The experiments were commenced at the Western Pumping Station at Pimlico, and have since been transferred to Crossness, where, in the course of a few days, the chemical treatment of a million gallons of sewage daily will commence in order to ascertain the best conditions under which the whole of the metropolitan sewage may be purified. When this point is decided, the way will be prepared for the gigantic task of precipitating the solid matters from the enormous volume which rolls through the London sewers. The Royal Commissioners demand that this shall be followed up by conveying the effluent to an area of land where it shall be filtered, or else it must be taken down to a new outfall, to be placed on the northern shore at least as far away as Hole Haven in Sea Reach. Even at that remote point no crude sewage must go into the Thames. Precipitation must be practised somewhere, either at Crossness and Barking, or at Hole Haven; and if the effluent goes into the Thames at the present outfalls, it must be subject to the refinement of filtration. How far the Metropolitan Board will adopt these proposals, and how far that body will be required to do so, are points at present undetermined. The impending task is tremendous, and Captain Galton would have us believe that its magnitude has even been underrated by the Commissioners. He once more proclaims that inadequate means are being proposed, and that the flow of sewage is greater than the volume calculated upon. If all the sewage is to be chemically treated, both in wet weather and in dry, the expense, Captain Galton says, will be so great that the better plan, on the score of simplicity and cheapness, might be to adopt his scheme of "dilution" in long tidal channels. But Captain Galton seems to be in the dark as to the chemical experiments of the Metropolitan Board, and there is reason to hope that both in respect to cost and efficiency, these will throw fresh and welcome light on the whole sewage question. Should these experiments result in disappointment, then the recommendations of the Royal Commissioners in their length and breadth may be deemed imperative, and a heavy additional burden will have to be thrown upon the metropolitan rates. So far as any pressure from the Government is concerned, it is limited to the prevention of a nuisance, whether on land or water. But that some purification of the London sewage was originally expected to be carried out is sufficiently clear, and the attempt to escape this issue now comes to an end.

HEATING FEED-WATER.

THE economic advantage to be derived from heating feed-water before it is pumped into a boiler is a matter easily settled, if the temperatures of the feed-water before and after passing through the heater, and the boiler pressure are known. For example, let the boiler pressure be 100 lb. absolute—that is, 85 lb. safety valve load, and the normal temperature of the feed-water be 60 deg. The total quantity of heat in a pound of steam of 100 lb. pressure measured from 32 deg. is 1181 deg. Or to put it more accurately, 1181 units of heat are used up in converting one pound of water at 32 deg. into steam of 100 lb. pressure. Now, if we heat the feed-water from 60 deg. to, let us say, 250 deg., then the number of heat units to be supplied in the boiler will be $1181 - (250 - 32) = 963$, and the economy of fuel effected will be in the inverse ratio of 963 to 1153, or in other words, it will amount to a little over 17 per cent. The calculation is extremely simple. In "steam tables" will be found the total heat of steam of various temperatures and pressures, always stated from and at 32 deg. To this total heat so given add 32 deg., in order that we may measure from zero of the Fahrenheit scale, because it is from zero and not from 32 deg. that the heat of the feed-water is measured. The same result may, of course, be got by deducting 32 from the temperature of the feed-water, but the method we suggest will be found the simplest. From the total heat of the steam subtract the temperature of the feed-water, the remainder is the quantity of heat to be supplied, as we have said, in the boiler. The simplest possible rule of three sum will give the percentage of saving effected by any given temperature of hot feed as compared with cold feed. The percentage given above, namely, 17, is very high, because the temperature of the feed-water is unusually great; and it will be readily understood, we hope, that it is quite impossible that anything like savings of 25 and 30 per cent., sometimes claimed by sanguine inventors of feed-water heaters, can have any foundation in practice. It is, however, possible under certain conditions that a much greater saving than calculation shows to be practicable may be secured by the use of a feed-water heater, and it is well that the nature of these conditions should be fully understood by steam users.

It has been shown by Peclet, the great French authority no heat, that the conducting powers of a metal have little or nothing to do with the cost of generating steam. Thus, for example, copper is a much better conductor of heat than iron is, the ratio being as 892 is to 374; but no economy is secured by the use of copper as a material for heating surfaces. The reason is that the conducting powers of all metals are greatly in excess of their absorbing and emitting powers. Thus one square inch of iron will conduct as much heat as 9in. or 10in. of it can absorb or give out. A pin of wrought iron, 1in. in diameter and 6½in. long, set in the side of a locomotive fire-box, let us say, so that 3in. of the pin are in the water, while 3in. are exposed to the heat of the furnace, cannot be burned away, because the heat absorbed by that portion of the pin in the fire and given up by that part in the water, is readily conducted through the one circular inch of area in the thickness of the fire-box. It will be readily understood, then, that the absorbing and emitting surfaces have much more to do with the efficiency of a boiler than has the material of which it is made. Now, incrustation, lime deposit, scale, and such like, very seriously interfere with the heat emitting power of a plate; and the reason why some feed-water heaters apparently give a splendid result, is that they keep the heating surfaces in the boiler to which they are applied clean; and this they do because the salts of lime and magnesia are insoluble in hot water, although they are soluble in cold water. The popular notion is that all those things which "melt" at all melt more readily in hot than in cold water; but there are many exceptions to this rule, and the lime in hard water is one of them. Let us suppose that a boiler has been cleaned out, and well chipped and scaled. For a short time it will make steam freely, and there will be a saving of fuel; but in a few days the surfaces will be all furred over again, and the old wasteful forcing of fire becomes necessary. The average result, therefore, for the year will be bad. How bad or how good will depend more on the chipping and scaling of the boiler than on any other factor. If, however, a feed-water heater is applied, and matters are properly managed, the lime does not find its way, save in small quantities, into the boiler. The surfaces remain clean, and at the end of the year it is seen that a great saving of coal has been effected. The whole of this is, as a matter of course, credited by the inventor to his feed-water heater. In a sense, but only in a limited sense, is he right. The feed-water heater produces two effects—one primary, the supplying of hot water to the boiler; the other secondary, the keeping of the surfaces clean; and it is to the secondary effect that the greater portion perhaps of the merit of the invention ought to be attributed. That is to say, if it was not that the feed-water was heavily charged with lime salts little or no advantage would be derived from the heater—certainly no more than is indicated by the method of calculation which we have described above.

It appears to be highly desirable that makers of feed-water heaters should devote attention to this point—the deposit of lime salts. It will be seen that these ought to be thrown down neither in the boiler nor in the feed-water heater; but if there is only a boiler and a heater, they must be thrown down in one or the other, or in both. The proper expedient is to provide some form of settling chamber or tank between the heater and the boiler, the contents of which can be readily removed and thrown away. Shingle, stones, coarse gravel, broken bricks, &c., answer well; the deposit, which would otherwise find its way to the boiler, adhering to these. When they become loaded, they can be removed and used as road material A very simple and efficient arrangement consists in fitting a large tank with a number of inclined sheet iron trays. The feed-water enters the tank at the top and runs down the trays in thin films. The exhaust steam from the engine is admitted into the tank, which is practically open to the air. The feed-water can readily be raised to a temperature of 200 deg., and a very considerable portion of the lime will be found crusted hard on the trays, which can be removed and thrown away when done with. They are too inexpensive to be worth cleaning. It is very remarkable that so little attention has been paid to this simple method of getting rid of deposit troubles. Steam users will fly to all sorts of nostrums to keep their boilers clean, but they seem entirely to forget what potent agents heat and time are in this connection. No doubt much disappointment has been caused by attempts made to accomplish impossibilities. The whole of the lime cannot be got out by heating. Mud cannot be got rid of at all, nor can common salt, nor "chemicals," such as sulphuric acid. But that very hard and bad water can be rendered comparatively soft and good for boilers simply by raising it to a high temperature and keeping it so for some little time—the longer the better—before it is pumped into a boiler, is a thing that admits of no dispute.

LIABILITIES FOR STREET MAKING.

THE decision by Mr. Justice Mathew in the case of Hill and another *versus* Edward will, it is to be hoped, prove to be final in determining the asserted responsibilities of tenants on lease for the expenses incurred by Local Boards in properly finishing new streets opened by London builders. If it do so, a great boon will have been conferred by it on a very numerous class of tenants, who, tempted by low rents, are willing to take leases of property in unfinished neighbourhoods. In the case to which we have referred the defendants had taken certain premises on lease, covenanting to pay, among other charges, "the tithe, or rent-charge in lieu of tithes, land tax—if any—sewers rates, main drainage rates, and all other taxes, rates, impositions, and outgoings whatsoever, then and thereafter to be charged or imposed, on or in respect of the said premises or any part thereof—except the landlord's property tax." The premises had a frontage to two roads within the jurisdiction of the Hornsey Local Board, and after a neglected notice to the landlord to sewer, level, and pave the roads in question, the work was done by the Board itself, who claimed from the plaintiffs as landlords the amount of their share of the cost, £104, which sum was duly paid by them, and they now sought to recover it from their tenant, Mr. Edward, under the provisions of his lease. Without going into the legal technicalities of the case, we may conclude our notice of it by stating that the judge held that the term "impositions" relied upon by the plaintiffs could not be held to include works of the character for which the claim was made, the lease not specifically stating that it was the intention of the plaintiffs to impose liabilities of this nature on their tenant.

Now we are aware that many of those who have leased residences in several of the new neighbourhoods springing up in the outskirts of London, in their unwillingness to be subject to the risk and cost of a lawsuit, and in the apparently indeterminate position of the law on the point, have paid demands of a similar nature made upon them by their landlords—they having signed their leases in complete ignorance of any such liability. We may imagine the case of an elderly lady reading one of the many highly coloured advertisements as to houses appearing in the daily papers, and readily allured by the prospect held out by it. She reads that on a gravel soil, in a neighbourhood famed for its salubrity, close to every means of conveyance—by rail, tram, or omnibus—are to be obtained houses fitted with every modern convenience, such as were not dreamed of less than a generation back, and at a rent which would scarcely have obtained a suburban cottage within the limits of a very short memory. A visit confirms the favourable impression produced, and despite the unfinished character of the surroundings, which our intending tenant is assured will soon be put into shape, a seven years' lease is agreed to; the clauses in this lease being assumed as only of the customary character. The civil landlord is profuse in promises. Yes, he will certainly make this or that other little alteration. Papers? "Oh! surely he will leave these to the lady's taste;" and within a very short time our unsuspecting tenant is in full enjoyment of her nice little residence. But, if indoors all is comfort, "hope is left behind" when once the street door is passed. The pavements have an uncomfortable irregularity tending to constant tripping; pools of water accumulate after the least shower of rain at all the crossing places, not one of which has been provided with pavement; while the general pervasion of mud—and such mud!—absolutely often enforces days of imprisonment rather than venture to face it and its disagreeable results. Our tenant ventures on a mild remonstrance with her obliging landlord when, after some six or seven months' residence, the slough of despond deepens rather than improves. "When is anything going to be done to the roads?" She then learns that nothing can be done until the vestry consents to take them over from the builders, and meanwhile the best that can be done is being done by throwing gravel over the clayey surface. For a few days that alternative succeeds in deceiving fresh victims, the surface of the roads looking clean. But the mud is insatiable, and the whole beach of our shores might be deposited before it could be overcome; so for two or three years of tenancy our tenant suffers greatly.

At length the vestry takes over the road and it is put into good order. Then the victim—we will hope now of a past type—is told for the first time that, having taken the house on a lease, she has become liable for her share of the cost of making the roadway in front of it decent. To the protests made it is answered that, as the tenant will benefit by the work to the extent of the lease, she must pay for that benefit. It is vainly pleaded that no information was afforded upon this point at the time of signing the agreement, but this is replied to by the statement of the landlord that of course he had presumed acquaintance with general custom; while the further plea advanced, that, presuming there had been such acquaintance, the half of the tenancy had been passed under conditions of intense discomfort, and the advantage has been reduced by that extent and should receive consideration in the amount of payment, is equally unavailing to reduce the claim. There are also cases which have been brought under our notice where the houses occupied have been in a square or facing some open space where there were no opposite buildings, wherein the tenant has not even been relieved to the extent of a division of the cost of the full width of the road, and in one instance known to us the tenant of a very moderately-sized house has paid as much as £34 rather than contest the claim of his landlord.

We hold, therefore, the decision in the case we have cited will be a great relief to those who may be in dread of similar claims being made upon them; and even should its effect be to cause suburban builders, in view of the responsibilities they must now assume, to slightly increase rentals, it will be better for their tenants fully to know the extent of their liability before concluding leases upon which hitherto they have been subject to claims for which they were unprepared, and which have undoubtedly subjected many to very considerable hardships.

RAILWAY RATES.

RAILWAY companies are, or ought to be, in the position of public trustees. They have special rights and special privileges granted to them by the State, and they are, to a great extent, protected from competition. Of course, these benefits conferred on them, and not on others, carry with them certain liabilities. In return for granting what is practically a monopoly, the State—that is, the public—expects that a railway company will conduct its affairs in the public interest. It does not expect that a railway board of directors, or their general managers, will stoop to petty practices which would be scarcely creditable to an ordinary trader. It does not expect that it will regulate its charges according to the temporary necessities of its customers, taking low prices of those who have other resources, and heavily mulcting those who have not. Such a policy would not be surprising if adopted by third-rate money-lenders, or other such hangers on to the outskirts of civilisation; but they are utterly unworthy of those whose duty it is to administer great public trusts. These occupy their high position because they are believed to be able to rise above pettifogging notions. Railway directors are supposed to know and appreciate the fact that the true interest of shareholders is, by a wise, fair, and liberal policy, to encourage the trade of their district. They are expected to take a broad and just view of things, and not to keep up among traders and the public a feeling that they must fight for their rights if they are to get them. These remarks would probably be deemed severe by the directors of the North-Eastern Railway and their traffic managers. But that they are fully deserved by them it is not at all difficult to show. Let us first compare the third-class railway fare from Middlesbrough to Glasgow with that from Middlesbrough to Manchester. Being regulated by Act of Parliament, these may be taken as correctly representing the comparative distances. The former is 15s. 11d. and the latter is 9s. The distance to Glasgow is apparently about one and seven-ninths the distance to Manchester. Now, let us inquire what is the rate for undamageable iron, say, plates, bars, and angles for the same distances. The rate for the longer distance is 10s. per ton. To make it proportionate with the third-class passenger fares—that is, with the distance—the undamageable iron rate to Manchester ought to be 5s. 8d. It actually is 11s. 8d.! Not less in proportion to distance, not less at all, but more! A higher rate by 16 per cent. for a distance shorter by 44 per cent.! What justification is there for such an anomaly as this? The difference to the Middlesbrough finished iron trade between a rate of 11s. 8d. per ton, and one of 5s. 8d. is enormous. It makes all the difference between supplying the Manchester market and not supplying it. It makes all the difference to the Manchester engineers, of buying their iron 6s. per ton cheaper than at present; and this difference is sufficient to determine orders for heavy constructive work away from Middlesbrough. But why should the North-Eastern and the Lancashire and Yorkshire Railway managers—for they are the guilty parties—do this thing, when the North-Eastern and North British do not? The only answer ever given to this question is that Manchester is not a seaport and Glasgow is. Senders of iron must make use of the railways to Manchester, whereas they have the option of sending by sea to Glasgow. Therefore, it appears that the rates compared are not regulated by distance, but by the competition of steamers. The managers do not consider—as they are forced by Act of Parliament to do in respect of the third-class fares—what are the distances respectively. They ask themselves apparently—"Have we got these customers in a corner or have we not? In sending to Glasgow we have not, therefore let us charge moderately. In sending to Manchester we have, therefore let us make them pay immoderately." No broad view is taken. There is no appreciation of the probabilities of gaining or losing trade. Just the one narrow, short-sighted view is acted upon. There is no competition—make them pay! Another recent instance will suffice for the present, though, did time and space permit, multitudes might be given. The rate for similar merchandise from Middlesbrough to Hull up to the end of last year was 5s. 10d. if for shipment, but 6s. 8d. if for consumption in the town. Why this difference? At first sight one would suppose the latter rate included some terminal expense not incurred when the iron was exported. It never could be discovered, however, what this mysterious service was, inasmuch as the 6s. 8d. was charged just the same when the trucks were unloaded by buyers themselves in their own sidings. The truth came out, however, last month. Some enterprising firm started a small steamer to run from Middlesbrough to Hull in competition with the railway company; immediately, the latter issued a circular, wherein the manager announced a reduction of the rate for local consumption to the same as that for shipment. There had manifestly never been any justification for the higher rate. But there was no competition, and therefore it was demanded. It was not imposed on shipment iron lest other shipping ports should be preferred and the traffic lost. Seeing how dependent the population of Great Britain is upon trade and manufactures, and how these depend largely on cheap internal communication, it is clearly contrary to public policy that railway rates should be determined or influenced by the circumstance of there being competition or no competition. The prime cost of conveying—which of course is in proportion to distance—together with a reasonable allowance for profit, should be the sole factors. When national interests are at stake, and national aid is given, it is time that a broad and liberal policy should be insisted on. That rates should be moderated immediately on the appearance of competition, and to an extent calculated to cripple that competition, and nothing more, is a mean and miserable policy. The railway companies are clearly not to be trusted to decide what is fair as between themselves and their customers. They look too exclusively to the narrow and immediate interests of their shareholders, and grasp what they can within the limits of their Parliamentary powers, if they limit themselves at all. Our best chance of compelling them to do otherwise is in the perpetuation and extension of the judicial action of the Railway Commission. All new rates made and all old rates complained of by an adequately-signed petition should be revised and settled by them. Let us hope that the present evil times will not be allowed to pass away without some reform being made in the direction indicated.

BELGIAN IRON IN ENGLAND.

