ON THE STEERING OF THE BICYCLE.

By G. T. McCAW, B.E.

THE complexity of the question of the steering of the cycle has, no doubt, revealed itself to the rider who has given the matter any attention. He finds at once that the speed has a preponderating influence on the steering. The intelligent rider soon learns also that the weight and size of the steering wheel have a large effect. Indeed, one frequently is told that the larger the front wheel of the bicycle the better will the machine steer—a statement which contains only a partial truth. The steering, however, is affected by other considerations not so obvious, as the wheel base and the proportion of total weight on the front wheel. The question then arises, Can a general formula be obtained which will include all the foregoing, and by which the proper design of the steering head may be determined?

It is hardly necessary to point out the necessity for correct steering: every experienced rider knows how much less is the fatigue to hands and arms of riding an easily-steered machine. It is therefore desirable that the causes which affect the question should be investigated, and, if possible, a theoretical analysis worked out, from the results of which the best design can be determined beforehand, thus avoiding the waste of time and money entailed by the alternative necessity for a series of experimental tests on the various models.

Since the straight front fork was abandoned in favour of the curved, opinions have varied as to the proper design of the latter. Each maker has his own ideas on the subject, and only in a few cases does success seem to be attained. Thus the variation of the rake—the angle which the steering head makes with the vertical—is considerable. The perpendicular distance from the centre of the front wheel on the steering axis—*i.e.*, the axis of the steering socket—is also very variable. Again, the amount of curvature of the front fork frequently exhibits a difference of opinion. Some consideration should reveal the fact that provided the rake and the perpendicular above mentioned are the same, the particular curvature has no effect on the steering, though for purposes of strength the curvature should be as continuous as possible, and ought not to change abruptly, as in some models of to-day. It is obvious that if the rake and perpendicular distance above are determined, the position of the steering axis is determined; or the axis may be fixed by finding the rake and the point where the axis cuts the line of ground contact.

The following investigation necessarily involves a rather complex analysis; the results are, however, summed up at the end for those who do not care to wade through the mathematics of the subject.

We shall assume, at the beginning of the argument, that the bicycle is moving at a uniform rate on a circular track, and that the banking is such that the surface is perpendicular to the plane of the machine. The resultant, therefore, of the weight and centrifugal force is perpendicular to the surface of the track. In what follows we shall speak of this as the "resultant," and when we speak of a rise or fall of the centre of gravity it is to be understood that the distance is measured on this resultant and not on the vertical. The following are the symbols adopted. The dimensions given are used in some examples at the end:—

W weight of machine and rider, 190 lb.
w weight of front wheel, 4 lb.
R resultant of total weight and centrifugal force.
n fraction of resultant weight on front wheel, $\frac{6}{19}$.
a radius of front wheel, 14in.
k radius of gyration of front wheel, $12\frac{5}{16}$in.
b wheel base, 44in.
v velocity on track, $10\frac{1}{4}$ miles per hour = 15ft. per second.
r radius of track.
α rake of steering head.
θ angle through which the handle-bar is turned.
z the distance from point of ground contact of front wheel to point where steering axis cuts the base.
y length of perpendicular on steering axis from centre of front wheel.

The steering axis is now usually designed to cut the ground in front of the point of wheel contact. In this case a rotation of the handles will have the effect of lowering the centre of the front wheel by an amount we shall call h. Hence, when the cycle is moving round the track, the plane of the front wheel making an angle θ with the plane of the machine, the centre of gravity of machine and rider—considered as one system—will have fallen by an amount $n\,h$. The resultant tends to move the steering wheel further from the plane of the machine; its effect, however, is neutralised by the gyrostatic couple, and correct steering will be assured by equilibration of these opposing forces. We have, therefore, by the principle of work,

$$R \,.\, \delta\,(n\,h) = K \,.\, \delta\,\theta \quad . \quad . \quad . \quad (A),$$

where K is the gyrostatic couple. It will first be necessary to find h.

In Fig. 1 the steering socket is supposed held rigidly in position while the wheel is turned through an angle θ. The wheel is now raised off the ground by the amount h. If the wheel be projected back on the normal plane its figure will be an ellipse, centre O′, and the height of the horizontal tangent to this ellipse will give the required distance.

The equation of the ellipse to the axes is

$$x^2 \cos^2\theta + y^2 = a^2 \cos^2\theta.$$

The equation of the horizontal tangent P′ Y is

$$x \cos\alpha - y \sin\alpha = a\sqrt{1 - \sin^2\alpha \sin^2\theta.}$$

The height of O′ above the base line P Z is

$$a - y\,(1 - \cos\theta)\sin\alpha$$

Hence

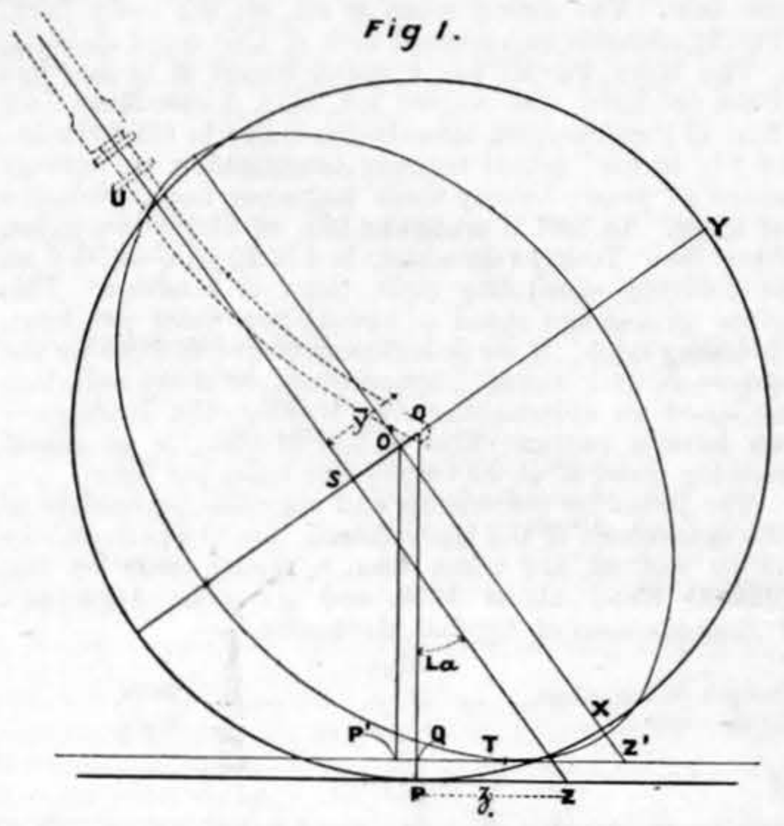
$$h = a - \bar{y}\sin\alpha\,(1 - \cos\theta) - a\sqrt{1 - \sin^2\alpha\sin^2\theta} \quad (B).$$

From this equation it follows that $h = o$ when (1) $\alpha = o$, and (2) when

$$\sin\alpha = \frac{a\,y}{a^2 - (a^2 - r^2)\sin^2\frac{\theta}{2}},$$

or $\sin\alpha = \frac{y}{a}$ approximately, when θ is small. Since under these circumstances $z = o$, we have proved the

Fig 1.



following, which is, of course, otherwise evident. When the steering axis passes through the point of ground contact, h is approximately zero for small values of θ. If there were no gyrostatic action, therefore, the steering axis should intersect the lowest point of the wheel, and this is nearly the correct position when the speed of the cycle is very low.

From equation (B) the following is derived:—

$$d\,h = \frac{\sin\alpha\sin\theta\,d\,\theta}{\sqrt{1 - \sin^2\alpha\sin^2\theta}}\,[a\sin\alpha\cos\theta - y\,\sqrt{1 - \sin^2\alpha\sin^2\theta}] \quad . \quad . \quad . \quad . \quad (C).$$

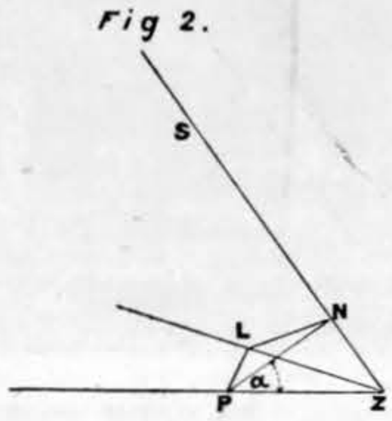
In the second place, it is necessary to find a value for K, the gyrostatic moment. If ω be the angular velocity of rotation of the fore wheel, ϕ its rate of turning round the track, or, as it is called, the angular velocity of precession, then the above quantities are connected by the following equation:—

$$K = \frac{w}{g} \,.\, k^2\,\omega\,\phi \quad . \quad . \quad . \quad . \quad (D)$$

—Perry: "Spinning Tops," p. 90.

Now $\phi = \frac{v}{r}$, and r may be found as follows. Referring to Fig. 2, L Z is the trace of the front wheel as the

Fig 2.



machine travels round the track. If, then, a plane L N P be drawn perpendicular to the steering axes S Z, the angle L N P = θ. Hence when θ is small

$$\theta = \frac{P\,L}{P\,Z\cos\alpha} = \frac{\angle\ P\,Z\,L}{\cos\alpha}.$$

Also, it is evident that $\angle\ P\,Z\,L = \frac{b}{r}$.

Hence $\phi = \frac{v\ \theta\ \cos\alpha}{b}$. Also $\omega = \frac{v}{a}$. Substituting these values of ϕ and ω in equation (D),

$$K = \frac{k^2}{a\,b} \,.\, \frac{w\,v^2}{g} \,.\, \theta\cos\alpha \quad . \quad . \quad . \quad (E).$$

Having thus found expressions for K and $\delta\,h$, we apply these to equation (A), which then becomes, when the increment of θ is taken infinitely small—

$$n \,.\, R \,.\, \frac{\sin\alpha\sin\theta}{\sqrt{1 - \sin^2\alpha\sin^2\theta}}\,[a\sin\alpha\cos\theta - y\,\sqrt{1 - \sin^2\alpha\sin^2\theta}] = \frac{k^2}{c\,b} \cdot \frac{w\,v^2}{g}\cos\alpha\,.\,\theta \quad (F).$$

From this equation y can be found for all values of α.

Suppose, however, that θ is very small, so that the cycle is travelling practically in a straight line, then neglecting $\sin^2\theta$ and putting $\sin\theta = \theta$ and $\cos\theta = 1$, the equation (F) becomes

$$n\ W\sin\alpha\,(a\sin\alpha - y) = \frac{k^2}{a\,b} \cdot \frac{w\,v^2}{g} \,.\, \cos\alpha.$$

But $a\sin\alpha - y = z\cos\alpha$, hence

$$z = \frac{w\,.\,v^2\,.\,k^2}{n\ W\,.\,g\,.\,a\,b\sin\alpha} \quad . \quad . \quad . \quad (G).$$

This neat result gives the value of z corresponding to any chosen rake of head, and hence the position of the steering axis is exactly determined.

In the above investigation we have neglected (1) the friction of the steering head, (2) the ground resistance to rolling, (3) the ground resistance to turning the wheel. Of these the first two need not be considered. The third, however, may not be negligible if the speed is low and the tire soft; however, as the speed increases the friction will diminish, and in the absence of experiments it is doubtful whether this resistance would appreciably affect the result at ordinary speeds with tires properly inflated. It has also been assumed that the speed is constant. Especially in the case of high gears this is not quite true; obviously, however, the machine should be designed for the average speed on the level.

We shall now discuss the practical results which this formula (G) affords. In the first place, it allows a choice of rake, but the angle of rake having been chosen, the position of the steering axis is absolutely fixed, since the formula gives a definite value for z—the distance from point of front wheel contact with base line to the point where the steering axis cuts the ground—corresponding to any chosen value of α, the angle of rake. The choice of this angle, within certain limits, depends on other considerations than the steering, such as strength, stiffness, and general convenience of design. We say within certain limits, because, suppose the angle were excessively increased so that the spring of the front forks became considerable, it is obvious that this in itself would adversely affect the steering; indeed, it may be stated generally that any diminution of strength and stiffness of the fore-carriage will militate against ease of steering, provided, of course, that the position of the axis is correct in the first instance. As an example of the influence of the question of strength in deciding the proper angle, it may be noticed that this angle should be as far as possible chosen that y—the perpendicular distance from the centre of front wheel on the steering axis—may be as small as possible, for it is evident that the greater the distance through which the centre of the front wheel is moved from the plane of the machine, the greater will be the cross strains introduced, and consequently the more will the strength be impaired. With the ordinary safety the limits above mentioned may be 18 deg. and 25 deg.

In the second place, the formula shows the great influence of speed on the steering, for it proves that z increases as the square of the velocity. Again, it demonstrates that the distance z should increase directly as the weight of the front wheel, and approximately as the radius of the same. These three results are conformable to experience. The formula, however, also proves that z should decrease as the proportion of total weight on front wheel, the wheel base, and the rake increase. These latter results, though they follow from the argument, are not so obvious to the expert rider. We shall apply this formula to a few examples.

Example 1.—Taking the case of a safety having the dimensions already given, and supposing the rake to be about $24\frac{1}{2}$ deg., so that $\sin\alpha = \frac{5}{12}$, it follows that z should be 3·32in.

Example 2.—If in the same safety the speed were only eight miles an hour = 12ft. per second, the distance z would be only 2·12in.

Example 3.—If the machine were a tandem—weight of front wheel, $4\frac{1}{2}$ lb.; radius of gyration, $12\frac{1}{2}$in.; wheel base, 66in.; and speed, 18ft. per second ($12\frac{1}{4}$ miles per hour); weight on front wheel, 130 lb.—then, other things being the same, the value of z would be 1·84in.

The following table gives the values of y and z for a single safety of the dimensions stated at beginning of article, the steering angles varying from 15 deg. to 35 deg.:—

α	15°	18°	20°	22°	24°	25°	26°	28°	30°	35°
y	in. −1·53	in. +0·08	in. 1·00	in. 2·20	in. 2·60	in. 2·96	in. 3·31	in. 3·98	in. 4·61	in. 6·06
z	+5·33	4·46	4·03	3·68	3·39	3·26	3·14	2·93	2·76	2·40

In the same way tables may be formed for any speed, size or weight of wheels, weight of rider and machine, &c., and for any type of rear-driven safety or tandem bicycle. The results are also approximately true for tricycles of the Cripper type.

AMERICAN PADDLE-WHEEL STEAMERS WITH BEAM ENGINES.

No. VI.

THE frequency with which the Hudson River steamers have been lengthened has already been commented upon, and the lengthening of the New York by 30ft. in 1897, by cutting it apart amidships, and pulling the bow section ahead 30ft., to make room for a new section, was an operation of exceptional interest. The following particulars are therefore given somewhat in full, from information published in the *Scientific American*, and from drawings furnished the writer by Mr. W. D. Dickie, Superintendent of the Erie Basin Dry Docks, owned by the John N. Robins Company. The New York was taken into the dry dock at Brooklyn, and was placed upon the ordinary arrangement of keel blocks and bilge blocks. The vessel was then cut between the engine and the boilers, the hull being cut at the riveted joints, and the superstructure being cut straight across.

As the forward part was to be pulled ahead, launching ways and cradles were built under this part of the boat. The ways were 102ft. long, placed 10ft. 9in. apart in the clear, and outside of these main ways—3ft. 9in. from them—were additional ways to take the weight of the boilers. The fixed ways were of timbers 10in. deep and 14in. wide, laid upon blocking upon the floor of the dock. Guide pieces 12in. deep were spiked against the outside of these, to keep the sliding ways in place. These sliding ways were timbers, 6in. by 14in., laid flat, and connected at regular intervals by transverse timbers, 12in. by 12in., resting upon them. The contact surfaces of the fixed and sliding ways were planed and smoothed, and were

lubricated with a mixture of fish oil and tallow. The space between the transverse timbers and the hull was filled in with blocks and wedges, while at the forward end were shoring pieces and a short cradle to fit the decreasing width and the taper of the bow.

The hauling arrangements consisted of two 1⅜in. chains which were passed through the hawse holes, one on each side, at the main deck. Each chain was wrapped around four sets of bitts, and secured to a fifth bitt, all along the edge of the main deck. In front of the stem these chains were wrapped together, and the end of each was attached to a five-sheave block. At the head of the dock, two four-sheave blocks were attached each to a 1⅜in. stud chain, these two anchor chains being led back through one of the buildings and secured to a horizontal timber, 12in. by 12in., lying on the ground and bearing against the building. Each five-sheave block was connected to one of the four-sheave blocks by a 5in. manilla rope, and the free end of each rope, returning from the five-sheave block, was led to a steam winch having two cylinders. One of these winches had cylinders 6in. by 10in., and the other had cylinders 6in. by 9in. The steam pressure was 70 lb. per square inch.

Everything being ready, the wedges in the blocking were driven home, raising the forward section of the ship until its weight was carried entirely by the ways. This weight was about 350 tons. A signal was then given and the winches were started simultaneously at a slow speed, the superintendent, Mr. W. D. Dickie, standing on the floor of the dock, under the bow, and directing the men at the winches, until the cut part of the boat reached a mark on the floor of the dock, 30ft. from its original position. The work of hauling occupied 5½ min. The two sections of the vessel were then lined up with piano wire, but the hauling had been done so carefully that the forward section had only to be jacked up $\frac{3}{16}$in. on one side, and the stem to be jacked over 1in.

The fifteen new steel frames had already been made, and the work of putting them in was at once commenced. The framing and plating is similar to that originally used, except that two additional keelsons were put in. These are of ⅜in. plate, and are spaced about 16ft. apart. The cutting out of the rivets in the hull was commenced at 11 a.m., November 11th, 1897, and was completed the same night. The ways were completed by 3.30 p.m. next day, and the forward section was moved, and the new frames secured in place by noon of November 13th. The working time was 17½ hours.

It is estimated that the lengthening will not lessen the speed, as the boat will now trim better, especially with heavy loads, when the passengers crowd to the forward decks, and the boat has a tendency to go too much by the head. In fact, this additional length gives a surplus buoyancy of about 5½in., giving the feathering buckets of the paddle-wheels a better dip with less immersion. It is therefore expected that the wheels will make a greater number of revolutions per minute.

The view—Fig. 30—gives a very good idea of the construction of this ship. In the middle are the new frames of the hull, already set, and the men are passing another frame down the side of the dry dock. To the right is the forward section of the ship, with the main deck "guards" extending out beyond the hull, and supported by inclined braces or struts from the hull frames. Above this is the saloon deck, the open ends of which are boarded up, while the stairways and the companion hatches on the promenade decks are covered in with canvas. Forward of the two companion hatches may be seen the bottoms of the three smokestacks, each with its short escape pipe in front, and forward of this again is the pilot-house, which is entered by a stairway from the promenade deck. The after section of the vessel, at the left of the view, shows the main and saloon decks with their narrow promenades or gangways outside, the latter protected by a canvas awning, while above is the open promenade deck. It will be noted that all the windows are large, and are fitted with sliding sunshades or blinds of polished wood.

No article on the steamers of the Hudson River would be complete without reference to the Mary Powell, a steamer of wide-spread fame for speed. This celebrated steamer has been styled the "Queen of the Hudson" on account of its speed. It is a day boat, running between New York and Rondout, a distance of about 92 miles. It was built in 1861, the hull by M. S. Allison, and the engine and boilers by Fletcher, Harrison, and Company. It was rebuilt in 1874, while the hull was entirely rebuilt by Ward, Stanton, and Company, in 1884, at which time a new engine cylinder, 72in. by 144in., was put in to replace the original cylinder 62in. by 144in. At the first rebuilding the vessel was lengthened about 40ft., but in the second rebuilding no further alterations were made, the lines of the wooden hull being strictly preserved.

Originally it was 260ft. long, 34ft. 6in. beam, 64ft. wide over the guards, and 10ft. 3in. deep, with a draught of 6ft. As rebuilt in 1874, it was 286ft. long on the water-line and 300ft. long over all. It has a gross tonnage of 983 and a net tonnage of 877 tons. The cylinder is 72in. by 144in., and the engine developes 3000-horse power when running under forced draught. The wheels are 31ft. diameter, with twenty-six buckets 10ft. 6in. long and 1ft. 9in. wide, the dip being 3ft. 6in. The two boilers are placed outside the superstructure, on the main deck guards, overhanging the water, aft of the paddle-boxes. The boiler pressure is 45 lb. A donkey boiler is also provided, and for fire protection there is a complete system of piping, kept constantly charged by a Delameter steam pump.

The hull has very graceful lines, and is strengthened by timber hog-frame trusses, as well as by iron rods passing up from the ends and over pole masts. Above the main deck is a superstructure, with saloon deck and promenade deck, each of which extends from the stern to a point about half way between the paddle-boxes and the bow. The dining room is aft, on the main deck. Fig. 31 presents an excellent view of this noted steamer.

The Mary Powell has a speed record of twenty-five miles per hour. On August 7th, 1874, it ran from New York to Poughkeepsie, seventy-five miles, in 3 h. 39½ min., or 3 h. 19 min. actual running time, giving an average speed of nearly twenty-three miles per hour, exclusive of stops. In 1881 it made the trip of ninety-two miles, from New York to Rondout, in 4 h. 12 min.—3.33 p.m. to 7.45 p.m.—including eight stops or landings. This gives an average speed of twenty-two miles per hour, including stops. If we deduct twenty-five minutes for the stops—which is a small allowance in view of the reduction of speed on approaching and leaving the landings—we have a running time of 3 h. 41 min., or an actual running speed of about twenty-five miles per hour.

The following interesting and complete particulars of the dimensions of the Mary Powell, and the performance of its engines, are taken from a report made by Mr. Theron Skeel about 1878, and given in Appleton's "Encyclopædia of Applied Mechanics"—

Ship.

Length on water-line	286ft.
Length over all	294ft.
Beam at water-line	34ft. 3in.
Width over all (over guards)	64ft.
Depth of hold	9ft.
Height from main deck to promenade deck	10ft.
Height from promenade deck to upper deck	8ft.
Draught of water at mean load of passengers and coal	6ft.
Midship section, estimated	200 sq. ft.
Projected area of surface resisting head wind	2000 sq. ft.
Displacement, estimated	28,000 cu. ft.
Length of trip	Five hours and return
Average number of passengers	250
Personnel (exclusive of steward's department): One captain, two engineers, four firemen, four deck hands, two pilots, one clerk, one baggage master; total	15

Engine.

Diameter of cylinder	6ft.
Stroke of piston	12ft.
Piston-rod, diameter	8in.
Air pump, diameter	3ft. 4in.
,, stroke	5ft. 2in.
Shaft, diameter	1ft. 3in.
Journal, diameter	1ft. 3⅝in.
,, length	1ft. 5in.
Crank-pin, diameter	8⅝in.
,, length	10⅜in.
Paddle-wheels, diameter over tips of buckets	31ft.
Buckets, length	10ft. 6in.
,, width	1ft. 6in.
,, number to each wheel	26
Greatest immersion of outer edge of bucket at mean draught	3ft. 6in.
Displacement of piston per revolution	676 cu. ft.
Clearance at both ends of cylinder	25 cu. ft.
Diameter of steam and exhaust valve openings in steam chest	1ft. 2¾in.

Boilers.—Two steel, dimensions of each.

Length over all	26ft.
Cylindrical shell, length	16ft. 1in.
,, ,, diameter	10ft.
Fire-box, length	9ft.
,, width	11ft.
Steam drum, diameter	5ft. 10in.
,, ,, height	12ft.
Steam chimney, diameter	4ft. 2in.
,, ,, sectional area	25 sq. ft.
Furnaces, number	2
,, length	8ft.
,, width	4ft. 10in.
Direct flues, length	9ft. 1in.
,, ,, diameter	2 of 9in., 2 of 14in., 6 of 16in.
Tubes, diameter outside	4½in.
Smokestacks (two), diameter	4ft. 6in.
,, height above grate	68ft.
Grate surface (two boilers)	152 sq. ft.
Heating surface (two boilers)	2660 sq. ft.
Superheating surface (two boilers)	340 sq. ft.
Flues, area	23¼ sq. ft.
Tubes, area	17¼ sq. ft.

Record of Performance for 1877.

Total number of miles run	15,300
Hourly quantities—	
Speed in miles (5280ft.)	19·3
Revolutions	1306
Pounds of coal consumed	5970
,, ,, combustible (ashes 16⅔ per cent.)	4870
,, ,, coal consumed per square foot of grate surface	39·3
Pounds of combustible consumed per square foot of grate surface	32·8
Pounds of coal per square foot of heating surface	2·25
Pounds of combustible per square foot of heating surface	1·88
Temperatures—	
Atmosphere	70 deg.
Hot well	120 deg.
Feed-water	120 deg.
Chimney gas	Zinc melts
Pressures—	
Steam, pounds per square inch above atmosphere	28
Vacuum, inches of mercury	25
Initial pressure, pounds per square inch above zero	40
Pressure at cut-off, pounds per square inch above zero	31·2
Pressure at end of stroke, pounds per square inch above zero	16·4
Mean back pressure	5·6
Pressure at end of cushion, pounds per square inch above zero	40
Mean total pressure, pounds per square inch above zero	29·94
Mean indicated pressure, pounds per square inch	24·34
Mean net pressure, pounds per square inch (friction 1·5)	22·84
Point of cut-off, fraction of stroke	0·47
Point where cushion commences, fraction of stroke	0·80
Power—	
Total horse-power	1899
Indicated horse-power	1540
Net horse-power	1446
Pounds of steam used per hour	42,000
,, steam used per total horse-power per hour	22·1
,, steam used per indicated horse-power per hour	27·3
,, steam used per net horse-power per hour	28·9
,, coal used per total horse-power per hour	3·14
,, coal used per indicated horse-power per hour	3·87
,, coal used per net horse-power per hour	4·13
,, water per pound of coal, from 120 deg.	7·0
,, water per pound of coal, from 212 deg.	7·8
,, water per pound of combustible from 120 deg	8·2
,, water per pound of combustible from 212 deg	9·1
,, water per square foot of heating surface per hour	14

Results of Performance for Two Years.

	1876.	1877.
Number of observations	12	27
Running time, Newburgh to New York, or return, minutes	187·5	182
Distance run in above time, miles	60	60
Revolutions per round trip from Rondout to New York and return	13,100	12,190
Distance as above, miles	90	90

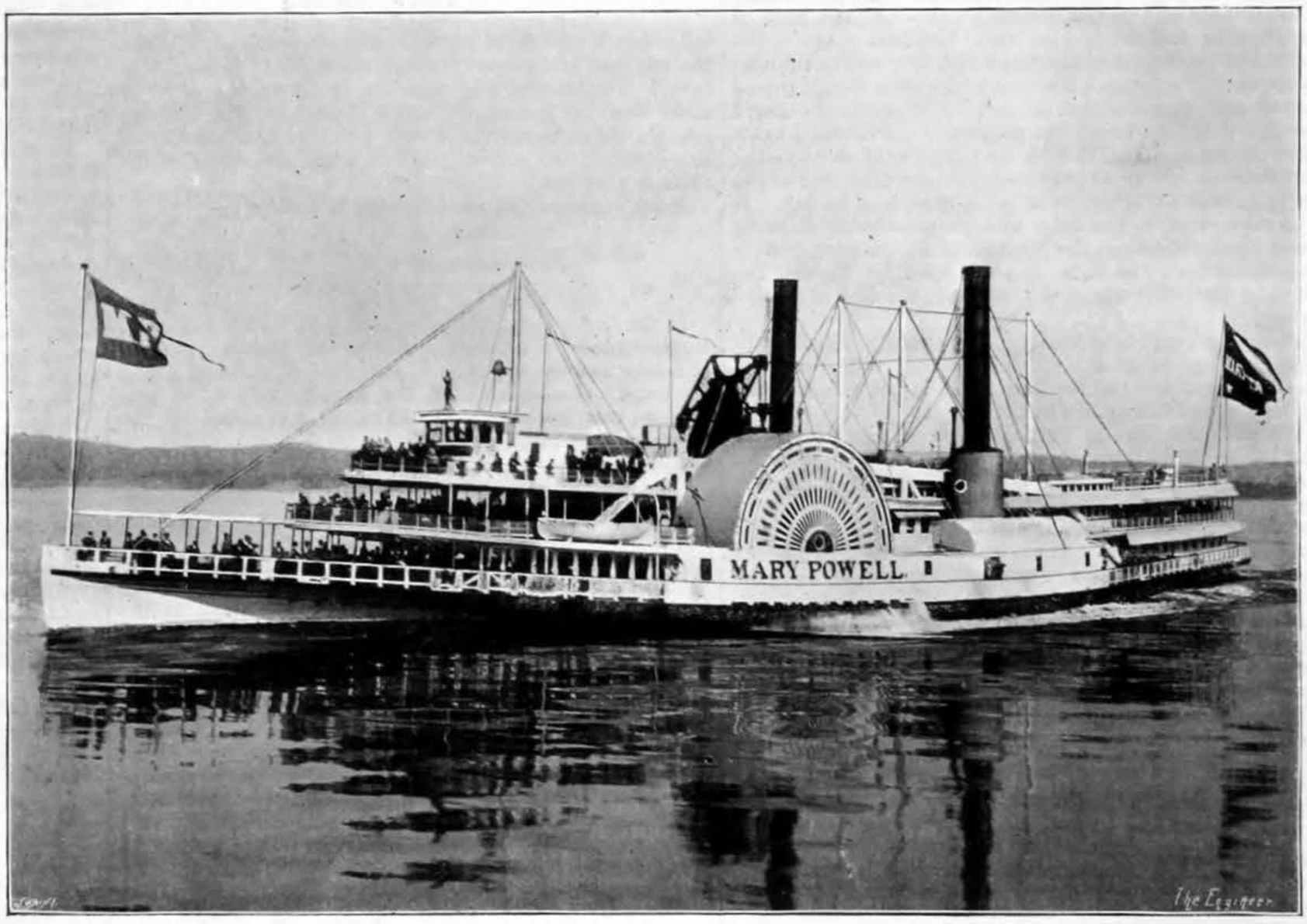


Fig. 31—THE HUDSON RIVER STEAMER MARY POWELL

Revolutions per minute, Newburgh to New York, or return	21·30	...	21·77
Speed in miles per hour, Newburgh to New York, or return	19·20	...	19·80
Coal per round trip, gross tons	22·85	...	24·25
Coal per revolution, pounds	4·57	...	4·37
Slip of wheels, per cent. (calculated for centre of paddle)	14·50	...	11·90
Revolutions from Newburgh to New York, or return	4007	...	3963
Revolutions per mile from Newburgh to New York, or return	66·8	...	66
Revolutions per mile per round trip	72·9	...	67·2

LITERATURE.