IT would be interesting to know the value of Belgian iron imported into England for building purposes alone. The trade has now been in full swing for many years, and it may be assumed that much less of the foreign make is at present being used than in the years of prosperity. Still, the grand total even for last season must have represented a large amount of capital. In the Sheffield district, which is a long way inland from the port of delivery, Belgian iron chiefly for girder purposes can be laid down at fully 15 per cent. less money than the Butterley brand or any other kind of English iron. This, of course, makes all the difference between a profit—a handsome profit—and a loss. One hears it said sometimes that the Belgian girders are not so good. Possibly this may be so, but the prompt reply of one of a large Yorkshire firm of builders to this objection was that he had used Belgian girders extensively for many years and he had never known one to fail. His firm have had Belgian girders to the value of £10,000 a year. In one building in Sheffield they recently put in £4000 worth of Belgian iron. The depressed state of the building trade has greatly decreased the demand, and it is probable that not much more than £5000 worth was brought into Sheffield last year, though at one time the business done in the Sheffield district by the Belgian ironmasters must have been at least £20,000 a year. The low rates of shipping are all in favour of the foreigner; but a more important factor is the cheap labour so abundant in Belgium. It is believed that the foreign workman will give six days' labour for the remuneration given to his English brother for four to four and a-half days' work. This handicaps the British manufacturer most seriously, and is, after all, the main reason why this singular feature of the iron trade is maintained—the delivery of Belgian iron in the very heart of the English iron districts at 15 per cent. under the quotations of home firms who have the raw material at hand and no carriage to pay. So long as the Belgian iron worker is content to work hard for so little wages, the English girders will fail to get a hold even of the English markets, where the great point is price.

A PRUDENT COLLIERY COMPANY.

AN unusual incident has occurred in the South Yorkshire coalfield which has scarcely attracted the attention it deserved. Messrs. John Brown and Co., of the Atlas Steel and Ironworks, Sheffield, own the extensive collieries of Aldwarke Main. At one of its pits, the Swallow Wood, the Government Inspector gave it as his opinion that shot firing would not be safe owing to the prevalence of gas in the workings. The management of the colliery concurred in this view, and intimated to the miners that they would not be permitted to get coal in the ordinary way—*i.e.*, by shot firing—and, further, that the state of the coal trade would not allow of more remuneration being paid for getting coal in the other fashion. The men did not like the idea of working with wedges at the same price as by firing, believing that they could not make sufficient wages. The management, therefore, had no other course open in the safety of the miners themselves than to withhold their permission to work the mine in the manner which had been condemned as dangerous. The men thereupon preferred to draw their tools out of the pit, which is closed for the present. At the same time the company has done what it could for the miners—some four hundred—who were thus thrown out of employment. It decided to increase the output at the other pits, to make up in some measure for the deficiency caused by the stoppage at Swallow Wood. At these pits it has taken on a number of the unemployed miners. February is a notoriously dangerous month for those engaged in the arduous occupation of coal-getting, and had any calamity occurred at Swallow Wood, after the clear warning of the Government Inspector—coupled with the company's own convictions of the peril—the responsibility of all concerned would have been grave indeed. The action of the colliery management in thus promptly taking measures in the sensible path of prevention cannot be too highly commended. If other companies would follow this example, there would be fewer fatal explosions to darken the record of coal-getting in Yorkshire and other mining districts.

FOREIGN SHIPBUILDING.

THE secretary of the North of England Steam Shipowners' Association has procured for the annual meeting of that body, a few days ago, some facts that have a wide interest. From France, Holland, and Hamburg he procured statements as to the condition of the shipbuilding industries in those countries which were read by the chairman—Mr. C. M. Palmer, M.P.—at the annual meeting to which we have referred. Their tenour is as doleful as the same reports from this country would have been. From Havre it is reported that, "as regards merchant steamers, since the bounty law came into force, few steamers have been built here, and those few have not been successful." From Bordeaux, it is said that the bounty laws have given orders for vessels to shipbuilders out of France, and that they have "not had a favourable result upon the French shipping trade." From Hamburg, it is said that "hundreds of steamers are laid up at the Baltic ports," and that no "new orders for ships have been given since the beginning of last year;" and from Holland, shipbuilding is stated to have "practically come to an end for the present." All round, the conclusion is that the shipbuilding trade has felt the paralysis that is known here, and as it was when our yards were glutted with work that the foreign yards obtained orders, now that so many of our yards are only partly employed, it must be expected that foreigners will feel the dulness still more keenly. At the same time the conclusion is irresistible that the result of this general cessation of shipbuilding must be to give very early relief to the freight market, because the loss of vessels is constant, and affects not only our own merchant fleets, but those of other nations. As shipbuilding is checked and loss goes on, and as the trade of the world grows over the oceans, it must be concluded that there is in progress a relief first and then a recovery in the shipping trade that will in due time affect shipbuilding. It is doubtful whether the worst is entirely past, but at any rate the indications of an improvement are to be found in the figures we have referred to.

THE DEFENCES OF HONG KONG.

INFORMATION reaching us from our Chinese colony has made us aware that in that one colony at least the residents of European extraction object strongly to pay the quota imposed upon them as their share of the cost of defensive works recently decided upon by the Home authorities. It is not because the contribution asked for is excessive that this disinclination to vote the sum required has been manifested by the committee of the local legislature—a disinclination, indeed, which has taken the obstinate form of entire refusal to recommend the vote—but really because it is held to be insufficient. That committee, of course, includes men who have long been resident in the colony, and who are familiar, not only with the requirements evident to experience and common sense, but with the various recommendations on the subject which from time to time have been made by naval and military commanders at the station; and its verdict is to the effect that the scheme to which it is asked to contribute is utterly insufficient and unsatisfactory, and that the execution of it will lead to a sense of security which would not be justified in the event of hostilities. We have before urged that the plans decided upon for the protection of our several colonies seemed to have been dictated more by consideration for economy rather than on a basis of actual requirements; and should other colonial bodies raise the same objections that have been started by the residents at Hong Kong, our Government will find itself in a dilemma not easy to escape from. If, in opposition to the views of men of long local experience, that Government adopts a course which may hereafter produce disaster, a very serious responsibility will devolve upon its members, and we should recommend careful revision, and, perhaps, extension of existing proposals.

EXHIBITION OF SHEFFIELD MANUFACTURES.

THANKS to the enterprise of the Master Cutler—Mr. J. E. Bingham—Sheffield is about to undertake an exhibition of an interesting and most important character. It will be in the form of an industrial exhibition, illustrative of the various handicrafts of Sheffield in all the varied stages of production. Few towns in the world have so many manufactures, ranging from the tiniest of needles to the monster propeller blade and huge armour plate; and there is no doubt that the undertaking will excite great interest outside the wide boundaries of Hallamshire. When Mr. Bingham was Master Cutler in 1881, the idea occurred to him then, but he was not able to get it carried out. Now, however, the Cutlers' Company is heartily with him, as it is felt that the time has come when the industrial supremacy of Sheffield in many important branches of manufacture should be asserted. It is intended to give prizes and certificates to workmen for excellence in workmanship, and this will at once enlist the sympathy and stimulate the energies of the artisans to put forth their highest skill in the articles they enter for competition. Care will be taken to conduct the exhibition in such a way as shall not play into the hands of the keen-eyed foreigner anxious to pick up points with which to compete with Sheffield firms in distant markets.

STEEL TIN PLATES.

THE tin-plate trade is at present in a little excitement concerning steel tin-plates. It is well known that steel has for some time been in the market instead of coke and charcoal iron, and that its quality in the matter of ductility is all that can be wished. Of late, however, customers complain that the tin does not appear to properly cover the steel, and the result is that the plates become dotted with minute specks of rust, under each of which is a pin-hole, so to speak, through the tin. These defects do not manifest themselves for some time after the plates have been made. Defects of the kind have occasionally been manifested by coke plates of iron; but the evil was of no magnitude or importance to the trade. We understand that the question has now been referred to the chemists, all the efforts of the tin-plate manufacturers having hitherto proved useless to overcome the difficulty. The plates may be quite sound and good when they leave the works, but when the boxes are opened, in two or three weeks, a large percentage of their contents is found to be worthless, and this although the boxes are packed in soldered cases. It is to be hoped that the difficulty will be got over, but it seems that we are not yet done with charcoal plates.

LITERATURE.

London and Provincial Water Supplies, with the Latest Statistics of Metropolitan and Provincial Waterworks. By ARTHUR SILVERTHORNE, Assoc. M. Inst. C.E. London: Crosby Lockwood and Co. 1884.

THIS book deals chiefly with the financial considerations which claim the careful attention of all concerned in construction and management of town water supplies. The questions which beset with difficulties the first stages in the obtainment of a supply, and cause engineers to bow to ancient error in the form of custom without any longer existing reason, are dealt with at great length, and the author does real service in exposing anomalies and difficulties so as to show how, where, and why they exist. The first part of the book is on provincial water supplies, and here subjects treated in a limited sense in the author's previously published book on the purchase of gas and waterworks are treated at length. The effects of the dependence of provincial supplies or supply works chiefly upon the Waterworks Clauses Act of 1847 are traced in the cost of new works and the growing cost of water in the many towns increasing in population and rateable value. One question vigorously attacked is the great cost of many works and supplies caused by the excessive demand for compensation water for mills. Commonly one-third of the whole available rainfall has had to be allowed for this purpose, but in some cases it actually exceeds the supply applicable to the district or town requiring the water for domestic purposes, with the result that reservoirs and other works have to be constructed and dividend paid on a cost made absurdly high to continue the working of a few mills not worth a fraction of the cost they involve for these works. At Halifax, the supply of no less than 14 inches of the available rainfall involved the construction of enormous works for this compensation, while at Bolton 9,180,000 gallons per day have to be delivered for this purpose; a quantity which is nearly double that delivered to the town for all purposes. This sort of thing has contributed enormously to the cost of nearly all modern supplies, and throws a great annual burden for ever upon towns. The author combats the idea that the system of constructing works by means of loans payable in from thirty to forty-five years is placing a burden upon the present generation by compelling it to provide a free supply to populations of the future, because he says the decennial returns of population show that each generation will have to contribute its own section to present works.

The author refers to the embarrassment sometimes caused by the modern doctrines of a few of the purists who, blindly following the some-time craze for water pure from the analytical chemistry point of view, have done so much harm in decrying rivers as sources of supply. He gives quotations from Sir William Fergusson and others, showing the absurdity of the supposed necessity in a potable water of having nothing but pure and simple H_2O, and referring to mortality returns, points out that while improved water and drainage works have invariably been followed by improved sanitary returns, the particular character of the water itself—that is to say, whether from rivers, red sandstone wells, drainage areas, or chalk sinkings—does not in any degree affect that result. It is very satisfactory to find that in all directions the merely chemical view of purity is giving way to the broader view of the physiologist; and the number ready to decry a river supply in the face of generations of proof by experience is growing smaller every day. In fact, there will soon be none left to decry waters which obviously satisfy every potable requirement, except those whose views are inclined by some personal motive.

The second part of the book deals with the London water supply from a financial and statistical point, and with the statistics of the water undertakings supplying eighty large manufacturing and residential towns in the United Kingdom.

LOCH KATRINE AND THE GLASGOW WATER SUPPLY.

As far as may yet be gathered, it appears that the most interesting and most enterprising of the private schemes to be brought before Parliament this year will be those relating to water, either in regard to navigation or to public and private supply. Some of these—notably the Ship Canal Bill—we have previously alluded to, but there is one other at least that deserves special attention from an engineering as well as a public point of view. More than this, it is calculated to stir the feelings of tourists and other ardent lovers of nature, for it is a deliberate proposal to make a fresh attack on Loch Katrine, one of the brightest and most attractive of Scotland's many lovely scenes.

Thirty years ago the shrewd, practical, and increasing denizens of Glasgow, casting about for sources of water supply, fixed their eyes upon Loch Katrine, and induced Parliament to give them the powers they asked for, to draw water from that fountain. That example has been followed in later years in regard to English lakes, but even yet it may be said that the public at large are by no means reconciled to works that tend to diminish, if not destroy, their most precious scenery. The Water Commissioners of Glasgow, however, obtained their Act, and thereby they were authorised to make good the deficiency in the water supply for manufactures and domestic purposes. To understand the new proposal, it is necessary to glance at their first project as it was carried out. The Act of 1855 gave them power first to raise Loch Katrine 4ft. above, and to draw it down 3ft. below the previous summer level, the two processes giving a total of 7ft. available for the purposes of the waterworks. That being done, they were empowered to draw a maximum of 50 millions of gallons per day of 24 hours. In order to provide compensation to the riparian owners thereby affected, the Act also authorised the Commissioners to raise Loch Vennachar no less than 5ft. 9in. above its previous summer level, and to draw it down 6ft., giving a total of 11ft. 9in.; and further to raise Loch Drunkie as much as 25ft. Thus the Act took effect in all upon three lochs, and though the second and third are of little consequence in comparison with Loch Katrine, tourists at least will not need to be told how serious such interference with Scotch lakes might be. Having so arranged for their new supply of water, the Commissioners constructed an aqueduct, 8ft. across and 8ft. high all through, running down from Katrine, across the valleys of the Duchray, the Endrick, and the Blane, to Glasgow. It was formed partly of syphon pipes and partly of tunnelling through the solid rock, and for some miles the rock was so hard that it seemed not to require lining, and was therefore left in a rough state. At first the syphon pipes were not designed to carry the maximum of 50 million gallons a day, but as time went on additional pipes became necessary, and the whole original work was only completed within the last four years. But although the Commissioners supposed they had provided for supplying the large daily quantity authorised, experience has proved that, partly through the rough surface of the tunnels impeding the flow of water, and partly through other causes, such as some necessary stoppages during the year, not more than 42 millions of gallons can be brought down per day, and even to get this much some further alterations must be made in the aqueduct. In connection with stoppages for repairs, it is interesting to note in passing that the water from Loch Katrine is so pure that it acts destructively upon the mortar used in some portions of the aqueduct. The deficiency of eight million gallons per day would be sufficiently serious by itself, but other causes have been at work to render a largely increased water supply absolutely necessary. The proportion of the Glasgow Commissioners area of supply has in recent years grown at the rate of 38 per cent. in ten years, and at the same time the supply of water has increased in greater proportion, involving an addition each year of something like a million gallons per day; and this, notwithstanding moderately successful efforts to prevent waste by mechanical appliances. Taking 39 million gallons per day as the quantity required last year, and assuming an addition of one million gallons each successive year, as already mentioned, it is calculated by the Commissioners that two years hence the 42 million gallons, which is the maximum per day now obtainable, will be required; that is, in 1887. What will they then do to meet the increased demand in 1888 and following years? This is the problem they seek to solve by means of their new Bill during the current session.

Assuming that this Bill passes through Parliament this year, it is obvious that two years will be a mere trifle of the time necessary to carry out the new works required, and four years are likely to be absorbed in completing the first part of the proposed scheme. By that time, taking the present rate of increased consumption, the need will be 45 million gallons a day, or 3 millions more than the existing system can supply. The first consideration then is that of meeting the demand during the interim, without reducing the supply per head. The great increase in consumption has been mainly due to trade and manufactures, for the domestic supply has been kept fairly steady for some years past, by means of severe supervision as to water fittings and waste preventing apparatus. The demand per head is estimated at 35½ gallons per day, but past experience goes to show that further operations in the same direction would reduce the consumption by about 7,000,000 gallons per head. That saving would postpone for a few years the exhaustion of the present supply, while the new works were being effected, and that course has already been urged upon the Commissioners, if it has not already been put into operation. This extended period being secured, it is assumed that the enlarged works could be made available when absolutely required, if proceeded with at once. Now, the first plan that might suggest itself for enhancing the present supply would be the widening of the existing tunnels and the smoothing of the rough surface which hitherto has impeded and restricted the flow. But the few stoppages which have been necessary each year are as many as the absolute demands will permit; no further interruptions can be allowed for alterations, and the amount of alterations that could be made during these suspensions would be of no practical use. Other methods must therefore be pursued, and the first that Mr. J. M. Gale, C.E., proposes in the scheme before Parliament, is the construction of additional tunnels. The chief feature in his Bill will accordingly be a new aqueduct from Loch Katrine, on the same level and following virtually the same course as the existing aqueduct, but so laid as to cross the present pipes at a point in the Endrick Valley. The new aqueduct will have to be made somewhat further into the hillside than the present one, and that will necessitate some additional tunnelling, but that is likely to be counterbalanced by advantages arising from the nature of the rock. Looking far ahead, it is proposed that the new aqueduct shall be at least half as large again as the old one, on these grounds: putting the existing supply at 40 million gallons a day, an exact duplicate of the present aqueduct would give only the same amount, and allowing for the present rate of consumption, the new supply would be exhausted in forty years. Mr. Gale, therefore, recommended the Commissioners to take powers for obtaining an additional supply of 60 million gallons a day, so that the total possible supply from both aqueducts should be 100 million gallons a day. This being done, the future requirements of Glasgow might be considered as sufficiently well provided for, especially as the Corporation works at Gorbals yield four million gallons a day independently.

Notwithstanding the large quantity already taken from it, Loch Katrine is believed to be capable of yielding at least the additional supply proposed, but for this purpose the storage in the Loch itself must be increased. The engineer does not, however, contemplate drawing the whole of the 100 million gallons from this source, but contents himself with a total of 75 million gallons a day. To secure this he proposes to raise Loch Katrine 5ft. above its present high-water level, and to also raise the level of Loch Arklet, which flows into Loch Lomond, by 25ft., and so convert it into a reservoir. The area will thus be increased from 200 to 300 acres, and the surplus water will pass into Loch Katrine, 83ft. lower down, through a tunnel 1000 yards long. The raising of the level, and some slight operations at the outlet, are all the works projected with regard to Loch Katrine itself, and in answer to objections from some quarters, the promoters of the scheme maintain that neither the Loch nor Ellen's Isle will suffer permanent detriment in regard to its picturesqueness. That remains to be seen. For the remaining 25,000,000 gallons of the 100,000,000 under consideration, the promoters could turn to Lochs Lubnaig, Voie, and Doine, the area draining into these being almost equal to that draining into Lochs Katrine and Vennachar. Finally, the cost of the proposed works will probably be about £1,000,000, everything included. This outline is drawn from the proposals submitted to the Glasgow Corporation by Mr. Gale, and the actual Bill now before Parliament practically embodies his scheme as it stood. What opposition there may be is not yet known, but if there be any, it will probably come from cavilling ratepayers or zealous and enthusiastic lovers of natural scenery.

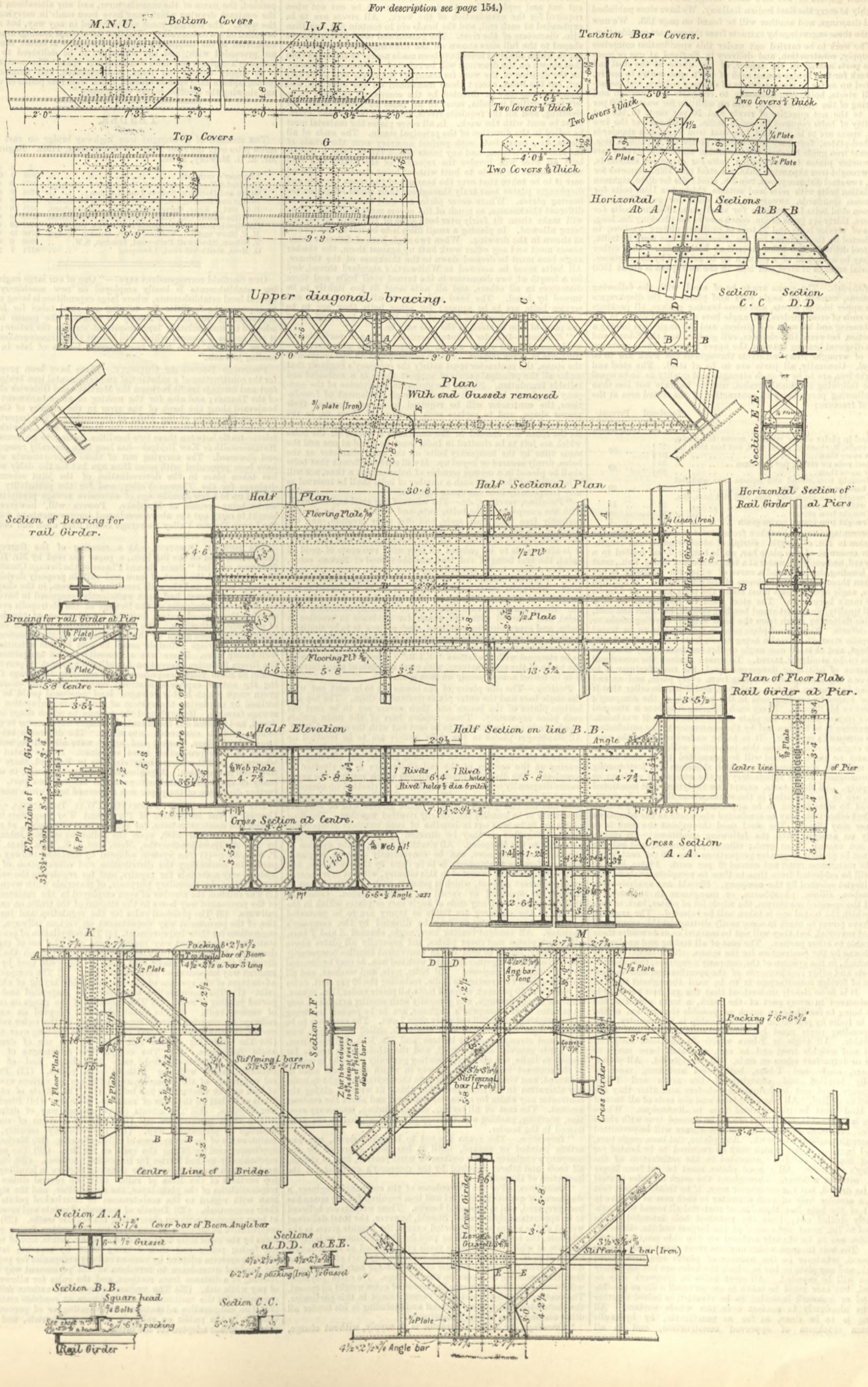
RAILWAY ACCIDENT.—On Wednesday a goods train on the Great Northern Railway broke down near Claypole, about seven miles north of Grantham, owing, it is stated, to the failure of a brake in one of the wagons. Both lines were blocked, and considerable delay to the traffic ensued. The five o'clock express from King's-cross did not reach Sheffield until 10.30, being ninety-nine minutes late, and trains both ways were similarly delayed.

POLYTECHNIC INSTITUTE.—A course of six practical demonstrations in lathe work will be given by Paul N. Hasluck, on Thursday evenings, commencing February 26th, 1885, at eight o'clock. Preparing work for mounting on the lathe: Centreing, how to find the centre; drilling, size, form and speed of drills; countersinking, its object, various tools used; trueing the work; Thursday, February 26th. Turning the plain cylinder: Mounting on the lathe, setting the tool in position; why various heights do not answer in slide-rest turning; speed of work, rate of feed of cut, lubrication; Thursday, March 5th. Action of cutting tools: Forms of tools for various purposes, depth of cut; Clement's driver and other chucks; finishing cut; Thursday, March 12th. Screw-cutting: Outline of the process, usual change wheels; standard threads; calculation of the wheels; tools used; depth of cut; quick withdraw and return motion; Thursday, March 19th. Screw-cutting—continued: Square threads, odd pitches, fractional threads, multiple threads, left-handed threads; arrangement of carriage so that odd threads are not spoilt at subsequent cuts; Thursday, March 26th. Wheel-cutting: The teeth of wheels, their forms, proportion, &c.; outline of the apparatus used; the cutters and how they are made; sizing the blank wheels, cutting the teeth; Thursday, April 2nd.

THE GIRVAN WATERWORKS.—At the eighth meeting of the Glasgow Engineers' Association, held on Thursday, 22nd ult., a paper descriptive of the Girvan Waterworks was read by Mr. James Stuart, C.E. The town of Girvan, situated in Ayrshire, about fifteen miles south of Ayr, has about 5500 inhabitants. It lies on a porous, sandy subsoil, through which water percolates freely, and owing to the wells in the immediate vicinity becoming polluted, the local authority in 1881 found it necessary to procure another source of supply. Mr. Gale, C.E., engineer to the Glasgow Water Commissioners, was called upon to report upon the matter, and ultimately decided upon what was named the Bynehill Scheme, the works for which were designed by Mr. W. R. Copeland, C.E., Glasgow. The drainage area included in this scheme extends to about 1200 acres, which it was considered would yield a supply of not less than 200,000 gallons per day. The rainfall on this area for the last five years has each year exceeded 40in., and this would give a supply of 1,485,000 gallons per day. The works consist of weirs on streams utilised, conduits to reservoirs, reservoirs, filter, and tank, and main and distributing pipes. The reservoir has an area of about 3½ acres, and a storage capacity of about 5,740,000 gallons, or about 46 days' supply of 125,000 gallons. The water can be drawn off at three levels—the top level being mostly used, however—by an upstand pipe 2ft. in diameter. The upstand is also directly connected by an 8in. pipe with inlets. The filter is 60ft. long by 40ft. wide, and has a filtering capacity of 180,000 gallons per day of 24 hours, the rate of filtration being assumed at 12 cubic feet per square foot per diem. The filtering material is arranged as follows:—Whinstone metal, 3in. ring, 12in.; Whinstone metal, 2in. ring, 4½in.; gravel, 6in.; perforated fireclay tiles, 12in.; Sannox Bay, Arran, sand, 24in. The tank is circular in form, about 55ft. diameter, is capable of holding about half a day's supply, and gives a head of 200ft. even to the higher parts of the town. The paper was well illustrated by a full set of drawings.

THE HOOGHLY BRIDGE—DETAILS OF GIRDERS.

(For description see page 154.)



THE HOOGHLY BRIDGE.

In our impression of the 23rd January we gave an engraving of the main girders of the new steel bridge to be erected over the Hooghly to carry the East Indian Railway. We have since published detail drawings, and another will be found on page 153. We now describe these engravings by extracts from the contract specification.

"The work to be carried out under this specification comprises the supply, construction, and delivery in England at one or more of the ports named in the tender, of the whole of the steel and ironwork for two bridge spans, each of 420ft. span centre to centre, rivetted up as far as the conditions of delivery require, and including all rivets, bolts, &c., necessary to complete the erection and rivetting of the work in India, with an addition for waste of 50 per cent. to the net quantity of rivets and 10 per cent. to the net quantity of bolts required for use in India. With each of the two 420ft. spans are to be supplied two cast iron expansion standards and bed-plates, four cast iron washer plates for expansion pins, four cast iron guide brackets for expansion standards, sixteen cast iron washer plates for foundation bolts for expansion standards, four wrought iron expansion links, six steel pins 15in. diameter for ditto, two steel distance pieces, two 3in. steel bolts for ditto, eighteen foundation bolts with nuts and cotters, thirty-five 1½in. bolts for expansion standards, twenty-six stud bolts for guide brackets, eighteen stud bolts for washers for steel pins, 1070 ⅞in. bolts for sleepers, thirty-six gross of ⅜in. coach screws for planking 2in. long, 4 tons of service bolts and 2½ tons of ordinary platers' washers, to be selected by the engineer for the erection of the work in India, 300 steel drifts for 1in. holes tapered at both ends so that either end may be used, and of a pattern to be selected by the engineer. The total amount of steel and iron in the two spans is about 1950 tons.

"*Materials.*—The spans are to be of steel, with the following exceptions, namely, all angle bars and plates for the diaphragms in the upper booms, struts, and cross-bracing girders, all packings at the ends of cross girders, all angle bars and gusset plates in the cross bracing and between rail girders, and the angle bars joining a connection between the sleepers, rail girders, and the Z-bars, and in the diagonal bracing between the upper booms. These parts are to be of wrought iron; all rivets throughout the work are to be of steel. Generally, all parts are to be of steel. The steel and wrought iron are to be of such strength and quality as to be equal to the following tensional strains, and to indicate not less than the following percentages of contraction of the tested area at the point of fracture:—

	Tensional strain per sq. in.	Percentages of contraction.
Steel in plates either with or across the grain, angle, T, channel, or flat bars, not less than ..	27	30
Or more than	31	
Steel rods for rivets, not less than	25	40
Or more than	28	
Wrought iron round and square bars and flat bars, under 6in. wide	24	20
Wrought iron angle and bars and flat bars, 6in. wide and upwards	22	15
Wrought iron plates	21	8
Wrought iron plates, across grain	18	3

The percentages are to be taken from pieces so cut as to show the extension in 8in. of length. Strips of steel, whether cut lengthwise or crosswise of the plate bar, angle bar, or T-bar heated to a cherry red, and cooled in water at a temperature of 82deg. Fah., must stand bending double round a curve of which the diameter is not less than three times the thickness of the piece tested. In addition to this, angle and flat bars must stand the tests known at Lloyd's as the ram's horn tests. The steel used for rivets must be of a special quality, and must stand bending double, both hot and cold, and also flattening down from the head without showing cracks or other defects. Every steel plate used in the work is to be tested for tensile strength, samples being taken from both end and side shearings, and at least one angle or flat bar from every charge of steel is to be similarly tested. To guard against the occasional acceptance of brittle or dangerous steel, the manufacturer is to preserve a side and an end shearing from every plate, and an end shearing from every flat bar, angle bar, and T-bar, in order that it may be tested by bending cold in the presence of the company's engineer or his deputy. Every such shearing is to bear a stamped number corresponding to the plate or bar from which it was taken. This number is to be stamped by the contractor to the satisfaction of the company's engineer. It is to be understood that the company's engineer will insist on this inspection with regard to every item, and no piece of steel will be permitted to be used in the work until its corresponding marked shearings are forthcoming and pronounced to be satisfactory by the company's engineer or his deputy. All these tests, except the analytical test mentioned below, are to be conducted in the works where the steel is manufactured by some person to be appointed by the company's engineer, but other tests may be conducted elsewhere as the company's engineer may direct. The steel used throughout the work is to comply on analysis with the following conditions:—Its carbon must not exceed ·3 per cent.; silicon, phosphorus, and sulphur must not be present in greater proportions than ·06 per cent. each, and the manganese must not exceed ·6 per cent. Plates, bars, or rods will be subjected from time to time to complete analysis by a metallurgist selected by the company. Should any analysis show the carbon, silicon, phosphorus, or manganese in the steel to exceed the specified maximum, the whole lot of plates, bars, or rods from which the tested one is taken will be rejected. The engineer shall have power to mark in some easily distinguishable manner all rejected material, but they will not be marked so as to render them unsaleable to other parties. The cost of all testing and analysis is to be borne by the contractors for the spans. No material is to be used which, in the opinion of the company's engineer, falls short of the tests and other requirements of the specification, and no steel or iron of foreign manufacture is to be used throughout the contract. It is to be clearly understood that the greatest accuracy is to be observed in every part of the work, a main object of the design being to facilitate as much as possible the erection of the spans in India by perfection of workmanship in this country. All corresponding parts must be made exactly similar and interchangeable. All angle or T-bars which do not hold their full widths and weights from end to end, or which have rough or jagged or imperfect edges or ends, will be rejected. All plates, flat bars, angle and T-bars, both steel and iron, must be carefully levelled and straightened—the angle and T-bars by pressure, and not by hammering—before and after they are punched or drilled. All edges of plates and the ends of all bars of every kind must be planed dead true to dimensions. Where planing is impossible, the edges are to be dressed true with chisel and file. No rough edges fresh from the shears will be permitted anywhere throughout the work. Any plates, flat bars, angle bars, channel bars, or T-bars which may be required to be heated for bending must be carefully annealed to the satisfaction of the company's engineer. All shaped plates must be cut from larger plates, without welding. Throughout the work all holes in steel are to be drilled, but the contractor may, if he thinks proper, first punch a smaller hole of such diameter in each case as to leave in no part of the hole less than ⅛in. of material all round to be subsequently drilled out; thus the punched hole intended to be enlarged to 1in. must not exceed at the largest end ⅞in. diameter. The holes are to be slightly arrissed on the side next the rivet heads. The hole through which any one rivet passes must exactly correspond, whatever be the number of plates and bars passed through, and any plate or bar in which the holes are not accurately in place will be rejected. All rivet holes in ironwork may be punched, but care must be taken to use as small a die as possible All steel or ironwork intended to be rivetted or bolted together must be absolutely in contact over the whole surface. All rivetting is to be done, as far as practicable, by hydraulic or steam machines of approved construction, and in all cases the rivets must completely fill the holes when rivetted up. The rivet steel must be of such a size that the rivet when inserted hot shall be a tight fit in the hole. All loose rivets and rivets with cracked, badly formed, or deficient heads must be cut out and replaced by others. Rivets must be cut out when required for the examination of the work. All rivets are to be cupheaded at each end, and the heads are to contain not less than 1¼in. diameters of the rivet. The gussets and cover plates must be shaped to the full sizes shown on the drawings, and any plate or bar in which the rivet holes have been made nearer to the edges than that shown on the drawings will be rejected. Wherever necessary for the division of the work for transport the rivets are to be left out, but the holes, except those mentioned on the drawings, and such others as may be directed by the company's engineer to be left to be drilled in India, must in all cases be drilled ready for rivetting, and all the requisite rivets, including 50 per cent. extra, must be sent with the work. In all cover plates the material must be rolled in the direction of the principal strain. The ends of all plates, &c., must butt with perfect accuracy over the whole of the meeting surfaces, and any joints which fail to form a perfect butt all over will involve the rejection of the plates and bars which cannot be made to butt without being shortened. Special care is to be taken that over the bearings of the spans the side and diaphragm plates bear truly throughout their whole length on the bearing plates. Where cover plates are used to connect plates of different thicknesses, so much of the covers must be planed off as will make them fit fairly over both sides of the joint, no packing being allowed. In planing a small fillet is to be left in the corner, as shown in the drawing. When two angle bars of different thicknesses meet and any other work butt up against them, the thicker angle bars must be dressed down to the thickness of the thinner. All bolts must be screwed to Whitworth's standard thread, and for a length of two diameters in the turned steel bolts and three diameters in all others, and all nuts must fit too tightly to be turned by hand. The head and nuts of all timber bolts and service bolts are to be square; for other bolts they are to be hexagonal. The head and body of all bolts are to be forged out of one piece of iron or steel, as the case may be.

"*Erection.*—In order to ensure accuracy of fit and perfection of workmanship, the spans are to be erected—but not rivetted—complete in every respect. Before proceeding with the erection of the spans, the contractor must satisfy the company's engineer that under all the principal points of support there is a sufficient and reliable foundation. Should the girder, in the opinion of the company's engineer, become distorted through settlement of foundations, the contractor will be required to restore them to their proper shape, and to replace such portions of them as, in the opinion of the company's engineer, have been strained or injured. As the spans are erected in the contractor's works, all the holes which are left to be rivetted in India must be filled at one and the same time by the temporary bolts of the same diameter as the holes, firmly secured or keyed up. It will not be sufficient that bolts shall be placed in a certain number of holes only at a time, nor will it be sufficient that only such a number of bolts shall be inserted as may temporarily hold the spans together.

"*Painting, marking, &c.*—The whole of the steel and ironwork, with the exception of the bolts, nuts, and rivets, is to be scraped perfectly free from rust, scale, and dirt after erection, and the whole of the work, except the cast iron, is then to be brushed all over with boiling hot linseed oil, and including the cast iron work, it is afterwards to be painted all over with two coats of good oil paint, the first being of red lead and the second of Roman ochre, or other colours to be specially approved by the company's engineer. Different colours will be chosen for different parts of the work. The bolts, coach screws, and rivets are to be heated to the temperature of melted lead, and then dipped into boiled linseed oil. Every portion of each span is to be distinctly stencilled with paint, and marked with the punch for guidance in erection in India, and every piece or bundle of steel or iron is to be similarly marked, and every packing case branded with such shipping marks as the company's engineer may require. All parts of the work are to be stamped with the letters "E.I.R." A neat casting, bearing the name of the manufacturer, with place and date of manufacture, is to be bolted conspicuously on each span.