The Cofferdam Process for Piers: Practical Examples from Actual Work. By CHARLES EVAN FOWLER, Member American Society of Civil Engineers, Bridge Engineer. First edition. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898.

THE separate classes into which all descriptions of cofferdams may be divided depend upon the presence of several different conditions, which are by no means numerous. In all instances the object to be attained is the same, and consists in an attempt to reach a solid, durable foundation by the best and most economical means at the disposal of the engineer. The principal varying conditions which demand the employment of one or other form of cofferdam are the depth of water, the depth at which the foundation bed must be laid beneath the natural bed of the river, lake, or stream in which the permanent erection is to rest, and the existence of currents, and whether they be feeble or strong. Other points to which consideration must be given are the nature of the strata through which the cofferdam must be driven or sunk, and the character of the foundation bed itself when it is reached. Passing over the historical notice, and the account of some of the primitive and earlier types of cofferdams recorded in Article I., we are introduced in the second to the subjects "Construction, Practice, and Crib Cofferdams." Obviously the simplest case to be treated is that in which the water is shallow, and there is very little or no current. A simple structure of earth, clay, or clay mixed with a small proportion of sand will suffice for the exigencies of all such situations. The thickness of the top of the dam need rarely exceed 6ft., and its height above water 3ft., but the slope of the sides may range 2 to 1 to 3 to 1, according to the consistency of the material of which they are composed. It is this variable quantity which is the chief factor in restricting the employment of earthen cofferdams within their present narrow limits.

Articles II., III., and IV. are devoted to the description of actual examples of cofferdams, their construction, different designs and forms, methods of excavating and dredging, and stopping leaks—an operation which frequently entails a serious amount of trouble, accompanied with much vexatious delay. The various kinds of pile drivers are also enumerated, including the well-known Nasmyth steam hammers. The author draws attention to two cases in which failure occurred. One was due to the excavation of an overlying porous strata not being carried out so completely and effectually as it should have been by the proper dredging operations, and we quite concur in the remark, "This is perhaps the most frequent source of failure of a well-constructed cofferdam." A second example of failure is very suggestive of the influence the form of a cofferdam may have upon its ultimate strength, and carries a warning lesson with it. The dam was circular in shape, and the main piles, consisting of whole balks, were driven down close together until they reached the rock. They were all hooked or tied together at the top by boiler iron about 4ft. in width, and the idea was that, while this iron band would suffice to hold them together at their upper extremity, the thick *couche* of mud overlying the rock would be equally efficacious at their lower end. The event, however, proved the fallacy of the idea. After the first dam—for there were three trials undertaken—had been pumped dry, it suddenly collapsed in less than an hour afterwards. In the second and third experiments the iron boiler-plate hoop was replaced by a strong steel rail, and, in addition, the third specimen was strongly reinforced by a number of tie rods radiating from the centre to the circumference. In spite, however, of all extra precautions, both failed by collapsing before the pumping of them out was accomplished. These three failures in succession led to the abandonment of the circular form, which was perhaps a little premature. It is quite possible that had the structure been strengthened at regular intervals lower down by iron bands or rails, until at least the superincumbent layer of mud had been reached, it would have withstood successfully the pressure upon it.

There are three general cases selected by writers on the design and construction of cofferdams. The first includes single dams, in which the piles are regarded as beams fixed at one end and free at the other—as cantilevers, in fact—and subjected to the action of a uniformly varying load, which may be conveniently treated as an equivalent resultant load acting at the centre of gravity. Under the second category may be classed similar dams, but with the upper extremities of the piles supported by struts fixed at right angles to them. These are exactly in the position of beams supported at both ends, and calculations respecting them can be made on that assumption. The third case is that in which the dam is strutted both at the top and about half down its height. It may be considered also as a beam supported at both ends, and although the distribution of the load is somewhat different from what obtains in the other two instances, yet practically it may be taken as uniform, and applied also at the same point. Simple formulæ are laid down in the text for determining the thickness of the piling, the strength of the waling pieces, and other timbers, and some useful diagrams appended to illustrate the different examples. The author observes that when two rows of sheet piling are to be driven to form a puddle chamber, and there is no internal bracing, the common rule "is to make the width of the puddle chamber equal to the height above ground up to 10ft." When the height exceeds 10ft., add one-third of the excess height to 10ft. for the width. This is Rankine's rule, and is generally accepted by the authors of text-books and treatises on the subject, and probably by professors and others. It does not appear that it is founded upon any particularly trustworthy data, nor is there, so far as we are aware, any accurate method of ascertaining what the proper thickness should be. A certain minimum thickness is indispensable to render the dam water-tight, which, however, varies from about 2ft. to 5ft. Numerous existing examples of cofferdams constructed of sheet piling are described and illustrated in Chapter VI., and Mr. Fowler endorses a statement recently made in our columns by remarking that "the growing scarcity of timber will doubtless lead to the use of metal at some time in the future to replace sheet piling for cofferdams." In the two succeeding "Articles," cylinders, caissons, piers, and cofferdams of metal, including those of the Forth Bridge, are treated of. Some of these were used as cofferdams and some were not, and in the majority of instances they constituted part of the permanent structure. The contents of these articles include a full account of the different types of pumps used from early times.

It may be perhaps fairly asked, is there any reason for describing and illustrating pumps which "are, however, little used." There is just a slight *soupçon* of the trade circular in a portion of the matter in Article VIII. The views of the author are correct in his comparison of the relative merits of the reciprocating and the centrifugal pump, from which he concludes that the latter is essentially a low-lift machine. While not professing to impart any information of an original character, the volume of Mr. Fowler will save those who have an object in perusing it, much valuable time, and greatly facilitate the labour of research.

Elasticität und Festigkeit. Von C. BACH, Professor des Maschinen-Ingenieurwesens an der K. Technischen Hochschule Stuttgart. Berlin: Julius Springer. 1898.

THIS is a very complete treatise on the testing of materials, and on the associated mathematical theories. It is worth the careful consideration of modern engineers in guiding them to the most appropriate designs, and in warning them against the misapplication of material, in excess as well as in defect, both faults being equally capable of conducing to weakness of structure. A notable feature of the work consists of the elaborate photographic diagrams taken of the actual pieces experimented upon, and showing by ruled lines on the surface the deformation of the substance anterior to its destruction by fracture. Testing machines are now plentiful in engineering laboratories, and the present work should form a necessary accompaniment in supplying the requisite theory, and in showing what has already been realised with careful, well-chosen experiments. Without avoiding any essential difficulties, the author has kept his mathematical treatment condensed within reasonable limits. The argument is, however, occasionally difficult to follow where he has been compelled to make some additional assumption to get out of a difficulty, and has not given his readers sufficient warning of the change of front in his argument. According to the note on page 232, the modification of Euler's formulæ for the buckling load of a column, which Rankine attributes to Gordon, had been given some time previously by Navier and Schwarz. In connection with Euler's theory, it is well to investigate the effect of what is called *ganelissement* in French, due to lack of torsional rigidity in a structure, like the too scientifically-designed panel of a bridge, destined to resist stresses in a vertical plane only, and apt to twist and cockle under very slight excentric loading. But perhaps this will extend beyond the scope of the present treatise, which is intended to cover the work and experiments carried out in an engineering laboratory. These experiments are of a totally different character to those niggling minute operations prescribed in the so-called physical laboratory, which must tend to cramp the mind of any engineering student, except an electrical one. The theory of helical springs is treated in an elegant manner on page 57, followed by the discussion of the stresses in thick cylinders and spheres, as required in the design of modern artillery. The author makes a courageous attack on the theoretically intractable problem of the elasticity of plane unstayed surfaces, such as cylinder covers, and by some judicious assumptions arrives at working formulæs of practical utility. Altogether, the work will perform a useful service, if only in showing our young engineers the careful training in habit of mind of their German rivals, whose increasing competition in our own and foreign markets will show that it is not safe to rest on the laurels of an older school of engineering.

Ordinary Differential Equations. By JAMES MORRIS PAGE, Adjunct Professor of Pure Mathematics in the University of Virginia. London: Macmillan and Co. 1897.

THE author has set himself the laudable task of presenting, in an elementary manner to a beginner, the theory of the infinitesimal transformation of differential equations, invented by Professor Sophus Lie, formerly of Leipzig, but recently called to the chair of mathematics of his native country in Christiania, where he carries on the traditions inaugurated by his immortal countryman Abel.

After two short introductory chapters on the ordinary theory, the author starts in Chapter III. on Lie's theory. Ever since the discovery of the infinitesimal calculus, the integration of differential equations has been one of the weightiest problems that have attracted the attention of mathematicians. It is not possible to develope a method of integration for all differential equations, but it was found possible to give theories of integration for certain classes of these equations. All these special theories of integration were regarded by the older mathematicians as different theories based upon separate mathematical methods.

But Lie has shown that it is possible to subordinate all these older theories of integration to a general method; he showed that the older methods were applicable only to such differential equations as admit of known infinitesimal transformations. In this way it became possible to derive all the older theories from a common source, and at the same time to develope a wider point of view for the general theory of differential equation.

The expression "infinitesimal transformation" is ignored as yet in our treatises, so the writer, who had the privilege of hearing in 1886-7 Professor Lie's first lectures on this subject at the University of Leipzig, has done well in popularising the ideas in the present treatise. The engineer may ask how such abstract theory may concern him, to be told that some of the most important differential equations of the dynamics of vibration—say, of the mast of a steamer, or of an electric light installation—would be intractable without the assistance of Lie's researches.

Lectures on the Geometry of Position. Part I. By THEODOR REYE, Professor of Mathematics in the University of Strasburg. Translated and edited by THOMAS F. HOLGATE, M.A., Ph.D., Professor of Applied Mathematics in North-Western University. London: Macmillan and Co., Limited. 1898.

THIS is a subject which, under the name of descriptive geometry, does not flourish in this country, although cultivated to a great extent in Germany. Perhaps Professor Henrici's pupils at the Central Institution are the only followers of the method among us. It requires the combination of abstract and advanced geometrical study with the skill of the draughtsman on the drawing-board, two antagonistic qualities with us. The geometer will rarely take the trouble to use rules and compasses to make a diagram, while the draughtsman is kept at work in a strictly utilitarian spirit. The present volume of 240 pages forms only Part I. We are reminded of the lavish luxuriance of some treatises on graphical statics. We suppose both these subjects have the fascinating facility of, say, trilinears in pure mathematics. The "free use of pencil and paper" is, however, beginning to gain ground with us, as seen from Professor Hele Shaw's British Association "Report," 1892, and the present treatise will give an unlimited supply of interesting exercises.

Five-Plane Logarithmic and Trigonometric Tables. By J. W. NICHOLSON, A.M., LL.D, Professor of Mathematics, Louisiana State University, and Agricultural and Mechanical College. London: Macmillan and Co., Limited. 1898.

FOUR-FIGURE logarithms are quite long enough for the ordinary work of the engineer, and these can generally be cut down to the three-figure logarithms of the slide rule, considering the uncertainty of the physical data on which he has to work. These tables have been prepared chiefly for use in solving the exercises in the author's text-book on trigonometry, where, as in very accurate surveying and geodesy, the angles are supposed to be read to the decimal of a minute. The second part of the book is a collection of the elements of plane and spherical trigonometry, such as would be useful to surveyors on a large and small scale.

SHORT NOTICES.

Hazell's Annual for 1899: *A Cyclopædic Record of Men and Topics of the Day.* Revised to November 22nd, 1898. Edited by W. Palmer, B.A. (Lond.) London: Hazell, Watson, and Viney, Limited. 1899. Price 3s. 6d.—This useful encyclopædia of the principal events of past years and record of arrangements recently made, or of events due to occur shortly, maintains its position by the careful bringing up to date of the quantity of information it contains.

Trigonometry at a Glance: A Graphic Demonstration of the Various Functions. For Class Use and Private Study. By George W. Usill, M.I.C.E., and Frederick J. Browne, C.E. London: George Philip and Son. Price 2s. net.—This "book" consists of two stout cards hinged together, each measuring 10in. by 7½in. On one, besides other figures, there is a circle marked with the trigonometric function, having one end of a loose travelling arm attached at its centre, so that it can be moved up into any radial position. On the other card are printed the functions of angles of 30 deg. and 60 deg., and a transparent triangle of celluloid centred at the corner of a quadrant, about which it can be rotated to show the complementary functions. The cards should be useful to an elementary class with the help of a competent instructor.

BOOKS RECEIVED.

The London University Guide for the Year 1898-9. London: Published at the Univ. Corr. Coll. Press.

Michael Faraday: His Life and Work. By Silvanus P. Thompson, D.Sc., F.R.S. London: Cassell and Co., Limited. 1898. Price 5s.

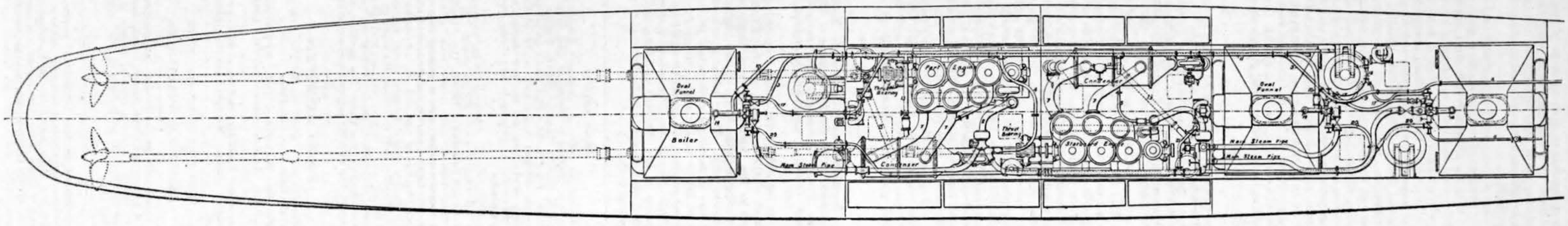
The Witwatersrand Goldfields: Banket and Mining Practice. By S. J. Truscott. London: Macmillan and Co., Limited. 1898. Price 30s. net.

ALMANACS, DIARIES, &c.

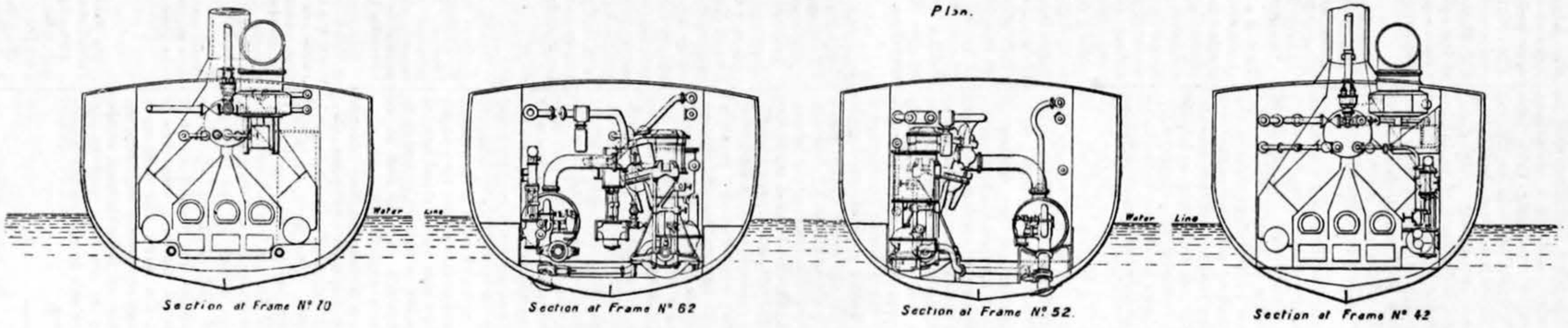
WE have to acknowledge the receipt of a beautifully printed calendar in a leather case, from Messrs. Ismay, Imrie, and Co. There are twelve cards, with two graceful designs by Mr. Linley Samborn, and photogravure productions of views connected with the White Star Line.

IT is announced in the American papers that the United States have secured a site for a coaling station on the Chiriqui lagoon, which is a large inlet from the Caribbean Sea, on the Eastern Coast of Costa Rica. This lagoon is a natural harbour lying midway between Greytown, the probable starting point for the Nicaragua Canal, and Colon, the Atlantic opening for the Panama Canal.

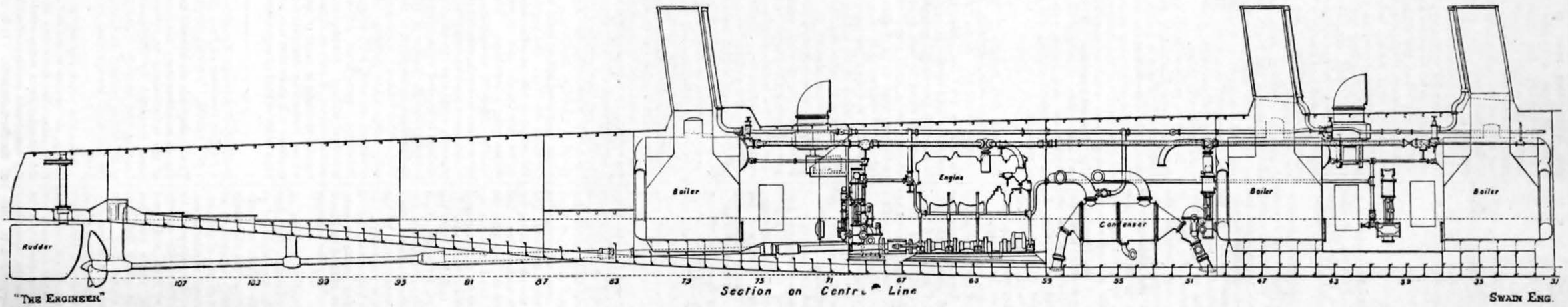
TORPEDO BOATS Nos. 24 to 35, FOR THE UNITED STATES NAVY



Plan.



Section at Frame N° 70 — Section at Frame N° 62 — Section at Frame N° 52. — Section at Frame N° 42



"THE ENGINEER" — Section on Centre Line — SWAIN ENG.

TORPEDO BOATS FOR THE UNITED STATES NAVY.

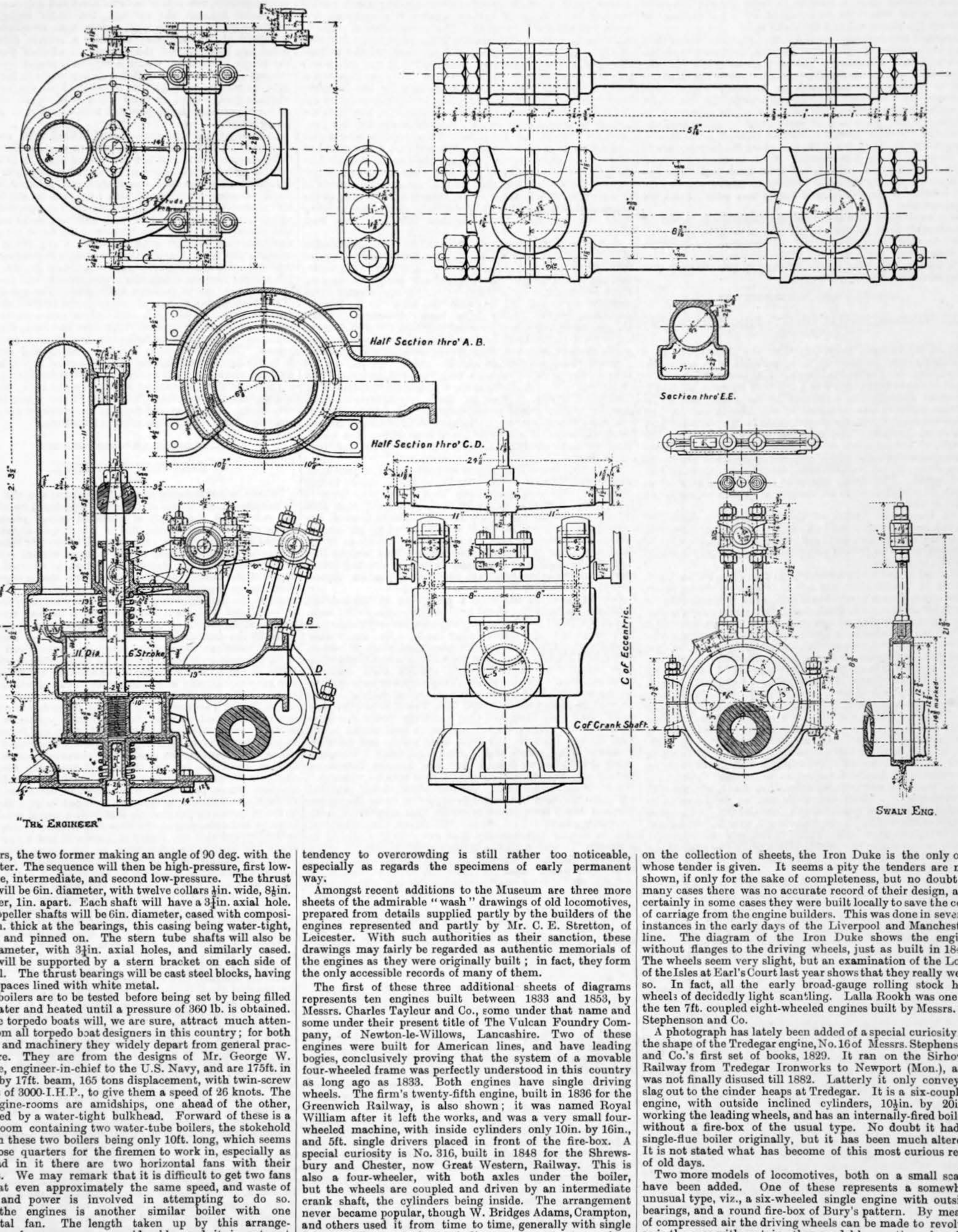
In our impression for October 21st we published an illustrated description of certain torpedo boat destroyers, to be added to the United States navy. We now illustrate certain parts of twelve torpedo boats, which are to be constructed at once, reserving other drawings for another issue. These boats will be of 150 to 170 tons displacement on the trial trip, including an allowance of 9 tons for ordnance, 10 tons for coal, and 8 tons for crew, stores, &c. Each will be propelled by twin screws, driven by vertical engines in separate compartments, steam being supplied by water-tube boilers, and the bunkers having a capacity for at least 40 tons of coal. There will be two conning towers, the forward one built of ½in. nickel steel. The battery will comprise three rapid-firing guns, and on the deck there will be mounted three 15ft. torpedo tubes, with torpedoes, and space must be provided below for storing two additional torpedoes and five war heads. The total weight of all ordnance and ammunition will be 13 tons. There is to be accommodation for twenty-six men and three officers, with provisions for twenty days. The builders are to guarantee a speed of at least 26 miles per hour, and if the boat does not attain a minimum speed of 25 knots per hour on a run of two hours, it will not be accepted. Each boat is to cost not more than £34,000, and is to be completed in twelve months. They are to be of good freeboard and seagoing qualities, and capable of operating at high speed in a moderate seaway. They will be classed as Nos. 24 to 35, and are rated for a speed of 26 knots per hour on a displacement of 165 tons. The main propelling engines —see illustration, page 563—will be of the vertical, inverted, direct-acting, triple-expansion type, with four cylinders, developing about 3000 indicated-horse power at 350 revolutions per minute. They will be placed in separate compartments, with the high-pressure cylinders forward, and low-pressure cylinders aft. The high-pressure cylinder will be 14in. in diameter; intermediate cylinder, 22in.; and the low-pressure cylinders, 25½in. diameter. The stroke will he 18in. Each cylinder will have a single piston valve, operated by the Stephenson link motion. Each main piston will have one piston-rod, with a crosshead working in a slipper guide.

The engine bed-plates will be of cast steel, supported on forged steel keelson plates, and the framing will consist of vertical forged steel columns. There will be two condensers, made of composition and sheet brass, each having a cooling surface of 1240 square feet, measured on the outside of the tubes through which the water passes. Each main engine will have a double-acting air pump, driven from the shaft, and each condenser will have a circulating pump of the centrifugal type.

The crank shafts will be hollow, and made in one section. The shafts, piston-rods, valve rods, connecting and excentric rods, and working parts generally will be of forged nickel steel, The propellers will be right and left, made of manganese bronze. Steam will be supplied by three water-tube boilers, built for a working pressure of 250 lb., having a total grate surface of at least 137 square feet, and a total heating surface of at least 7544 square feet. Each boiler will have its own funnel, and a blower for forced draught. Two of the boilers will be in a compartment forward of the engines, and the third in a compartment abaft the engines. The pump equipment will include two main feed pumps, one auxiliary feed pump, and one fire and bilge pump, each having a capacity of 147 gallons per minute at a piston speed of 100ft. per minute. The weight of all machinery, boilers, auxiliaries, condensers, pipes, stores, and spare parts, pipe, &c., and water in the boilers is not to exceed 79·745 tons.

Each crank shaft will be 6¾in. diameter, and 10ft. 4½in. long, with crank pins 6¾in. by 9in., a 4in. hole being bored through each shaft and pin. The cranks of the high and intermediate-pressure cylinders will be opposite each other, as will be those of the two low-pressure

TORPEDO BOATS FOR THE UNITED STATES NAVY—AIR PUMP



cylinders, the two former making an angle of 90 deg. with the two latter. The sequence will then be high-pressure, first low-pressure, intermediate, and second low-pressure. The thrust shafts will be 6in. diameter, with twelve collars ½in. wide, 8½in. diameter, 1in. apart. Each shaft will have a 3¼in. axial hole. The propeller shafts will be 6in. diameter, cased with composition ⅜in. thick at the bearings, this casing being water-tight, shrunk and pinned on. The stern tube shafts will also be 6in. diameter, with 3¼in. axial holes, and similarly cased. These will be supported by a stern bracket on each side of the hull. The thrust bearings will be cast steel blocks, having collar spaces lined with white metal.

The boilers are to be tested before being set by being filled with water and heated until a pressure of 360 lb. is obtained.

These torpedo boats will, we are sure, attract much attention from all torpedo boat designers in this country; for both in hull and machinery they widely depart from general practice here. They are from the designs of Mr. George W. Melville, engineer-in-chief to the U.S. Navy, and are 175ft. in length by 17ft. beam, 165 tons displacement, with twin-screw engines of 3000-I.H.P., to give them a speed of 26 knots. The two engine-rooms are amidships, one ahead of the other, separated by a water-tight bulkhead. Forward of these is a boiler-room containing two water-tube boilers, the stokehold between these two boilers being only 10ft. long, which seems very close quarters for the firemen to work in, especially as overhead in it there are two horizontal fans with their engines. We may remark that it is difficult to get two fans to run at even approximately the same speed, and waste of labour and power is involved in attempting to do so. Abaft the engines is another similar boiler with one horizontal fan. The length taken up by this arrangement is, of course, very considerable, and it is cut out of the roomiest part of the boat. Not only is the general arrangement quite novel, but the engines themselves are full of novel, or, at least, unusual practice. The bed-plate girders containing the main bearings are only united to each other longitudinally by the hull of the vessel, there being no fore-and-aft girders, as usual in English practice. The engines are, however, well stiffened in both senses by diagonal bracing. We shall illustrate them later.

RAILWAY EXHIBITS AT SOUTH KENSINGTON.

THE important collection at the South Kensington Museum of drawings, models, and relics connected with the early history of railways steadily grows in extent and interest. It is to be regretted that the space allotted to it scarcely expands in proportion, so that the old tendency to overcrowding is still rather too noticeable, especially as regards the specimens of early permanent way.

Amongst recent additions to the Museum are three more sheets of the admirable "wash" drawings of old locomotives, prepared from details supplied partly by the builders of the engines represented and partly by Mr. C. E. Stretton, of Leicester. With such authorities as their sanction, these drawings may fairly be regarded as authentic memorials of the engines as they were originally built; in fact, they form the only accessible records of many of them.