Packing.—The side plates of the booms are to be sent out with the angle bars and the outer plates rivetted to them. The top and bottom plates of the booms and their covers are to be sent out each piece separately. Those tension bars of the main girders which are in two lengths are to be sent out with the covers left off. All diaphragm plates in the main girders are to be rivetted up complete in themselves. The ordinary cross girders, the box cross girders at the ends, the rail or trimming girders, and the diagonal bracing at the centres of the rail girders are to be rivetted up complete. The diagonal bracing girders which connect the upper booms diagonally over the roadway are to be rivetted up complete except at the central joint. The connecting plates of the central joint and the end gusset plates of these girders will be sent out separately or in bundles temporarily rivetted together. The floor plates are to be sent out in bundles of such numbers temporarily rivetted together as may be directed by the engineer, subject generally to the foregoing. All rivetting which, in the opinion of the company's engineer, can be conveniently done in England, having reference to shipment, is to be done by the contractor, and all rivetting is to be executed in this country, without extra charge on the contract amount, which is possible under the conditions of delivery as specified or varied as hereby provided. Generally throughout the work any ends of angle bars or plates which in the opinion of the engineer are liable to injury are to be protected by timber or ironwork, as may be directed by the company's engineer. All straight bracing bars, angle, channel Z and T bars, all gusset plates and cover plates, and generally all plates above 12in. square, are to be sent out in convenient bundles temporarily rivetted or bolted together or bound with rod iron, as may be directed by the company's engineer. All bolts, nuts, and washers, and all rivets required for erection in India, including the 50 per cent. extra of rivets and 10 per cent. extra of bolts, all plates under 12in. square, all loose zigzag bracings, and generally such smaller articles as may be selected by the company's engineer, are to be packed in strong cases weighing when full not more than 7 cwt. The cases are to be made of 1¼in. deal boards, with elm ends, nailed with 3½in. wire nails, and strengthened by battens and No. 16 b.w.g. hoop iron, the joints grooved and tongued, and the whole made secure for transit to India, the above representing generally only the intention of the contract in respect to the way in which the whole shall be delivered, and the company reserve to themselves the right to make any alteration in the same that they think fit without giving the contractor any claim for extra payment over and above the contract amount. The cost of all testing, oiling, painting, temporary erection, marking, packing and delivery is to be included in the price named in the tender.

"*Inspection.*—The spans are not to be taken down, nor any article painted or packed, until it has been approved by the company's engineer. The contractor must provide, free of charge, all tools and labour required by the company's engineer for the inspection of the work.

"*Quantities.*—For the convenience of the company's engineer, a statement of quantities of steel and iron required for the spans has been prepared, and is appended hereto. These weights are believed to be approximately correct. Should, however, the total delivered weight of the spans as constructed exceed the weights given in the schedule, the contractor will be paid for the additional weights at the rate at which his tender is made up, as stated in the schedule attached to it, provided that such excess in any part of the spans does not arise from the thickness of any plates or bars being greater than that specified or shown on the drawings. No extra payment will be made to the contractor in respect of extra weight so caused. The contract amount is not to be varied, except in this particular, the contractor taking upon himself and including in his tender all other contingencies of every description.

"*Drawings, &c.*—The contractor is to supply, without charge, three sets of neatly executed hand-made tracings on cloth of the spans as constructed, drawn to the same scale as the contract plans. They must be fully dimensioned, and contain all erection and shipping marks, notifications as to the colour the bridge has been painted, the name of the manufacturer, and any alterations from the contract drawing which may have been made in carrying out the work. The tracings must not be folded in any way, but must be rolled on a wooden roller. The first set of these tracings must be submitted to the company's engineer for approval before the rest are proceeded with, and the whole are to be delivered to the company's engineer not later than the first span. The contractor is to supply twenty-four large, well-executed, and unmounted photographs of each span as erected, taken from four points of view, and showing the erection marks very clearly."

TENDER.

The erection of a wrought iron highway bridge on cast iron screw piles over the river Nar. Width of river, 113ft. Engineer: Mr. E. G. Mawbey, Lynn.

	£	s.	d.
Engineer's estimate	2900	0	0
Goddard & Massey, engineers, Nottingham—accepted	2875	0	0
Green and Burleigh, Suffolk-lane, London	3294	0	0
Bridge and Roofing Co., Darlaston, South Stafford ..	3362	0	0
E. C. and J. Keay, Corporation-street, Birmingham.	3421	16	4
C. Williams and Co., Queen Ann's-gate, Westminster	3638	0	0
Handyside and Co., Britannia Ironworks, Derby ..	3717	10	0
M. T. Shaw and Co., Cannon-street, London Bridge.	3766	15	0
T. Gibson, Stockwell Park-road, London, S.W. ..	3900	0	0
G. Moss, South-hill-road, Liverpool	4171	7	2

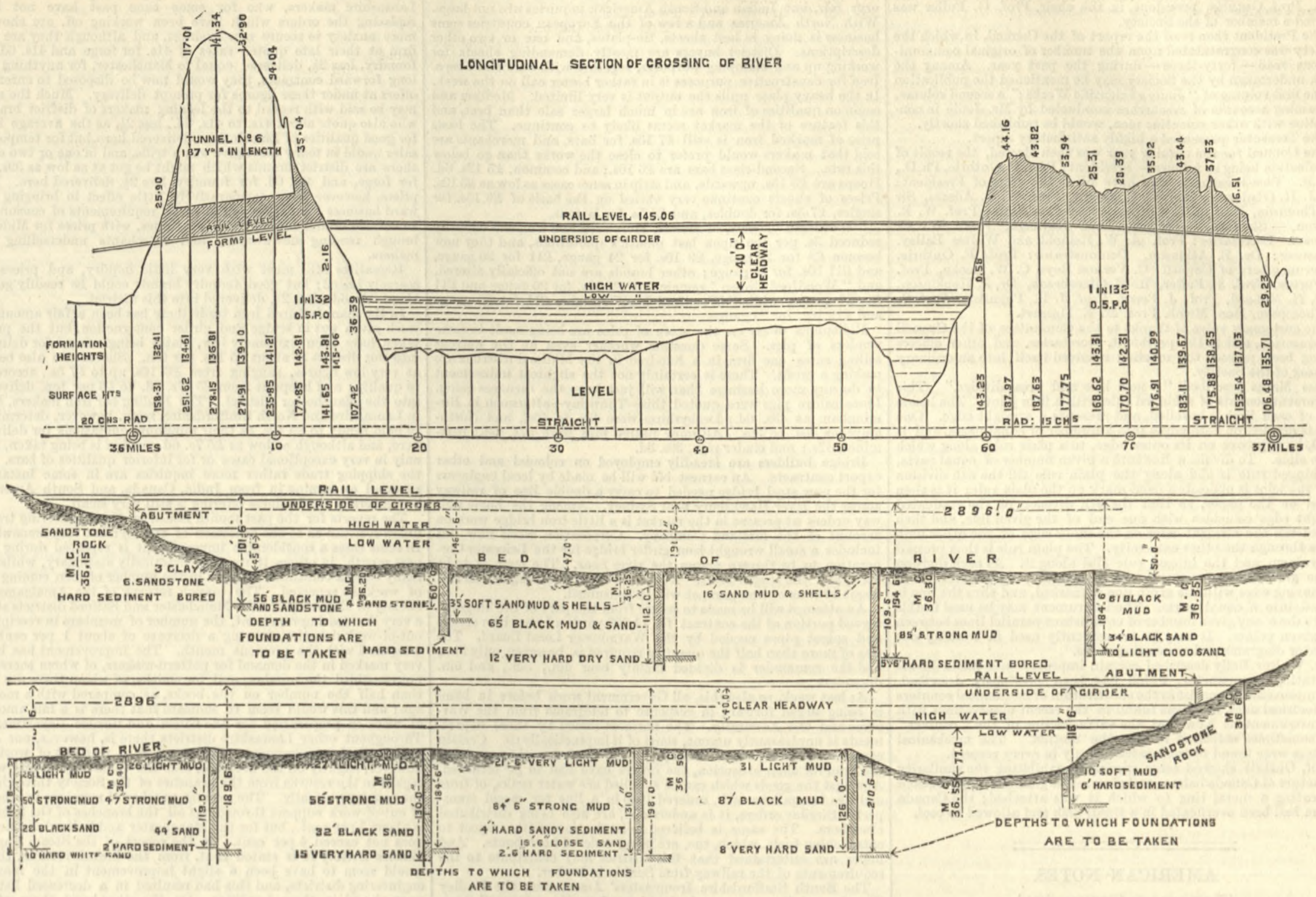
Our Sheffield correspondent says:—"One of our large engineering establishments is busily employed on new machinery for several local establishments, where large expenditure is being made to increase the facilities for turning out steel tubes for heavy ordnance. I am not at liberty to mention the means to be adopted in manipulating large ingots of steel in the future; but it will not be a process which will benefit the hammer-makers, in whose interests there have been several letters of late in the leading journals."

Proposed Bridge at Chiswick.—Plans have been prepared for the construction of a substantial and ornamental iron bridge for foot and carriage traffic between the Mortlake and Chiswick shores of the Thames; and also for the making of an embankment and boulevard along the bank of the river in the vicinity of Grove-park, on the estate of the Duke of Devonshire. The importance of direct communication between the Mortlake and Chiswick districts—traffic between these two localities having to go round by Hammersmith or Kew Bridges—has long been generally recognised and discussed. The carrying out of these improvements would have been proceeded with some time ago but for the delay which has taken place in the determination of the joint scheme of drainage for the Thames Valley, and for the probability that existed up to a few months ago of extensive sewage precipitation works being erected at Mortlake. Powers will, however, be sought to carry out the above-mentioned improvements as soon as the Lower Thames Valley Sewerage Board fixes upon and obtains sanction for their scheme.

The Sewage Question.—At a meeting of the Surveyors' Institution, held on the 9th inst., a paper was read by Mr. Henry Robinson, entitled "Some Recent Phases of the Sewage Question." The author said the want of care and skill in properly devising a sewerage scheme and the evils resulting therefrom, in the shape of nuisance and disease, had been sufficiently recognised to have led the Royal Commissioners on the Sewage of the Metropolis even to say that the cesspool system deserved consideration at the hands of municipal authorities. The author regretted that this encouragement had been given to that system, as all the objections to the water carriage principle could be met by due attention to well-known rules. There was a necessity for an amendment of the Rivers Pollution Prevention Act of 1875 by which its provisions would be made more compulsory. On referring to sewage farming the author expressed a strong opinion that the enormous green crops which highly sewaged land produced could be best utilised by employing the system of ensilage in conjunction with sewage farming. He explained the process by which silage is produced, and pointed out the chemical changes which occur in green fodder, and its conversion into silage. The difference between two kinds of silage, "sweet and sour," were alluded to, and the causes of their production were explained. It was stated that whereas in 1882 there were only six silos in England, there were now 1000 in operation. A prolonged discussion ensued, in which many of the leading authorities on the subject took part. The further discussion of the paper was adjourned to a future meeting.

The Institution of Permanent Way Inspectors.—The Council of the Institution of Permanent Way Inspectors invite papers and communications, for reading and discussion, at meetings during the year 1885, upon the following subjects submitted by Mr. A. Hamilton-Smythe, Mem. Inst. C.E., Hon. Mem. Inst. P.W.I., &c.:—(1) The system adopted by different railway companies for controlling the distribution and consumption of permanent way materials for repairs, and for regulating the sale or consumption, for secondary purposes, of materials when worn out. (2) The relation the number of men employed in the maintenance of the permanent way bears to the amount of the traffic on various railways. (3) The practical rules for the regulation and instruction of the permanent way department on various railways, with suggestions for their improvement. (4) The compilation of practical statistics of permanent way maintenance, and the use of graphic diagrams of statistics. (5) The systems of reporting on the condition of the line and works, and stock of materials used by permanent way inspectors on various railways. (6) The comparative advantages of the systems of outside and inside keying of chaired rails. (7) The comparative advantages of suspended and supported jointing of rails. (8) The widening of the gauge on curves of various radii. (9) The practical means adopted on various railways for ensuring correct super-elevation of the outer rail on curves, relative to the greatest of the trains running over them. (10) The stiffening of the rail-joints by the use of deep or angle fish-plates. (11) The comparative advantages of bull-headed or double-headed rails in chairs, and of flat-bottomed rails with or without sole plates. (12) Practical experience of the economy and efficiency of various systems of lock nuts or washers for fish bolts. (13) The effects of various kinds of ballast on the lines of rails and sleepers. (14) Steel and iron sleepers. (15) The effects on permanent way of defective rolling stock working on it. (16) Various systems of surface drainage of permanent way. (17) The economy, security, and maintenance of various systems of railway fencing. (18) Mechanical appliances used for lifting the rails on the line. (19) The use of mechanically-worked lorries for inspection purposes. (20) Simple appliances in use on railways for assisting the eye in levelling the top surfaces of the lines of rails. (21) The several duties and responsibilities of the plate-layer, the signal fitter, and the signalman with regard to the maintenance of interlocked points and their connections. (22) Details of renewals of points and crossings at busy junctions without obstructing the regular traffic. (23) The comparative advantages of the systems of working facing point locks by the same lever that works the facing points, and of working facing points and their locking bolts by separate levers. (24) The systems adopted by various railway companies for providing medical attendance to members of the permanent way staff residing at a distance from stations, and the rules for allowances of pay while sick. (25) The systems adopted by various railway companies for the maintenance of buildings at roadside stations. (26) The comparative advantages of tolerating or of preventing trespass by the public on railways in remote districts, and the practical means adopted for the latter.

CONTRACTS OPEN—BORINGS FOR THE HAWKESBURY BRIDGE.



CONTRACTS OPEN.

PROPOSED BRIDGE OVER THE RIVER HAWKESBURY—SOUTHERN AND NORTHERN JUNCTION RAILWAY, NEW SOUTH WALES.

THE following are the conditions upon which competitive designs and tenders are invited for the construction and erection of a bridge over the river Hawkesbury, on the Southern and Northern Junction Railway, from Homebush to Waratah:—Each tenderer to furnish his own designs and detailed specification. The bridge is required for a double line of railway, on a gauge of 4ft. 8½in., to have a clear internal width of 25ft., and a headway of 15ft. 3in. to lowest point of overhead bracing. The foundations to be carried down to the depths marked on the accompanying section of the river,* which is furnished for the guidance of those who may desire to send in designs. Upon this section the borings are marked, and the extreme width of the river shown. The bridge is to finish on stone abutments on each side of the river. The tenderers will not only be required to send in drawings and specification, but detailed estimates of the cost of the work, including constructing and erecting complete; also the maintenance of the whole structure for a period of twelve months after it has been opened for public traffic, when it shall be handed over to the Railway Department in perfect order and condition, and to the satisfaction of the Engineer-in-Chief for Railways. Each tenderer is to provide satisfactory guarantees for the completion of the work, and must also state in what time he will engage to complete the bridge ready for traffic. The superstructure to be of mild steel, of a tensile strength of not less than 30 tons and not exceeding 33 tons per square inch of section, and of such design that the greatest load which can be brought upon it, in addition to the weight of the bridge, shall not produce a greater strain on any part of the material than 6½ tons per square inch. Tenders and designs are to be sent to the Agent-General for New South Wales, 5, Westminster-chambers, Victoria-street, London, on or before the 1st day of June, 1885. No design will be taken into consideration which does not comply with the following conditions:—Level of rails, 45ft. above H.W.M. in river; clear headway, 40ft. from H.W.M. to underside of girders; clear height, 15ft. 3in. from rail level to lowest point of overhead bracing; minimum width, 25ft. inside of bridge; waterway, 2896ft. between abutments; maximum strain, 6½ tons per square inch on any portion of loaded superstructure; foundations, to be taken to the depths of borings shown on section of river. A schedule to be appended to the tender, stating a price per foot at which the tenderer will sink the piers below the depth marked on the section, and also a price at which deductions may be made should the foundations not require to be taken to the depths shown. Sydney is the nearest port to Broken Bay—the entrance to the Hawkesbury river—which is about eighteen miles north of Sydney. The distance from Broken Bay Heads to the site of the proposed bridge is about nine miles, and the water over this portion is deep enough to admit with perfect safety vessels up to 1500 tons burthen. All information about soundings may be obtained from the Admiralty chart of Broken Bay and the Hawkesbury river.

List of drawings.—General drawing,† showing section of Hawkesbury river, scale 50ft. to 1in.; and plan and section, 4 chains to 1in. Mr. John Whitton, Railways Office, Sydney, is the Engineer-in-Chief.

THE INSTITUTION OF CIVIL ENGINEERS.

THE MODERN PRACTICE IN THE CONSTRUCTION OF STEAM BOILERS.

AT the ordinary meeting, held on Tuesday, the 3rd of February, Sir Frederick J. Bramwell, F.R.S., President, in the chair, the paper read was on "The Modern Practice in the Construction of Steam Boilers," by Mr. David Salmond Smart.

It was stated that mild steel, from 30 to 36 per cent. stronger than iron, which enabled it to be advantageously used in boiler construction, was now being extensively and successfully adopted. It was superior to iron in general ductility, but this was a quality of which it had sometimes been found deficient, causing a lack of implicit confidence. Most of the mistrust, however, had been the result of want of knowledge of the material, and of the methods of its successful manipulation. Some brands of steel would in general weld like iron, whilst other brands would break like cast iron under the hammer, and could not be reliably welded. Notwithstanding the defects which had been from time to time found, no serious accident had yet occurred with a steel boiler, nor anything sufficiently detrimental to check the use of steel. It could not yet definitely be said what deteriorating effect long service might have on steel boilers, as compared with those of iron, but from experiments quoted it might be inferred that it would be less. Steel rivets were now extensively employed in boiler construction, and with increasing favour. They should be heated in furnaces with an even temperature. With care, and the improvement of the material, there was no doubt steel rivetting would become general. It was desirable that not only the rivets, but all the other parts of steel boilers, should be of steel, to prevent the corrosive action of that metal on iron when in electrical combination. Experiments in proof of this were quoted. When iron and steel were not combined, steel suffered rather more than iron. The presence of local defects in steel was manifested by the action of corrosion. When steel was exposed to corrosion, the oxide scale on it caused rapid decay of those parts not covered by it, therefore the scale should always be removed. In choosing iron plates, a thorough knowledge of the different brands was requisite, as they were very misleading, and steam users were consequently in many cases deceived. A great deal of inferior iron was used. It was stated that hydraulic and mechanical rivetting was better than hand rivetting. Steel plates were generally drilled, but sometimes punched and afterwards annealed. The effect of punching on iron and steel was referred to, and it was stated that thick plates suffered more than thin. Lap joints of thick plates had a smaller ratio of strength than thin ones. The employment of butt joints was recommended with thick plates. Single-rivetted butt joints with double strips were stronger than double-rivetted lap joints. It was pointed out how covering strips should be cut. Instances of welding of boiler seams were mentioned, and it was urged that fullering was preferable to caulking.

The author then dealt with staying and the strengthening of internal flues; the best forms of longitudinal stays and their application; deflection; gusset stays, and how applied; and breathing space. In multitubular boilers of whatever description, only stay tubes should be used in the tube space. The injurious effect of rod stays among tubes was mentioned, and how tube stays should be fitted. A description of the various forms of screw stays, and how they should be put in, followed; both copper, iron, and steel were used. Reference was then made to girder stays, the best methods of fitting them, and the objections to their use. They were now to a great extent being superseded by direct stays, the modes of applying which were described. Stays from the shell to the flues in Lancashire and Cornish boilers were objectionable on account of the hogging of the internal flues. These flues were now strengthened by flanged seams, Bowling hoops, Galloway and other tubes, and by being corrugated. Expansion rings, or hoops, as such, were of little value, and what compressibility they possessed was a disadvantage, as with corrosive water grooving was by this means transferred from the end plates to the rings—from parts easily repaired to those which were not. As means of strengthening, however, they were indispensable. Corrugated flues had been much improved since they were first introduced. They were much stronger to resist collapse than plain flues, but inferior to them in their capacity of stays of the boiler ends. Longitudinal stays were required close to them. Their form had been modified to admit of the introduction of Galloway tubes. The flues of most old boilers had a collapsing pressure much less than the bursting pressure of the shells. The best methods of strengthening such flues were by angle-iron hoops, with a water space under them, and Galloway tubes, where practicable. ⊥ hoops had been much used in the past. They commonly failed by the fracturing of the webs radially through unequal expansion.

With reference to special types of boilers, it was observed that externally-fired boilers must be thimble-plated, with the laps turned away from the fire. Other boilers now were plated parallel, with outer and inner belts alternately. The arrangement of the seams was the next topic. Domes were now seldom put on. Steam-collecting pipes were preferable. When domes were still fixed, the plates under them should not be cut out larger than ordinary manholes, and should be strengthened, and, where necessary, further stiffened. The various modern forms of manhole frames and strengthening plates, and also stand pipes for mountings, were mentioned. As regarded Lancashire boilers it was shown how the necessary breathing space around the flues was obtained. End plates should be in one piece. Plain cylindrical externally-fired boilers were much used with puddling and other furnaces, but were liable to lap fractures, unequal expansion and contraction, and consequent seam rips. Extreme length in such boilers should be avoided. It was better to make them in two distinct pieces, and it was stated how best to connect them. Rastrick boilers were not a desirable type on account of the unequal expansion, and because great strength could not be obtained, as they must be thin, owing to their being externally fired. The plates opposite the furnace necks should always be protected by firebrick bafflers. Vertical boilers for utilising waste heat, not being externally-fired, might be made of any strength. Cross tubes if inserted in the flues, should be placed obliquely to promote circulation. The author pointed out how the flues should be lined at the top and bottom. Permanently fixed iron ladders, or other means of access internally, should be provided. Horizontal boilers for utilising waste heat met with more approval than the others mentioned. It was most important that they should be heated externally as well as internally. In vertical hand-fired boilers, the crown plate of the shell should be flat, to admit of expansion, and the uptake should be lined. Cross tubes in the fire-box should be placed with one end higher than the other. Finally, it was mentioned that, in locomotives, the thickness of the tube plate in the fire-box under the tubes was reduced, while, in some cases, the tubes were bent slightly upwards at mid-length, to allow free expansion and contraction.

The paper was illustrated by a number of diagrams.

ACCIDENTS ON RAILWAYS TO SERVANTS.—During the first nine months of 1884 there were 374 servants of companies or contractors reported as having been killed and 1660 injured, in addition to those included in Division I. Of these 17 were killed and 246 injured whilst coupling or uncoupling vehicles; 1 was killed and 19 were injured by coming in contact, whilst riding on vehicles during shunting, with other vehicles, &c., standing on adjacent lines; 28 were injured whilst passing over or standing upon buffers during shunting; 25 were killed and 210 injured in getting on or off, or by falling off, engines, wagons, &c., during shunting; 3 were killed and 143 injured whilst breaking, spragging, or chocking wheels; 4 were killed and 25 injured whilst attending to ground-points, marshalling trains, &c.; 1 was killed and 97 injured whilst moving vehicles by capstans, turntables, props, &c., during shunting, and 4 were killed and 213 were injured by various other accidents during shunting operations; 7 were killed and 21 injured by falling off engines, &c., during the travelling of trains; 9 were killed and 13 injured by coming in contact with over-bridges or erections on the sides of the line during the travelling of trains; 5 were killed and 42 injured whilst getting on or off engines, vans, &c., during the travelling of trains; 3 were killed and 64 injured whilst attending to, or by the failure of, machinery, &c., of engines in steam; 87 were killed and 134 injured whilst working on the permanent-way, sidings, &c.; 6 were killed and 4 injured whilst attending to gates at level crossings; 111 were killed and 173 injured whilst walking, crossing, or standing on the line on duty; 30 were killed and 91 injured by being caught between vehicles; 16 were killed and 85 injured by falling or being caught between trains and platforms, walls, &c.; 44 were killed and 15 injured whilst walking, &c., on the line on the way home or to work; and 1 was killed, and 37 were injured from other causes.

* The original of this and the map mentioned may be seen upon application at THE ENGINEER office.

† Map of country around Sydney, showing site of proposed railway bridge over the Hawkesbury.

THE PHYSICAL SOCIETY.

At the annual general meeting of this Society, held on the 14th inst., Prof. Guthrie, president, in the chair, Prof. G. Fuller was elected a member of the Society.

The President then read the report of the Council, in which the Society was congratulated upon the number of original communications read—forty-three—during the past year. Among the work undertaken by the Society may be mentioned the publication of the first volume of "Joule's Scientific Works;" a second volume, containing accounts of researches conducted by Mr. Joule in conjunction with other scientific men, would be published shortly.

The Treasurer presented a highly satisfactory report.

The Council for the ensuing year was then elected, the result of the election being as follows:—President: Prof. F. Guthrie, Ph.D., F.R.S. Vice-Presidents who have filled the office of President: Dr. J. H. Gladstone, Prof. G. C. Foster, Prof. W. G. Adams, Sir W. Thomson, Prof. R. B. Clifton. Vice-Presidents: Prof. W. E. Ayrton, — Shelford, — Bidwell, Lord Rayleigh, Prof. W. C. Roberts. Secretaries: Prof. A. W. Reinold and Walter Bailey. Treasurer: Dr. E. Atkinson. Demonstrator: Prof. F. Guthrie. Other members of Council: C. Vernon Boys, C. W. Cooke, Prof. G. Forbes, Prof. F. Fuller, R. T. Glazebrook, Dr. J. Hopkinson, Prof. H. McLeod, Prof. J. Perry, Prof. J. H. Poynting, Prof. S. P. Thompson, Hon. Memb. Prof. M. E. Mascart.

The customary votes of thanks to the Committee of the Council of Education, and to the president, secretaries, and other officers having been passed, the meeting resolved itself into an ordinary meeting of the Society.

Miss Marks described "a new line and area divider." This instrument consists of a hinged rule with a firm joint. The inside edge of each limb is bevelled, and presents a straight edge. One limb is divided on both edges into a number of equal parts, and is fitted, by a groove on its outer edge, to a plain rule, along which it can slide. To divide a line into a given number of equal parts, the hinged rule is slid along the plain rule till the nth division from the joint is opposite a fixed mark on the plain rule; it is then placed on the paper, so that the nth division on the graduated straight edge coincides with one end of the given line, and then opened till the straight edge on the inner edge of the other limb passes through the other extremity. The plain rule is then pressed firmly down, and the hinged rule slid along it. As each division of the graduated edge passes the fixed mark, the intersection of the moving edge with the given line is marked, and thus the line is divided into n equal parts. The instrument may be used in this way to draw any given number of equidistant parallel lines between two given points. It may be conveniently used in working out indicator diagrams and measuring areas.

Mr. Walter Baily described certain improvements made in his integrating anemometer, which has been previously described. The improvements consist in the substitution of mechanical counters for electrical ones, as it was found in the recent observations with the instrument at Kew that the extra friction of the "contact" was sometimes sufficient to stop the motion. The mechanical counters were found to work satisfactorily in every respect.

Prof. Guthrie showed some specimens exhibiting the similarity of fracture of Canada balsam and glass. The glass had been cracked by heating a metal ring to which it was attached; the Canada balsam had been overheated in a small dish and allowed to cool.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, February 6th.

The only feature of special interest among the industries this week is the receipt by the locomotive and car builders, bridge, and plate iron makers, of orders of some magnitude, amounting to fifty locomotives and 400 cars, and from 700 to 900 tons of building and plate iron. These orders are the first evidences that railroad companies and contractors have begun to place their orders for spring requirements.

The rail makers have inquiries for large lots of rails, but the business being done from week to week is in 100 to 500 ton lots, with an occasional 1000 to 2000 ton lot, which are placed at 27 dols. and 28 dols. according to size. There are some inquiries in hand for large lots of rails, for delivery during the spring and summer, with 26 dols. to 26 dols. 50c. offered. This low price is likely to be accepted, because of the announced purpose of the managers of three rail mills to reduce wages from 10 to 15 per cent. The managers of one large mill employing 3000 hands have announced their purpose of not resuming unless that reduction is accepted, and if so it will lead to like reduction by other mills, and this decline in the cost of production will stimulate competition, which will bring prices down to the figures named. Several roads have been projected within a few weeks, and unless something of a discouraging nature should arise, the spring orders for rails will be large, and number sufficient to justify resumption of two or three mills now idle. All kinds of finished iron and steel are in only moderate request, and millowners are actively seeking orders at extremely low prices.

Advices from the western market seem to indicate that the stocks of material in hands of implement and tool makers, heavy hardware manufacturers, carriage and wagon makers, &c., are light, and that the improved demand is the result of this scarcity.

The coal trade is on the eve of activity. Prices have been reduced under active competition, notwithstanding the usual agreement. A good many smaller manufacturing establishments are resuming, and their requirements for iron, steel, and for fuel will likely impart a good deal of activity to the raw material market, and help to stimulate lagging trade. Numerous failures are still reported in the commercal circles, but the greater number of them are among small traders, whose disappearance is not a matter of regret.

The probabilities are that only in exceptional cases will lower prices be named for crude material of any kind. The production of pig iron in the United States last year was 4,585,000 net tons against 5,146,972 tons in 1883. The production was 290,000 tons more than the year 1880, which was the most prosperous. The anthracite production was 1,586,000 tons; bituminous production, 2,541,000 tons; charcoal, 758,000 tons. Unsold stock, January 1st, was 591,000 net tons, as against 533,800 tons a year ago. The number of furnaces in blast January 1st was 235 as against 307 a year ago. These figures show that the iron trade has probably seen its worst, and that the expected improvement will not be a disappointing one, after the railroad requirements for the season have been placed. No attempt will be made to unsettle the traffic this winter; in fact it is doubtful whether the urgent requests of the commercial element will be regarded.

The compromise Silver Bill will pass, but nothing will be done with the Bankrupt Bill. In short, the policy of the present congress will be to let all vexing questions alone.

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

(*From our own Correspondent.*)

A few ironmasters announce this week that their turnover last month was larger than in any month of 1884. Such cases are, however, decidedly exceptional, and the description of iron manufactured was light merchant sections, such as hoops, strips, &c. These same firms find this month a falling-off again, attributable, perhaps, to consumers having rather over-bought in January. The present being the shortest month in the year, local purchasers are not disposed to operate freely, and the mills and forges are still running short time. To start the week on Tuesday night has now become generally "the form" at the ironworks.

Merchant orders on Australian and New Zealand account are very fair, but Indian and South American inquiries are not large. With North America and a few of the European countries some business is doing in best sheets, tin-plates, and one or two other descriptions. District buyers are mostly demanding sheets for working up and stamping purposes, together with bars and hoops. Iron for constructive purposes is in rather better call on the week. In the heavy plate mills the output is very limited. Medium and common qualities of iron are in much larger sale than best, and this feature of the market seems likely to continue. The basis price of marked iron is still £7 10s. for bars, and merchants are told that makers would prefer to close the works than go below this rate. Second-class bars are £6 10s.; and common, £5 12s. 6d. Hoops are £5 15s. upwards, and strip in some cases as low as £5 10s. Prices of sheets continue very varied on the basis of £6 15s. for singles, £7 5s. for doubles, and £8 5s. for lattens.

"Woodford" sheets, of Messrs. Morewood and Co., are officially reduced 5s. per ton upon last month's quotations, and they now become £8 for 20 gauge, £9 10s. for 24 gauge, £11 for 26 gauge, and £11 10s. for 28 gauge; other brands are not officially altered, and "Woodford Crown" remains at £9 10s. for 20 gauge and £11 for 24 gauge, while "Woodford best" remains £11 for 20 gauge and £12 10s. for 24 gauge.

Ridiculous offers on the score of price are being made to some vendors of pigs. Some question whether even at the current selling rates one firm in a hundred in the Midland districts are making a profit. There is certainly not the slightest inducement to do any more business than will just keep the furnaces going. Lincolnshire pigs were quoted this—Thursday—afternoon in Birmingham at 43s. 6d.; Derbyshires were 42s. to 40s., and Northamptons 40s. to 39s. All-mine native pigs were 57s. 6d.; part-mines, 42s.; and cinder pigs, 36s. 3d.

Bridge builders are steadily employed on colonial and other export contracts. An earnest bid will be made by local engineers for the new steel bridge needed to carry a double line of railway across the river Hawksbury near Sydney. Among the home railway orders at present in the market is a little iron bridge work on account of the Midland Company. Corporation work now out includes a small wrought iron girder bridge for the Leicester Corporation to be thrown across the river Soar. The span is to be 45ft., and the length 210ft. About 300 tons of wrought iron and about 10 tons of iron parapet will be consumed.

An attempt will be made to secure from this part of the kingdom a good portion of the contract for 14,766 yards of cast iron socket and spigot pipes needed by the Warminster Local Board. The size of more than half the quantity required is, however, only 3in., and the remainder is divided mainly over 4in., 5in., and 6in. diameters.

As last week, so also this, all Government work before in hand is being urged forward in response to telegrams from the War-office and the Admiralty. The business issued by these departments is unpleasantly urgent, some of it impractically so. Certain canteen requirements, for example, being needed within a period too brief for their execution, the orders have had to be returned. Amongst the goods which can be supplied are water tanks, of from eight to ten gallons each, ordered 1000 in a line for camel transport. Similar orders, it is understood, are also being distributed elsewhere. The same is believed to be the case with respect to entrenching tools, which, too, are being ordered hereabouts. And hopes are entertained that this district may contribute to the requirements of the railway from Suakin to Berber.

The South Staffordshire Ironmasters' Association, the Dudley Chamber of Commerce, and the Shrewsbury Town Council, have all decided to present petitions to Parliament against pending Railway Rates Bills. The president of the Dudley Chamber believes that the companies will be beaten. The Coventry Chamber of Commerce, in addition to forwarding a petition, are collecting subscriptions to meet the expenses of the opposition of the Birmingham and District Railway and Canal Traders' Association.

The Gas Committee of the Birmingham Corporation have made a profit on the past year of £28,465, which is a decline on the year of £31,924. This decrease is principally due to three causes—the reduction in the price of gas, the small increase in its consumption, and the reduced price obtained for residuals. The decrease of income from residuals is £15,077. Yet the Committee, in face of this lessened favourable report, have this week obtained the consent of the Town Council to supply gas for public lighting at 1s. per thousand cubic feet, instead of the present 2s. 1d.

Strenuous efforts are being put forth to make the novel wages movement in the nut and bolt trade a success. This week a meeting of a kind unique in the annals of the trade, and consisting of employers and workmen alike, was held at Darlaston, to consider what steps should be taken "for mutual protection and support." Mr. Arthur Keen, of the Patent Nut and Bolt Company, Smethwick, was in the chair, and employers representing four-fifths of the trade of the district, and workmen representing four-fifths of their own body, were present. Resolutions were come to asserting "that the time had now arrived when there should be complete union between employers and workmen engaged in the nut and bolt trade;" and that as "the action of employers and workmen outside the trade association was seriously injuring the prospects of trade, and if continued would lead to further reductions in prices and wages, the employers should be asked to engage none but associated workmen, and that the latter, in their turn, should work only for associated employers."

The important new railway route from Stratford-on-Avon to Blisworth has just been officially inspected by Major-General Hutchinson, and will be reopened on March 2nd. The line was originally opened in 1873 by the East and West Junction Railway Company, but a few years ago it was determined to close it. The work of relaying and equipping the line has been carried out by the Stratford-on-Avon, Towcester, and Midland Junction Railway Company at an estimated cost of over £350,000. Previously light and flat-bottomed iron rails were used, but these have been replaced by a chair road, with steel rails weighing 80 lb. to the yard. The passenger carriages and engines are fitted with the Westinghouse brake, and the carriages have been built by the Birmingham Railway Carriage and Wagon Company. The whole line from Bloom to Blisworth is 42 miles in length. The Midland Company are taking steps in the ensuing session of Parliament to obtain a Bill enabling them to purchase the line.