The first of these three additional sheets of diagrams represents ten engines built between 1833 and 1853, by Messrs. Charles Tayleur and Co., some under that name and some under their present title of The Vulcan Foundry Company, of Newton-le-Willows, Lancashire. Two of these engines were built for American lines, and have leading bogies, conclusively proving that the system of a movable four-wheeled frame was perfectly understood in this country as long ago as 1833. Both engines have single driving wheels. The firm's twenty-fifth engine, built in 1836 for the Greenwich Railway, is also shown; it was named Royal William after it left the works, and was a very small four-wheeled machine, with inside cylinders only 10in. by 16in., and 5ft. single drivers placed in front of the fire-box. A special curiosity is No. 316, built in 1848 for the Shrewsbury and Chester, now Great Western, Railway. This is also a four-wheeler, with both axles under the boiler, but the wheels are coupled and driven by an intermediate crank shaft, the cylinders being inside. The arrangement never became popular, though W. Bridges Adams, Crampton, and others used it from time to time, generally with single drivers. The next sheet of diagrams represents various examples of Messrs. R. Stephenson and Co.'s practice from 1825 to 1851, beginning with the first Stockton and Darlington engine, Locomotion, and ending with Crampton's 6ft. single Folkestone, built for the South-Eastern Railway, and shown at the Great Exhibition of 1851. This also has an intermediate crank shaft. The two first engines built with direct action instead of beam or other motion, Messrs. Stephenson's Experiment for the Stockton and Darlington, and America for the Delaware and Hudson line, 1826 and 1828, are shown on this very valuable record, as well as another bogie engine of 1833 for America. Within the last few weeks a sheet of similar diagrams of early Great Western engines has been added to the collection. They are of especial interest now that the broad gauge is no more, and comprise the North Star—this is also on the Stephenson sheet—Vulcan, Lion, Ajax, Fire Fly, Iron Duke, and Lalla Rookh, the dates ranging from 1837 to 1855. Of the whole lot shown on the collection of sheets, the Iron Duke is the only one whose tender is given. It seems a pity the tenders are not shown, if only for the sake of completeness, but no doubt in many cases there was no accurate record of their design, and certainly in some cases they were built locally to save the cost of carriage from the engine builders. This was done in several instances in the early days of the Liverpool and Manchester line. The diagram of the Iron Duke shows the engine without flanges to the driving wheels, just as built in 1847. The wheels seem very slight, but an examination of the Lord of the Isles at Earl's Court last year shows that they really were so. In fact, all the early broad-gauge rolling stock had wheels of decidedly light scantling. Lalla Rookh was one of the ten 7ft. coupled eight-wheeled engines built by Messrs. R. Stephenson and Co.

A photograph has lately been added of a special curiosity in the shape of the Tredegar engine, No. 16 of Messrs. Stephenson and Co.'s first set of books, 1829. It ran on the Sirhowy Railway from Tredegar Ironworks to Newport (Mon.), and was not finally disused till 1882. Latterly it only conveyed slag out to the cinder heaps at Tredegar. It is a six-coupled engine, with outside inclined cylinders, 10½in. by 20in., working the leading wheels, and has an internally-fired boiler, without a fire-box of the usual type. No doubt it had a single-flue boiler originally, but it has been much altered. It is not stated what has become of this most curious relic of old days.

Two more models of locomotives, both on a small scale, have been added. One of these represents a somewhat unusual type, viz., a six-wheeled single engine with outside bearings, and a round fire-box of Bury's pattern. By means of compressed air the driving wheels can be made to revolve, as is the case with certain other model locomotives close by. The model in question is beautifully made, mostly of brass, and represents a passenger engine of about 1837, with inside cylinders 12in. by 18in., and 5½ft. drivers. It was built by Mr. J. Dawson, superintendent at Southampton of the London and South-Western Railway. The other model is of particular interest, having been made by Timothy Hackworth, and retained in his family till quite recently. It is a design constructed to show how an engine built by Wilson in 1826 for the Stockton and Darlington would work if re-built with six wheels coupled and two vertical cylinders driving the trailing wheels. The engine was so re-built, and as the Royal George, No. 5, worked from 1827 to 1842, drawing 130 tons on the level at five miles an hour.

Some fine photographs of the standard passenger and goods tank engines of the Taff Vale Railway, as built at Cardiff by Mr. T. Harry Riches, are shown, as well as models and photographs of the coal tips on the same line at Cardiff

and Penarth. In these the ingenious Thomas-Bachelor box for lowering the coal straight down into the hold of the ship, instead of running it down a shoot and breaking it up, is exhibited. The Midland Railway Company have a model of the vacuum brake, as fitted to their coaching stock, with Mr. T. Clayton's improvements. The brake cylinder is shown swinging upon trunnions, in order to save the space which would otherwise be occupied by a connecting-rod between the piston-rod and the brake lever.

Amongst minor curiosities is a cotton handkerchief printed with twelve views of the trains, stations, and scenery on the Liverpool and Manchester Railway, about 1831. In the centre is an engine of the Samson class, four-wheeled goods, and a description underneath in English, French, and German. In these days of acute competition the idea might be revived, and handkerchiefs with views of the scenery down the line might prove a good speculation at shops near the terminus. Several models of various types of cattle trucks, designed for enabling the cattle to feed on the journey, are to be found at South Kensington. Much ingenuity has been expended upon this subject, but with little benefit, as the animals are usually not at all inclined to avail themselves of any benefits in the direction of dining cars adapted to their requirements.

It is understood that the Museum authorities have already considerably more railway objects of interest than they have room to exhibit simultaneously. They consequently adopt, to some extent, the system of changing the minor exhibits from time to time—not a very satisfactory plan, but the best possible under the circumstances.

THE MINERAL WEALTH OF THE PHILIPPINE ISLANDS.

From a mineral point of view the Americans have apparently very good cause to be satisfied with their new acquisition, the Philippine Islands. The four million pounds which are to be paid to Spain as a sort of compensation, simply represent the value, as estimated by the Americans, of the various public works contained in the islands, and have no reference whatever to the actual value of the islands as producers of revenue. The conquerors will now obtain the benefit of the resources of the islands, and with intelligent management and the well-known energetic direction of the Americans, a very considerable income may reasonably be anticipated. The islands appear to abound in minerals of all kinds, from gold down to oil, though at present silver is not cited as being present.

Mr. George F. Beeker, of the United States Geological Survey, has recently visited the Philippine Islands, and from a report which he has sent in it would appear that coal is to be found, and is at present being mined very largely throughout the Archipelago.

The coal is said to be analogous to the Japanese coal, and to that of Washington, but not to Welsh or Pennsylvania coals, which means to say that it is a highly carbonised lignite or soft bituminous coal. Such coal usually contains a considerable amount of combined water—as much as from 8 to 18 per cent. is not uncommon in lignites such as this—which would render it a bad coal for carrying, but evidently it can be used locally in preference to higher-priced English or other imported coal for a large number of purposes. Unfortunately for the United States it is not, so far as can be judged, at present likely to be of use for marine work. This would have been a magnificent thing for them had it been so, but though for this purpose they will no doubt have to import all they need, the native coal should if properly worked prove of great pecuniary value. Of its kind the quality is high, and on account of its being widely distributed and the seams thick, it should be easily and cheaply mined. There is no information to hand at present as to at what depth it is found, nor as to what special difficulties, if any, are met with in obtaining it. There are, moreover, no details as to its heating value, which presumably is low, like that of the other lignites of the world. Even supposing it to be as low as, say, 4000 British thermal units, which is low even for lignite, it should be easily able to compete with any foreign coal for use on the islands themselves, where labour is most probably exceedingly cheap.

It is urged in disfavour of such coals that they are liable to contain much injurious foreign matter, such as sulphur, and that they are hurtful to boiler plates. There is no evidence at present that sulphur is present to an injurious extent, and before expressing any opinion we should like to see some analyses. It is not unlikely, however, that it is very largely present, considering the volcanic nature of the islands.

Natural gas is said to exist together with the coal in places. This is by no means an unmixed blessing, but may still be turned to good account, and oil seems to be present also, though in what quantity it is not stated. It would seem to be similar to the American oil, and in places it is highly charged with paraffin.

Gold, copper, iron, and lead seem to be the principal metals which are known to exist, at present at all events, though we should be very surprised to hear that there are no others. Gold, however, appears to be present in a large number of places, principally in alluvial deposits, whether in existing streams or in watercourses now destitute of water. It would therefore be readily obtained, no crushing being needed. Copper is reported from many of the islands, and probably is of fairly frequent occurrence, while iron ore is said to exist in abundance in four, at all events, of the islands; and if this is easily obtainable it should turn out to be of great commercial value. Lead has already been mined to some extent, and no doubt as the islands become more and more American other mineral resources will be brought to light, and we may be sure that our cousins across the water will make the best possible use of them.

EAST LONDON WATER SUPPLY.

We are glad to hear that the East London Water Company has at length, after a period extending over more than three months of intermittent supply, been able to resume constant supply in Poplar, Limehouse, Millwall, Ratcliff, Bromley, Loughton, Chingford, Chigwell, and Buckhurst Hill, and that before the end of this week it is expected that the whole of the district served by the company will receive its due amount. We congratulate the company on the termination of what must have been to it a period of anxiety. We stated the other day that it was extremely difficult to obtain any trustworthy information as to the exact state of affairs; and even now it is not easy to get at the whole of the facts of the case. Bit by bit, however, we are learning more about it, Without doubt the watershed of the Lea has this year undergone a period of drought, worse than anything previously recorded. Moreover, the smallness of the total actual rainfall has been accentuated by the way in which it came, namely, in small quantities at a time, and at long intervals. Hence many a small shower fell on ground which simply received it on its dried surface, whence it evaporated, and never reached the river at all. The average flow of water in the river Lea during the months June to October inclusive of this year never exceeded 31·6 per cent. of the average flow, and during September and October it was only 5 to 7 per cent. respectively of the average. This average, moreover, is not one got up for the occasion by the company itself; it has not been concocted and brought forward by the authorities as an excuse in full for deficiencies, but it is the average prepared from careful records made by the Conservancy Board of the river Lea. These records extend over a period of forty-seven years. The previous driest year had been 1874, and when we add that the lowest average flow during the worst month of that year was a trifle over 37 per cent. of the average, and that for the corresponding period of this year the flow in the river only reached 7 per cent. of the average, it will be seen that we are by no means exaggerating when we say that the conditions this year have been phenomenal.

So much, at all events, can be said for the East London Water Company, that it has had great difficulties to contend with, whatever its shortcomings may have been. No doubt, too, the company has had to pay dearly before overcoming these difficulties. The failure of the river necessitated extra pumping—pumping which, with the river in its normal condition, would hardly have been necessary. Then, though no figures are at present available, it is not to be supposed that the East London Company can have got connections made with the other water companies for nothing. Four of these assisted during the crisis. In the case of three of them, the Southwark and Vauxhall, the Kent and the Grand Junction Companies, connections were made by means of mains. Some of these operations rendered necessary some pieces of engineering. Of course, they all cost money, and naturally enough the water obtained through them will have had to be paid for, as well as for that which the New River Company allowed to flow down the river past its intake.

We cannot leave this subject without a word or two upon the action of the London County Council with regard to this company. We have heard many hard things said about it lately, but is it entirely to blame? Is it not true that on all possible occasions the London County Council has opposed not only extension of storage capacity but also of supply? Surely on such an important subject as water supply, a thing of absolute need not only for a healthy life, but for life itself, the companies should be assisted rather than hindered in their desire to render their position beyond chance of breakdown.

One thing which has gone a great way to increase the difficulty has been the doing away with cisterns. We mentioned this in August last. No doubt the sanitary authorities had cause for the action they took. No doubt they have found difficulty in making the inhabitants of certain districts of East London keep their cisterns clean, and when they found this impossible have ordered their removal. They could not—though perhaps they ought to have done so—have realised the possible consequences of such an act, or we venture to think they would have found some other way out of their difficulty; and they certainly would not have permitted the "cheap house" builder, so well known in the East End, to take his cue from their action and build his houses with no cisterns at all. We do not think it too much to say that had every house in the East London Company's district had its cistern, there would have been no "famine." We know of houses in the district which, being provided with cisterns, have had an ample supply of water during the whole of the time of scarcity, while near neighbours, with no cisterns, have been in want. We repeat that which we said in August last, namely, that every builder should be compelled to put a dirt and dust-proof cistern in every house he builds. Uncleanliness, the great objection to their use, would thus be removed, and a reserve of water be always at hand, should it at any time become necessary to discontinue for a short period the constant supply. We learn with pleasure that the East London Water Company is seeking in Parliament, not only for increased powers in connection with storage and supply, but also for the compulsory restitution of cisterns. We sincerely trust that it may obtain all it seeks, and that as a consequence we may hear no more of water famines in East London.

NEW TRAINS FOR THE METROPOLITAN RAILWAY COMPANY.

The Metropolitan Railway Company have recently put on their line a series of new and specially-designed trains that have been built for them by the Ashbury Railway Carriage and Iron Company, Limited, of Manchester, and which are examples of what can be done in the way of making travelling on city and suburban lines, or over short distances, comfortable. The drawings we give to-day as a supplement show the general and detailed arrangements, which have been carried out by Mr. Thomas S. Raney, the company's carriage superintendent. The general dimensions are as follows:—Total length over buffers, 244ft. 1½in.; length of bodies, 39ft. 6in.; width of bodies, 8ft. 3in.; centres of buffers from rails, 3ft. 5in.; centres of bogies, 25ft.; wheel base of bogies, 7ft.; and height inside from floor to roof at centre, 7ft. 2in.

The trains are fitted with the automatic vacuum brake, and consist each of six carriages mounted on four-wheeled bogies, a van being at either end. They are close coupled, and will run as block trains, the vans only being provided with the usual couplings. The bogies and underframes are built entirely of steel, the former of patent flanged plates and the latter of channels. The weight is transmitted from the bolster through a set of helical springs to the swing beam, and thence to the bogie frame. The side bearing springs are of the laminated type, with india-rubber auxiliaries. The bodies of the vehicles are of varnished teak-wood picked out on the mouldings, with gold bands and vermillion lines, the whole train presenting an elegant, well-finished appearance as it stands on the rails.

Two special features of these trains are the heating apparatus and the electric lighting, the former being on the storage principle. A pipe connected to the engine runs underneath the carriages the entire length of the train, having suitable couplings between the vehicles. From this pipe, branches run to the storage heaters, one of which is placed in each compartment. The heater consists of a cylinder containing a non-freezing mixture, and has a steam jacket surrounding it; steam from the engine raises the temperature of the mixture, which afterwards gradually radiates the heat into the compartment. The electric lighting is on Stone's system, by which each carriage is lighted independently, two sets of accumulators and a dynamo being suspended beneath the carriage, the latter being driven from one of the axles in such a way that, no matter what the speed of the train may be, after a certain determined point has been reached, the amount of current passing to the lamps is constant, whilst a regulator placed outside at one end of each carriage switches on the whole or half of the light, as may be desired. The lighting of all the carriages, whether first, second, or third class, is of equal efficiency, each compartment being provided with a couple of 8-candle power lamps.

In their general arrangements and fittings these trains are also quite up to date in meeting modern requirements. The third-class compartments are upholstered in rep, with lace and cord to match, whilst the roof is covered with papier mache decorated with floral and line design, and polished teak fittings, oak-grained woodwork, with fibre mat on the floor are also noteworthy features. The second-class compartments are upholstered in crimson velvet, with buttoned backs and seats and elbow rests under the windows; the doors are padded, and the floor covered with linoleum, a rug being placed beneath the seats bearing the company's monogram. The roof and sides are of papier maché, finished in gold, with a gilt cornice running round the compartment, and the woodwork fittings are of polished mahogany. The upholstering of the first-class is of figured rose-coloured Bagdad moquette finished with silk lace and cord; elbow rests, which when not required may be pushed flush into the back, divide the seats, and all the metallic fittings of the first class are nickel-plated. The woodwork is polished walnut and sycamore with gilt edging, and the roof is of decorated lincrusta, with polished walnut and gilt mouldings. Balanced spring blinds are fitted to all the windows throughout the train, and each compartment is ventilated by means of two "torpedo" air extractors. The sides and floors of the carriages are packed with hair felt to deaden the noise of travelling.

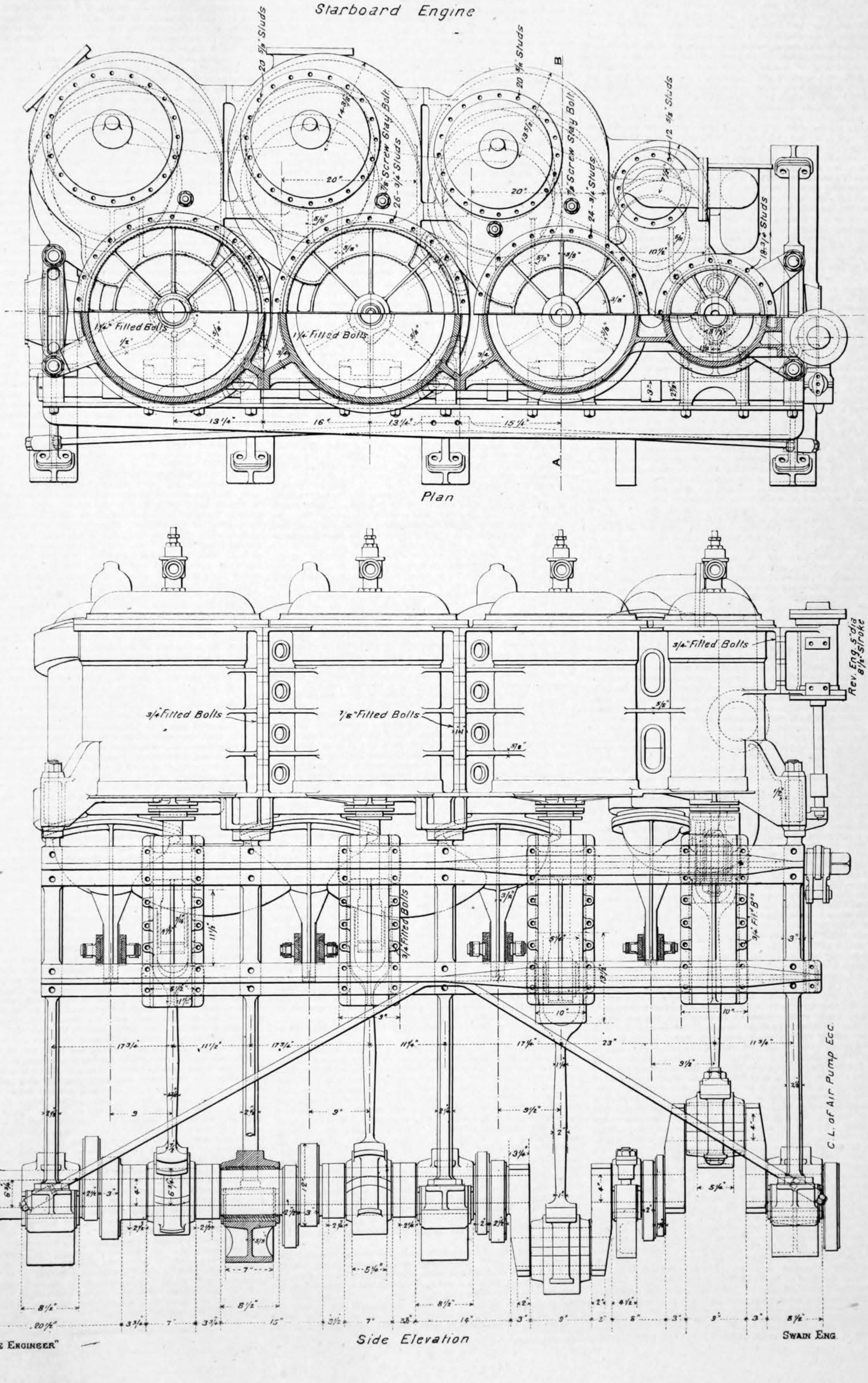
ELECTRIC LIGHTING.

It may be remembered that a few months ago the Select Committee of the House of Commons appointed to consider the question of the supply of electrical energy presented a series of recommendations, one of which was in favour of powers being granted in certain cases to electric light companies to supply electrical energy in areas distant from the district in which the generating station is situated. The report of the Select Committee embodying the recommendations was presented too late for the consideration of Parliament in the past session, and hence it may not unreasonably be concluded that until the Government has had an opportunity of deliberating upon the subject, the suggestions made by the Committee will remain in a state of abeyance. In the meantime, two or three companies have given notice of their intention to apply for powers in accordance with the terms of the recommendation above referred to, whilst one company has already been making strenuous efforts in order to take advantage of the recommendation of the Select Committee before Parliament has thought fit to decide whether the object aimed at shall become legally operative. The company in question—the County of London and Brush Provincial Electric Lighting Company—has been desirous of laying mains from its generating station at Wandsworth across a portion of Lambeth, for the purpose of supplying electrical energy in the district of Camberwell. But the London County Council, whose permission was sought to carry the mains through the districts in question, declined to give sanction to the proposals on the grounds that such a course would lead to great inconvenience at the time of purchase by the local authority, and that the Vestry of Lambeth had no power to grant the company's application to lay mains through a portion of that district. In view of this opposition the company not unnaturally appealed to the Board of Trade as the higher authority, and the result of the appeal was communicated to the London County Council last week in a report submitted by the Highways Committee. It appears from this report that the award of the Board of Trade is in favour of the company, in so far as the works are concerned that are proposed to be carried out within the areas of supply authorised by the Provisional Orders possessed by the company, but excluding any part of the district of Lambeth where the company has no statutory powers. The award of the Board of Trade is, however, coupled with a condition that will doubtless cause considerable surprise. The condition is that the company shall give a written undertaking to the Board that it will, if and when required by the Board, provide a suitable and sufficient generating station within the areas of supply authorised by the following orders:—The Camberwell Electric Lighting Order, 1896; the St. Olave's Order, 1895; the Southwark Order, 1892; and the St. Saviour's Order, 1896, for the supply of electrical energy in those districts. It will be obvious from this decision that the Board of Trade has entirely ignored, as perhaps it is entitled to do, the recommendations of the Select Committee in regard to the supply of electrical energy from a generating station in one district to a distant locality through an intervening area where lighting powers could not be exercised. At the same time it is impossible entirely to dismiss the suspicion that the Board of Trade is very largely consulting the wishes of the London County Council to the detriment of the company, although the latter would have been well advised not to have pressed the point in question before Parliament had had an opportunity of deciding whether to adopt or reject the recommendations of the Select Committee.

Association of Mechanical Engineers.—The annual meeting of the Birmingham Association of Mechanical Engineers was held on Saturday evening at the Grand Hotel, Colmore-row, and there was a large attendance of members and friends. The business included the election of president for the ensuing year. Mr. T. Bernard Hall, in moving the re-election of Mr. J. Cox, for the third year in succession, remarked that his ardent interest in all that affected the welfare of the association, and his endeavours to raise the association to the high level it had attained, were worthy of their sincerest thanks. Mr. Deakin seconded the resolution, which was carried unanimously. Mr. J. J. Innis was re-elected vice-president. Messrs. G. Conaty, W. J. Talbot, H. W. Ward, and T. Judge were appointed members of the council. The President said he was pleased to be able to announce another gift of valuable books to their library from Mr. W. M. Ward.

TORPEDO BOATS FOR THE UNITED STATES NAVY—ENGINES

(*For description see page* 561)



THE MORBID ANATOMY OF IRON AND STEEL SHIPS.*

By Mr. S. J. P. THEARLE, Principal Surveyor to Lloyd's Register of Shipping, at Newcastle-on-Tyne.

VERY recently you have had a lecture delivered to you in this room upon the subject of "Failures." I was not present to hear that lecture, nor am I aware which were the particular failures about which you were spoken to, but I do know that the art of ship construction has been evolved through as substantial a series of failures as any art with which I am acquainted. Not, however, as a rule, by absolute failures, but rather by many partial ones in regard to the particular qualities which have been sought to be attained. By "trial and error" has ship construction, for the most part, been developed, and through the experience gained from failures has each sure advance been made. It is about ships built of steel and iron that I wish to speak to you to-night, and about what is to be learnt from an examination of the diseases to which they are found to be liable. And here let me remark that the title chosen for this paper is a phrase which originated, I believe, with the late William Denny, and it has been adopted by me because it so aptly describes the purport of what I have to say.

The inspection of iron and steel vessels when in course of construction, has undoubtedly a highly educative value in the programme of your studies, but a persistent examination of existing vessels as they come under repair in dry dock or on slipways would be productive of even still more instructive results. In the one case you see the applied results of accumulated experience, but in the other you have presented to you the data itself upon which further evolutionary changes will be based. When examining a vessel about to be repaired you would observe symptoms of weakness being displayed here, indications of unduly rapid decay there, and in many shapes and forms you would be assured that the best known to the builder of that ship was yet short of being the best attainable. Few indeed, are the works of man's hands in which possibilities of improvement are not speedily manifested when they are applied to the purposes for which they are designed. Although the art of shipbuilding in iron is now about fifty years of age, and although mild steel has been in very general use for about fifteen years of that period, yet we are still discovering faults in our newest vessels and still making improvements in their construction. This is partly due to the fact that both steam and sailing vessels are every year being built of larger dimensions than we have hitherto been accustomed to, and with the increase in size there is an attendant augmentation in the stresses to which they are subjected. It is also partly due to the opportunity which the greater lapse of time affords us for observing the relative durabilities of iron and steel at different positions in the vessels' hulls. Time is, indeed, always an important factor in determining the extent and accuracy of our knowledge regarding natural phenomena. "He who lives longest sees most."

So long as vessels were being built of wood, every succeeding decade witnessed great advances in their construction, both in regard to the questions of structural strength and material durability. Never before had wooden ships been built so strongly, and never before were they found to be so free from early decay as at the time when they were displaced by vessels of iron. And so we may reasonably except that the construction of steel vessels will continue to make advances in all the particulars which render them less liable to wear, tear, and decay until some other material comes to take the place of steel as iron took that of wood. Whether or not such a replacement will ever occur I am unable to say, but it would be both unscientific and unwise to deny the possibility. Considering, then, the sailing ship and steamer built wholly or for the most part of mild steel, and of wrought iron where mild steel is not used, let us study for a short time the morbid appearances which are presented when they come under the ship repairer's scalpel and dissecting knife. At the same time let us endeavour to find out to what causes these appearances may be properly attributed and how they may be remedied or cured.

In so doing I propose to classify iron and steel ship diseases under two general heads, namely:—First, diseases of constructional weakness; secondly, diseases of material decay.

First, then consider the diseases of constructional weakness. A ship is a floating structure for the safe conveyance of cargoes, and must be primarily studied as such. But, in addition, she has to be grounded upon blocks in a dry dock from time to time, and hence must not only be strong enough as a floating structure when loaded, but also strong enough for enduring shoring upon blocks in a dry dock when unloaded. Moreover, she must not only be able to endure the structural stresses due to rolling and heaving movements when in a seaway, but also the local stresses due to the blows and buffetings of individual waves and masses of water. Hence constructional weakness includes both structural and local weaknesses. Instances of each of these are occasionally seen in surveying vessels coming under repair.

To range completely over the whole gamut of observation would be manifestly impossible in the limits of time at our disposal this evening. We must therefore be content with the results of but a few anatomical studies grouped under the headings I have indicated.

The substitution of steel for iron in shipbuilding was attended with other results than the mere reduction of weight in the materials necessary for obtaining the requisite structural strength. The chief object sought for in using the stronger metal was doubtless a diminished weight of hull and a corresponding increase in the cargo-carrying capability of the ship, and for this advantage in freight-earning a heavy extra price was paid at first for the steel as compared with that paid for iron. As, of course, you well know, that difference in price has wholly disappeared, and mild steel is now as cheap as wrought iron. But, as I have said, something more was gained than mere freight-earning by the change. The steel vessel is safer than one built of iron. Stresses which break iron plates only bend steel plates; stresses which break iron ships only distort those of steel. And consequently steel ships remain afloat and carry passengers and cargo into port under conditions which would cause the total loss of ships built of iron. At first, this quality seemed to make steel vessels unpopular with underwriters, and this was chiefly due to a singular instance in which a disaster to a steel vessel proved to be more costly to her underwriters than would have been the case had she been of iron. A new steel sailing ship was being towed in ballast to her loading port, and being insufficiently ballasted, she capsized and sank in shallow water near the shore. Steps were at once taken to raise her by passing chain slings under her keel and attaching them at low water to pontoons, which as the tide rose lifted the vessel off the bottom and enabled her to be towed into still shallower water. Now, through some carelessness in carrying out this simple process, the stresses upon the chains were not evenly distributed, and had the vessel been built of iron the chains would have torn some of her iron plating. Being, however, of steel, the plates yielded and bent, while at the same time the whole structure of the vessel became twisted, so that she lost her symmetry of form and had no longer both sides alike. Had she been built of iron the repairs would have been comparatively costless, as the renewal of a few broken plates would have restored her to her former condition. But as the case stood, the owners refused to take the ship from the underwriters until they had made her once more of a symmetrical form. To do this was practically impossible, and so the owners got a new ship and the underwriters recouped themselves so far as possible by selling the first one to a purchaser who was content to sail a ship not perfectly symmetrical in form which he was able to buy cheaply. This accident gave steel ship risks a bad name for a short time, but it very soon became evident to underwriters that "one swallow does not make a summer," and that with steel vessels they had to pay for small damages which would often have been total losses if the vessels had been built of iron. Over and above this consideration is the greater one—namely, that human life is saved which would otherwise have been sacrificed. Both as regards structural and local forms of weakness the morbid conditions observable in steel vessels are fewer and less serious than in those built of iron.

In estimating the intensity of stress on the upper works of a vessel it has been very usual to treat the midship section as the cross section of a loaded beam. You are no doubt familiar with the method whereby the equivalent girder is determined and the maximum bending moment and shearing stress calculated under extreme conditions, such as when supported on the crest or in the hollow of a wave of the vessel's length. Now, in this interesting and in many respects valuable calculation, you will remember that all iron and steel decks, shell plating, inner bottom, &c., are as it were condensed or squeezed so as to form the horizontal and vertical members of an equivalent girder, and the intensity of stress, either extensive or compressive, is determined upon the assumption that the horizontally and vertically-arranged materials in the vessel's hull behave under extension and compression just as the parts of this so-called equivalent girder would. Now, I have no desire to say one word in disparagement of such calculations, which are useful in affording comparative values. But, as an absolute indication of what takes place in the upper works of a vessel steaming among long waves, they are misleading, and the ships themselves show this to be the case.