The agitation amongst the manufacturers for increased railway facilities between Kidderminster and Wolverhampton would seem to be having the desired effect. The Great Western Company, which monopolises the traffic, is now engaged in making inquiries throughout Sedgley, Kingswinford, Gornal, and other districts, with a view of perfecting a scheme for providing better accommodation.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—There is still a very poor outlook for trade in this district, and a despondent tone continues in both the iron and the coal branches of industry. In the iron trade there is still not only an absence of buying, but users of pig iron are in many cases not taking the deliveries of what they have bought, and unless they are prepared to put largely into stock, makers are being compelled to find a temporary outlet for their production, which, not unfrequently, has been already sold, by offering concessions upon late rates to secure orders for prompt delivery. They are, however, still strongly disinclined to entertain business for long forward delivery at the low prices which are being taken for present sales. Finished iron makers continue very indifferently supplied with work, and in many cases it is only with difficulty that forges are kept even partially employed with small orders coming in from hand-to-mouth.

The iron market at Manchester on Tuesday again presented a generally depressed tone, and comparatively little or no inquiry of any importance was reported. For pig iron prices were weak. Lancashire makers, who for some time past have not been replacing the orders which have been working off, are showing more anxiety to secure new business, and although they are still firm at their late quoted rates of 41s. for forge and 41s. 6d. for foundry, less $2\frac{1}{2}$, delivered equal to Manchester, for anything like long forward contracts, they would now be disposed to entertain offers at under these figures for prompt delivery. Much the same may be said with regard to the leading makers of district brands, who also quote about 41s. to 41s. 6d., less $2\frac{1}{2}$, as the average basis for good qualities of Lincolnshire delivered here, but for temporary sales would in many cases give way a trifle, and in one or two cases there are district brands which might be got at as low as 39s. 6d. for forge, and 40s. 6d. for foundry, less $2\frac{1}{2}$, delivered here. Low prices, however, have comparatively little effect in bringing forward business beyond the actual small requirements of consumers. In outside brands a weak tone continues, with prices for Middlesbrough tending downwards, and merchants underselling the makers.

Hematites still meet with very little inquiry, and prices are scarcely tested; but good foundry brands could be readily got at about 52s. 6d., less $2\frac{1}{2}$, delivered into this district.

In the manufactured iron trade there has been a fair amount of work given out in bridge and girder construction, but the prices taken have been extremely low, plates being offered for delivery into this district at about £5 10s. per ton. Sheets can also be got at very low figures, ranging from £6 10s. up to £7 5s., according to quality; and hoops at from £5 17s. 6d. to £6 per ton, delivered into the Manchester district. The leading bar iron makers, both in Lancashire and North Staffordshire, seem, however, determined to hold firmly to £5 10s. as their minimum quotations for delivery here, and although as low as £5 7s. 6d. per ton is being taken, it is only in very exceptional cases or for inferior qualities of bars. In the shipping trade rather more inquiries are in some instances reported as coming in from India, Canada, and South America, but generally the business offering is still very small.

The reports for the past month issued by the engineering trades union societies as to the condition of employment vary somewhat. In some cases a considerable improvement is reported during the past month, in others it remains practically stationary, whilst in many cases a continued increase in the number of men coming out of work is reported. The branch returns of the Amalgamated Society of Engineers for the Manchester and Salford districts show a very decided improvement, the number of members in receipt of out-of-work donation showing a decrease of about 1 per cent. as compared with the previous month. The improvement has been very marked in the demand for pattern-makers, of whom there are not one-third the number, and for smiths, of whom there are less than half the number on the books, as compared with a month ago; and this would seem to indicate that there is a fair amount of work in preparation for the fitters' and turners' departments. Throughout other Lancashire districts there is, however, not any very marked improvement. The number of men out of work is, however, slightly on the decrease, and the same may be said with regard to the returns from the branches of the Society throughout the country generally. The average number of members in receipt of out-of-work support throughout all the branches of the Society is about 5 per cent., but for the Manchester and Salford district it does not exceed 4 per cent. In the report of the Steam Engine Makers' Society it is stated that, from the branch returns, there would seem to have been a slight improvement in the marine engineering districts, and this had resulted in a decreased list of unemployed in these localities. On the other hand, there was a perceptible decline in millwrighting work and in general engineering that had led to an increase in the number of members receiving out-of-work donation, which now averaged $3\frac{1}{2}$ per cent., and was slightly in excess of the returns for the previous month.

With regard to the general condition of trade, not much hope of improvement is held out in the reports. Locomotive builders everywhere are reported to be fully employed, and tool-makers and machinists are kept fairly employed, but this is only being accomplished, from my own observation, by an increasingly keen competition for all new orders giving out. The shipbuilding trade, the continued depression in which is the really serious drawback, shows no sign of revival. For the Lancashire districts the general tenour of the reports is: Manchester and Salford, still very fairly employed; Bolton, Oldham, and Rochdale, also fairly well off for work; Wigan, Preston, and St. Helens, bad; Barrow, slightly improving, but Liverpool and Birkenhead districts still but bad.

During the past week I had an opportunity of inspecting in operation, at a couple of works, a new injector, recently patented by Messrs. Holden and Brooke, of Salford, Manchester. The special feature of this injector is that it does away with the flap or hinged nozzle, the nozzle being rigid and continuous, and it consequently dispenses not only with the large surface, which is frequently a great objection in the ordinary injectors, but with much of the delicate construction so apt to get out of order. Messrs. Holden and Brooke's new injector is on the exhaust principle, and at one of the works I visited was feeding against 80 lb. pressure in the boiler. The action of the injector is very simple, and it possesses one advantage, that it can be absolutely relied upon for re-starting automatically directly the engines commence work, whilst its efficiency was thoroughly tested by its being able to feed continuously, under conditions which had previously proved so fatal to injector feeding that it had been necessary to pump the water supply for the boiler.

The coal trade continues dull, with only a very poor demand, which is on the decrease, for all descriptions of fuel. In house fire coals business has fallen off as the natural result of the mild weather, but the demand for other classes of fuel has been affected by the general depressions in trade; for iron-making requirements are much below the average, and for steam purposes inquiries have been lessening. In most cases pits are only working short time, with stocks accumulating, and prices tend downwards. At the pit mouth best coals can be got at from 8s. 6d. to 9s.; seconds, 7s. to 7s. 6d.; common, 5s. 6d. to 6s.; burgy, 4s. 6d. to 5s.; best slack, 3s. 9d. to 4s.; and common sorts, 2s. 6d. to 3s. per ton.

In shipping there has been less doing, with steam coal offering freely at from 7s. up to 7s. 6d. for the best qualities delivered at the high-level, Liverpool, or the Garston Docks.

Barrow.—The state of the hematite iron market is disquieting. The improvement manifested a few weeks ago is, like Ophelia's intellect, "gone, quite gone," and there is no knowing how long a period may elapse before it returns. With the blowing out of several furnaces in this district the output has been restricted, and makers are in no hurry to accept contracts at the present profits. Indeed if they were actuated by the reverse principle they would be no better off, for consumers are as reluctant to give orders as makers are to accept them. Few deliveries are being made, but some heavy orders have to be finished before spring ends, and it is those which practically are keeping the works going. Quotations are not changed, 44s. per ton net at works prompt being the figure for No. 1 Bessemer, and other samples are in like proportion. Finished iron makers have little work in hand, but steel producers are a trifle better employed. Iron ore is in slow demand. Coal and coke show a tendency to recede in price, but on the whole the market is fairly steady. As showing the state of trade during the latter end of 1884, it may be mentioned that the Furness Railway Company's traffic receipts for the half year were £31,000 less than for the corresponding period in the preceding year. Some alarm has been caused in Barrow by a report that the foundations of the tower in the new Town Hall, which is approaching completion, had subsided. An examination shows that the subsidence was no more than usually takes place in large buildings of the same kind, and that the foundations, resting on a solid bed of clay, are as good as can be desired.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

MESSRS. JOSEPH RODGERS AND SONS, the well-known cutlery manufacturers of Norfolk-street, have just held their annual meeting. According to the local papers "the dividend" was declared. "The dividend" means 16 per cent. per annum, which, large as it is, is less by 1½ per cent. than was paid a few years ago. The company occupies a unique position in local manufactures, and is frequently fully employed when others are almost idle. At this moment in one important branch, razors, the orders are so heavy that the company is about a year in arrears. This is largely owing to the dry season last year, as most of the razor grinders live outside the town and are dependent on the mountain streams for the water-power with which they grind their blades. They resolutely decline to abandon their semi-rural life, partly because they like their "bit of land" on which they can keep a cow, and partly on account of the independence they possess of the trade unions, who would interfere with their having apprentices, even though the apprentices were their own sons. The United States and India are the chief markets for razors at present. The company was formed in 1871, with a capital of £130,000 in fully paid-up shares of £100. The dividend touched its lowest point in 1874, when it was 15 per cent.; it rose after that to 17½ per cent., at which it stood till two years ago, when 16 per cent. was paid. The £100 shares (which very rarely come into the market) are now quoted at 266.

Another prosperous company, whose meeting I attended on Tuesday, is Messrs. John Round and Son, Limited, silversmiths and electro-platers, Tudor Works, Tudor-street. The dividend for some time was as high as 12½ per cent., and it has never been less than 10 per cent., which was the amount paid this week. The chairman (Mr. Joseph Gamble) stated that the last year had been a period of extreme depression, limiting the turn-over and also decreasing the profit; but taking everything into account, it was considered that 10 per cent. was a satisfactory dividend. This was the opinion of the shareholders as well, and the report and statement of accounts were unanimously passed. Messrs. Wm. Hutton and Sons, of High-street, have completed the erection of immense business premises in West-street, for the more effective carrying on of their great silver and plating business. Messrs. James Dixon and Sons, of Cornish-place, are also exceedingly busy, both on home and foreign account; but other manufacturers give me a most depressing account of the condition of the home markets.

Our local makers of tires and axles have just received considerable orders from the Midland Railway Company for these goods to be fitted into carriages and wagons which the company has built at its works at Derby. Wagon builders are at present fairly well off for work, the Great Eastern and other railway companies having recently placed some good lines for wheels and axles, while loose wheels have been ordered for South America. On the whole, the wagon companies, the reports of which are now being issued, have had a very fair year, the dividends ranging from 4 to 6 per cent., very few being under the latter figure. The North Central Wagon Company, Rotherham, which has a paid-up capital of £126,459, declares 6 per cent., carries £500 to the reserve fund, and brings forward £112. The directors state that the fire which occurred at their repairing sheds on the 21st of January did much damage, but that the loss will not be serious as most of the property was fairly insured. The men suffered severely in the loss of their tools, but a fund was liberally subscribed for them by the public.

The Hull and Barnsley Railway Company is asking for tenders for a number of wagons.

The Admiralty continue to send orders for small lots of armour for the war-ships they have in progress. Tenders were sent up last week by our local firms for the armour of the turret of the Hero. This work is usually divided between the two companies Atlas and Cyclops, but the turret has in the meantime been ordered from Messrs. John Brown and Co., Atlas Works.

It is not quite the fact, as I see it stated at a distance, that the Sheffield firms have as much work in hand for armour-plates as they can manage. Messrs. John Brown and Co., and Messrs. Charles Cammell and Co., could both produce much larger quantities of armour if the Government pleased to place the orders. As a matter of fact, what were called "the extra orders" given by the Government, to increase the strength of the Navy, were very little in excess of what would have been received in the ordinary course of the Admiralty requirements. When the Government get the plates they have ordered they will still need guns, of which they have a deplorable scarcity.

The tenders to the Admiralty by the shipbuilders for the new cruiser of the Scout class are due next week, and although no armour is required, some portions of the material will probably come to Sheffield as hitherto. The armour clad vessels have not been tendered for yet. It is probable that the Soudan question is discouraging expenditure in this direction.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THERE are still no signs of improvement in the Cleveland pig iron trade. But very little business is being currently transacted either by merchants or makers, and prices continue to droop.

At the market held at Middlesbrough on Tuesday last, the tone was exceedingly flat, and from merchants No. 3 g.m.b. could be purchased at 3d. per ton lower than at the previous market. Consumers are, however, unwilling to buy even at the present low rates, as they hope to do better by waiting.

For small lots and prompt delivery they will give 34s. 4½d. per ton, but the lowest accepted by merchants on Tuesday was 34s. 6d. The usual quotation given by makers is still 35s. for prompt delivery. Some of them are, however, not unwilling to book considerable orders at 34s. 9d.

Forge iron is somewhat scarce, and has not fallen to the same extent as No. 3. For some brands 33s. 6d. per ton is obtainable, whilst others can be had at 1½d. to 3d. per ton less.

There is no enquiry for warrants, and no transactions have recently taken place in them. They are therefore difficult to get at the price, but there is every reason to believe they could be had at about 34s. 3d. per ton prompt cash.

Shipments have improved during the last few days and are slightly above what they were last month. The quantities are 33,473 tons for this month, as compared with 28,916 tons for last month during an equal number of days.

The stock of Cleveland pig iron in Messrs. Connal and Co.'s Middlesbrough store was on Monday last 51,319 tons, being five tons less than a week previously.

There is a slight improvement in the shipbuilding trade. Makers of finished iron do not, however, feel much benefit, as several of the vessels are being built of steel. Makers of steel plates and angles are fairly busy, though low prices have to be accepted. Competition is very keen in this branch of trade, as, indeed, in all others. Orders for iron plate, bars, and angles, come but slowly to hand, notwithstanding that prices have fallen so low. Ship-plates are offered at £4 17s. 6d. per ton on trucks at makers' works, angles at £4 10s. to £4 12s. 6d., and bars at about £5, all less 2½ per cent. discount. Puddled bars are £3 5s. per ton net on trucks.

Messrs. Swan and Hunter, of Wallsend, have booked an order for two large steamers, and have a fair prospect of being able to keep their yard well employed to the end of the year.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been very little animation in the iron market this week. Values of warrants have been a shade more steady, but do not exhibit any improvement. Despite the low figures at which all sorts of iron is quoted, speculators cannot be induced to invest. The inquiry for home consumption is backward, but this week the shipments are larger, although not equal to what they were twelve months ago. They amounted to 8315 tons, compared with 6505 in the preceding week, and 9070 tons in the corresponding week of 1884. The shipments to both Italy and the United States are larger, but France, Germany, India, and other countries are taking less. One furnace has been put out of blast at the Ardeer Ironworks, and there are now ninety-two in operation against ninety at the same date last year. Stocks are accumulating at makers' works, and in the course of the week there has been an addition of fully 2000 tons to the stock on Messrs. Connal and Co.'s Glasgow stores.

Business was done in the warrant market on Friday at 41s. 0½d. and 41s. cash. On Monday forenoon the quotations were 41s. and 41s. 1d. cash, and in the afternoon 41s. 1d. and 41s. 0½d. cash. At Tuesday's market transactions took place at 41s. 0½d. to 41s. 1d. cash in the forenoon, and 41s. 1½d. cash, and 41s. 3½d. one month in the afternoon. Business was done on Wednesday at 41s. 1d. to to 40s. 11½d. cash. To-day—Thursday—the market was slightly firmer at 40s. 11½d. to 41s. 1½d., closing at the latter figure.

The restricted inquiry for shipping iron has rendered it impossible for the ironmasters to maintain the values of the special brands, most of which show a decline of 3d. to 6d. a ton. The current market values now are:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 52s.; No. 3, 47s.; Coltness, 55s. and 50s. 6d.; Langloan, 55s. and 51s. 6d.; Summerlee, 51s. 6d. and 46s. 6d.; Calder, 52s. and 47s.; Carnbroe, 49s. and 46s.; Clyde, 47s. and 43s.; Monkland, 42s. 3d. and 40s.; Quarter, 42s. and 39s. 6d.; Govan, at Broomielaw, 42s. and 40s.; Shotts, at Leith, 51s. 6d. and 51s. 3d.; Carron, at Grangemouth, 49s. (specially selected, 58s. 6d.) and 48s.; Kinneil, at Bo'ness, 44s. 6d. and 43s. 6d.; Glengarnock, at Ardrossan, 48s. 6d. and 43s.; Eglinton, 43s. and 39s. 9d.; Dalmellington, 47s. and 43s. 6d.

Business continues very quiet in the malleable department, with scarcely any prospect of an early improvement.

There has been a remarkable shrinkage of late in the exports of machinery and manufactured iron and steel goods from the Clyde. For several weeks it was thought that the falling off might be an accident due merely to the arrangements for shipment; but the continuance of light cargoes is now regarded with anxiety, as showing that these branches, which were busy during the greater part of last year, are now also about to experience their season of depression. In the past week the shipments included locomotives and tenders to the value of £18,550, of which 9250 went to Calcutta, £8500 to Bombay, and £800 to Madras. The other kinds of machinery shipped were valued at £8900, the steel goods at £2300, and the iron manufactures at £14,000.

The coal trade has been fairly active in some parts of the country. Domestic consumers are increasing their demands in consequence of the recurrence of colder weather, and the shipments at some ports are very good. This is observable, for example, at Ayr, where 8500 were despatched in the course of the past week. The total coals shipped at that port since 1st January has been 50,952 tons against 38,979 tons for the corresponding period of last year, being an increase of 11,973 tons. At Troon the week's dispatches amounted to 4299 tons. The quantity sent away from the harbour of Glasgow has been 21,568 tons, and at Irvine 2685, and Grangemouth 7863 tons. The steam vessel trade in coals at the last-named port is reported to be well maintained. There is a comparatively poor demand for shipping coals at the harbours of Fifeshire.

A number of gas coal contracts are now coming into the market, and it is probable that they will meet with sharp competition.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE question of railway rates, and the proposal to increase them by several railways traversing Wales, will not pass without a strong opposition. Meetings have been held at Cardiff, Newport, and Swansea, influentially supported, and within the last day or two petitions have been circulating for signature. Mr. C. B. Holland, of Ebbw Vale Works, presided at a meeting of freighters in Newport, Mon., on Tuesday, when the subject was well discussed.

Even the public who are not directly intetested, as coalowners and ironmasters, are showing their objections to the proposed measure, and Mr. Simons, of Merthyr, solicitor to the Coalowners' Association, has given able expression to the opposition, and helped the public materially in forming an adverse opinion. With regard to the coalowners and ironmasters, trade at present is dull, and never was a more inopportune time for increasing burdens. Llandaff, Treforest, and the Merthyr Wireworks, at one time three promising industries, remain closed, and the prospects of a re-start are as remote as ever. Jenkins Steel Works, near Cardiff, are getting into ship-shape, and the promoters are sanguine of a trade for their brand of steel. I hear also hopeful views of the Britannia Steel Works—crucible steel—which will come into better development now that the new line, the joint Rhymney and Great Western, is open. The contractor's plant of this line was dispersed last week, aed realised good figures.

The busiest works are confessedly Dowlais and Cyfarthfa, though they only partake as regards the rail trade of their share of the syndicate. But at both places there is a good deal of life shown; at the first, in carrying out a number of improvements; and at the second, in practically testing the new steel works, which, as I have stated, are working admirably. Cyfarthfa only needs the latest coke oven arrangements—washing machines, &c., to stand at the head of the steel works of the country.

Dowlais is, however, making up for lost time. Mr. Menelaus has a fit successor in his pupil, Mr. Martin, who is now expending large sums in putting the works into a most efficient state. Two additional boilers are being erected to supply the Luhrig Company's patent coal-washing machine, which is further to be supplied with the electric light. Two new foundries are being constructed, one in the upper works for the moulding of steel, and the other in the lower works for ingot moulds; a new cogging mill is to be erected on the site of the old centre Goat Mill, and several of the old and disused furnaces are being transformed for use in the new order of things. These, with other indications which I note in various works, imply some degree of hope, and give a little encouragement in the present dull times.

A minor strike of furnacemen at Port Tennant has been amicably adjusted. Two men were killed by a fall in Deep Duffryn Pit, Mountain Ash, this week, and numerous casualties, including a fatal fall in Castle Pit, Cyfarthfa, are reported.

Cyfarthfa has been busy of late in the coal trade, but briskness is not general; comparing the two weeks, the past and the present, there are more important clearances going on now, and it is significant that a good deal of best steam is being sent to foreign coaling stations. This week cargoes of 2000 tons and upwards to Port Said were common.

The Cardiff Marine Insurance Company has been wound up, but the business of the late company will be carried on by the Northern Marine Insurance Company lately opened at Cardiff.

The plant used in the construction of the Mount Stuart dry docks, Cardiff, is to be sold by auction next week.

Speedy work may now be expected in starting the Cardiff waterworks in the Taff Valley, near Merthyr. The contract for the trial pit to prove the strata beneath has been given to Messrs. Pickthorne. Three thousand men will shortly be at work in this valley, and the utmost expedition is certain for four or five years.

I am glad to see that my note respecting the danger likely to concur by an overflow of the Merthyr reservoirs has received attention officially, and the railways in the valley are on the alert. At the present the effect of the excessive rain is modified by keeping the pipe at the bottom of the reservoir constantly open, but this cannot be maintained, otherwise the population of Dowlais would be without water if a time of scarcity set in.

FLOATING BREAKWATER.—A floating breakwater of novel type is shortly to be put up experimentally on the Sussex coast. The Board of Trade has assented, and although its permission was originally asked with a view to erection at Seaford, after the hearty support given to the scheme at Eastbourne, it is pretty safe to assume that the substitution of Eastbourne will be sanctioned. There is no harbour of refuge between Dover and Portsmouth, and notwithstanding many official recommendations in favour of the construction of such, nothing has yet been done in this direction except the works now in progress at Newhaven. No doubt the great cost of harbour works and breakwaters has thus far deterred enterprise. According to the old principle of solid stone walls carried down to the bottom, the expense of erecting breakwaters is very considerable. At Dover, where there is exceptionally deep water, the cost is £415 per lineal foot, at Plymouth £300, at Alderney £284. Even at Portsmouth the employment of convict labour has reduced it only to £120. By the adoption of the modern system of building upon huge monoliths of concrete—thus far applied only at Aberdeen and Newhaven—the cost has been reduced to £72 at Aberdeen and £52 at Newhaven. For the system now advocated it is claimed by its inventors, Messrs. A. E. Carey and E. Latham, that the initial cost will amount to only £18 per lineal foot. An experiment on a small scale is to be made at Eastbourne, and should that succeed a breakwater will be erected at the same place of sufficient size to afford shelter to 30 or 40 yachts. The proposed breakwater as described by the *Sussex Advertiser* seems to be the same as that of Mr. Grennay Thomas, and consists of a double row of empty iron boxes—to be possibly filled with cork to maintain buoyancy in case of damage by accidental collision or hostile acts in war—running out into the sea in parallel lines. The front facing the sea tidewards has a wedge-like shape. A lattice frame is carried 12ft. below the pontoon, which will—especially when overgrown with seaweed—help to render the pontoon heavy and steady. The breakwater is to be moored by means of an endless cable of phosphor-bronze, and reeved on above water rollers.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

10th February, 1885.

1787. TRICYCLE, H. T. Harris and H. Courteen, Hayling Island.
1788. CYCLES, H. Courteen and H. T. Harris, Hayling Island.
1789. SADDLES of BICYCLES, R. J. Russell, London.
1790. GILLS or FALLERS used in PREPARING WOOL, T. H. Wharton, Bradford.
1791. SHEDDING MOTION for LOOMS, J. Peel, Manchester.
1792. EVER-POINTED PENCIL-CASES, J. Appleby, Birmingham.
1793. SPIRIT MEASURING TAPS, W. Ross, Glasgow.
1794. PERAMBULATORS, W. Powles, Birmingham.
1795. FACILITATING the REMOVAL of SEWING MACHINES, &c., R. T. Grocott, Longport.
1796. STEAM BOILERS, S. Lister, Halifax.
1797. HEATING WIRE, J. M. Wood and R. Hall, Halifax.
1798. LIFTING WATER, H. Stott, Halifax.
1799. HOLDFASTS for CARPENTERS, &c., A. Keighley and A. Watson, Halifax.
1800. LIFE-SAVING APPARATUS, J. W. Robertson, Leith.
1801. ADJUSTABLE HELICAL SPRING, G. P. Lemprière, Birmingham.
1802. ORDNANCE ARTILLERY SMALL-ARMS, C. Jackson, Nottingham.
1803. CONVERTING NON-SAFETY BICYCLES into SAFETY VELOCIPEDES, T. Cummings, Birmingham.
1804. REGISTERING FARES, &c., J. Lott and F. Lott, Liverpool.
1805. LIGHTING, D. M. Nelson and J. L. Bruce, Glasgow.
1806. VERTICAL STEAM BOILERS, A. H. B. Sharpe, Gainsborough.
1807. LOOMS, W. P. Thompson.—(*F. Kesselring, U.S.*)
1808. WINDOW BLINDS, W. P. Thompson.—(*H. E. Willer, U.S.*)
1809. AXLE-BOXES, W. P. Thompson.—(*S. A. Bemis, U.S.*)
1810. CUTTING VELVET, &c., H. Thomas, Liverpool.
1811. SAFETY LAMPS, A. Smith, Liverpool.
1812. ROLLING METAL, H. J. Allison.—(*L. D. Farra, U.S.*)
1813. ELECTROLYTIC LIQUIDS, H. J. Allison.—(*W. E. Case, U.S.*)
1814. FURNACE for HEATING FILES, &c., M. Hague, London.
1815. CIRCULAR SAWS, W. Beckett, London.
1816. BICYCLES and TRICYCLES, W. Bown and E. Corr, London.
1817. VERMIN TRAPS, J. Roberts, Wednesfield.
1818. DRAWING CORKS, J. H. Smiles, Stockton-on-Tees.
1819. UMBRELLAS, &c., A. G. Aaron, London.
1820. APPLYING PEDALS to PIANOFORTES, F. H. Browne, London.
1821. FUMIGATORS, W. D. Luff, Farnham.
1822. FILLING and SYRUPING AERATED BEVERAGES, J. McEwen, London.
1823. LOCKS, F. Jones and J. S. Foster, Birmingham.
1824. CANDLESTICK, W. E. Farrer, London.
1825. STOPPERING BOTTLES, E. Denning, London.
1826. COVERS for STACKS or RICKS, T. Hubbard, Oadby.
1827. MONOCYCLES, A. M. Clark.—(*F. E. Mills and W. McMahon, United States.*)
1828. PARCEL GRIP, E. Nunan, London.
1829. FLANGED PROTECTING FERRULES for BOILER TUBES, I. Morris, Bloxwich.
1830. IRONING APPARATUS, W. H. Davey, and H. and J. Fabian, London.
1831. VOLTAIC BATTERIES, D. G. FitzGerald and T. J. Jones, London.—*25th September*, 1884.
1832. AIR-TIGHT STOPPER for CASKS, C. B. Booth, London.
1833. STEREOTYPE MATRICES, &c., A. J. Boult.—(*O. Mergenthaler, United States.*)
1834. FRICTION BEARINGS, G. W. Shoemaker, Dalton, United States.
1835. TREATING SCRAP and OLD LEATHER, J. Ross, London.
1836. STEAM GENERATOR, W. Fairweather.—(*The Babcock and Wilcox Company, United States.*)
1837. KILNS for DRYING GRANULAR SUBSTANCES, W. Davidson, London.
1838. CRANKS, CRANK PINS, and CONNECTING RODS, J. Lyall, London.
1839. DRAW-BARS for LOCOMOTIVES, T. C. Craven, New York.
1840. CAP SPINNING and TWISTING FRAMES, A. Anderton, London.
1841. ELLIPTIC SPRINGS, W. Davison, London.
1842. PLATFORM WEIGHING MACHINES, G. E. Zethrin.—(*H. R. Lindell, Sweden.*)
1843. TABLE or COUNTER SCALES, G. E. Zethrin.—(*H. R. Lindell, Sweden.*)
1844. TUMBLERS and other GLASS VESSELS, H. Willetts.—(*J. Willetts, United States.*)
1845. PERAMBULATORS, BATH CHAIRS, &c., W. H. Dunkley, London.
1846. AUTOMATIC REGULATOR for COMPOUND ENGINES, W. Dean, London.
1847. DISTRIBUTING CERTAIN MATERIALS and LIQUIDS, J. Tullidge, London.
1848. FILE, F. Podany, London.
1849. MAKING UP PATTERN BOOKS, &c., J. H. Kruse, London.
1850. STRAW TRUSSING APPARATUS, J. Howard and E. T. Bousfield, London.
1851. HEATING LIQUIDS, A. Browne.—(*A. Fromm, M. Ballo, and F. T. Kugler, Hungary.*)
1852. MOTIVE POWER ENGINES and PUMPS, P. W. Willans, London.
1853. DYNAMO-ELECTRIC MACHINES, T. Nordenfelt.—(*O. F. Jönsson, Sweden.*)
1854. ELECTRIC ARC LAMP, T. Nordenfelt.—(*O. F. Jönsson, Sweden.*)
1855. OPENING ELECTRIC CIRCUITS, T. Nordenfelt.—(*O. F. Jönsson, Sweden.*)
1856. SEMI-INCANDESCENT LAMP, T. Nordenfelt.—(*O. F. Jönsson, Sweden.*)
1857. REGULATING the SPEED of MOTOR DRIVING DYNAMO MACHINES, T. Nordenfelt.—(*O. F. Jönsson, Sweden.*)
1858. BELL and other BUOYS, S. B. Goslin and R. A. Stoker, London.
1859. TAPPING MAINS UNDER PRESSURE, O. Brown, London.
1860. GOVERNORS, C. A. Day.—(*W. B. Mason, United States.*)
1861. HEEL COUNTERS for BOOTS and SHOES, O. Imray.—(*R. White, Canada.*)
1862. SECURING DOOR, &c., KNOBS to their SPINDLES, J. Wilesmith, jun., London.
1863. STAINING WOOD, &c., J. Wilesmith, jun., London.
1864. SAFETY SADDLE BAR, W. M. Campbell, London.
1865. FIRE-ARMS, &c., G. Rowell, London.
1866. IRON and STEEL, G. Rowell, London.
1867. FRAME for RACKETS, LAWN TENNIS, &c., C. G. Gill, London.
1868. PROTECTING NITRATE of AMMONIA against DELIQUESCENCE, W. R. Lake.—(*R. S. Penniman, U.S.*)

1869. Packing for Joints, W. R. Lake.—(*G. Boty and J. Lechat, Belgium.*)
1870. Electricity for Stopping Railway Trains, W. R. Lake.—(*R. Sayers, Belgium.*)
1871. Button Fastener, G. Payne, London.
1872. Wood Flooring, A. Putney, London.
1873. Toilet Apparatus, J. H. Dickson, London.

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1874. Knife Sharpeners, J. J. McCann, Birmingham.
1875. Extinguishing Fires, &c., G. A. J. Schott, Bradford.
1876. Gut Fishing Lines, S. Allcock, Redditch.
1877. Machines for Warping in Sections, P. J. Livsey, London.
1878. Securing Ends of Hoops, &c., H. W. Brewtnall, Thelwall.
1879. Application of Carbonaceous Substances to the purposes of Ornament, G. Hirst, Whitby.
1880. Mechanism for Obtaining an Adjustable Stroke Reciprocating Motion, W. Niblett, Bristol.
1881. Projectiles, R. Morris, London.
1882. Catching, &c., Vermin, W. Burgess, Malvern Wells.
1883. Advertising, S. Groves, Birmingham.
1884. Apparatus for Holding Meat, T. F. Finnesey, Liverpool.
1885. Slide Valves, J. Eatock, Liverpool.
1886. Machines Operated by Explosive Gases, J. Robson, Handsworth.
1887. Driving Gear for Velocipedes, P. Angois, Nottingham.
1888. Flooring, G. H. Ellis, Exeter.
1889. Oil Cups, R. C. S. Woods, Wakefield.
1890. Automatically Varying Cut-off in Engines, H. G. Holborow, London.
1891. Furnaces for Treating Refuse, J. Richmond and T. Birtwistle, London.
1892. Golf Clubs, R. and R. Anderson, Edinburgh.
1893. Mitre Frame Cramp, G. R. Hammond, Snodland.
1894. Shuttles employed in Looms for Weaving, J. Holding, London.
1895. Folding Boxes and Cases, R. W. Brumby and S. Clarke, Sheffield.
1896. Building, &c., the Heels of Boots and Shoes, T. Salmon, Kettering.
1897. Preventing Crib Biting by Horses, &c., H. Young, Burgess Hill, Sussex.
1898. Self-locking Setter for Carriages, &c., M. J. Rowley and C. A. Wheeler, London.
1899. Screw Propeller, T. Leitch, Glasgow.
1900. Magnesium Chloride, E. K. Muspratt and G. Eschellmann, London.
1901. Combined Lawn-tennis and Racket-bat, J. E. Gynne, Peckham.
1902. Davy Safety Lamp, R. W. Sedgwick, London.
1903. Furniture Castors, T. Sennett, London.
1904. Breech-loading Fire-arms, G. Jefferies, London.
1905. Expansible Trunks, &c., M. A. Laughton, Putney.
1906. Card Fasteners, D. A. Lowthime, London.
1907. Bicycles, W. Bevan, New Cross.
1908. Meters, &c., H. Stockman, London.
1909. Metallic Tubes for Locomotive Steam Boilers, &c., J. T. Grice, London.
1910. Twisting Machines, P. Smith, jun., and S. Ambler, London.
1911. Torpedoes or Mechanical Mines, J. T. Bucknill, London.
1912. Steaming Fibres, Fabrics, &c., W. Mather, London.
1913. Garden Label, A. H. Stuart-Wortley, London.
1914. Fur-like Fabric from Feathers, C. D. Abel.—(*Messrs. Bacher and Leon, Germany.*)
1915. Picture Frames, H. J. Haddan.—(*J. Brandt and G. W. v. Nawrocki, Germany.*)
1916. Lamps for Burning Mineral Oils, H. J. Haddan.—(*L. Sepulchre, Belgium.*)
1917. Annealing Copper or its Alloys, W. R. Lake.—(*W. Wallace, U.S.*)
1918. Turning Lathes, E. S. Higgins, London.