Deck plating is sometimes torn from hatchway to gunwale without the sheer strake showing any distress, and side plating is torn or the butts of same started without the adjacent deck plating appearing to be concerned in the trouble. A moment's consideration shows why this should be the case. How big a gap do you think would be torn in the upper edge of a sheer strake before the adjacent deck plating would be bent sufficiently to be in tension? Remember the sheer in the deck when thinking this matter out for yourselves. And then, again, how much cross racking would a deck endure before receiving succour from the shell plating? These are the questions which ships answer when under the ship doctor's hands. Their every failure and defect indicates that the primary function of an iron or steel deck is to resist racking stresses, while the duty of the shell plating is to deal primarily with vertical bending moments. Only in their association one with the other as mutual stiffeners and supports does either take a share in doing the essential work of the other. The stringer plate stiffens the sheer strake and helps to keep it from flinching, and the sheer strake, in return, does as much for the stringer. But the upper deck stringer and plating of a ship have not a duty strictly analogous to that of the upper member of an I section beam, and this is notably the case when the sheer strake extends above the deck. For in that condition the upper edge of sheer strake may be ruptured without the deck plating being perceptibly bent. An interesting case illustrating what I am endeavouring to show you came under my notice some time ago. A sheer strake was wounded by the presence of a number of circular lighting and ventilating scuttles, besides having the ordinary relatively weak places at its butt connections. And yet when under a severe hogging stress the sheer strake was ruptured at where a solid half round iron moulding on the upper edge was butted. So you will see that such a simple break in the continuity of strength on its upper edge as was afforded by a 3in. solid cope iron was sufficient to cause failure in the sheer strake to take place at that point. Moreover, the fracture avoided the butts of the sheer strake, and the holes cut for side lights, notwithstanding that one of these latter was only a short distance away. No injury was sustained by the stringer plate, although the vertical flange of the gunwale bar was torn, and the horizontal flange a little bent.

In another vessel, recently come off a stormy Atlantic voyage, the upper deck plating was torn from the corners of a cargo hatchway nearly to the sides of the vessel without a movement being visible in a butt of the side plating. This hatchway was nearly, although not quite, at the middle of the length, but at midships there was a larger opening for machinery, the plating at the corners of which was not torn. Now, why this apparent eccentricity in the tear? Of course there was a reason for it, and one had not to seek far for that reason. Closely adjacent to the tear was a transverse water-tight bulkhead, which contributed an element of stiffness to the plating alongside it. Had the bulkhead not been there distortion would probably have resulted without fracture. But the local stiffness prevented distortion by the racking stresses operating on the deck, and consequently fracture resulted. This does not show such bulkheads to be elements of weakness, but rather the contrary. What it shows is the necessity for seeking the maintenance of continuity of resistance to stresses. The corners of the wide hatchway should properly have been secured with doubling plates—a precaution which is always desirable, and especially so when the large opening is closely adjacent to a stiff transverse bulkhead. Regarding the fracture to the sheer strake, there can be no doubt that the vessel in question was structurally weak, or the sheer strake would not have torn at all, either at the butt of a cope iron moulding or elsewhere. But that the rupture should have occurred at such a place shows how important it is to maintain not only general strength, but continuity of strength of the upper part of the side plating of a vessel. One of the commonest experiences when examining steamers as they come under survey is to find the bulwarks torn at the extremities of a bridge house. It is true that the tendency to such fracturing is aggravated by the frequent presence of water ports and holes, for mooring purposes at those parts of the bulwarks; but in vessels with no bridge houses at all, bulwarks do not tear, either at the ports or anywhere else. It is the sudden break in the continuity of strength in the side plating at the extremities of the bridge house which causes the trouble and necessitates our making the bulwarks much thicker there than elsewhere, in order to avoid it. But a bridge house is not a source of weakness on that account; on the contrary, a bridge house extending over a fairly long portion of the vessel's length is a valuable element of longitudinal strength, provided it be properly constructed. The tendency of recent years is to more and more utilise for structural purposes an erection which was at first designed to serve other uses. Indeed, in vessels of large size and of extra proportions of length to depth, the bridge house covering at least half the midship length is now considered essential to her structural efficiency.

But our study of the morbid conditions of steamers has told us more than that.

I remember cases in which bridge houses were fitted without any regard to their structural uses, but simply on account of the passenger accommodation they afforded, and the protection they gave to the engine and boiler spaces; they were not any more substantial structures than such services necessitated. But what was the consequence? Being the upper member of a deep girder throughout the portion of the vessel's length over which it extended, such a bridge house was necessarily subjected to severe tensile and compressive stresses, when the vessel was pitching and 'scending in a seaway, and having very little plating on its beams, the saloons and cabins beneath could not be kept water-tight. Everywhere in this light superstructure annoying and damaging leaks were continually being experienced, which no caulking of the wood deck with oakum could keep out. Two courses were open to the owners, either to rebuild the structures and make them equal to resisting the stresses which their position in the vessel rendered them liable to, or else to cut them in two across the deck and fit a sliding water-tight joint which would allow of movement without admitting water. The latter was the alternative adopted and the trouble ended.

But this remedy, although suitable in this particular case is yet an unusual one. Good constructors seek to make all the components of a vessel of structural value, whatever may be the primary reason for their presence. And so bridge houses are now-a-days in most cases built in such a way as not only to serve their original purpose in the economy of the vessel's design, but also to take up their share of the stresses she has to endure, and render the whole structure the more efficient by their presence. It is not unusual to reduce the thickness of the sheer strake or even dispense with a doubling to the sheer straked within the limits of the bridge house, by using the material thus saved in thickening the bridge side-plating, especially at its upper strake. In such cases the sheer strake is, of course, always doubled at the bridge ends to avoid discontinuity of strength thereat. And here it is desirable to note one other manifestation which present practice is seeking to obviate. It will be evident to you that while the maximum bending moment is experienced at about the centre of a vessel's length, and therefore at about the middle of the length of the bridge house, the maximum shearing stresses on the bridge side plating will be towards its extremities. Hence, while the tendency to rupture the bridge sheer strake, or to open its butts, is at about the middle of its length, the tendency to shear the rivets in the landings of the bridge side plating is greatest at its extremities. This is often shown to be the case in actual experience. Bridge side plating was, until very recently, connected by single-riveted edge joints, but the number of cases in which the riveting of the edges has been found started and loose at the ends of the bridge showed conclusively what scientific reasoning might have predicted would happen. It is now usual to double-rivet these landings for, at all events, some 12ft. to 20ft. from each end of the bridge, and to treble rivet the butts of the bridge sheer strake throughout. To render a bridge house an efficient structural factor in a vessel it must, of course, have a plated deck, for it is of no use providing against one set of simple stresses without at the same time providing against all. Indeed, in a seaway, when a vessel is pitching, rolling and labouring in all directions in rapid succession, it is only by the complete interaction of all her parts that efficient resistance can be offered to the many and varying stresses being set up.

In the limits of time at our disposal this evening it is impossible to do more than glance at a few of the morbid conditions presented by different parts of vessels when they come under survey. Among those which are due to overwork as distinguished from the presence of disease, may be classed the various phenomena of butt movements.

Sam Weller once asked "Did anyone ever see a dead donkey?" and I would class with that inquiry, "Did anyone ever see a sheared rivet?" I have come across many cases of structural rupture—in one instance that of a vessel broken in two—and many instances of bottoms set up, plating torn and keelsons broken and distorted. Moreover, I have had to do with very many cases of damage by collision in which much material was torn asunder. But I have seen very few sheared rivets, and these for the most part have been in beam cases. From this it would seem that whatever deficiences there may be in the riveted joints of iron and steel vessels the faults are not in the rivets but in the materials riveted. A very old experience with butt joints in shell plating is the rapidity with which they waste at the bilges of comparatively long vessels, more especially when engaged in certain trying trades, as that of the North Atlantic. To obtain the speed desired in passenger service it is found desirable to maintain rather large proportions of length to depth. This, of course, tends, especially in steel vessels, to accentuate any tendency which may be set up in the way of bending in a seaway. Now, I do not suppose that in any well-designed and constructed steamer the bending can be very considerable, but it is easy to conceive that a movement, however slight, is often set up at the butts, and this movement will be greater on the outer than at the inner strakes of the plating, because the latter are afforded so much stiffening at their butts by the overlaps of the former. Moreover, the butt straps to outer strakes, when fitted on the inside of the vessel, do not extend to the full breadth of the butt. Now the corrosion which takes place at these butts is not simple oxidation. The butt joints when found wasted are always blackened, and the iron or steel is found converted into a carbonate of iron, very much resembling plumbago in appearance. I have never heard any authoritative explanation from a chemist in regard to this phenomenon, but there can be no doubt that the corrosion is due to the action of free carbonic acid gas in the sea water upon the iron or steel plating. That this action should be limited to these strakes seems to me to indicate that globulas of carbonic acid gas are imprisoned under great pressure between the butt joints of the plates every time the vessel is placed under a severe bending stress in a seaway. Be this as it may, the remedy of fitting outer butt straps is found to be a sufficient one.

The phenomenon of "panting" is one of interest and importance to naval architects. I suppose all of you have heard of "panting beams," "panting stringers," and so forth, but perhaps a personal inspection of what actual panting is in a ship may not have come under your observation. The term "panting" is suggestive of the phenomenon it serves to describe The tendency to "pant" in a vessel is most observable at the bow, but I have seen cases of panting at the stern also. The shape of a vessel's body throughout the greater portion of her length is such that a transverse section yields a curved frame which in itself is stiff, by reason of its form, against the water pressure on the outside. But towards the bow this curvature diminishes so that the transverse sections at that part are of a flatter form. This is especially the case in sharp vessels, and less so in the full-bowed cargo steamers now so commonly built. But in all vessels, whether sharp or full, the bow is the part that receives the first impact of the sea when the vessel is being driven through waves. As a consequence it has been found that there is a tendency for the comparatively flat sides of a vessel near the bow to yield under the influence of such extra sea pressure. The framing and plating is observed to move like the ribs of a man's body when the lungs are alternately inflated and emptied, or like a dog's ribs when panting. The result of this movement, when long maintained, is to start and loosen the riveting in the frames and shell plating, and in this way not only is the strength of the vessel diminished but her cargo is damaged also. To prevent this movement it is the practice to fit additional beams both before the fore peak bulkhead and for some distance abaft it, and in addition thereto to fit extra stringers and additionally attach them to the beams by means of gusset plates. In all cases the stringers should be wrought intercostally and attached to the shell plating. Even with these precautions, if not sufficient for the purpose, panting still goes on, and the connection between the panting beams and stringers gets torn away. Quite recently when surveying one of our earliest Atlantic Greyhounds I found that her panting beams were all broken clean away from the frames and stringers, and that they had fallen from their places in the fore peak. In this case the attachment between beams and stringers was insufficient to resist the panting stresses. All we had to do was to make the attachment equal in strength to the beams attached, and to ensure that these latter were sufficiently strong. All of which has now been done. I remember once surveying an iron sailing ship having a very fine after body, in which panting beams had been fitted. Upon examination all the panting beam knee rivets were loose, thus showing that not only do vessels "pant" at the after part, but that in this case the "panting" was more than the beam knee rivets could resist. Upon calling a shipbuilder's attention to this case in order to convince him that I was justified in asking him to fit similar panting beams in a vessel building by him, he replied that if the beams had never been put there I would never have known whether the vessel panted or not. This was intended to be smart, but in point of fact the tearing of beam knee connections is the least serious consequence of panting. All shipowners and, in fact, everybody who has to do with the North Atlantic trade, know only too well what a serious thing panting is, and how necessary it is to prevent it. It has been no unusual thing in days gone by for vessels to come under the riveters' hands after every winter Atlantic voyage to make good defects in the neighbourhood of the bow due to panting. It is safest in dealing with this malady to err on the side of too much rather than too little provision of what is commonly spoken of as "panting arrangements," when "arrangements to prevent panting" is meant. At all events, so careful are we now-a-days to brace up and stiffen the bows of steamers, that troubles through panting are becoming scarcer every year.

(To be continued.)

* A lecture delivered to the Glasgow University Engineering Society.

RAILWAY MATTERS.

THE Board of Trade have recently confirmed an order authorising the construction of a light railway from Summerhill-road, in the city and county of Bristol, to Hanham, in the parish of Kingswood, in the county of Gloucester.

WE are informed that Mr. Harry S. Wainwright has been appointed, from January 1st, 1899, locomotive, carriage, and wagon superintendent to the Managing Committee of the joint lines of the South-Eastern Railway and London, Chatham, and Dover Railway.

WE have received a copy of the Christmas number of the *Locomotive Magazine*, entitled "British Expresses, 1898." The number contains fifteen full page plates representing some of the best-known expresses on the leading lines of Great Britain and Ireland. The illustrations are reproduced from instantaneous photographs with really excellent results.

AS a goods train was coming out of the down goods yards near Crewe Station, during Saturday night, to get on to the line for Manchester, it was run into by a light engine, which struck it obliquely, cutting it in two. An engine and several wagons were thrown off the line, and the goods traffic was blocked for several hours. No one was injured. The collision was stated to be due to a signalman's mistake.

ON Tuesday morning a railway accident occurred on the Glasgow and South-Western Railway, near Closeburn, ten miles north of Dumfries. A Glasgow goods express, when going at the rate of sixty miles an hour, broke away, and the second portion dashed into the first after crossing Cample Viaduct. Both up and down lines were blocked, and the English mail and Pullman passengers were delayed for four hours.

AT a general meeting of the London County Council held on the 29th ult., Mr. John Young, at present general manager of the Glasgow Corporation Tramways, was appointed Chief Officer of Tramways for the metropolis. The General Purposes Committee of the Council, to whom the selection of a gentleman for the position had been remitted, after personal interviews, unanimously recommended that Mr. Young be appointed. There were seventy applicants for the post.

THE Science and Art Department has lately placed in position at the South Kensington Museum a large diagram prepared from official drawings, showing seven of the Great Western Company's early locomotives, namely:—North Star, Vulcan, Lion, Ajax, Fire Fly, Iron Duke, Lalla Rookh. They are all drawn to ½in. scale. The Iron Duke has its tender; all the others are without tenders. A list of details and dimensions, and the section of the railway, are also given.

A COLLISION occurred on the Midland Railway on Wednesday at Ynysgeinon, Brecknockshire, resulting in injury to six passengers. Four carriages had been detached from a Swansea train for conveyance to Brynamman, Carmarthenshire. An engine which was sent to take them on got out of control, and dashed with considerable force into the coaches. The guard, who was standing at the end of the rear carriage ready to couple the engine, had a narrow escape, leaping aside just at the moment of the contact. Little damage was done to the rolling stock, but the passengers were badly shaken, and six received contusions and flesh wounds.

APPLICATIONS for light railways are received by the Light Railway Commissioners twice a year, in the months of May and November. The applications received in November, 1898, amounted to fifty-four, under which it is proposed to construct 192½ miles of line at an estimated cost of £3,344,563. This estimate is for construction only, and does not include the cost of plant and rolling stock for their equipment. This is the largest number of applications that has yet been received by the Commissioners in any one half-year. The total number of applications previously received in the four half-years since the appointment of the Light Railway Commission in 1896, amounted to 121 for 1302¼ miles of line, at an estimated cost of £7,555,976 for construction.

IT is publicly notified that in the ensuing session of Parliament power will be sought to incorporate a company to construct a ferry, to be worked by electricity or other power on submerged rails, across the river Thames, with roadways and approaches thereto for the passage of vehicles, foot passengers, animals, and general traffic, as also with generating station and electrical or other machinery and appliances. The ferry as proposed will run from a point at or near the site of Brewhouse-lane, one chain or thereabouts to the west of the Ship Hotel, terminating in the parish of All Saints, Poplar, at or near the western boundary of the Island Gardens. It is proposed to take power to sell or lease the undertaking or any part of it to the Corporation or the London County Council or any corporate body, or to make agreements with such authorities with respect to the construction, management, and maintenance of the undertaking.

THE Tramways Committee of Dundee Town Council have decided to introduce the overhead system of haulage in connection with the tramway system of the city. Professor Kennedy, London, who had been asked to act as consulting engineer, wrote briefly advising the overhead system to be adopted, and maintaining that the conduit principle was as yet only at the experimental stage. Discussing the advisability of delay in deciding to adopt the overhead system, in view of the possibilities of the conduit system, a member of the Council contended that even supposing the conduit system were a success, and the initial expense with it were not less than between £5000 and £6000 a mile more than the overhead system, no one, surely, would be prepared to recommend its adoption. After a few years, if the conduit system were proved a success, nothing would be lost by meantime adopting the overhead system, and subsequently introducing the conduit in the centre of the city. This would simply mean the removal of the posts and wires to some suburban portion of the lines, and the saving in the first year by the adoption of the overhead system would be enough to enable them to meet any losses they had made by having first erected the overhead system and then having to take it down. The proposal to adopt the overhead system was carried by twenty-three votes against four in favour of remitting the matter back for further consideration.

NOTICE has been given of an important railway scheme which will extend to a distance of between fifty and sixty miles, mainly in the county of Lanark, but traversing the northern part of Dumfries-shire. The line, which is called the Glasgow, Motherwell, and Sanquhar Railway, branches off from the City Union Line of the Glasgow and South-Western Railway near Eglinton-street, running south past the east side of Eglinton Toll, goes thence in a south-easterly direction through Govanhill, Rutherglen, Cambuslang, passes near Blantyre, and onward through Stonehouse, Lesmahagow, Douglas, and Crawfordjohn. Several miles beyond Crawfordjohn the line enters Dumfries-shire, and passing Kirkconnel, joins the Glasgow and South-Western Railway about 1000 yards to the south of the present railway station at Sanquhar. Power is sought in the Bill for the construction of branches to the Paisley and Canal Line, and to Hamilton, Motherwell, and Wishaw. It is evident that the object of the line is to bring the Glasgow and South-Western Railway into the coal and iron fields of Lanarkshire. This would give them a valuable traffic to and from their harbours at Irvine, Ardrossan, and other ports on the west coast. The new line will also have the further advantage of affording improved facilities for passenger traffic, and shorten the road from Glasgow to Sanquhar. The Glasgow and South-Western Railway Company are supposed to be the promoters of the scheme.

NOTES AND MEMORANDA.

DURING last month Scotch shipbuilders launched nineteen vessels of 31,213 tons. The aggregate for the eleven months of this year is 409,948 tons, an amount greater than that of any other whole year.

AS the result of experience acquired in the late war with Spain, the United States naval authorities have decided in future to paint their battleships a dead grey colour with a yellowish shade. This mixture is said to approximate most nearly to the colour of rock and of the obscured horizon.

ACCORDING to the returns of the Association of German Iron and Steel Manufacturers, the total German output of pig iron in October was 651,122 tons, which compares with 614,497 tons in September, and with 611,779 tons in October, 1897. The previous largest monthly total was 626,871 tons in January last.

A NEW process is announced for seasoning wood by electrical action. The timber to be treated is put into a quadrangular tank of liquid, immersed to rather more than half its depth, and an electric current applied through a metallic conductor, so arranged as to distribute it throughout the area, and it is stated that in a space of four minutes the sap begins to exude at the lower end of the wood; in six hours it is all extracted. The wood is then placed in another tank from which a septic solution is forced into the pores by an electro-capillary method. If, says the *Builder*, this process has successful results at a cost which will not be commercially prohibitory, it may prove of great importance.

LATEST official statistics of the German Empire show that there is used by the German industries, including commerce and traffic, horticulture and stockbreeding, a total of 3,421,194-horse power. The various sources of power are given in the table following:—

Source.	Horse-power.
Wind	18,364
Water	629,065
Steam	2,715,078
Gas	53,841
Petroleum	7,249
Benzine, gasoline, &c.	3,501
Hot air	1,298
Compressed air	11,162

Electricity was employed in 2245 establishments. In the mining and iron industry there were employed 994,050-horse power, or almost one-third of the total. In the manufacture of foodstuffs 686,279-horse power were used, in the textile industry 514,986, in the machine industry 182,767, and in the chemical industry 83,164.

THERE has been some talk lately about the existence of a lake in the sandstone at Reigate. From the description the *Builder* presumes the upper greensand formation contains it. Some workmen first of all discovered a series of caves, which consist of several chambers about 24ft. by 20ft., and each chamber has a door communicating with the next. On the floor of the first cave broken into washed sand lay to the depth of 4in., showing that running water had been at work, and further search proved the existence of a spring of water. Not content with this wonderful discovery, the floor of the cave was broken up, and the explorers were rewarded by finding a "real lake of pure soft water." No mention is made as to whether fairy boats or the usual accompaniments of such underground finds were seen. Our contemporary presumes that the "dailies" will now give us "underground lakes" day by day; there is plenty of similar material to work upon, and it would be useful from the point of view of water supply. This particular lake is said to be capable of yielding 500,000 gallons of soft water per day. The "caves" alluded to are doubtless old stone mines.

BEFORE a meeting of the members of the Royal Scottish Society of Arts, held recently at Edinburgh, Mr. Gilbert Thomson, C.E., read a paper on "Drain Testing," in which he advocated a standard system. Since the desirability of having an air-tight system of house drainage was first recognised, many improvements had, he said, been made both in construction and in methods of testing. At present the standard of construction appeared to be rather above the standard of ordinary testing. For new work it was desirable to have a positive, and not only a negative proof of soundness. Two such tests were available, and frequently used—the water test and the air test. The latter was the more generally applicable, and might be made a standard to which all drains and pipes put in under building bye-laws might be made to conform. So far it had usually been applied in a rough-and-ready fashion, and even then was much superior to smoke. It could easily be made to give exact numerical results, and the suggestion was that bye-laws and specifications should not stipulate in general terms that the work was to be satisfactory, but that it should stand an air pressure of so many inches of water, and should retain it without perceptible loss for so many minutes.

AT a recent meeting of the Society of Naval Architects and Marine Engineers, held in New York, a paper was read on "Portable Pneumatic Riveters in Shipbuilding," by Mr. W. I. Babcock. The author stated that with portable pneumatic riveters and in-deck and tank-top work three men and a heater boy would drive from 800 to 1000 rivets in a day. As to the quality of the work done, it was stated that the rivets are first-class in every respect, while the saving over hand riveting was from one to two cents. per rivet, or 4000 dols. to 5000 dols. in a 4000-ton steamer. Another important advantage was that the high-handed riveter could be replaced by unskilled labour. In the discussion which followed one speaker stated that at the yard of Messrs. Harland and Wolff an immense gantry spanned the whole ship under construction and carried the riveter on special cranes, which themselves travel up and down and bring to bear a pressure of from 40 to 50 tons on the rivet, the plant being specially designed for work on the Oceanic. The firm had ordered a duplicate plant for smaller work. In replying, Mr. Babcock said that the reason he favoured pneumatic over hydraulic riveters was that the former could be manipulated by hand, and there was no reason why 2in. rivets could not be driven satisfactorily. The gantry crane was, he added, an extremely expensive construction.

AT a meeting of the Institution of Engineers and Shipbuilders in Scotland recently held, Mr. A. E. Shute read a paper on "Feed-water Filters." The author referred to the danger of permitting foreign substances to enter boilers, and said that by the great improvements in evaporators, which were really filters or separators dealing with matters in solution, no sulphate or carbonate of lime or salt need ever be found in a boiler. Some filter deposit was found to contain 60·7 per cent. of organic matter and moisture and 39·3 per cent. of mineral matter. Of the former, 37·8 per cent. consisted of fatty acids, and 15·3 per cent. mineral oil. Oil, when deposited on the heating surfaces of a boiler, was one of the chief causes of loss of efficiency, collapse of furnaces, and straining and buckling of fire-box plates. Oil being lighter than water, one would naturally think, he remarked, that it would remain on the surface, but, as shown by Professor Lewes, it did get below the surface. Oil, if used at all—either directly in the engines or indirectly in swabbing piston and valve-rods—should, he said, be purely mineral oil, and not mineral oil adulterated with vegetable or animal oil or fats, as the latter, besides furnishing the fatty acids, were dangerous from the property they possessed of being converted into a state whereby they could enter into solution with the feed-water, and thus pass any filter made. Mineral oil did not possess this property in anything like so marked a degree, and could, therefore, be trapped on its way to the boiler.

MISCELLANEA.

WE understand that the first meeting in the New Year of the Institution of Mechanical Engineers will be held in their new home at Storey's Gate.

IT is said that the bicycle season of 1899 will see the introduction into this country of a "fifteen dollar" machine by one of the largest manufacturers in the United States. What next?

THE steamer Londonian, of the Wilsons and Furness-Leyland Companies, has been found abandoned and in a sinking condition in the Atlantic. She carried no passengers, but her crew of eighty are missing.

ON Saturday last a fire broke out in the Royal Arsenal at Ferrol, and effected damage, it is estimated, to the extent of 4,000,000 pesetas. The naval stores and fittings ready for the Cardinal Cisneros battleship were burned.

THE Admiralty have ordered Messrs. Laird Brothers, Birkenhead, to build two twin-screw sloops, to be named the Mutine and Rinaldo. They are to be similar to, but rather larger than, the Rosario and Condor, building at Sheerness.

THE United States Consul at Bogota has informed Mr. Hay, Secretary of State, that the Colombian House of Representatives has rejected the petition of the Panama Canal Company to extend for six years the time for completing the canal. The company has still six years to carry on work.

THE Margate surf boat, Friend of all Nations, was lost on Wednesday night, the 30th ult., whilst attempting to reach a steamer in distress. It is a singular coincidence that the occurrence happened on the anniversary of the capsizing of the boat last year. All the hands were saved by the tug Harold, which was on her way from the Thames to the Dover harbour works.

THE Clan line steamer Drummond foundered on Thursday, the 1st inst., in the Bay of Biscay. She left Liverpool on the 28th ult. for Algoa Bay, Port Natal, and Delagoa Bay, with sixty-two persons on board, thirty-five of whom were drowned. The Clan Drummond was a screw steamer of 2908 tons gross, built at Glasgow in 1882, and belonged to Messrs. Cayzer, Irvine, and Co. According to the survivors a huge sea carried away the bridge, and the vessel sank almost immediately.

MANUFACTURERS contemplating sending travellers to Denmark should bear in mind that commercial travellers in that country are placed under certain restrictions. Every traveller must have a licence, for which he is taxed about £9. The licence is available for a year, and has to be inspected by customs and police authorities in all the towns he calls at. If he omits to show his licence he is liable to a fine not exceeding £5, and if he commits the offence a second time he is liable to have his licence cancelled and be politely requested to get out of the country. He must also have a certificate, drawn up in legal form, properly accrediting him to his firm, while if he represents more than one firm he will have to pay one half of the amount of the tax for every firm he represents.

THE new naval dry dock soon to be built by the Government at Boston, U.S.A., will have the following dimensions, according to a published interview with officials of the Navy Department:—Length, 750ft.; width on floor, 80ft.; width at top, 114ft.; width at entrance, 95ft.; depth to floor, 40ft.; depth on sill, 30ft. It will be built of granite, or concrete faced with granite. The steel caisson gate will be about 95ft. long, 36ft. deep, and 24ft. beam. The pumping plant will include three 45in. centrifugal pumps. If built entirely of granite, about 576,000 cubic feet of cut stone and 1,390,000 cubic feet of rubble masonry will be required; if concrete faced with granite, the quantities would be about 256,000 cubic feet cut granite and 1,710,000 cubic feet of concrete.

IT is rather singular, says *Fairplay*, that whilst the name and praises of James Watt are annually remembered on Clydeside on the recurrence of his birthday, there is not a British steamer afloat larger than a lighter bearing the great engineer's name. Formerly there was a James Watt tramp steamer belonging to Greenock, but she was sold to foreigners and had her name changed some years ago. The same owners followed up the James Watt with the Newcomen, which has also been sold to foreigners, and now figures under another name. So that there is a clear field for the owners of some of the numerous boats now building on the Clyde to do honour to the memory of notable engineers of the past by bestowing their names on their vessels, which would be much more appropriate than the extraordinary names adopted by some Clyde owners for their boats.

THE arrangements for the development of liquid fuel appear to be making progess at the Admiralty as well as in mercantile circles. The experiments on the torpedo boat destroyer Surly are encouraging, and are leading to further developments, says *Fairplay*. Different kinds of oil are to be tried so as to ensure that favourable results are not dependent on one kind of fuel only. There is no structural difference between the general arrangements of a torpedo boat destroyer for burning coal as compared with burning liquid fuel; but, so far as detailed modifications are concerned to enable liquid fuel to be burnt, the change can be effected inexpensively and without laying up a vessel for any great length of time. In the new destroyers which are about to be built, the possibility of the future addition of liquid fuel arrangements will, according to our contemporary, be kept in view, and in the meantime the experiments and arrangements for the continuous supply of liquid fuel are to be pushed on.

THE packing of the American cotton bale is again causing trouble abroad, regardless of the repeated warning of American consuls on this head, says an American contemporary. Reports from Liverpool say that English companies are refusing to insure against loss from "wet and mud damage" due to loose and badly-packed bales of American cotton. It is estimated that the claims arising from cotton thus damaged and delivered at Liverpool during the last season will aggregate 500,000 dols. The English insurance companies sent an agent to the United States to investigate the cause, and the blame is placed partly upon the producer and partly upon the transportation companies. A closer and better woven covering is urged; but the chief requisite seems to be greater care in both packing and transport, and some decrease in the belief that foreign nations must take our cotton "any how." Indian and Egyptian cottons are active competitors, and the splendid condition in which cotton from these countries arrives in England is a very sharp contrast with our own.

THE productive resources of all the main shipbuilding centres being now taxed to the uttermost, shipyards and engine works both on the Clyde and the North-east coast are not only being extended, but others, inoperative and partly dismantled for some time, are being re-started as overflow establishments by firms whose orders compel such a step, or by new firms whose prospects justify it. At Port Glasgow, Messrs. Hamilton and Co. are re-starting the Newark yard, which has for years been inoperative; at Yoker, the shipyard formerly occupied by Messrs. Napier, Shanks, and Bell, is being again set agoing by a new firm, Messrs. Napier and Miller, Limited; the shipyard at Ardrossan formerly carried on by the Ardrossan Shipbuilding Company is about to be re-started by a new proprietary, the representatives of which hail from Glasgow, Sunderland, and Newport. At Londonderry the Foyle Shipbuilding and Engineering Works, which under various managements have produced important shipping in the past, are again about to be set agoing under the management of two experienced and practical gentlemen from the Clyde and the Newcastle districts. Much of the plant is being renewed with the latest and most improved machinery, and the works will shortly be in operation on all classes of work.