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1919. Adjustable Prop for Use in Mines, S. Morgan, Birmingham.
1920. Thermometers, C. W. Folkard, Chiswick.
1921. Boiler-feeding Apparatus, B. D. Healey, Liverpool.
1922. Facilitating the Laying of Rails, F. Rouse, Halifax.
1923. Regulating Draughts, E. S. Hellawell and H. W. Bamforth, Halifax.
1924. Controlling, &c., the Flow of Liquids, H. Sutcliffe, Halifax.
1925. Raising and Lowering Carriage Heads, H. W. and W. P. Weatherill, Manchester.
1926. Joint for Socket Pipes, J. Cooper, Halifax.
1927. Bottles, J. Hall, Halifax.
1928. Draw-plate for Fire Ranges, T. Gelder and J. W. Wilson, Halifax.
1929. Cross-finishing Woven Pile Fabrics, T. Cotton, Halifax.
1930. Tobacco-pipes, H. A. and T. H. Mellor, Halifax.
1931. Shearing Machines, E. Martin and T. F. Drake, Halifax.
1932. Combined Slate Pencil Sharpener, Holder, and Point Protector, H. Shaw, Birmingham.
1933. Dials of Watches, &c., H. East, Birmingham.
1934. Treating Iron in the Bessemer Converter, R. Schliwa, L. Gildemeister, and R. Feldtmann, Glasgow.
1935. Adjusting Toilet Looking-glasses, W. Lea, Wolverhampton.
1936. Lock-up Safety Pocket, G. Hayes, Whittington, near Oswestry.
1937. Recovery of Ammonia in the Manufacture of Carbonate of Soda, E. W. Parnell and J. Simpson, Liverpool.
1938. Freeing Carpets, &c., from Dust, R. Park and S. J. Blane, London.
1939. Stoppers for Bottles, E. Woodham and P. Ockenden, London.
1940. Automatic Stench Trap for Water-closets, J. Easby, London.
1941. Carriages for Twist-lace Machines, R. B. Gamble, London.
1942. Lock-nuts, H. B. Young, Barnstaple.
1943. Securing the Frames of Swings, C. J. Sayer, London.
1944. Automatic Water-feeder for Steam Generators, A. Rollason, London.
1945. Grinding and Surfacing Stones, G. Newsum, London.
1946. Avoiding Waste in Using String, &c., J. Bray, London.
1947. Attaching Rudders to Small Boats, A. T. Frampton, London.
1948. Safety Bicycles, J. Lee, London.
1949. Safety Lamps, S. Humble, London, and R. Mellor, West Hallams.
1950. Regulating and Controlling Engines, T. R. H. Fisken and J. E. Weyman, East Greenwich.
1951. Rubbing, &c., Works, S. Bellotti, London.
1952. Condensers, W. J. D. Walker, London.
1953. Advertising, E. J. Hayball, London.
1954. Cast Metal Pulleys, R. Morris and J. Wood, London.
1955. Grinding Quartz, &c., R. Morris and J. Wood, London.
1956. Precipitation of Solid Matter, J. Humphrys, London.
1957. Dog-grates and Fire-places, H. S. Moorwood and J. S. Watson, Sheffield.
1958. Chemical Treatment of Hydrocarbons, R. Punshon and S. H. Beckles, London.
1959. Injectors, H. Holden, R. G. Brooke, and T. H. White, Manchester.
1960. Elastic Fabrics, L. Turner, London.
1961. Chimney Tops and Flues, W. Holt, London.
1962. Adjusting the Movable Parts of Easels, &c., D. T. Lee, London.
1963. Self-inking Endorsing Presses, G. K. Cooke, London.
1964. Spirit or Liquid Level, &c., G. P. Evelyn, London.
1965. Wax Tapers, &c., R. Bell, London.
1966. Compound Drink for Cattle, &c., W. Dibbins, London.
1967. Rotary Printing Machines, W. Millard and T. James, London.
1968. Spherical Rollers, W. Hillman, London.
1969. Card Tables, H. Creagh, London.
1970. Use of Liquefiable Gases, W. R. Lake.—(*Société Knab and Co., Germany.*)
1971. Vertical Steam Boilers, T. Rounthwaite, Manchester.
1972. Bleaching Sugar, C. A. Day.—(*E. O. Foster, United States.*)
1973. Preservation of Stored Provisions, &c., J. H. Johnson.—(*G. Ripberger, Germany.*)
1974. Caustic Baryta, J. H. Johnson.—(*H. Kessler, France.*)
1975. Kilns, J. Watson and J. L. Spoor, London.
1976. Separating, &c., Postage Stamps, &c., A. Browett, London.
1977. Drying in Vacuo, H. J. Haddan.—(*E. Passburg, Russia.*)
1978. Lithographic Ink and Inking Rollers, H. J. Haddan.—(*F. A. Lischke and R. Lauterbach, Saxony.*)
1979. Steam Engines, W. Lowrie, London.
1980. Regulating Gas Lights in Railway Trains, J. Imray.—(*R. Pintsch, Germany.*)
1981. Low-pressure Steam Motor, H. Davey, London.
1982. Decarbonation of Carbonate of Barium, &c., W. L. Wise.—(*R. Radot, France.*)

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1983. Security Stops or Catches for Windows, H. E. Gresham, London.
1984. Scouring Wool, &c., J. and W. McNaught, jun., London.
1985. Cutting and Stamping Leather, &c., C. H. and F. J. Dale, Leicester.
1986. Preventing Smoky Chimneys, &c., F. L. Merritt, London.
1987. Writing Pens, &c., N. Wright, Coventry.
1988. Curling and Cutting Hat Brims, H. H. and A. Turner, Denton.
1989. Warming Hat Brims, &c., H. H. and A. Turner, Denton.
1990. Electric Light Indian Club, T. Crier and T. Clark, London.
1991. Driving Velocipedes, &c., W. Short and J. Allen, Birmingham.
1992. Cutting Nippers made of Wire, W. T. Smith, Birmingham.
1993. Curled Yarn, T. F. Firth, Halifax.
1994. Baths, J. Hamilton, Derby.
1995. Ventilating Buildings, &c., W. Dean, Manchester.
1996. Fastening Shuttle Tips, J. Sellers, Manchester.
1997. Oil Lamps, G. Roby, near Bolton, and G. Roby, Wigan.
1998. Gill Stoves, T. W. Roberts, Bramley, and Yates, Haywood, and Co., Rotherham.
1999. Fastening and Locking Doors, Gates, &c., F. Carruthers, Lockerbie.
2000. Boiler for Circulating Hot Water, R. A. Perrott, Cork.
2001. Concrete Buildings, &c., W. Thompson, Stratford-upon-Avon.
2002. Checking Receipts, &c., J. W. Blakey, Leeds.
2003. Brakes, G. Weston, Sheffield.
2004. Glass Taps, E. J. M. Cetti, London.
2005. Tube Vices, C. Neil, London.
2006. Handles of Cutlery, Whips, &c., C. Ibbotson, Sheffield.
2007. Stoppering Bottles, S. Skeritt, Sheffield.
2008. Agitator and Boiler for Bleaching, &c., A. Whowell, London.
2009. Drying Tins, A. Whowell, London.
2010. Seamless Dress Shields, &c., A. Oppenheimer, London.
2011. Perambulators, Cradles, &c., W. J. Parker, London.
2012. Hands and Dials of Watches, &c., W. Thomas, Birmingham.
2013. Instantaneous Lock Bottle Stopper, A. H. and J. Guy, London.
2014. Preservative Composition, H. J. T. Ford, London.
2015. Applying Leaves of Metal to Veneers of Wood, &c., A. and C. de Bourbon, London.
2016. Forming Projections on Castings, R. Clayton and J. Mason, London.
2017. Feeding Troughs, T. Phillips, London.
2018. Medium for Advertising, H. C. J. Horner, London.
2019. Looms, C. A. Day.—(*G. Crompton, United States.*)
2020. Mincing Sausage Meat, T. Williams, jun., London.
2021. Detachable Handle Bars for Velocipedes, W. Hillman, London.
2022. Lamps, J. H. Ross and R. Nolan, Dublin.
2023. Lamps, C. Barton and W. W. Popplewell, London.
2024. Smoke Tubes, J. H. Johnson.—(*A. Normand et Cie., France.*)
2025. Separating Metals from their Ores, L. Q. Brin and A. Brin, London.
2026. Leather, T. Macdonald and S. L. Evans, London.
2027. Thermometers, J. J. Hicks, London.
2028. Stirrups, S. Duffield and J. H. James, London.
2029. Portable Cinder Sifter, I. Ansell, London.
2030. Steel Studded Jewellery, &c., E. E. Atkins, London.
2031. Handcuffs, A. D. Melson, London.
2032. Roller Bearings, W. R. Lake.—(*La Société Troussel, Faure et Smitter, France.*)
2033. Supporting the Concaves of Thrashing Machines, C. Woolnough, London.
2034. Busks for Stays, J. Dupuis, London.
2035. Kilns for Burning and Drying Bricks, &c., C. Price, London.
2036. Machines for Cutting Laths, &c., W. Ellis, London.
2037. Washing Casks, F. Pontifex, London.
2038. Making Spindles, A. Kershaw, Belfast.
2039. Flour, J. A. A. Buchholz, London.
2040. Scale or Weighing Apparatus, A. G. Brookes.—(*M. G. Cook, United States.*)
2041. Treating Foul and Noxious Gases, J. Horne and S. Hollyman, London.

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2042. Casting Ladles for Casting Iron, &c., A. G. Arfwedson, London.
2043. Navigable Vessels, &c., J. I. Thorneycroft, London.
2044. Embossing Trade-marks, &c., C. H. and F. J. Dale, Leicester.
2045. Padlocks, D. Buggins, London.
2046. Corkscrews, J. L. Shorrock, Manchester.
2047. Washing Machines, J. Hall, Leeds.
2048. Obtaining Hydrochloric Acid, A. McDougall, Penrith.
2049. Locks for Pocket Books, &c., A. G. Brookes.—(*J. Meyer, Germany.*)
2050. Spooling Thread upon Bobbins, S. Bash, Manchester.
2051. Coupling, &c., Railway Vehicles, W. Herald, Manchester.
2052. Thrust Journals of Propeller Shafts, J. and J. M. Thomson, Glasgow.
2053. Compound Engines, H. C. Ashlin and H. Turner, Liverpool.
2054. Bicycle and Tricycle Handles, T. A. Aston, Birmingham.
2055. School of Art Desk and Easel, J. Gough, Birmingham.
2056. Ironing and Laundry Stoves, T. and J. Southall and J. Hall, Worcester.
2057. Drain Traps, S. Cowan, Dalbeattie.
2058. Water-lifting Appliances, S. Hawke, Hayle.
2059. Supplying Oil to the Wicks of Hydrocarbon Oil Burners, E. L. Fenby, Sutton Coldfield.
2060. Burners for Hydrocarbon Oil Lamps, J. Read, Birmingham.
2061. Incubators, J. M. Martin, Edinburgh.
2062. Composite Fenders, J. Halley, London.
2063. Gasaliers, E. W. Wheatley, London.
2064. Fixing Lead Soil and Ventilating Pipes, A. C. Billings and A. D. Middleton, London.
2065. Working Fans or Blowers, J. J. Miller, G. J. Tupp, and H. G. A. Rouse, London.
2066. Electric Arc Lamps, A. Serraillier and F. Ducher, London.
2067. Breech-loading Small-arms, J. C. Mewburn.—(*A. Beer, France.*)
2068. Velocipedes, F. J. J. Gibbons, London.
2069. Portable Dustbins, J. Jeavons and G. Reynolds, Halifax.
2070. Preventing Rust on Metals, A. C. Bagot, Rugeley.
2071. Fastenings for Folding Supports of Tables and Forms, W. M. Hardy, Swanage.
2072. Screens, J. H. Johnson.—(*H. Graepel, Austria.*)
2073. Safety Saddle Bar, N. Buxton, London.
2074. Cruet Frames, C. A. Coombe, London.
2075. Fast and Loose Reed Looms, J. Marshall, London.
2076. Kindling Stuff, G. Gruber, London.
2077. Ejectors, M. W. Household, London.
2078. Artificial Froth, W. H. Beck.—(*M. Marcus, France.*)
2079. Washing Diamondiferous Soil, &c., H. J. W. Raphael and J. Syme, London.
2080. Projectiles for Ordnance, R. Elliott, London.
2081. Incandescent Electric Lamps, O. E. Woodhouse, F. L. Rawson, and T. V. Hughes, London.
2082. Low-water Alarms for Steam Boilers, W. L. Williams, London.
2083. Breech-loading Fire-arms, J. and W. Tolley, London.
2084. Dining Tables, H. C. A. Köhler, Hamburg.
2085. Photography, F. J. Ashburner, London.
2086. Valve Gear for Engines, T. and D. McCulloch and T. White, London.
2087. Sanitary Utensils, I. Greenbury, London.
2088. Railway Chairs, R. Robson, London.
2089. Corking Bottles, &c., W. A. M. Brown and J. M. Porter, London.
2090. Cartridges, H. S. Maxim, London.
2091. Drying Machines, W. A. Gibbs, London.
2092. Catches of Door Locks, A. Campbell and J. Ash, London.
2093. Knitting Machines, A. M. Clark.—(*La Société A. Roux et Cie.*)
2094. Distribution of Electricity for Lighting, &c., G. Forbes, London.
2095. Fire-proof Floors, J. Doulton, London.
2096. Slipways, J. Standfield, London.—19*th May*, 1884.
2097. Power Travelling Cranes, F. W. Walker, London.
2098. Hydraulic Forging Presses, B. Walker, London.
2099. Machinery for Making Network of Metallic Wires, T. Green and J. Whitehead, London.
2100. Method of Purifying Fat, H. H. Lake.—(*J. P. A. Larson, Sweden.*)

16th February, 1885.

2101. Crimping Frilling, &c., by Machinery, C. Jackson, Nottingham.
2102. Photographic Camera Lense Shutters, C. Preston, Birmingham.
2103. Engines, J. Roots, London.
2104. Clocks, &c., with Movable Dials, F. Taylor, Liverpool.
2105. Baling, Cider, and other Presses, J. T. Moore, Crewe.
2106. Electric Stop Motion for Knitting Machines, R. H. Lendrum, Halifax.
2107. Oil Cans, J. Pease and G. A. White, Yorkshire.
2108. Pilasters, H. Hatton, Hereford.
2109. Watch Protectors, J. Adler, France.
2110. Needles, J. Gordon, Sussex.
2111. Tapping Barrels, &c., T. J. E. Davis, Sussex.
2112. Self-locking Changing Dial for Twenty-four Hour Clocks, F. Mitchell, London.
2113. Process of Engraving on Metal, B. Hawerkamp, London.
2114. Apparatus for Spinning Fibres, &c., N. Greenwood, J. Butterworth, and D. Gledhill, Halifax.
2115. Portable Candlestick, C. H. Gunn and W. Houghton, London.
2116. Velocipedes, J. J. Ryan, London.
2117. Electric Telephony, J. G. Lorrain, London.
2118. Fastening Buttons on any Material, A. F. Randall, Northampton.
2119. Centrifugal Sifting Machines, H. J. Haddan.—(*F. Winkler, Saxony.*)
2120. Manufacturing Metallic Casks, P. Legrand, London.
2121. Horse Hoes, F. C. Lake, Essex.
2122. Dynamo-electric Machines, H. Jones, London.
2123. Pumps for Compressing Air and Gases, G. E. Belliss and A. Morcom, London.
2124. Velocipedes, C. W. Lee, London.
2125. Apparatus for Dressing Printing Type, T. Holiday, London.
2126. Vessels for Galvanising Iron, &c., W. H. Luther, London.
2127. Holder to be Used as a Candlestick, L. J. Pirie, London.
2128. Apparatus Employed for Heating Feed Water, J. Kirkaldy, London.
2129. Automatic Grippers, W. Rutherford and T. Thompson, London.
2130. Grease Boxes, W. Rutherford and T. Thompson, London.
2131. Furnaces or Fire-boxes, J. H. Johnson.—(*H. Graepel, Austria.*)
2132. Screens for Separating Grain, &c., W., and H. S. Rainforth, London.
2133. Bowling Apparatus for Playing Cricket, &c., G. Nobes, London.
2134. Top-boots and Long Boots, J. A. and A. L. Thierry, London.
2135. Insulators for Telegraph Wires, W. C. Johnson and S. E. Phillips, London.
2136. Hot Air Engine, M. P. W. Boulton and E. Perrett, London.
2137. Brushing Machine, W. R. Lake.—(*A. Lenormand, France.*)
2138. Sewing Machines, A. Anderson, London.
2139. Explosive Compounds, A. Favier, France.

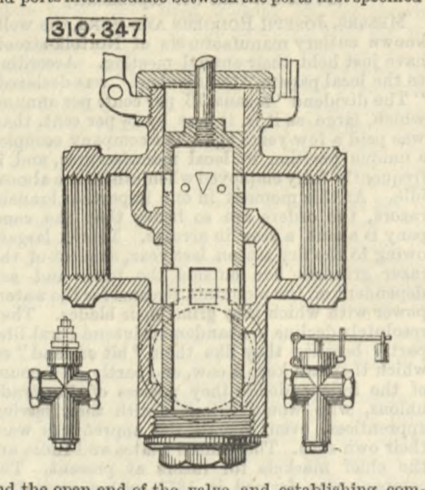
SELECTED AMERICAN PATENTS.

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

310,347. Pressure Regulator, *George Westinghouse, jun., Pittsburgh, Pa.—Filed June 21st, 1884.*

Claim.—(1) In an apparatus for regulating and relieving excess of fluid pressure, a valve having supply ports, delivery ports, and a relief port located, respectively, at different points in its length, said port being adapted by the movement of the valve to effect the supply of fluid when the valve is in certain positions and the relief of pressure when in other positions, substantially as set forth. (2) The combination of a valve casing having supply and delivery connections and a discharge passage, and a weighted tubular valve fitting in said casing and having supply ports, delivery ports, and a relief port located, respectively, at different points in its length, said supply and delivery ports controlling communication between the supply and delivery connections, and said delivery and relief ports controlling communication between the delivery connection and the discharge passage, substantially as set forth. (3) The combination of a valve casing having supply and delivery connections separated by a partition, and a discharge passage on one side of said partition, a weighted tubular valve passing freely through said partition, and having a closed and an open end, ports formed in said valve adjacent to i closed end and controlling communication between the supply connection and the interior of the valve, and ports intermediate between the ports first specified

310,347

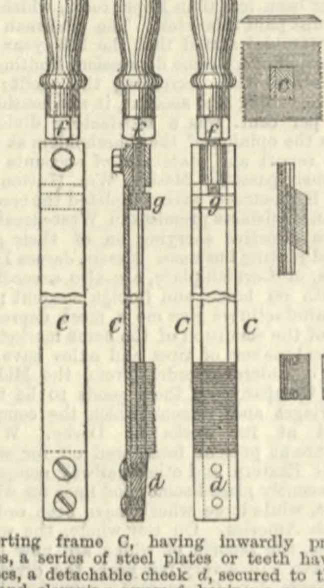


and the open end of the valve, and establishing communication between the delivery connection and the interior of the valve, substantially as set forth.

309,973. File, *Ludwig Müller, Dresden, Saxony, Germany.—Filed November 7th, 1884.*

Claim.—(1) The combination of the supporting frame C, having inwardly protecting flanges, a series of steel plates or teeth having side recesses, and means for clamping the teeth in the supporting frame, substantially as set forth. (2) The combination of the

309,973



supporting frame C, having inwardly projecting flanges, a series of steel plates or teeth having side recesses, a detachable check *d*, secured to the outer end, and clamping screw *f*, having a cross head *g*, arranged at the opposite end of the frame, substantially as set forth.

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