THE IRON AND STEEL INSTITUTE.

No. VIII.

OUR pleasant reflections on the old-world charms of Laxå were soon interrupted by our arrival at Degerfors, which is on the line connecting Stockholm and Christiania, and in proximity to the railway there stretched in begrimed grandeur an extensive perspective of irregular buildings, which proved to be the Degerfors Steel Works. They displayed evident signs of the use to which they are put; and, moreover, of having been the scene of considerable activity. Further evidence that that activity was still extant was furnished by the large amount of building material that was lying about, which, by the way, was quite an interesting exhibition of granitic and gneissic rock specimens that delighted the petrologists of the party. The external appearance of these works was indeed striking; but the interior was still more so, for the first structure to be entered was a vast, lofty, spacious building which seemed to contain innumerable mills, with their accompanying re-heating furnaces and squads of ever-moving, perspiring, half-clad men. In all directions there was action, the cumbersome mill gear and rolls rumbling on incessantly to the right and left; the flitting about of metal in all stages of hotness, from dull red to white, and in all forms, from ingots to plates, sheets, bars and rods; and on the extreme right, towering somewhat above the rest in ponderous rectangular solidity, a bench of open-hearth furnaces in full work; yet all with a remarkable absence of any appearance of steam. A further examination disclosed no less than nine mills under this single roof, with all their accessories, and in addition the row of three ten-ton open-hearth furnaces, with one long casting pit in front. These, too, were tapped simultaneously at the time of the visit, and produced an effect that it would be difficult to exceed in brilliancy as a pyrotechnic display. The ingot moulds were arranged in a double row in the casting pit, and the metal was run from each of the three ladles into two moulds at a time. The moulds in use were of two patterns, some round with trunnions and others square and made in two pieces.

There are many notable features about these works, amongst others the mills are driven direct by turbines, each mill having its own; then many of the re-heating furnaces are provided with plates cooled with water in the front, which facilitated their working in a marked degree; further, there were some excellent machine cutting tools for shaping sheets, and here, too, the rolling of tubes could be witnessed—the hollow billet for the purpose is punched from the ingot under the steam hammer by driving it over a mandril and through a die. The material produced here is of excellent quality, and an example of this as regards plates was on view; it consisted of a ship's plate that had been crumpled up in a collision, and although it resembled a piece of a huge concertina in appearance, there was no sign of a crack visible. To ensure getting the material of the desired quality, the pig iron is produced at the works; or which purpose there are two blast furnaces 55ft. high, 6ft. diameter at the throat, 10ft. at the boshes, and 4½ft. in the crucible. One of these was tapped in the presence of the visitors. The pigs are cast in moulds, into which the stream of molten metal is directed by a movable runner. The blast is delivered at a temperature of 350 to 400 deg. Cent., and at a pressure of 1½ lb. The engine-house contains blowing engines of the inverted vertical type, with balance cylinders, and a 150-horse power dynamo, both driven direct by turbines. The dynamo is to supply current at 250 volts for new workshops. Outside the works there were two factors of prominence, the one the rapid voluminous river—Let-älfven—that contains an abundance of motive power, much of which at present runs to waste. This is to be modified, for in the near future the water will be held back by a dam that is in course of construction, which, too, had made considerable progress towards completion at the time of this visit, and when completed will render



Fig 1—BOFORS STEEL FOUNDRY

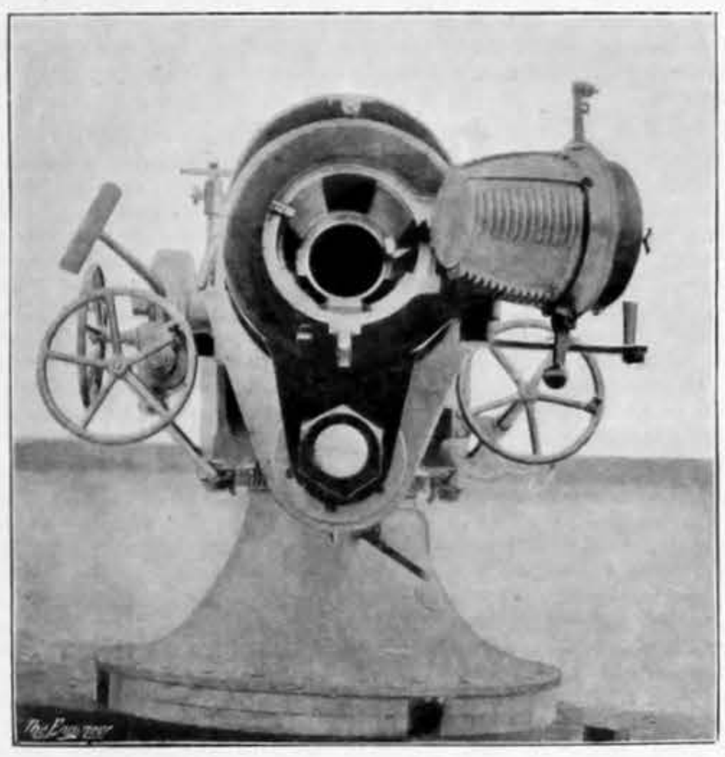


Fig. 2—BREECH MECHANISM OF BOFORS GUN

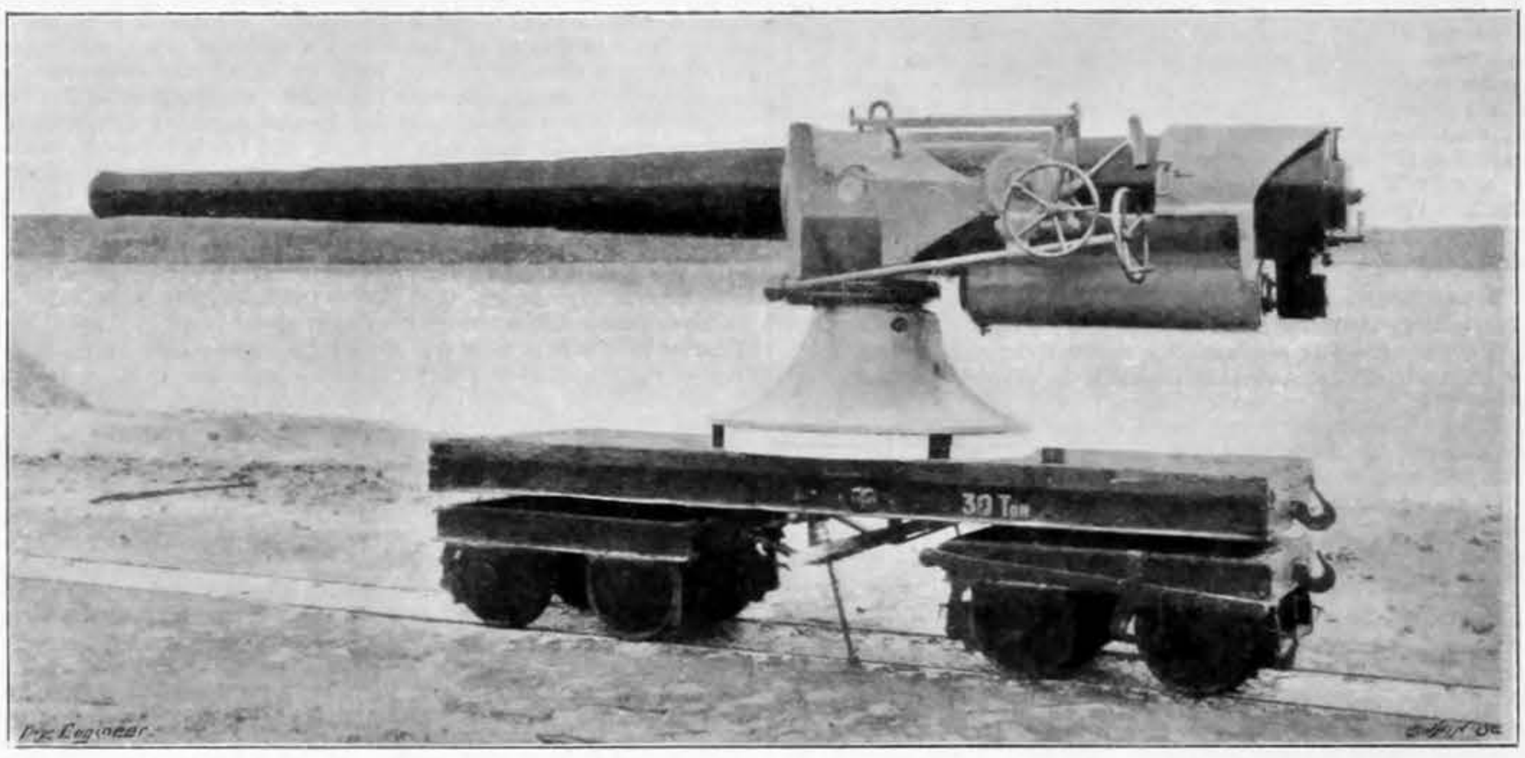


Fig. 3—BOFORS 15 c.m QUICK-FIRE GUN

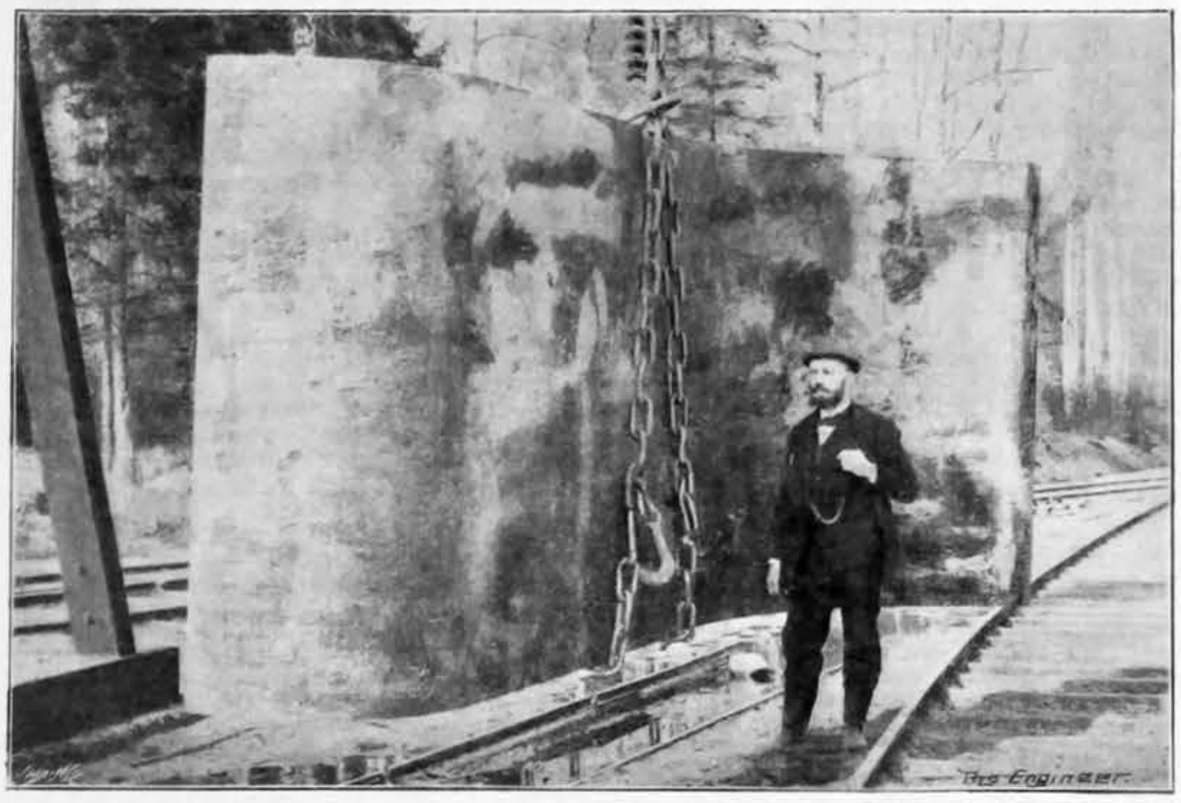


Fig. 4—CAST STEEL ARMOUR PLATE

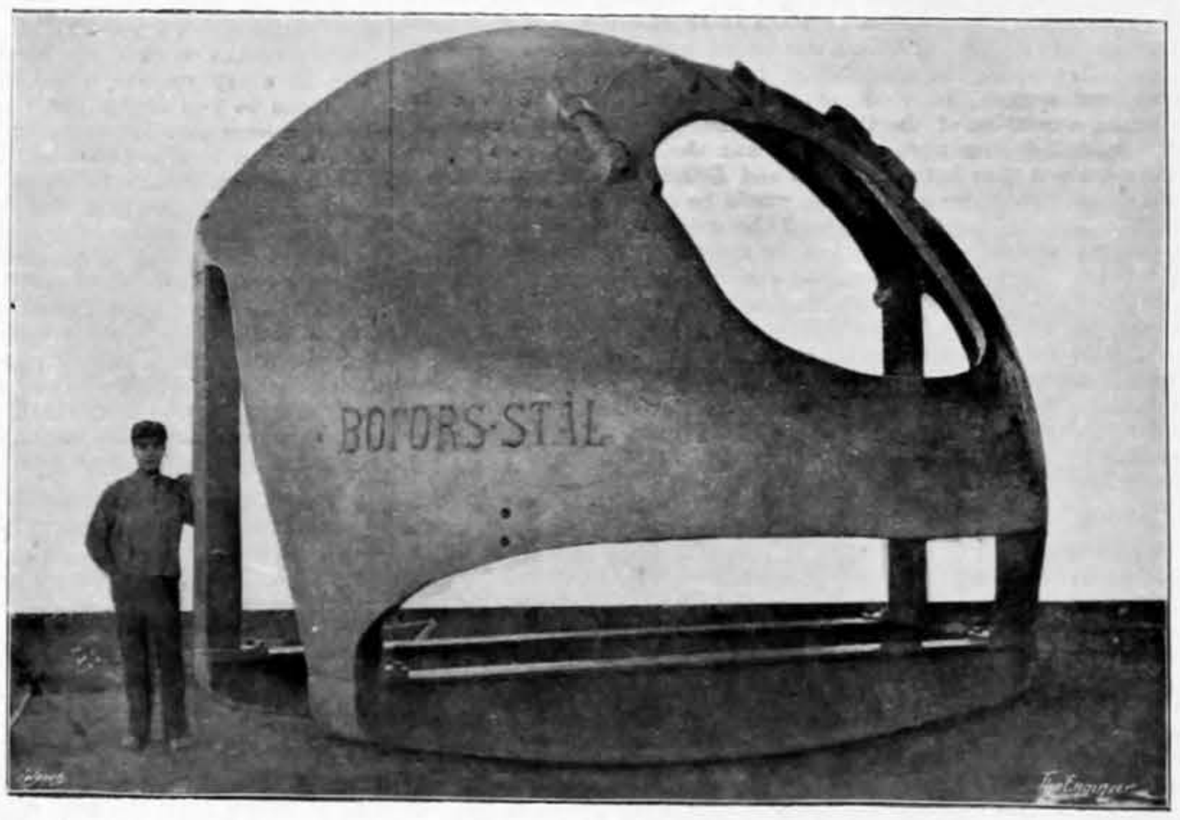


Fig. 5—SHIELD FOR 12in. GUN

a minimum of 4000-horse power available. The other prominent feature outside was the great piles of limestone and ores from different districts, Nora and Persburg amongst others; the ores are calcined—there are two calcining furnaces for the purpose—and are blended in the blast furnace charge to ensure the desired quality of the product.

It remains to say that these works were originally chartered by a Royal Decree dated June 15th, 1654, and now belong to the Strömsnäs Jernverks Aktiebolag, which was established in 1886, the output being at the present time more than 20,000 tons of open-hearth steel per annum.

The inspection was followed by luncheon, provided by the company, and served in a bowling alley, which had been adroitly transformed into a prettily decorated dining place, the magnates of the party occupying, at a special table, the position of the temporarily dispossessed nine-pins. The position was excellently selected, being charmingly situated in a garden overlooking the rapid and picturesque river that rushed along below. This enjoyable item of the day's programme came to a close with hearty votes of thanks to the hosts and to the guides. The train being gained, it sped off on its way to Bofors, eleven miles distant, amidst cheers from many gathered amongst the trees to see the party off. A nice card of views of Degerfus Steel Works was distributed, but unfortunately they were too darkly printed to serve for reproduction.

Bofors is on the Nora - Karlskoga line, and a broad road from the railway leads to a well-kept verdant open space, on two sides of which are the residences of the managing director, Captain Dyrssen, and some other officials, whilst the side away from the line opens on to a garden that slopes away downwards, and a fine view is obtained of a broad fertile valley, and of the well-wooded hills beyond. In this pleasant place, beneath the Swedish flag flying from the flagstaff in the centre, the introductions were made, and the party was divided into groups to inspect the Bofors Iron and Steel Works and the Bofors ordnance factory of Aktiebolaget Bofors-Gullspång.

Bofors has been the scene of an iron industry since 1646 at least; but it was of no great importance until 1870, when the works were greatly enlarged, whilst the present company was established in 1873, and the illustration Fig. 1 presents a view of the Bofors steel foundry and workshops belonging to the company, and will give some idea of the magnitude of the operations of this corporation, when it is borne in mind that this is only part of the works at Bofors, and that there are works at Björneborg, Gullspång, and elsewhere in the same ownership, which, however, were not visited by the excursionists. We may, however, remark here that the Björneborg Steel Works are equipped with two blast furnaces, two Bessemer converters, and a large steam forge, and that the average production of the company's iron and steel works is about 15,000 tons a year.

The Bofors Iron and Steel Works is provided at present with one blast furnace and a calcining kiln, two open hearth furnaces, thirteen furnaces for making charcoal blooms, five rolling mills for bars, rods, hoops, and sheets, and a steel foundry. As a matter of fact, the treatment as regards iron and iron ores is similar to that already mentioned in connection with the Laxa works.

Ores from Striberg, Haggrufvan, and Persberg mines are calcined and used in appropriate admixture in the blast furnace, which is 50ft. high, 9ft. at the boshes, and 4ft. in the crucible, and from which 100 to 120 tons of pig is drawn a week, the pigs in this instance being cast in sand, and at the present time are being made with 0·15 to 0·18 per cent. of silicon, the consumption of charcoal being from 17 cwt. to 19 cwt. per ton of pig. The pigs are converted into malleable iron in Lancashire hearths, two of which are double, and are worked from both sides without mechanical aid, whilst the others are fitted with the mechanical rabbler already noticed at Laxa. In the latter hearths the charge of pig is about 3 cwt., and in the former about 3½ cwt. All these hearths are supplied with blast at 230 deg. Cent. through water-cooled tuyeres, and the pigs are pre-heated as in other works already noticed; the lumps, too, are shingled under the tilt hammer, and rolled down into bars, wire, &c. But there are a few points of difference to be observed. Firstly, in the bloomery the charcoal is stored in hoppers placed between each pair of hearths, and fed from above by an overhead tramway; secondly, in the mill the re-heating furnaces are not gas-heated, most being wood-fired, whilst in others coal is the fuel, and is fed in by an automatic feeder, in which the coal is charged by hopper and bell into a holder, covered above and closed below by a disc that can be adjusted at any desired distance from the bottom of the holder, to suit the size of the coal. The disc is attached to a shaft that passes through the holder, and by means of a ratchet and pawl is given a rotary motion, which is transmitted to the disc, with the result that the coal is delivered continuously and regularly in just the quantity that is desired, and the required temperature is constantly maintained. These furnaces are flat near the grate, and slant upwards towards the flue, and, as in the other furnaces, the cold billets are charged at the cooler end of the furnace and push those already in further forwards or on to the flat portion, from which they are withdrawn as required. The whole arrangement appeared to work very well, but one would have liked to have a little more time to examine it. There was here, too, a special charging appliance, the billets in couples being lifted by a small hydraulic hoist to the level of the charging doors, and then pushed into the furnace by a ram worked by a rack and pinion; which, however, was not seen in operation. Further along in the mill the disposal of the wire rod after passing the last roll was better managed than in the other works, for it was coiled on a reel, from which it was readily removed and stacked on one side much more expeditiously than the length of straight rod. It may be mentioned that this mill is used almost exclusively for iron, the steel being used mostly for castings, so that only any excess of that material finds its way to the mill.

The manufacture of the steel is one of the most important operations at Bofors, for they specialise in guns and other objects made from unforged steel cast without blow-holes. The utmost precautions are taken to ensure the purity of the materials, and the steel-making is conducted in open-hearth furnaces fired with producer gas made from wood, and the practice usual in the production of steel that will cast without blow-holes is followed, namely, ferro-silicon or ferro-manganese is introduced just before drawing the bath, or when nickel steel is being made the nickel is put in the furnace and some aluminium is put in the ladle. The drawing of a 12-ton charge was witnessed on the occasion of our visit. In front of the furnace a Y-shaped runner was mounted, with a ladle each side, and the stream was directed first to the right into one ladle and then to the left into the other. The ladles were then lifted by cranes and readily adjusted over the work, which in this case was a 12-ton ring for the breech of a big gun; a similar ring was later on seen in the yard, whilst another of them was being turned on a lathe in one of the shops. In both instances they were closely examined, and certainly presented examples of high quality castings. However, there was plenty of other examples illustrative not alone of the goodness of the work, but also of its diversity, and the illustrations we give set forth more examples. Fig. 2 is a side view of a quick-firing gun, having the following data:—Calibre, 15 centimetres; length in calibres 45, in centimetres 675; number of grooves, 44; depth of grooves, 1 millimetre; width of grooves, 7·2 millimetres; width of lands, 3·5 millimetres; twist at breech, 60 calibres; twist at muzzle, 30 calibres; weight of gun, 5560 kilos.; weight of carriage, 3200 kilos.; capacity of bore and chamber, 118·2 litres; capacity of cartridge case, 12·53 litres; weight of projectile, 40 kilos.; weight of charge, 8·19 kilos.; capacity of cartridge case per kilo. of powder, 1·53 litres; muzzle velocity, 801 metres; muzzle energy, total 1310 metre-tons; per kilo. of powder, 160 metre-tons; per kilo. of gun, 236 metre-kilos.; range, with elevation of 17 deg., 10,300 metres; velocity of projectile at 1000 metres, 685 metres- at 2000 metres, 581 metres; perforation of wrought iron at muzzle, 48 centimetres; at 1000 metres, 39 centimetres—at 2000

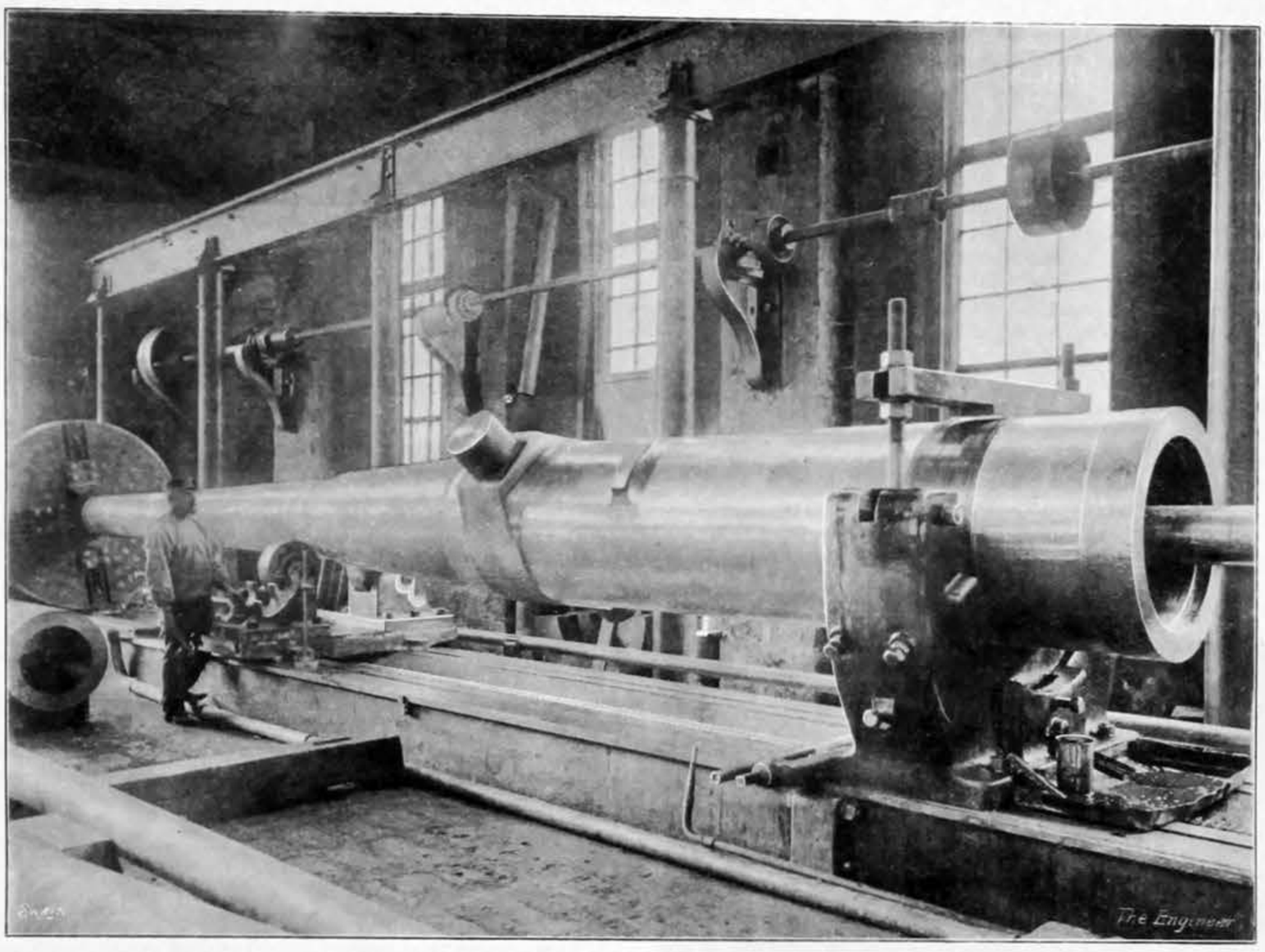


Fig. 6—25-CENTIMETRE GUN

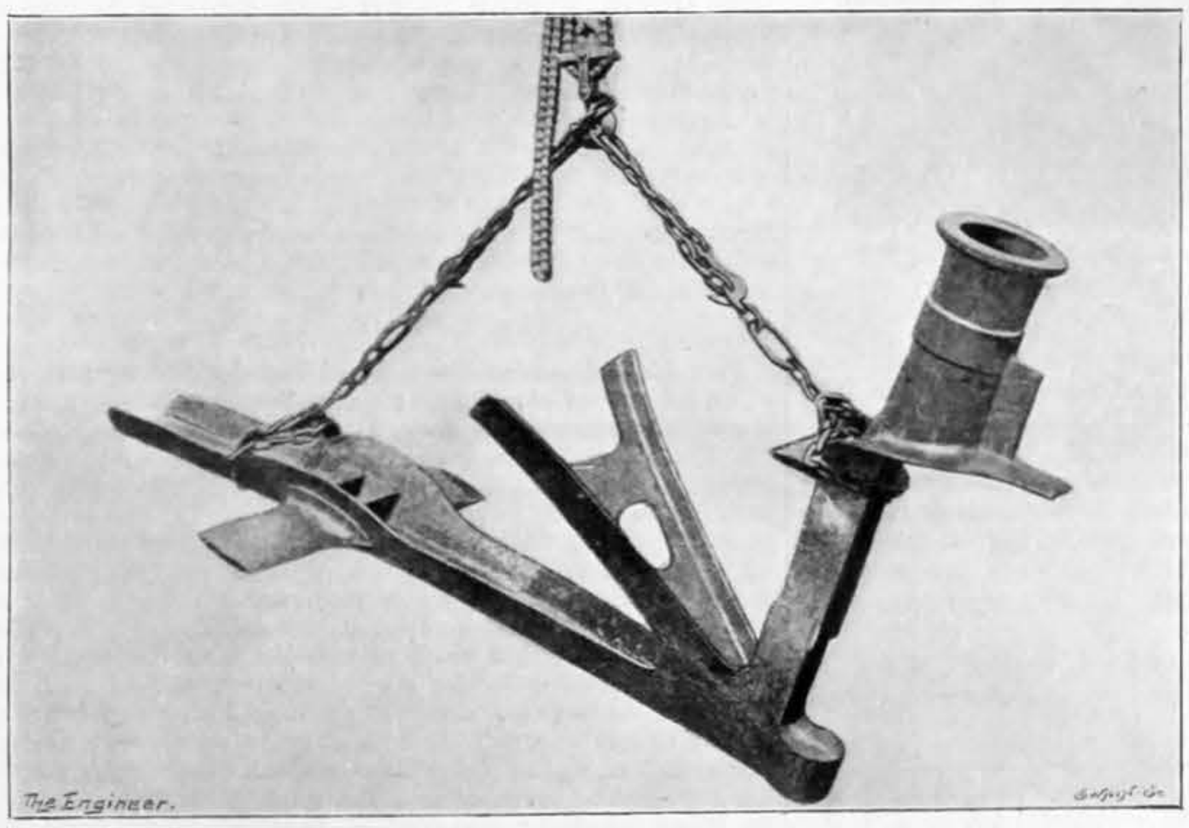


Fig. 7—STEEL STERN POST

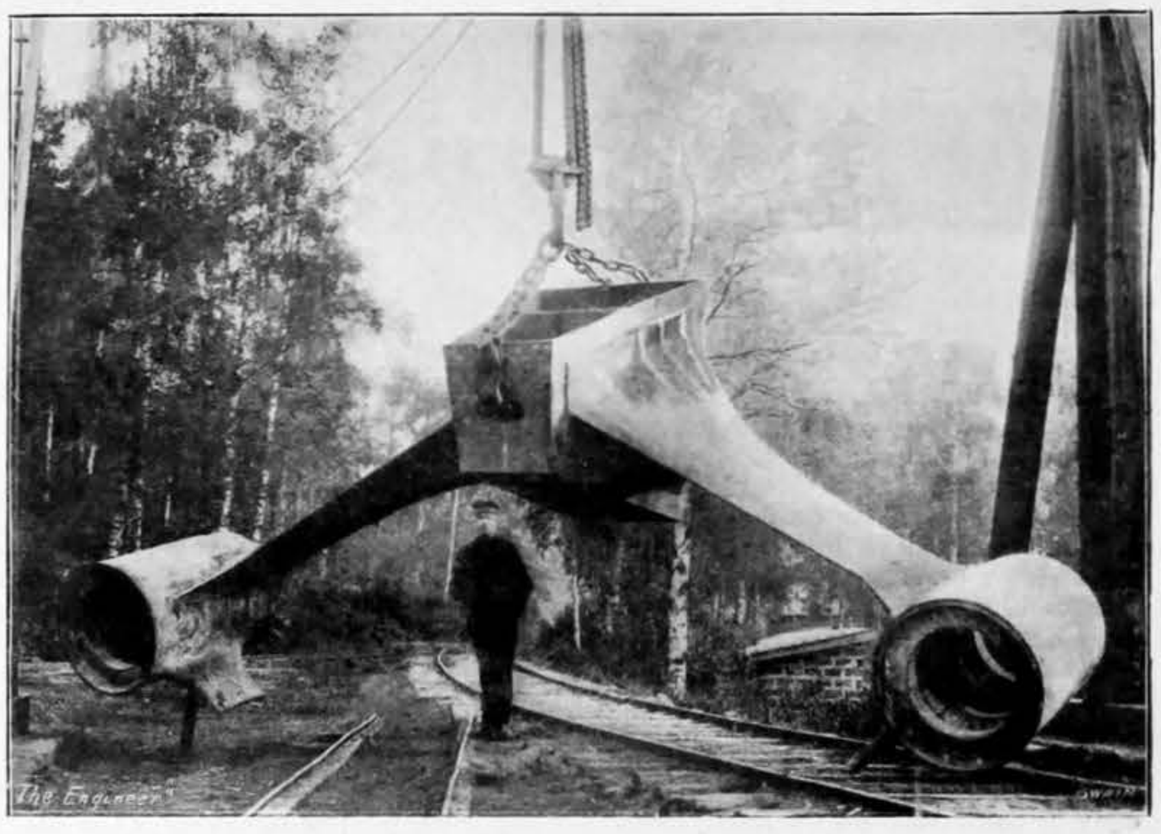


Fig. 8—STEEL TAIL SHAFT BRACKET

metres, 31 centimetres; length of recoil, 30 centimetres. We have retained the metric quantities for the sake of exactitude, and because the guns are manufactured, gauged, and registered in accordance with metric standards. Fig. 2 shows the rear end view of the same gun, and exhibits the mechanism adopted by the Bofors Company, and which we shall probably refer to again later on. Suffice to say now that the mechanism consists of closing gear, consisting of an ogival screw, a cover, locking lever, and accessories of firing and extracting mechanism.

The closing gear case is shown in the illustration, the advantages of the ogival screw over the cylindrical screw is that the former can be swung aside immediately after revolving it $\frac{1}{6}$th of a turn on its axis, whereas the latter requires many turns before it can be swung aside. The firing and extracting mechanisms, except the projecting levers, are within the cover.

Whilst we are on the subject of guns, it may be noted that what is claimed to be the longest ingot in the world was cast in the gun casting pit at Bofors, it was 16 metres in length and 16 tons in weight. The top 6 metres was cut off as a dead head and the remaining 10 metres bored for a 25-centimetre gun, which was seen later on in the gun shop, and is shown in Fig. 6.

Fig. 5 represents a shield for a 12in. gun, of which the upper part is a single casting and is screw-bolted to the lower portion; it weighs 15 tons and its magnitude may be gathered by comparison with the man alongside. Fig. 4 shows a bent cast steel armour plate made for the ironclad Odin. It was originally $7\frac{1}{2}$ tons, and finished $6\frac{1}{3}$ tons in weight, and 91 millimetres, or 3·583in. thick. The other dimensions may again be gathered from the figure standing by. Armour plates up to 20 tons in weight are cast at these works, and we witnessed the heating watched. The electric crane running on the gantry serves for manipulating the gun tube. A tube for a 15 cm. gun was in the furnace at a low red heat at the time of our visit, and during the afternoon the various groups of excursionists were assembled together to witness the withdrawal from the furnace and the plunging into the oil; the former went very smoothly when once the doors of the furnace had been opened. The gun tube showed no redness in the daylight, but nevertheless when plunged into the oil created a great disturbance, accompanied by a strong rush of flame and smoke, first from the mouth of the descending tube and then from the whole surface of the well, sending a high roaring column of flame and smoke far above the top of the structure. Earlier in the proceedings some members of the party grumbled at being urged by our kindly guides to withdraw from the immediate vicinity of the well during the progress of the operations, but were subsequently quite satisfied to have witnessed the remarkable display from the distance as recommended. The spectacle reminded us of a natural oil well on fire.

It may here be mentioned that this is not the only treatment to which the tube is submitted to get it into the proper molecular condition to suit the purposes of a gun. Starting from the ingot the head is removed and the cast block is thoroughly reheated, and embedded and allowed to cool completely, in pulverised cinders. Then after being rough finished and bored to a diameter slightly less than the regulation calibre, it goes through the treatment just previously described, after which it is annealed at a very low temperature, and is then ready for finishing.

The visit included an inspection of the shops —one of them is illustrated in Fig. 9—and great

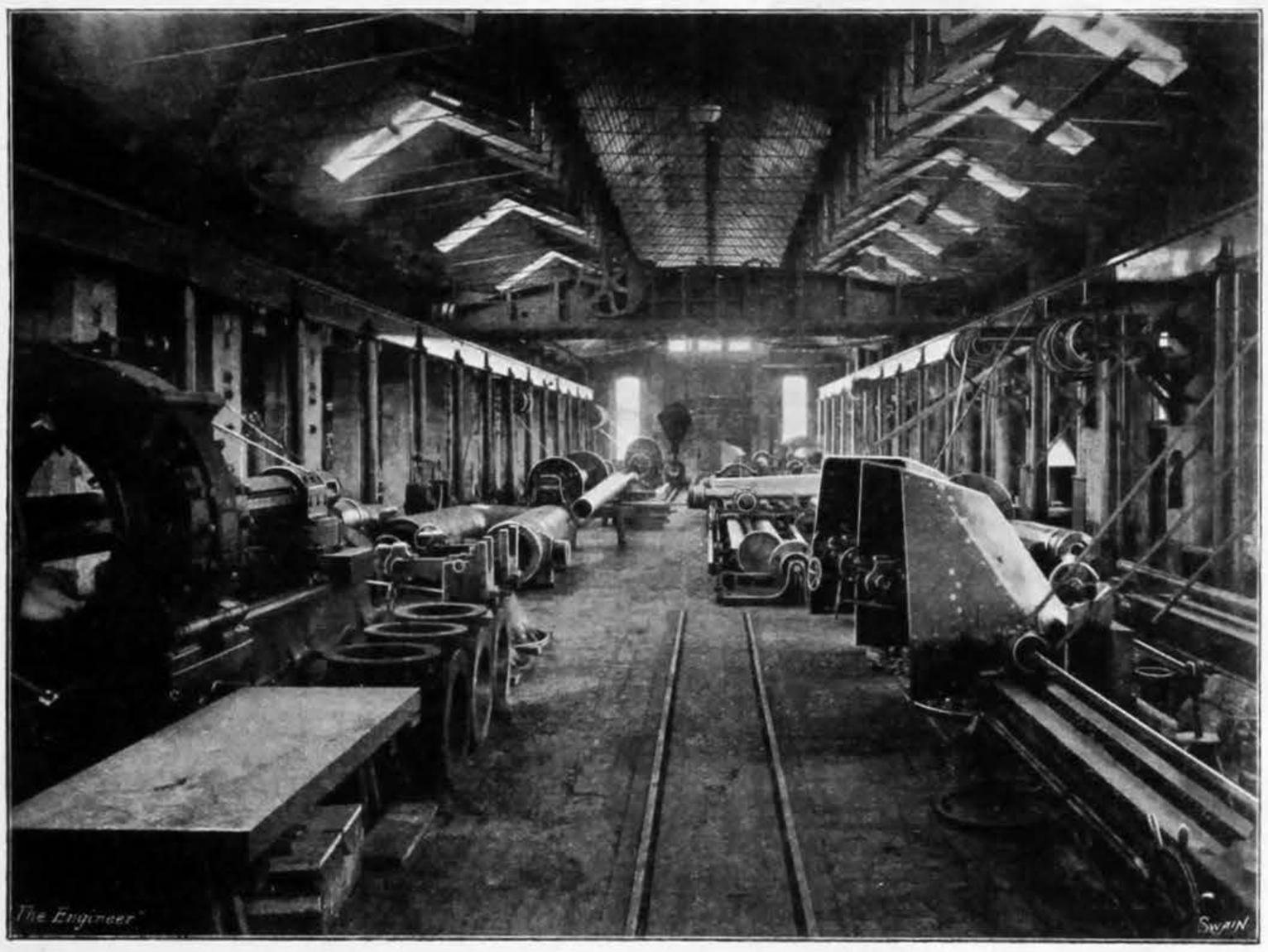


Fig. 9—GUN SHOP

laborious task of cutting a shoulder in a plate and the impressive sight of the bending of a plate cold in a 1000-ton hydraulic press which, by-the-bye, was one of the very few machines of English make observed at the works, and came from Messrs. Greenwood and Batley, of Leeds, who had also a gun-boring machine in another part of the works.

Intricacy or delicacy of design does not thwart our Bofors friends any more than magnitude of weight, as may be seen from Figs. 6 and 7, the former representing the sternpost, weighing nearly four tons, for the Danish ironclad Herluf Trolle; the latter the stern brackets for the shafts of the twin-screw propellers of the Czar of Russia's pleasure yacht Standart. Its weight was $9\frac{1}{10}$ tons, and its size and peculiar character for casting may be gathered from the illustration.

In fact, ordnance and other material is made in considerable quantities every year at Bofors; not alone for Sweden but for other States, and includes guns up to 10in. bore, gun carriages, armour plates for ships and for fortress work, armour-piercing projectiles, &c., and many specimens of them could be seen about the works or in stores. But the most inspiring spectacle of the Bofors visit was connected with the most conspicuous piece of apparatus in the place, that being the plant for re-heating and oil-tempering gun tubes, a construction that, it was stated, cost 80,000 krone. It comprises an oil well about 50ft. deep and a superstructure some 70ft. high, consisting of four substantial but graceful brick columns, supported on a heavy gantry, with a housed-in travelling electric crane on the top. At one side there is a vertical re-heating furnace, which, in the front towards the oil well, is provided with a series of doors for the admission and removal of the gun tube under treatment, whilst a series of gas nozzles run up the back of the furnace for firing, and a looking-glass placed at an angle of 45 deg. in a covered pit below ground, enables the interior of the furnace to be inspected and the progress of the pieces of work were seen in various degrees of finish; also a peep at the gun and other stores of finished articles, as well as a view of the laboratory. Space will scarcely permit any full reference to these, but we may note that all departments are good and well equipped, and that the machinery is mainly of Swedish or German manufacture; for beyond the gun-boring machine of Messrs. Greenwood and Batley, already referred to, no further piece of English manufacture was conspicuous.

Some tests were witnessed in the laboratory, and a few results that have been obtained with Bofors cast steel may be quoted here:—

Year of casting.	Open-hearth cast steel for the following purposes.	Test piece. Diameter, mm.	Test piece. Area, sq. mm.	Limit of elasticity.	Maximum resistance, kilos. per sq. mm.	Elongation per cent. in piece 100 mm.	Contraction.
91	Tube for 8 cm. field gun	18·10	257·30	36·54	63·04	18·4	27·6
91	Mantle for ditto	17·95	253·06	35·17	62·56	15·7	22·5
92	Carriage for 15cm. gun	18·00	254·47	27·90	57·77	15·6	12·9
91	Rudder frame	20·05	315·74	23·44	50·80	25·2	24·7
91	Stern-post	20·05	315·74	21·53	52·29	23·6	32·3

The company has a fine collection of photographs, some albums of which were distributed, and from these our illustrations have been prepared. The visit terminated most agreeably by a pleasant banquet, which was brightened by the presence of ladies, and was served in Captain Dyrssen's private residence on behalf of the company. At eight o'clock the party broke up, with expressions of thanks and feelings of regret; the train was regained and a start made for Filipstad, some sixty miles distant, which was reached before midnight.

DOCKYARD NOTES.

WHAT is likely to be the effect of 6in. or smaller shell bursting against casemates or turrets in close proximity to the gun—a little above the piece or a little upon one side? There are, we believe, two diametrically opposite theories—one that a shell bursting within 6ft. or 7ft. of the gun will destroy the projecting muzzle, the other that no harm will ensue. We cannot recall any experiments with the direct object of solving the problem. Presumably some have been conducted, but experiments of this sort are frequently kept confidential. The matter is exceedingly important, because, if the long modern gun is to be put out of action by the first shell that bursts anywhere near it, the value of the big gun is very heavily discounted. If a gun is to be so destroyed, then it is quite unnecessary to attempt to penetrate its protecting armour, in which case half a dozen 6in. guns would have at least six times the value of one big gun, even against the most heavily-protected battleship, so far as "beating down the enemy's fire" is concerned. This, if we speculate, gives a curious picture—a possibility of two battleships, practically intact, with scarcely a gun between them. Has a belief in the efficacy of a shell anywhere near a gun anything to do with the fashion in which the ram has again come into favour?

THERE is nothing new in the theory of attacking the big guns' muzzles, and much time and ingenuity have been expended in attaining loading positions, such that the guns may present a target only at the moment of firing; but the chances of a gun being actually hit are small. The chances of a shell bursting within a few feet of the muzzle are not by any means so small. If the theory is correct, then we have the curious reflection that all protection to the men is so much protection taken from the gun; in other words, the keeping out of a shell from passing through the battery, inside which it might or might not burst, means the almost certain destruction of the gun muzzle. And, viewed in this light, the Rossia, with her tremendous unarmoured battery divided up by screens, becomes a more logical vessel than the armour-coated Garibaldi, and still more logical than the Jeanne d'Arc, Terrible, Diadem, and so forth, all of which provide the maximum safety to the men; and the old muzzle-loaders on the main deck of the Alexandra become pregnant with defensive capabilities.

PERHAPS some of our readers know of experiments which do something to determine this question, or can cite instances of shells bursting near gun muzzles in actual war. Neither Santiago nor Yalu has given us such an incident; if any such occurred they might be kept secret—would probably be kept so. Neither of these actions, however, gives us the case of an armoured ship with long thin gun muzzles fired at at a range where missing was improbable. With modern trajectories shooting is likely to grow better, though shooting, good or bad, affects the time a battle takes more than it affects anything else. If both sides make only 2 per cent. of hits, or if they both make 50 per cent., the result to the ship attacked must be more or less the same in the end. We have not yet seen anything like equality in gunnery or ships; but given it, this question opens up a tremendous vista for entirely fresh speculations on the results of a naval fight.

ADMIRAL HARRIS, on the Cape station, has issued a memorandum to the effect that no cleanliness of the ship at inspection, or any form of "polish" will compensate for bad gunnery. A modern cruiser action, he says, will be decided inside five minutes if fought at 2000 yards, hence the all-importance of good gunnery. The memorandum does not seem to have attracted much attention. Different admirals have variously regarded guns as ornaments, as accessories on a par with the masts, as things that make the ship in a terrible mess on those occasions when they must be fired in order to satisfy Admiralty requirements; but Admiral Harris is one of the first to elevate the position of the gun.

THE United States Navy Board has decided against the extended use of electricity on ship-board. Electric hoists, electrically-manœuvred guns, all these are wonderful labour and time-saving devices, and on them the ability to put an excessive armament in a small ship depends; it would be a very difficult thing to maintain the rate of fire in a 4000-ton cruiser carrying fifteen to twenty guns without it. But although electricity works all right at target practice, target practice in no way simulates war. When a liner is wrecked out goes the electric light, and there is a pretty prevalent idea that a shell or two bursting on board will destroy everything in the way of mechanism the least bit delicate. At any rate, electricity is looked on with suspicion to the extent of doubting its ability to survive an action. Rangefinders, sights, telephones, and all other instruments, are expected to more or less share the same fate—they did on board American warships at Santiago merely from the jar of firing. Consequently the less dependence there is on mechanism the better, for if hand has to be employed in action it is better that it should, where possible, have to be employed in practice also. Here is a case in which a very great deal could be learnt by experimental firing at a ship fitted with every possible mechanical contrivance. If this were done on two or three separate occasions a great deal would be made clear.

THE new ironclad London is to have the same sort of stern as the Formidable—the dead wood cut away. For manœuvring this is a most excellent thing; the trouble is likely to come when the ship is docked. Considerable care is necessary on account of the great unsupported weight—that, at least, is the objection urged. Since, however, one has never heard of any trouble befalling the Elswick cruisers, which all have the form of stern, the danger may be very small. It is difficult to see why a strongly-built battleship should be endangered more than a fragile cruiser. There is, of course, no question whatever when turning is considered; to turn eight points the Yashima has to travel quite a hundred yards less than an ordinary battleship. One can scarcely realise on paper all that that entails.

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TO CORRESPONDENTS.

*** *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 stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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

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

REPLIES.

S. W.—We have fully dealt with the subject matter of your letter on this page.

VIATOR.—The paragraph is simply another example of the technical incompetence of the average newspaper reporter.

BELLEVILLE.—You will find large illustrations of the boilers in our issues of November 11th last and of October 2nd, 1896. We have printed articles upon them on many occasions. See pages 301, 307, &c., of vol. lxxxv.

E. L. (Huddersfield).—We cannot recall the name of any book that would help you much. Reynolds' "Stationary Engine Driving" (Crosby Lockwood) is perhaps the best. Wilson's "Treatise on Steam Boilers," fifth edition, by same publishers, would also probably be useful to you.

J. H. N. R.—We gather from your letter that you have just the same opportunities that we have for acquiring information. Under the circumstances we decline to express any opinion concerning the merits or demerits of the invention. We know nothing whatever about the patents referred to in the latter portion of your letter.

INQUIRIES.

MACHINE FOR STRAIGHTENING STEEL STRIPS.

SIR,—Can any reader give me the name of the makers of a machine for straightening steel strips by tension? J. N.

SMALL CUPOLAS.

SIR,—Will any reader kindly give me the address of makers of cupola furnaces for melting cast iron, for a small ironfoundry?
Cork, December 1st. A SUBSCRIBER.

HEATING FEED-WATER.

SIR,—I want to know whether there is in use—with maker's name—an arrangement for returning the exhaust steam from a steam donkey feed back into the suction pipe through a cone, which will help to increase the temperature of the feed-water.
Gracechurch-street, November 31st. H. P.

COMPRESSED PAPER HOUSES.

SIR,—Can any of your readers inform us as to where we might get prices and particulars of building materials for portable houses of compressed paper? This inquiry is from friends abroad, whom we would like to oblige by obtaining the information for them.
Glasgow, December 7th. J. McN.

WIND STRESS ON IRON CHIMNEY.

SIR,—Can any reader inform me where I can get particulars to calculate the strain on the bottom flange of a wrought iron chimney, ⅜in. plates, 60ft. high? The top 40ft. exposed to the wind being 2ft. 3in. diameter, and the bottom 20ft. being 2ft. 9in. diameter and sheltered; also the number of bolts, ¾in. diameter, required to take the strain, if no guy chains are used.
Derby, December 5th. W. J. C.

MEETINGS NEXT WEEK.

THE INSTITUTION OF JUNIOR ENGINEERS.—Saturday, December 17th, at 11 a.m., visit to Messrs. Yarrow's Works, Poplar, by the special permission of Mr. A. F. Yarrow.

THE SELF-PROPELLED TRAFFIC ASSOCIATION, LIVERPOOL AND DISTRICT CENTRE.—Monday, December 12th, at 8 p.m., at Royal Institution, Liverpool. Discussion on "The Judges' Report on the 1898 Trials, and the Conditions for the 1899 Trials," to be opened by Mr. Anthony G. Lyster, M. Inst. C.E., and Mr. John A. Brodie, M. Inst. C.E.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 13th, at 8 p.m., Ordinary Meeting. Paper to be discussed, "The Ventilation of Tunnels and Buildings," by Mr. Francis Fox, M. Inst. C.E.—Friday, December 16th, at 8 p.m., Students' Meeting. Paper, "The Kentish Town Widening, Midland Railway," by Mr. Walter Daniel, Stud. Inst C.E.

SOCIETY OF ARTS.—Monday, December 12th, at 8 p.m. Cantor Lectures. Four Lectures on "Acetylene," by Prof. Vivian B. Lewes. Lecture IV.: The combustion of acetylene—Acetylene burners—Smoking and carbonising of burners—Burners for heating—Acetylene for gas engines—Diluted acetylene and its applications.—Wednesday, December 14th, at 8 p.m. Ordinary Meeting. Paper, "Commercial Education," by Sir Albert Rollit, LL.D., M.P.

THE ENGINEER.

DECEMBER 9, 1898.

SMOKE.

A SOMEWHAT futile meeting has been held this week at the house of Mr. Verney in Onslow-gardens, to carry out a suggestion made by Sir W. B. Richmond, that a society should be formed to suppress the smoke nuisance. For some weeks too a correspondence, which cannot be called a discussion, because the correspondents are all in accord, has been proceeding in the *Times*. The subject is smoke nuisance. There is nothing new about this literature, and we should not refer to it were it not that it in some sense strengthens the hands of a few metropolitan magistrates who are inflicting fines right and left for breaches or alleged breaches of the law. The electric light companies seem to be singled out for special reprobation. Under the circumstances it is worth while to state a few facts very plainly. If they were known as well as they ought to be, innocent people would be spared a good deal of trouble and vexation.

To begin with, we would direct attention to the origin of the present outcry. It took its rise in the Welsh coal strike. The substitution of a North-country bituminous coal for the anthracite fuel of Wales was followed by the evolution of a great deal of smoke from chimneys which had heretofore given no offence. Nothing could more clearly demonstrate the truth that no satisfactory means of burning bituminous coal without the evolution of smoke has yet been invented. From the days of Queen Elizabeth to the present moment, attempts have been made to achieve what is impossible. It is not too much to say that many hundreds of inventions have been patented, and many thousands of pounds spent in the endeavour to burn bituminous coal without smoke, and up to the present moment no one has succeeded. We say this while we are perfectly cognisant of the fact that North-country coal is burned every day and all day long, and not a vestige of smoke escapes from the chimney. In Leeds, chimneys may be seen, the caps of which are ostentatiously coated with whitewash to direct attention to their immaculate purity. This in no way affects the accuracy of our statement. The conditions under which North-country coal can be burned without smoke are comparatively rare. They do not exist at all in the case of electric light stations, steamships, ironworks, or domestic fires, and there is no reason to think that the necessary conditions can be secured save at a far greater cost than the great cities of this country are willing to pay. At the best of times, when the engineer and the chemist are given free hands, it is very difficult to burn bituminous coal in such a way that it will not give off smoke. The conditions as regards steam boilers are that the boiler should be of such ample power that the fires never need forcing, and the demand for steam must be so constant that the dampers need never be touched. Conditions such as these obtain in cotton and weaving mills. Fairbairn cites an engine which ran so regularly that a belt from the crank shaft drove the hands on a clock dial on the wall of the engine house, and these hands were never, it was said, more than a few seconds wrong during the working day. Such uniformity of running was concomitant with clockwork regularity in steam production. An automatic stoker, such, for example, as Jukes' travelling grate, could be used with such effect that the coal might be burned with strict regard for the laws of chemistry; and we may add that in all probability the economic evaporation of the boilers was low because an excess of air was admitted to the furnace and flues, and the whole arrangement was liked, mainly because it permitted a coal worth about 3s. a ton to be used. The rate of combustion would not exceed 8 lb. to 10 lb. per square foot of grate per hour. Now, conditions such as these do not obtain in electric light stations. It is not nearly as well known as it ought to be known that in a station with engines of, say, 3000-horse power, that power will not, as a rule, be required for a longer period than about ten minutes, the duration of that which is known as "the peak of the load." To provide for the demands just then the fires must be forced. Besides, the requirements of the engines vary continually throughout the twenty-four hours, and this renders uniformity of firing absolutely out of the question. We may say here that mechanical stokers have been tried, and are in use with success to a limited extent in electric light stations; but in all cases they are supplemented by hand-fired boilers. In steamships it is well known that the prevention of smoke is well nigh impossible. It is quite useless for magistrates and patentees and smoke experts to assert that smoke is a preventible nuisance. It can only be prevented under conditions which are quite well understood, and which are impossible of attainment in great towns. The way out of the difficulty is to burn smokeless coal. When that cannot be had the community must put up with the smoke nuisance, or pay a long price to get rid of it. The electric lighting companies have not, as a rule, space enough to put down more boilers, and every attempt to obtain more is hedged round with difficulties which we need not stop to recount. The proper course is not to try to do that which is commercially impossible, but to construct power stations far enough away in the country so that smoke will not awaken a protest from a busy and luxurious community.

Those who have written to the *Times* have by no means confined themselves to denunciations of manufacturers. The crusade against the domestic hearth has once more set forth. We have read for the twentieth time the arguments of the anthracite man, who tells the world that salvation is to be found in Wales, and in it alone; we have the closed stove man, and the steam from central stations man, and the man who would wash the smoke, and the man who would make our house chimneys open into the sewers. It is the old, old story, and we feel some sense of shame in repeating the trite and well-worn statement of fact which sets at naught all these suggestions. Unless we have fogs domestic smoke causes so little inconvenience that no one writes to the *Times*, or if they do their letters are not published. When the fog comes we all grumble. To get rid of the dark part of the smoke nuisance it is necessary, first of all, to introduce and carry through a complete domestic revolution; in a word we must abandon once and for all the open fire. There is no alternative; anthracite is quite unsuitable for domestic use. The British householder likes a fairly large slow-burning fire which demands little attention. Anthracite can only be burned full blast or not at all. Many years ago a very ingenious anthracite man produced a stove with a small grate in the focus of a copper parabolic reflector. It was magnificent; but it was not at all what the English man, or, what is more to the purpose, the English woman, wanted. The open fire and bituminous coal were made for each other. They are to the last degree popular institutions, and it will be many a day before we shall be content in this temperate climate to adopt steam, or hot water, or close stoves, or anything but the open fire, which is endeared to us by a thousand associations, and is, smoke or no smoke, infinitely the most healthy way of warming our houses and towns. That it is possible to devise arguments deduced from practice in Russia, or New York, or Berlin, or Vienna, is not to the point; we have no necessity to resort to the expensive measures necessary to keep the people of other nations warm. The Gulf Stream plays a most important part in the domestic life of this country.

To repeat an old statement, in the hope that it may be of use, let us suppose that the domestic fire was absolutely smokeless, it is by no means to be concluded that we should not suffer in a fog. If any of our readers have the opportunity and the will, they can see for themselves that dwelling-house chimneys give off very little smoke—no black smoke whatever. In the first place, combustion is fairly complete because of the large excess of air. In the second place, our chimneys are admirable soot traps. The quantity of carbon sent into

the air is very minute, but a little of it goes a long way in developing a fog. But the carbon is, after all, not that which afflicts us most; it is the sulphurous and carbonic acids which sting our throats and produce headache, and the more perfect the combustion, and the more smokeless our fire, the greater will be the quantity of these objectionable gases that pollute the air. We do not think it is necessary to do more than refer to CO, for that gas is, very fortunately, not much in evidence. It follows that all claims for grates and stoves based on the perfect combustion idea are scientific frauds, as far as the suppression of the fog nuisance is concerned.

Thus we come back to a position which may be very simply stated. To be free from smoke a city must have no factories, and no open fires. For at least half a century the most able and enthusiastic men have struggled to find a way out of this, and they have not succeeded. Is it worth while to have cities without factories? Could we have them if it were? Is the smoke nuisance so great an evil that we are prepared to give up our open fires to get rid of it? It is vain to argue that improvements may be effected which will leave us our open fires and our factories and a clean sky. Perhaps when they come we shall be able to express an opinion concerning them. Our readers have an opportunity of judging what an ideal London would be. It has been supplied them by Mr. Frederic Harrison, who delivered a lecture on the subject at Toynbee Hall on Saturday. Mr. Harrison's London will have only 2,000,000 inhabitants. It will not be, as it is now, the centre of the financial and commercial world. "In ideal London the Thames would run as clear as at Henley, and again it would be the great highway of traffic. The bridges would be doubled in number, and the disfiguring railway bridges would have to be suitably treated. Steam engines would probably be prohibited within the city, and the air would cease to be polluted by the poisonous fumes of millions of chimneys. It is really strange how long we have allowed preventible nuisances to choke us. A pure and unlimited water supply would be carried through great aqueducts, as in Rome, from inexhaustible lakes and reservoirs." All this and much more is a pretty excursion into dreamland, and after all we think that most of our readers will join with us in saying that Ideal London might easily be a very terrible place in which to live. Happy, by the time it is called into existence the Londoner will be a different being, adapted to his novel surroundings, and content to live in great blocks of buildings, with common libraries, baths, and playgrounds.

OUR NEW QUICK-FIRE GUN.

There has been keen correspondence lately in the daily papers as to the question of a reported new 7·5in. quick-firing gun. While this piece is still in embryo is undoubtedly the time for discussion if any good is to be done. The introduction of a new calibre is regarded with dismay as involving new complications, some suggest the adoption of an 8in. gun; some think the present 6in. sufficiently powerful. Under these circumstances, a few words on the subject may be desirable.

At the present moment the gun on which we all depend in action is the heavy quick-firing gun which fights behind armour of medium thickness. Speaking generally, a typical battleship's primary or heavy guns possess about half the energy of fire per minute of her heavy quick-firing guns. In the Majestic class, Charlemagne, and Poltavar classes, this is the case. As, however, the heavy guns are generally all capable of being directed on any enemy, and only half the quick-firing guns, we may consider the available energy of each as about equal; but in the heavy guns it takes the form of one blow to ten of the quick-firing pieces. The former may undoubtedly produce a crushing decisive effect on the vital parts of an enemy, but the latter is more to be relied on, and on the lighter parts of a ship ten centres of explosion are better than one of more than ten times the power. We have seen in the battle of Santiago how rapidly ships may be destroyed by the action of shells on their upper structure. Clearly, at the present moment, then, quick-fire is of primary importance. By quick-fire we mean that of the heavy and protected quick-firing pieces, because it is probable that the light and comparatively unprotected pieces could not be manned in severe close action, and even when available their fire is probably more suited to the attack of men in unprotected places than to the incendiary and other structural effects which tell most in action. The selection of our heavy quick-firing gun, then, is of vital importance. The elements governing our choice are mainly (1) power to destroy the structure we attack, (2) speed of delivery. We put them in this order because this first consideration is imperative, the second is opposed to it, or is in inverse relation to it, but it comes in as soon as the first condition is fulfilled. That is to say, once fix the necessary standard of No. 1, and No. 2 forbids going any further. Let us see what the standard of No. 1 depends on. Clearly on our enemy's structure. We want to destroy her quick-firing batteries and her conning tower and set her on fire if possible. If we can bring down her masts or destroy her steering gear and her arrangements for the supply of ammunition, or even cut her funnels, &c., about, it will, no doubt, further help matters. Ships that have all the armour they can carry applied in the form of a belt from end to end, and patches over gun positions, generally give many openings to the entrance of very light shells, but generally our quick-firing projectiles will fail even at the present moment unless they can perforate 3in., 4in., or 5in. of ordinary steel, and this at a considerable angle.

Our 6in. guns are quite equal to this. Now, however, improvements in armour plate have come in, and other nations seem inclined to increase their protection. We have long protected the 6in. quick-firing guns of our strongest ships with 6in. armour. Foreign Powers may do the same, and this, if hard faced, becomes altogether too strong for our 6in. guns; it is necessary, then, to contemplate the introduction of a heavier and more powerful piece. Elswick, which led the way with quick-fire, took the lead also in applying the principle to large calibres. Published tables of quick-firing guns may prove misleading, because some elements of quick-fire are now embodied in the heaviest guns, and some makers put such pieces down as quick-firing guns, and thus the whole subject becomes masked. As a matter of fact, Elswick first designed and brought out quick-firing guns proper, introducing 30-pounders, and proposing 70-pounders to replace all the lighter ordnance of secondary batteries on board ship as early as 1886, and equipped cruisers for Chili and other countries carrying 8in. quick-firing guns long before the principal Naval Powers of the world contemplated such pieces as coming within practical consideration. The 8in. projectile weighs 250 lb.; the gun discharging it rapidly must have very complete and trustworthy machinery provided. Here, again, must be commended the practical treatment given to the subject by Elswick. If we turn to the tables supplied by Elswick to the *Naval Annual*, we find rates of fire obtained at sea, and note that on board the Blanco Encalada four rounds were discharged from the 8in. 15·5-ton quick-fire gun in 62 seconds, the ammunition being supplied from the magazine. This seems very much to the purpose. The power of perforation of this piece at the muzzle is 26·4in. of iron. This would mean probably 20in. at 1000 yards, or perhaps 9in. of Krupp process steel direct, or 6in. at about 30 deg.; so that at the present moment it would probably need an 8in. gun to attack one of our heaviest line-of-battle ship's quick-fire guns, and that at closer range than 1000 yards, to have any reasonable prospect of success. Surely it is high time that we had a quick-firing gun of this power, for we must reckon on an enemy sooner or later having the armour we carry, and we certainly should be able to perforate our enemies' armaments of secondary quick-firing gun batteries, and not be reduced to hope for chance effects against conning tower and other structures, or even to setting an enemy on fire, for we must expect that, following the example of Germany, all navies will get rid of wood on board their ships. America has already decided to do so. From all this, then, it appears that a piece equal in power to the Elswick 8in. quick-firing gun is a necessity. Is it wise then to contemplate obtaining this in one of 7·5in. calibre? The Elswick gun obtains the perforation we have mentioned by two alternative means, either with a 250 lb. shot discharged with a muzzle velocity of 2480 foot-seconds, or with a 210 lb. shot with 2650 foot-seconds velocity. Can we obtain the same with a 7·5in. projectile? We greatly doubt it. Possibly we may approach, or even reach, it with a brand-new piece, but how long will the power be retained?

We think then that we are only asking for the lowest standard which provides for the effectual attack of the quick-firing batteries of an enemy. Few, indeed, of them at present have 6in. of armour, and long may it be before this armour is Harveyed or Krupp process plate, but after all it is a mere question of time. We have taken a range under 1000 yards, an angle of impact of 30 deg., and a new gun, and it may be seen under these favourable conditions that the 8in. gun is barely sufficient to give hope of a good result. Is it wise to contemplate a 7·5in. piece? What are its advantages? The shell is easier to handle, no doubt, but what satisfaction is this if it will not perforate our enemy's armour when it is fired?

We submit that this question needs a thorough practical investigation before we introduce a new calibre, an entirely new gun that may end in earning the unenviable distinction of being just a little too weak to get through the armour that before long it may be called upon to attack.

SCREW PROPELLERS.

It may have occurred to our readers that the inventing or designing of marine propellers has gone out of fashion. The world of shipping is no longer distracted with the claims of rival screws. The jet propeller has not been even heard of outside lifeboats for some years. Possibly engineers have at last arrived at the conclusion so often enunciated, that while there is a better screw than any other for every ship, there is not 10 per cent. between the best and the worst—in reason—that can be fitted to her. The diameter, surface, and pitch that ought to be given are well known for every case; the result is, that all twin-screw fast steamers are, almost without exception, fitted with modified Griffiths three-bladed propellers. Tramp steamers have sometimes three blades, sometimes four, very rarely two blades. The large, original Griffiths boss is seldom seen; the boss, as a rule, is kept as small as is consistent with the secure fixing of the blades. There is very little difference between the forms given to the blades; and, such as it is, it does not appear to have any appreciable effect on the speed, power, or coal bills. The principal points to be attended to are that the propeller shall be sufficiently strong; that it shall be very smooth and sharp; that it shall not be so large that it locks up the engines, and prevents them from exercising their full power, or so small that the slip is excessive. When the marine engineer has satisfied these conditions he may rest content, and listen with equanimity to the animadversions of those who tell him that they could put a knot an hour on his ship, the consumption of coal remaining unaltered.

We scarcely go too far when we say that screw propellers are bought under much the same conditions as shoes or coats. We want something that will fit the ship, be strong and serviceable, and not cost too much money. Scientific refinements of form, and elegant mathematical curves, based on still more elegant mathematical disquisitions, are no longer heard of. They may, of course, turn up again. This very article may drag some of them into the light, or suggest his opportunity to some inventor. The propeller as it is has crystallised out of a mother liquor of mathematics, mechanics, and progressive speed trials. Nine screws out of ten are probably as good as can be, or need be, and no one knows whether the tenth is equally excellent or no. So much for form of blades and proportions. Can we be equally certain that we have got the best material and the best method of construction—things which, of course, have nothing at all to do with the mathematics of propulsion? There are three materials available—cast iron, steel, and some of the brasses or bronzes or gun-metals, the base of all these alloys being copper, with which is combined zinc or tin or aluminium, with small quantities of other metals, in certain cases phosphorus being used, in view of the important part which it plays in giving clean and sound castings of alloys containing much copper. The first of these is still greatly in favour for tramp steamers. Their engines run at slow speed, seldom much over sixty revolutions per minute. There is plenty of space for a big heavy propeller, of about 15ft. pitch. It is easy to make the blades thick and strong, and such a screw comes cheap. No doubt it wastes power, and is liable to corrosion and pitting, and it is not easy to get a sound casting with certainty, but on the whole for slow speeds cast iron answers very well. A cast steel propeller is better in every way save one. It can be made with much thinner, sharper, and smoother blades, and will still be stronger than the cast iron screw; but, unfortunately, the steel propeller is liable to attacks of corrosion of the utmost virulence. Now and then we meet with a steel screw which has entirely escaped; at others we come across steel propellers utterly ruined in two or three months. It would seem that in some cases at least the propeller escapes at the cost of the ship's stern, while in others matters are reversed. Even with the use of zinc anti-corrosion plates on the sternpost, steel is too risky a material to be trusted for propellers. There remains then the copper alloys, and these are so easily first, and so much better in every way than iron or steel, that they would be used exclusively if it was not for their considerable cost. This extra cost is due partly to the comparatively high price of copper and tin, and partly to something else to which we wish to direct particular attention.

It has long been the practice to make what may be termed the better class of propellers with detachable blades; that is to say, there is a large boss keyed on the shaft, and to this the blades are secured by flanges, bolts, and keys. There are certain advantages about this mode of construction. One is that a blade can be replaced without docking, by bringing the ship down by the head and raising her stern; or, if this cannot be done, the new blade may be bolted on by a diver. Again, when corrosion attacks steel blades they can be readily replaced without the often tedious, troublesome, and always expensive operation of drawing the tail shaft and fitting on a new propeller. But these indisputable benefits are not to be had for nothing. The built-up propeller is very much more expensive than one which is a single casting. It is also much more liable to accident through the shearing of the bolts, for example; and it is beyond question that the efficiency of a built-up propeller is not equal to that of a plain propeller, the hub or boss with its appurtenances offering a good deal of resistance at once in rotation and to passing ahead through the water. For a long time it was held that big bronze castings cannot be had sound, and so bronze propellers were built up. No one believes this in the present day. If bronze is used there does not appear to be any general necessity for building up propellers, save in a few exceptional cases. The cost of the cast propeller ought to be from 20 to 25 per cent. less than that of the built-up screw—perhaps a little more, but we like to be on the safe side—while the weight of the solid casting must, we should say, be nearly one-third less than that of a loose-bladed screws, and this, be it remembered, without any sacrifice of strength; indeed, the thickness of the blades will remain the same in either case. The argument against the solid propeller is, that if a blade is broken off the screw is ruined, and that large screws cannot be cast sound in this way. The first argument possesses no force. Modern alloys are so excellent that the blades may be twisted almost into knots, but they will not break, and they can in almost all cases be straightened or bent by the aid of jacks and bears. This can be done at least once, and has, we understand, been done more than once with some of the alloys with success. The objection that large screws cannot be cast sound had at one time some force in it; it has long lost it. A visit to the foundry of any of the bronze-making firms will settle the matter. For example, the Bull's Metal Co., of St. Mary Axe, has cast a solid propeller which was 17ft. in diameter and weighed 5¾ tons. Nor, we take it, is this the limit. We venture to say that shipowners may resort to copper-alloy propellers made in one piece; and that they will find the result quite satisfactory.

What we have said of propellers is in the main applicable to paddle wheels. Invention has long ceased to interfere with them. Out of Morgan's original idea has developed a type of paddle-wheel which is eminently adapted to the Channel, or shallow water service. The special feature of the modern as compared with the old wheel is the substitution of steel-curved "floats" for the old wooden "paddle board," with which substitution the late Mr. Stroudley had very largely to do. The wheels, too, are made much more strong than used to be necessary. This is, of course, a consequence of the great power now transmitted through them; the diameters of the wheels still remaining about what they were thirty years ago or more.

Possibly some of our readers will hold that an article dealing with propellers must be incomplete if it does not touch theory in some way. By way of satisfying a not unreasonable demand, we would suggest that some one who understands the subject would explain how it comes to pass that the net work of the screw and the paddle-wheel is about the same, although they are so widely different in their mode of action, and that it appears to be just

about 50 per cent. of the indicated horse-power. We have never yet met with a theory which is alike satisfactory for both screw and paddle. After we have deducted the loss by slip common to both, much which is not common to both remains to be accounted for.

THE RAGE FOR CHEAPNESS.

A CHANGE appears to be coming over the cutlery and general hardware trades of the country which has not received the attention it deserves. It has been the boast of some of our British firms that they would not make an inferior quality of goods, preferring to lose certain markets rather than turn out wares which they considered were not workmanlike. It is in this direction the German and American manufacturers, who have successfully systematised the production of large quantities of certain goods by means of machinery, have been able for years to command certain sources of trade which have practically been closed to British firms. It was thought by people at home that the rage for cheapness would be short-lived. They have been mistaken. The demand for lower-grade goods, instead of diminishing, has gone on increasing, and many of our Midland manufacturers have at last come to the conclusion that as there is a big market for these lower-priced wares, they had better make up their minds to provide them. This has been done, and no little success has attended the efforts of the firms who have been enterprising enough to take up the trade. In various classes of tools, cutlery, and hardware, as well as in plated and metal spoons, forks, and similar goods, machinery has been freely laid down, and the prices at which the finished articles have been put upon the market are bringing a good deal of the trade to the Sheffield and Birmingham districts. What the result may be in the end is hard to say. The fear of the Sheffield manufacturers was that if they produced wares which did not stand the test of time their reputation for honest, workman-like production might be lost. On the other hand, the cheaper goods are candidly stated to be of a lower grade, and the customer would be unreasonable indeed if he expected to get for a very small sum work which could not possibly be produced at less than double or treble the price. It is significant, however, of the drift of the times to find that even in Sheffield, where the greatest possible pride has been taken in producing nothing but high-class goods, it should have been found necessary in the extreme rivalry and keen pressure of foreign makers to meet them with their own weapons, and produce the secondary grade of articles in order to meet the all-prevailing demand for something showy at a low price. Many of the older heads in our large manufacturing establishments regard the change with much misgiving, but at the same time it has been generally felt that it was bound to come, and now that it has come it is just as well that it should be energetically entertained. The cutlery trade is peculiar, and things are admissible in it, perhaps, which are not to be thought of in other branches of manufacture.

GOOD TRADE FOR TWO YEARS OR MORE.

ABNORMAL activity and quiet confidence are the pleasantly distinctive features of business in the important centre of which Sheffield is the heart and capital. All the symptoms point to a period of uninterrupted prosperity for two or three years at least. Peace in the coalfield, which is usually the cockpit of commerce, is assured for a couple of years, and possibly for a longer period. Relations between employers and employed in all branches of industry are better than they have been for a very long time. Engineers, boilermakers, moulders, and other workmen on whom the heavy industries chiefly depend, are having their position materially improved by reasonable advances being granted when a fair case warrants. Now and again the wages dispute bulks pretty largely in the local Press, but its magnitude is infinitesimal when one has regard to the wide field in which it occurs. Perhaps there never was a time when so much re-arrangement of work and wages was in progress without external commotion or fuss. The men are showing, on the whole, a fairly reasonable regard for the circumstances in which their employers find themselves, and they appear to be getting wiser than to insist upon excessive increases of remuneration before the manufacturers have had time, by obtaining higher rates for their finished goods, to recoup themselves for the increased cost of raw materials and other considerations which cause output to be more expensive. Another feature which makes for a gratifying period of gradually improving business is the absence of "booms." The day of the "boom" may be said to have gone by; it was, to start with, an American exotic, and was only successfully transplanted in England when means of production were limited. Now the means of production are so enormous that if exorbitant demands are made in any particular industry, a check can quickly be given. All this tends to steady trade, to induce sellers to be reasonable in not exacting the last sixpence for their materials, to make manufacturers and workmen alike come to closer relationship in settling disputed points, which, when they lead to strikes or lock-outs, simply play into the hands of the foreigner. After careful inquiry made throughout a large centre of industrial activity the conclusion come to is that, barring some grave international trouble, the trade of the country, judging it by one of its most important localities, is likely to maintain for the definite period mentioned its present satisfactory condition, with the happiest results for employers and employed, the families dependent upon them, and the general mercantile interests of the nation.

IN view of the provision of Clause 6 of the Act of Parliament recently passed at the instance of the Lancashire County Council, that a county council may, if they think fit, contribute, or join with other local authorities in contributing, to the rebuilding, widening, or improvement of any bridge in the county belonging to any railway, canal, or other company, corporation, or person, and to the widening and improvement of the approaches thereto, and that any such contribution of the county council shall be paid out of the county fund, and shall be deemed a special county purpose, the executive council of the County Councils Association addressed a circular to county councils requesting information as to whether railway companies have prohibited the passage of locomotives across over-line bridges, and, if so, whether any inconvenience has arisen from such prohibition, and had the council taken any steps in the matter; and also whether, in the opinion of the council, it would be desirable to promote a Bill applying to counties generally the principles of the clause quoted. Replies to the circular have been received from twenty-eight councils.

THE SMITHFIELD CLUB SHOW.

THE centenary Show of the Smithfield Club was opened at the Agricultural Hall, Islington, on Monday last, and closes to-night, Friday. Although the primary objects of the Club are to encourage the selection and breeding of the best and most useful animals for the production of meat, or, to quote the words of the founders of the Club one hundred years ago, "to supply the Cattle Markets of Smithfield and elsewhere with the cheapest and best meat," it is chiefly known by its annual exhibition, which in the metropolis is looked upon as a sort of herald of the festive season closely following. But of the hundred shows which have now been held, thirty-six have taken place at the Agricultural Hall; previously for twenty years the Horse Bazaar in Baker-street accommodated it, and for thirty-three years again prior, the Club requisitioned Sadler's-yard in Goswell-street, while one year it was celebrated at Barbican, and the first six exhibitions were held in Dolphin-yard, Smithfield. From two small groups of cattle and sheep, without division of breeds, the exhibition has grown to one of 94 classes, containing about 1200 animals, not including table poultry, while the display of implements and machinery has come to be looked upon as second only to that at the Royal Agricultural Society's annual exhibition. At the time of the first Show in 1799, the institution was known as the Smithfield Cattle and Sheep Society—the present title not having been adopted till 1802. It had 113 members, and gave prizes amounting to the sum of £52 10s.; in 1839 there were 213 members, and £300 was offered in prizes, while the enormous growth of this typically English institution at the present may be best gathered from the facts that there are now 1120 members, and £5000 is offered in prizes for live stock.

In the implement and machinery section no inducement in the shape of prizes is held out, as at the Royal Show; nevertheless an excellent collection of appliances representative of the farming and stock-breeding industries is invariably got together. Last year, unhappily, the ruinous strike in the engineering trades had the effect of marring the display somewhat; not so much perhaps that a large section of the exhibitors belonged to the Federation, as that the materials which they required were unavailable. This year it is the almost unprecedented activity in the engineering trades which has robbed the Show, for in many respects the implement section does not compare with several of its predecessors. Not that the quality of the work shows any tendency to deteriorate—rather the reverse; but there is a thinness about the stands, and a general flatness due to the lack of novelties, which is more than ever apparent. Asked the reason of the thinness, several of the leading firms told us that they have experienced difficulty in producing anything at all for the Show, and that most of the exhibits were made to order, permission having been obtained from the purchasers to bring the appliances to Islington before delivery. Under the circumstances, then, not much can be said which has not previously been recorded. The genius we have looked for to liven matters up, by revolutionising some section of the implement industry, has not yet made his appearance.

Commencing on the ground floor, one of the most attractive stands is that of Messrs. Robey and Co., Lincoln. They show amongst other appliances a single-cylinder portable engine, an improvement in which is the substitution of steel brackets riveted to the boiler for carrying the crank shaft, plummer blocks, and the cylinder, in place of the usual cast iron saddle and cylinder bolted to the boiler. The plummer blocks are directly connected to the cylinder by steel tie rods, and are also connected together by a steel cross tie rod. The plummer blocks slide upon the planed guides of the brackets, so that the stresses due to the pull and thrust are taken off the boiler. The engine being thus erected upon the boiler as a whole, and having outside steam and exhaust connection, the number of bolt holes in the boiler is reduced to a minimum. By the use of the external stop valve and the external jacket feed, all concealed or inaccessible steam joints are avoided, and the durability of the boiler and engine very much increased. Messrs. Robey also show a high-speed vertical engine, fitted with automatic shaft governor acting on the slide valve direct. The crosshead of this engine is of special construction, with a steel gudgeon having a conical head, the piston-rod being secured to the crosshead by a coned end and cotter. With this construction the removal of the piston is much simplified. We also noticed an under-type compound engine and locomotive boiler combined, fitted with automatic governor and link expansion gear. This engine, we are informed, works with perfect regularity with varying loads, and is extremely economical in fuel, consuming under 2 lb. of best Welsh coal per indicated horse-power per hour.

The machinery shown by Messrs. Richard Garrett and Sons, Limited, of Leiston Works, included a semi-portable compound engine and three portable engines; the compound engine and one of the portables were fitted with the Turner-Hartnell shaft governor, and the two remaining engines with high-speed throttle valve governors. All four portable engines are mounted on high-pressure boilers fitted with this firm's well-known corrugated firebox. The threshing machine shown this year is a specimen of their light-pattern machine, which is expressly designed to work in conjunction with a portable engine. Like all their threshing machines, it is fitted with Garrett's reversible beater drum and chilled antifriction bearings. To those unacquainted with Messrs. Garrett's threshers, we feel sure a thorough inspection of this machine would create a very favourable impression. Another attraction, at least among that section of agriculturists interested in the cultivation of clover seeds, is the double-drum clover huller introduced by this firm some two years ago. By means of this machine the clover can be cobbed, drawn, and dressed in one operation. The clover is fed into a reversible beater drum, which strips off all the heads or cobs. These are dealt with in a second drum, the seed being cleansed by means of sieves and a second dressing apparatus, after which it is delivered into sacks ready for market.

Messrs. Hornsby and Sons have their usual representative display, including a portable steam engine, the Hornsby-Akroyd oil engine, and reapers, binders, trussers, and other farm implements. Messrs. Marshall, Sons, and Co., Gainsborough, whose stand is always attractive to an engineer, show a compound traction engine, a compound high-speed engine, and a horizontal Corliss engine with trip gear, amongst other exhibits. Messrs. John Fowler and Co, Leeds, who on the occasion of the last Show had to fall back upon relics of the past owing to the strike, have this year a single-cylinder ploughing engine fitted with a horizontal drum and self-acting coiling gear, a 10 horse-power double-crank compound traction engine mounted on springs, a single-cylinder agricultural engine, and a six-furrow turn-round plough for what is known as steam cultivation. During the past year several improvements have been introduced into these ploughs. The plough bodies are so constructed that they adapt themselves to the contour of the land, thus giving an equal depth of work. Skimmers and knife or revolving wing coulters are used to ensure all the top surface being turned underneath, and thus prevent the ploughs clogging, and the forecarriage is fitted with an improved ball-bearing castor movement.

The other exhibitors of portable and traction engines are: — Mr. William Allchin, Northampton; Messrs. Clayton and Shuttleworth; Messrs. Aveling and Porter, Rochester; Messrs. Brown and May, Devizes; Messrs. Chas. Burrell and Sons; Mr. William Foster, Lincoln; Messrs. Ransomes, Sims, and Jefferies, Ipswich; Messrs. Robinson and Auden, Wantage; Messrs. W. Tasker and Sons, Andover; and Messrs. Wallis and Steevens.

Messrs. Nalder, Limited, Wantage, show a new machine called a rotary bag-tie extractor and rougher out. This machine is intended as an adjunct to grain-dressing machinery. It not only takes out that troublesome pest, the "bag-tie," but extracts short straws, and other large and foreign substances, before the grain enters the dressing machine. It consists of an endless band, on which at intervals are fixed prongs or spikes, so arranged as to pass through a corresponding set of fixed prongs in the inlet. As the endless band moves, the prongs pick off the bag-ties, &c., conveying them away from the grain, which passes straight through them. The machine can be fixed to form part of the grain-dressing machine, at the inlet of set of feeding elevators to the same, or other convenient position.

Messrs. Stamford and Co., Colchester, have on view a combined seed thrasher and sheller fitted with an improved sifting apparatus. This machine is fitted with two drums, one for thrashing the cobs or heads of seed from the straw, the other for hulling or shelling the seed. All the cob is sifted, stones and other hard substance taken out, plantain and other weeds removed before passing into the hulling cylinder, thus reducing the wear and tear of the huller, and supplying a long-felt need. After the seed is drawn it is passed to the dressing sieves, where it is efficiently dealt with, the chaff being separated, freed from dust and dirt, and bagged direct. The dressed seed is delivered into sacks convenient for easy removal.

Messrs. Robinson and Auden show, in addition to a portable engine, horizontal and vertical engines, a thrashing machine, and a chaff cutter. The chaff cutter is furnished with an exhaust fan to remove dust, &c., from the chaff. They have also an engine fitted with their shaft governor, which we have before described. Messrs. Wood and Co. exhibit vertical engines, crushing and grinding mills, pulpers, cake breakers, root pulpers, turnip cutters, shredders, and chaff cutters; but though it is a fine display of these machines, there is nothing particularly new about any of them. Messrs. Ruston, Proctor, and Co. have a fine effective show, embracing a traction engine and a portable engine, also a horizontal, a vertical high-speed, and an oil engine, as well as a thrashing machine. The traction engine, which works at 120 lb. steam pressure, is a good, sound job, and the horizontal engine has many points of interest, one of which is the length of its stroke. The finish is good on all the exhibits. Messrs. E. R. and F. Turner have a large display of their corn-grinding and crushing mills, &c., and they also show a horizontal single-cylinder engine, which is fitted with the latest form of their patent shaft governor, the springs of which are now continually in tension instead of being as formerly continually in compression. Mr. James Coultas shows a number of drills, horse hoes, &c., which do not differ materially from his usual pattern. He also exhibits a manure distributor of novel design, which, it is claimed, is capable of dealing with any description of artificial manure or fertiliser. The substance to be distributed is put into a box which is pushed automatically upwards towards a circular comb-like spreader, so that an even feed is ensured. Messrs. Ransomes, Sims, and Jefferies have as usual a good serviceable-looking exhibit, which includes a large-sized road locomotive, a portable and various other engines, a thrashing machine, ploughs, haymakers, swathe turners, rakes, &c., all of which are more or less of ordinary type. They also show a potato planter of new design, which takes the potatoes separately in what are practically fingers and thumbs and drops them automatically in the right place. The Darby Land Digger Syndicate have one of their diggers, but this only differs in slight detail from the machine we described some few months ago. Messrs. Crossley Brothers, besides others, have a 16 brake horse-power self-starting oil engine. The starting is effected through a special valve by means of compressed air contained in an ordinary steel bottle, detached from the engine. This cylinder contains air at 180 lb. to the square inch, and holds enough for twelve "starts," and can be recharged by the engine itself. Other exhibitors of gas and oil engines are:—Messrs. the Campbell Gas Engine Co., Halifax; Allen and Barker, Taunton; Clayton and Shuttleworth; J. and F. Howard, Bedford; Edward

Humphries and Co., Pershore; the Trusty Engine Works, Cheltenham; Fielding and Platt, Limited, Gloucester; J. B. Petter and Sons, Yeovil; Mr. John Wallis Titt, Warminster; and Tangyes, of Birmingham.

Messrs. J. and F. Howard have samples of their portable and horizontal engines, and also an hydraulic hay and straw press. There is one hand pump to this press, but there are two sizes of plungers, the larger being used at first, and the smaller when the necessary pressure becomes greater. They have also one of their self-wiring presses, which we have previously described. Messrs. E. S. Hindley's exhibit is practically the same that we saw last year.

Messrs. Clayton and Shuttleworth's exhibit includes several steam and oil engines, &c. They have one traction engine which, when fitted with different wheels, becomes a road roller.

In the galleries Messrs. E. H. Bentall and Co. have a large exhibit, in which is one of their combined crushing and grinding mills, the hoppers of which are so constructed that the grain can be fed separately or simultaneously for both grinding and crushing. Messrs. Robert Boby and Co. show amongst other things their clover-seed cleaning apparatus, and their cellular-cylinder separators for cockle, half corn, &c. Messrs. Alfred Dodman and Co. have some nicely-finished miniature steam plants. Messrs. Kell and Co. have a manure distributor which is dependent in its action on a series of revolving stirrers, which throw the manure on to a revolving cylinder, which in its turn sends it to the ground through a shoot. In an effective exhibit Messrs. Kearsley and Co. show samples of their binders, reapers, and combined mowers and reapers. Messrs. Massey, Harris and Co. have a sheaf binder, a feature in which is an arrangement by which the ends of the straws are made to butt up against a specially-constructed board, and much neater work done. Mr. Thomas G. Slipper exhibits a mower, and claims that it is the only mower in which the "draw" actually comes upon the knife bar itself. A stay is run from the draw bar to where the knife bar pivots, and it is said that among the advantages attaching to this form of mower is the fact that the wheels are not lifted from the ground when obstacles come in the way of the knife bar.

Prominent amongst Messrs. Blackstone and Co.'s exhibits is their new swath turner, letters patent for which have been applied for. In this machine, as in the older swath turner made by this firm, the forks work at an angle to the line of draught, and have practically the same motion, although it is obtained in a different and simpler way. The two turning forks in the new implement are suspended from the opposite extremities of an oscillating beam, which works at a suitable angle to the main axle, giving the forks their necessary vertical motion. The horizontal movement of the forks is obtained by connecting each of them by means of rods attached at a suitable distance from their point of suspension to two of the pins of a three-throw crank, the third pin of which by similar means is made to oscillate the beam. The two movements described above, combined with the forward motion of the machine, result in an action of the tine bars eminently suited to turn the swathe in an efficient manner. The frame of the machine is very compact, as the working parts only require support at one point, and the whole of the movement is derived from one crank shaft, drawn by a single pair of bevel wheels. A Stamford cultivator, arranged for the purpose of general cultivation, is shown. In this form it may be used for working stubbles and clover leys at any required depth from 1in. to 5in. It covers a good width, and every inch of ground is cut. Messrs. Blackstone exhibit, for the first time, one of their new pattern horse rakes. This implement is both self-acting and manual, but if desired can be supplied as a manual rake only. It is made in three sizes, of both a light and heavy pattern, to suit every requirement. The tines can be raised on the lifting pawls, put in gear by either the hand or the foot of the driver, and can also be operated from the back of the implement. The lifting and locking mechanism is simple and efficient.

FEED-WATER HEATERS.

A MEETING of the Institute of Marine Engineers was held on November 28th, at the Institute premises, 58, Romford-road, Stratford, when an interesting discussion took place on the paper read at the previous meeting by Mr. George Halliday, on "Feed-water Heaters," reference to which has already been made in THE ENGINEER. Mr. Alderman G. W. Kidd, vice-president, occupied the chair.

Mr. W. Lawrie, who re-opened the discussion on the subject, said that in bringing this paper before the Institute Mr. Halliday had again placed the members under a very great obligation to him, and he was sure he was only voicing the feeling of every member present when he thanked the author for the very able and original manner in which he had dealt with the matter. In his opening sentences Mr. Halliday reminded them that the action of the ordinary surface condenser was somewhat in the nature of a feed heater, and most marine engineers of the pre-feed-heater period would fully endorse that statement, remembering as they did that by a judicious manipulation of the injection valve they had many times helped themselves to increased revolutions. Formerly the main idea of feed-water heating was the saving of waste heat, using gases that would otherwise be lost to them. Engineers were always alive to the fact that hot feed was a necessity for producing and maintaining high steam. How often had they had a dispute at the end of a watch about the height of the water-level in the boiler? And why did they always keep the water-level as low as possible consistent with a good relief? It was because the water necessary for raising the level in the boiler had to come from the supplementary feed at a temperature much below that of the water in the boiler, and the admission of this feed produced a serious reduction in the steam pressure. They all knew the value of hot feed-water, and why they stopped for so many years at the hot well was to him somewhat of a mystery. On the other hand, how many of them had made attempts, on their own lines, at feed heating? In 1863 he was the second engineer of a steamer running from Liverpool to Bombay, and the chief engineer of that vessel conceived the idea of running a steam pipe from the boiler into the hot well, and thereby increasing the temperature of the feed. That attempt was not altogether a failure, but it was not a success, and was discontinued. It was another illustration of the fact, however, that we were sometimes very near success without knowing it; and had they had better materials and appliances for the purposes of that experiment in 1863 there is no saying what might not have been the results. The idea of the chief engineer in making the experiment was not primarily for the purpose of heating the feed. He thought that when the natural draught was so very sluggish, as it was so often in the Red Sea, this heating of the feed-water would enable them to get better steam, and thus increase the speed of the vessel. He—Mr. Lawrie—said at the time that it was very much like robbing Peter to pay Paul, but the chief engineer replied that he would not mind robbing his own father if he could reduce the time occupied between Suez and Bombay by two or three hours. After referring in some detail to several of the comparisons set out in the paper, Mr. Lawrie alluded to the trials described by the author which had been carried out on board the New Palace steamer La Marguerite. Mr. Halliday had very fully described the experiments that were made in that vessel, but in regard to the reference by the author to the steam pressure of 105 lb. per square inch, he—Mr. Lawrie—might explain that that was a very easy full speed for La Marguerite. She happened to be on a run where full speed was not required, but, as Mr. Halliday explained, when the feed heater was used the steam kept rising, so that they had to close the dampers. When the feed heater was turned off they had to reverse the operation and open the dampers; so that by using the feed heater the advantage was, keeping the steam pressure at the same height with a considerably less coal consumption and a restricted draught. He had been somewhat surprised to read an article in THE ENGINEER, in the course of which the writer, referring to feed-water heaters generally, said, "Waste heat is not utilised in any way." Now, if by closing the dampers an engineer using a feed heater consumed less coal per square foot of fire-grate, with a very much lower rate of combustion, and still retained the same funnel temperature, he—Mr. Lawrie—maintained that there was a decided saving of waste gases. They were putting less air through the furnace, through which it passed more slowly, and there must surely be a saving of heat; otherwise where did the heat come from that produced the steam? The writer of this article said, further, that "nothing is to be had for nothing in this world, and it would seem clear that there must be a reduction of the temperature of the waste heat." But it was not suggested by Mr. Halliday that any more heat was taken out of the steam than was put into it. What Mr. Halliday did say was, that by the adoption of the feed heater a better use was made of the hot gases. Mr. Halliday showed them that in estimating the economy of the feed heater they must take into consideration not only the heat that was put into the boiler in the feed, but also that more heat was taken through the heating surfaces. The author showed that the higher the temperature of the feed the greater was the speed at which the water moved in the boiler over the heating surfaces, and the quicker did the water carry away with it the heat from the surface of the plates. In other words, when the feed was heated it influenced not one, but two things—the heat taken from the steam, and the heat taken from the hot gases. This was the explanation put before them by the author, and as it was the only reasonable theory that had been suggested, he thought they were bound to accept it.

The Chairman reminded the meeting of the suggestion made by Mr. Hawthorn, that the time was fast approaching when the present surface-condenser might be done away with altogether, his idea being that there was more force wasted in using the air pump than was gained by means of the vacuum obtained.

Mr. Lawrie said that experiments on the lines indicated by Mr. Hawthorn had been tried, and an attempt had even been made to pump the steam back into the boilers. Indeed, he believed an idea was propounded for sending a thousand-ton steamer round the world on a consumption of about ten tons of coal, but he was not aware that any attempt was ever made to give effect to this idea.

Mr. Sage said that a vast amount of ingenuity had been exercised in designing and constructing feed heaters which heated the feed by means of steam taken from the boilers, but in his opinion it was not beyond the ingenuity of the engineers of the present day to design a method of heating the feed by means of heat which would otherwise be wasted.

The Chairman thought it was apparent to all engineers that something ought to be done with the waste gases, and related an experience with a kind of feed-water heater fitted in the smoke-box. The great objection to the heater was that it stopped the draught, while the tubes after a short time became clogged, and had to be taken out. When this steamer reached her outward port, this water heater was removed, and, as a matter of fact, the ship steamed a good deal better without the water-heater than she did before.

Mr. M'Laren gave some particulars of a system which, it was stated, conduced greatly to boiler economy, and which consisted of pumping a special mixture into the boiler along with the water; but in answer to the Chairman he said he was unable to state the cost of the mixture.

Mr. Hulme described some trials with feed-water heaters, and the difficulties encountered and overcome; and after some remarks from Mr. Cook and others,

Mr. Halliday replied. He referred in some detail to the action and circulation of the water in the boiler as bearing on the question of the economy due to hot feed, and said that one advantage of using a feed heater was that less air went into the boiler with the water. Air in the water had the effect of causing pitting in the boiler. If they got rid of the air they got rid of the pitting. The feed heater also got rid of the oil, and without the oil they got a better transmission of heat through the plates. The ideal system of feed heating was that which heated the feed to the temperature of the water and steam in the boiler; and it was impossible to heat the feed up to this temperature except by means of a feed heater which used the waste gases. Live steam could not be a perfect feed-water heater. The only possible perfect water heater, from a theoretical point of view, was a heater in which the feed was heated by the hot gases.

On the motion of the Chairman, seconded by Mr. Aukland, Mr. Halliday was accorded a hearty vote of thanks, and it was announced that the discussion on the subject would be adjourned until the second Monday in December, when a paper on "Electric Lighting" will also be read.

A vote of thanks to the Chairman concluded the meeting.

LEEDS ENGINEERS' DINNER.—The thirty-third annual dinner of the Leeds Association of Engineers took place on Saturday evening, December 3rd, at the Queen's Hotel. There was a large attendance. The chair was occupied by Alderman F. W. Lawson, Professor Goodman being the vice-chairman. After the loyal toasts, the Chairman, in giving "Prosperity to the Association," said it was mainly to the engineering trade that Leeds had attained to the position it occupied. Although the engineers were all full of trade in Leeds, yet they knew they had to compete with foreigners. In 1873 he was at a dinner given to the British exhibitors at the Vienna Exhibition, and it was then said we had no need to fear the competition of any nation which allowed their women to go up ladders as bricklayers' labourers — that being the practice in Austria. At that time it was quite unusual to have in Austria any other than a British engine. Now it was quite unusual to have a British engine, and still the women went up ladders as bricklayers labourers. It would be necessary to exert all their powers to have the engineering works of Leeds and this country not only abreast but ahead of the times. After various other speeches, Professor Goodman proposed "The Engineering Trades," and Mr. J. H. Wurtzburg responded. Mr. R. Lupton gave "Our Honorary Members and Guests," which was acknowledged by Mr. J. H. Wicksteed and Mr. E. Matheson. Other toasts followed.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH AND AMERICAN MACHINE TOOLS.

SIR,—Your leading article on the above subject is too meek and mild, and does not, in my opinion, go far enough. Like yourself, I have no object in "puffing" American tools; the only end I wish to serve is to try and arouse British toolmakers to the actual reality of their position, and this from the point of view of a user and purchaser of machine tools. You have put in a few words the real distinction between the American and British toolmakers by saying that the former do not wait for their customers to tell them what is wanted, but show them how much more and better work can be done by new over old methods. Very few cases indeed can be pointed out where the British toolmaker has done this. I am afraid, from conversations I have had with some of our toolmakers, that they despise or affect to despise both American machine tools and American methods. These gentlemen, like the ostrich, bury their heads in the sand, and won't see what is going on about them. They tell me constantly, "Oh, yes, American tools may be good enough for the cycle trade and other light work, but when it comes to general engineers' tools, where are they?" The answer, and the very correct answer, is, "That the American tools are there, viz., in general engineers' shops, &c., and are likely to increase much faster in number than British tools." You, Mr. Editor, have a sort of feeling that way yourself when you say that it is beyond contention that no finer tools of large size are made in any part of the world than in Britain. I am not so sure of that. Let us go into detail. Where can you find finer designed or better constructed boring and turning mills—sometimes called horizontal lathes—than those made by the Niles Tool Works, Bullard Company, Pond Company, &c.? In fact, such machines have not been made in this country until a couple of years ago, with the exception of Messrs. Richards and Co., Manchester, who make them only in small sizes. Those now made by one or two Manchester firms are not so well designed as the American, because of want of experience in their use and construction. Their prices are as high, if not higher than the American, and as for time of delivery, well, the least said about that the better.

What about milling machines? It was undoubtedly the Americans who showed us what the milling cutter could do, and anyone unprejudiced will undoubtedly confirm my belief, that not only in small milling machines, but in large plain or slab milling machines, they stand pre-eminent. I am well aware that there are one or two firms in this country who make such large machines, but they have not had the experience in them that our cousins across the water have, and this can be seen in the designs of their various types of those machines.

Sometime ago I wanted to buy an automatic gear cutter. I tried the only firm in this country who advertise themselves as makers of such; their price was not only higher than the American make, but they wanted nine months to deliver it, while their machine was inferior in design and construction to the American. The fact of the matter is, there is to-day no machine maker in Britain who makes a push of automatic gear cutters. Here, surely, is an opening for some one who is wide awake enough to take advantage of it.

What about capstan and turret lathes? What firm or firms in this country except Alfred Herbert, Limited, of Coventry, can show us such a line of these tools for both bar and casting work as the Americans? If some of our toolmakers would either study themselves, or appoint some one with a head and brains to study, say, the Jones and Lawson, Gisholt, Bullard, and the Dreses and Mueller capstan and turret lathes, they would find what a great saving in manufacture is caused by the use of such tools, and the wide field which is open in this country for good firms to take up their manufacture.

What about planing machines? The largest and best planes made in this country are made on the American Sellers principle, but even then they are not up to date in speed. There are no firms in this country to-day who can offer a good planing machine with a cutting speed of 20ft., and a quick return speed of 80ft. These are the lowest speeds of the American planes. Further, let anyone stand beside an American plane while it is at work, one can hear oneself speak; but let him stand beside a British-made plane, and one has to shout, so great is the noise as compared with the American. The secret is that only cut gearing properly designed is used, and notwithstanding their quick speeds all are beautifully silent. Again, where can we buy in this country planes which give the user such a range of feeds as we find in the American? With the latter you can have from $\frac{1}{32}$ up to an inch, and sometimes more than that. The broad feed in finishing cuts is invaluable, but you can't get it on a British plane.

What about horizontal boring machines? Anyone conversant with this branch will find ample food for comparison if he reads an article on American horizontal boring machines in a recent issue of *Cassier's Magazine*. I recently wished to buy one or two of these machines, and asked several British makers for prices. The type which suited us best was priced at £335. I declined to pay such a price for the machine, and tried America. The result is that I am getting a better machine delivered f.o.b. New York for £240, and delivered in one-fourth the time of the British tool. Further, a guarantee has been given—voluntarily on the makers' part—that this machine will bore and face both ends of a cylinder at one time, and that it will finish in this manner nine cylinders 10in. diameter by 12in. long in ten hours. I ask, where such a machine can be bought in this country that can do this? I know that this has been done by many American machines.

What about drilling machines? Where can anyone buy a drilling machine in this country with a movable head, as is common in the American vertical drilling machines? The head can be moved down close to the work and so support the spindle; heavier cuts and stronger feeds can be given to such a machine than if the spindle had to stand out some inches. Further, in some American drills the double gear can be thrown in and out of gear without stopping the machine—a feature which is valuable in tapping holes. A much greater range of feeds is given on the American drill than in ours, while automatic stops to the feed are quite common, but on our own tools I have never seen one fitted.

What about lathes? About the ordinary sliding, surfacing, and screw-cutting lathes, I am not such a lover of the American machine. The feature I do not like in them is the tool rest. They are made far too weak and flimsy for heavy cuts, but our toolmakers must not think that this will escape the attention of the American toolmaker. The great feature they possess is that they find out themselves the weak points of their tools, and alter or adapt them to suit all requirements. The British maker is content to wait till his customer complains or kicks up a row, and then, perhaps, the next machine he makes he will alter. There are, however, many points for admiration in the American lathes. One very desirable feature is the friction back gear. Among the whole list of our toolmakers, I know no one who advertises friction back gear to their lathes. I am speaking, of course, of ordinary lathes, not special tools such as turret and capstan lathes. Again, any one examining an American lathe will see two projecting pieces of metal on the fast headstock below the cones. These are cast on the headstock to prevent the belt slipping into the back gear and getting chewed up, which, as any one knows, is done from time to time. These simple bits of metal are nothing in themselves, but I have not seen a British lathe possess them. Further, there are only one or two firms in this country, and that only recently, that can offer you a lathe with several changes of feed to the back shaft, without requiring to use change wheels. Lang's and one or two other firms are the only ones in this country who can do this. The old style was that the turner had to hunt about for his change wheels, pull off those he had on, and put on others, and perhaps he puts on the wrong ones, the feed oftener

being too slow than too fast. Also, where can we buy a British lathe to cut a range of different threads without the use of change wheels? I answer that there is not such a lathe made in this country. You can buy these from half a dozen American makers, all of whom make a strong point of them. Lathes with automatic stops to the feed in Britain cannot be had; they are common with our cousins.

What about keyway cutting machines? So far as I am aware, there is only one firm in this country who has a line of these, and it is an American patent. The patent, I understand, is in the tool used, and not in the actual machine itself. Sometime ago we ordered one from the firm in question. The "rig out" of tools was to cost more than one and a-half times the cost of the machine. We were prepared to pay this, as we saw a saving. Nine months passed, and no machine came. We cancelled the order, bought one in America for less than one-half the price of the British machine, and it was delivered at our door six weeks after the order was given. No machine could give us greater satisfaction, both as to quality and quantity of work, than the one we have. Why do not some of our toolmakers take up the making of keyway cutters? There are practically none to be bought here. A splendid opportunity lies open here.

This letter is longer than I anticipated, so I refrain from going further into detail. I only wish to say that the British makers are living in a "fool's paradise," and that they will get a rude awakening the first slack time that comes. They are busy now mostly on our own home demands, the foreign trade—Britain's greatest trade—is being neglected, and the American is filling Europe, &c., with their splendid tools. What a difficult matter it will be to oust them, is known only to those who have attempted similar things in other lines. Go where you will on the Continent, you will find American tools having a sale before British tools. Explain it if you can. I cannot, except on the ground that they are better tools, and better brought to the people in want of them. I have been told by some toolmakers here that even if they made as good tools as the American, they could not command the high prices. That, in my opinion, is a fallacy. The one thing the toolmaker has to do is to convince the purchaser that his tool is better than any other make, and he will get his price. It is a mistake, however, to suppose that the American machines are high in price as compared with those of our own good toolmakers. I have given instances where they were cheaper, and I could multiply them.

Gas and Oil Engine Works, HUGH CAMPBELL.
Halifax, December 5th.

THE DIESEL RATIONAL OIL ENGINE.

SIR,—I have read with great interest the article which appeared a few weeks ago in THE ENGINEER on the Diesel oil engine, and also the article which appeared in your issue of October 15th, 1898. The conclusion at which I have arrived is that the use of the word "rational" in describing this engine is not justifiable, and I shall feel obliged if you will grant me the small space necessary to give my reasons for coming to this conclusion. The subject of gas and oil engines has become one of very grave importance, and there are already many who think that the days of stationary steam engines are numbered.

The engine described in your issue of November 15th, 1898, is stated to have given out nearly 20 brake horse-power when running 175 revolutions a minute. The explosive cylinder is 9·8in. diameter and the stroke 15·7in., so that the volume swept out by the piston during the compression stroke is 68 cubic feet a minute. According to the diagram it is compressed to about 544 lb. absolute. The value of γ for air lies between 1·3 and 1·4. If we assume that the pressure of the air in the cylinder before compression was 14 lb. absolute, the ratio of voluminal compression will be 16·9 to 1 if $\gamma = 1{\cdot}3$ and 13·8 to 1 if $\gamma = 1{\cdot}4$. Corresponding to a voluminal compression of 16·9 to 1, the total volume of the charge per minute will be equal to 63·26 cubic feet, and the compressed volume to 3·74 cubic feet, and to the ratio 13·8 to 1 to 64·14 cubic feet and 4·64 cubic feet respectively. According to these data, the net indicated horse-power required to compress the air, if the compression is adiabatic, will be equal to 13·7 indicated horse-power if $\gamma = 1{\cdot}3$, and to 14·4 indicated horse-power if $\gamma = 1{\cdot}4$.

The oil is not mixed with the gas until after the air has been compressed in the explosive cylinder. The oil is then forced into the compressed air in the explosive cylinder by means of air compressed to much higher pressure pumped into a receiver. The diameter of the air piston is 2·7in., and the stroke 7·8in. The air pump does a full working stroke each revolution, so that if we allow ·2in. for clearance the volume of the air at atmospheric pressure pumped in 175 revolutions would be equal to 4·62 cubic feet. This is compressed to about 725 lb. absolute before the piston reaches the end of its stroke. During the compression stroke in the explosion cylinder the air is admitted to the oil chamber directly it is compressed to 725 lb., and in consequence of this the pressure falls from 725 lb. down to nearly the maximum pressure in the explosion cylinder before the piston reaches the end of its stroke, so that the work done by the air pump during this stroke will be less than when the air is pumped into the receiver against 725 lb. pressure. I make the indicated work in both strokes to be equal to about 1·4 indicated horse-power if $\gamma = 1{\cdot}3$, and 1·7 indicated horse-power if $\gamma = 1{\cdot}4$. In the case of gas engines the difference between the indicated and brake horse-power covers not only engine friction, but also the work done in the exhaust and charging strokes, and the difference between the work done in compression and the work that would be returned in expansion if no explosion took place. This last is a negligible quantity when the initial compressive pressure is less than 100 lb. In the gas engine trials of the Society of Arts the mechanical efficiency on this basis of the Atkinson gas engine was found to be equal to 85 per cent., of the Crossley to 86 per cent., of the Griffin to 81 per cent. The work done in overcoming machinery friction would probably not amount to less than 13 per cent. even in the case of the Crossley gas engine. The mechanical efficiency of the Diesel gas engine is stated to be equal to only 75 per cent., but in this case the difference between the indicated and brake horse-power covers the work done in pumping the air into the receiver. Taking all points into consideration, 15 per cent. of the indicated horse-power cannot be regarded as an excessive allowance for machinery friction in the case of the Diesel oil engine. From the above data we get the following analysis of the work of the Diesel engine, corresponding to the values $\gamma = 1{\cdot}3$ and $\gamma = 1{\cdot}4$.

$\gamma = 1{\cdot}3$.	I.H.P.	B.H.P.
Net work done in compression in explosion cylinder	13·7	—
Net work done in compression in air pumping	1·4	—
	15·1	17·7
Net external work measured by brake	—	19·8
Gross work done in expansion	44·1	37·5
$\gamma = 1{\cdot}4$.		
Net work done in compression in explosion cylinder	14·4	—
Net work done in compression in air pumping	1·7	—
	16·1	19·0
Net external work measured by brake	—	19·8
Gross work done in expansion	45·6	38·8

It is stated that the consumption of oil per brake horse-power per hour during the trial was ·54 lb., so that for 19·8 brake horse-power the hourly consumption would be 10·7 lb. The thermal power of 1 lb. is stated to be equal to 18,370 B.T.U. If we put the B.T.U. equal to 772 foot-pounds, the value adopted by Mr. Bryan Donkin, the mechanical equivalent of 1 lb. of the oil burned per hour would be 7·16 indicated horse-power, so that the mechanical equivalent 10·7 lb. would be equal to 76·6 indicated horse-power. In the following table of heat distribution the percentages are those given in Mr. Bryan Donkin's report of October 15th, 1897. The corresponding indicated horse-power have been calculated by myself on the basis of ·75 per cent. mechanical efficiency.

Heat converted into external work	33·7 per cent.	= 26·5 I.H.P.
Absorbed in water jacket	39·0 ,,	= 30·7 ,,
Dissipated in other ways	27·3 ,,	= 21·5 ,,
Total	100 per cent.	78·7 I.H.P.

This may be regarded as in practical agreement with the thermal value of the oil on the basis that the B.T.U. is equal to 772 foot-pounds. I venture to think, however, that a heat efficiency of 33·7 per cent. is an impossibility in the case of an engine of which the mechanical efficiency does not exceed 75 per cent., and from which the exhaust gas is discharged at nearly 60 lb. absolute pressure, and that the explanation is to be found in the value of the B.T.U. adopted by Mr. Bryan Donkin. If we adopt 1000 foot-pounds as the value of the B.T.U., the thermal power of 10·7 lb. of the oil used will be equal to 99·7 indicated horse-power, and we should have the following table of heat distribution:—

Heat converted into external work	26·8 per cent.	= 26·5 I.H.P.
Absorbed by water jacket	40·0 ,,	= 39·8 ,,
Absorbed in air pumping and overcoming friction, &c.	6·1 ,,	= 6·7 ,,
Dissipated in other ways	27·1 ,,	= 26·2 ,,
	100 per cent.	= 99·2 I.H.P.

The final pressure on the eve of exhaust is about 59 lb. absolute.

The indicated horse-power required for air compressing and pumping and giving out 19·8 brake horse power, plus 15 per cent. allowance for machinery friction, is according to my calculations for the value $\gamma = 1{\cdot}3$, equal to 44·1-horse power. According to the value of the indicated horse-power calculated from the diagram on the assumption that the work given out in compression would be equal to the work given out in expansion, if no oil was added, viz., 26·7 horse-power, the total indicated horse-power would be as follows:—

Net indicated H.P. calculated from the diagram	= 26·7 I.H.P.
Work done in compressing and air pumping	= 17·7 ,,
Total	44·4 ,,

As the work given out by expansion would certainly in the case of a water-jacketed cylinder be less than the work done in compression, the work calculated from the diagram, by means of the curve of expansion, would have been slightly more than 26·7-horse power. The agreement between the results attained, however, so nearly agree that we may regard them for all practical purposes as identical. In addition, therefore, to the *vis viva* expended by the fly-wheel in producing as nearly as possible an equal distribution of the power generated in one stage through the four stages of the Carnot cycle, sufficient will have to be expended on the stage of compression alone to give out from 47 per cent. to 49 per cent. of the gross power generated on the working expansion stage. In the case of engines which do not compress the charge to more than 80 lb. pressure, which was the case with the engines tested at the Society of Arts trials, the work done in compressing may be regarded from this point of view as a *quantité negligeable*. In the report of the judges the following particulars relating to the fly-wheels of the three engines tested have been given:—

	Atkinson.	Crossley.	Griffin.
Mean periphery velocity per second in lineal feet	39	45	52
Weight of wheel per indicated horse-power in pounds	131	91	74

What must be the periphery velocity of the fly-wheel in the case of the Diesel oil engine, and its weight per indicated horse-power, in order to enable it not only to distribute the effective brake horse-power as nearly as possible uniformly during the four stages, but also to give out in one stage from 47 per cent. to 49 per cent. of the gross power generated in another stage, without entailing a greater divergence from the mean velocity than that which occurred in the case of the three engines tested.

The oil used is described as petroleum. It was, however, a distillate of petroleum of the following composition:—Carbon, 85·13 per cent.; hydrogen, 14·21 per cent.; oxygen, 0·66 per cent.; total, 100 per cent. It was, therefore, a pure hydrocarbon oil. It is quite right to describe petroleum as a hydrocarbon oil, because its principal constituents are hydrogen and carbon, but we are not justified in describing a pure hydrocarbon oil as petroleum for two reasons. Firstly, because it is not petroleum. Secondly, because it can be obtained from other sources than petroleum. The makers of the Hornsby-Akroyd oil engine claim to get a brake horse-power per lb. of crude petroleum, from which not even the solids have been separated. The commercial value of 1 lb. of crude petroleum is less than half the value of 1 lb. of pure hydrocarbon oil, so that, if both claims are equally reliable, the Hornsby-Akroyd engine is a more economical working engine than the Diesel oil engine. It is claimed that the Diesel oil engine is noiseless, because no explosion is said to take place, but this is an error. The noise in the case of gas engines and cannons is not produced by the explosion within the cylinder, but by the impact of the exhaust gases against the air. The pressure in the case of the Diesel oil engine on the eve of exhaust is, according to the diagram, from 10 lb. to 20 lb. more than the usual exhaust pressure, so that, if extra precautions are not taken to smother the noise produced by the impact on the external air, the Diesel oil engine will be more noisy than existing gas and oil engines. There is another cause of noise in machinery, that due to the motion of the working parts. In point of simplicity of construction the Hornsby-Akroyd is much superior to the Diesel engine, and will, therefore, in this respect be less noisy. It seems to me that we cannot give a correct description to the Diesel oil engine without adding a monosyllabic prefix to the word "Rational."

December 2nd. ONLOOKER.

THE PATENT-OFFICE LIBRARY.

SIR,—On the 29th July last, page 105, you published an article on the Patent-office Library, and in your issue of last week there is also an article on the same subject, criticising with some severity the arrangements which you seem to have approved of only four months ago. The impression which a person unacquainted with the Library would form from your latest utterance must be most unfavourable. He would be led to believe that the Library is very imperfect, and that is the impression you evidently wish to convey by the closing words of your article last week, whilst four months ago you spoke of it as "a fine collection." You also call attention "to the importance of a good catalogue," thereby implying that the present catalogue is not good.

I am afraid that I shall be looked upon as a partial witness, having had a good deal to do with the Library. I was responsible for recommending the purchase of some thousands of volumes, and many a battle I have fought with the experts of the Stationery-office, who thought they understood the requirements of the public and the scope and objects of the Library better than I did. You compare it unfavourably with the British Museum, which, ever since its foundation, has been in a position to claim a copy of every English book published. But even in this department the Patent-office Library has no reason to be ashamed of its collection of technical, industrial, and scientific literature, especially as regards the Transactions of societies. The British Museum, however, has no rights over American and continental publishers, and, as regards foreign books, I have no hesitation whatever in claiming on behalf of the institution with which I was so long connected a marked superiority over the British Museum, and over every other library in England. When the Royal Society's "Catalogue of Scientific Papers" was being compiled, the editor and his staff spent many weeks at the Patent-office Library, working upon books which were not to be found elsewhere in London. I remember many instances in which persons have been referred to the Patent-office Library by the officials at the British Museum, and on one occasion this was done in my hearing.

Your suggestion that a book should not be placed permanently upon the shelves until it had undergone a period of probation, when its merits should be weighed by a body of experts, stamps you as a barbarian in literary matters. If adopted the Library would be in a state of constant flux, and you would be amongst the first to complain. What would you say, if you found that a book which you had consulted, say ten years ago, and wished to look at again, had been removed by order of the experts? Nothing is sacred to persons of that class, and they would even lay profane hands on the early volumes of THE ENGINEER, to make room for something more "up to date." It just occurs to me that several volumes of the British Museum set of your journal want the indexes, and are therefore partly useless. The "ideal library," to use your phrase, must contain not only books of the present day, but also those of the past, in order that a true view of the history of a subject may be arrived at. These are days of retrospection, as is proved by the purely historical articles which are constantly appearing in your columns. I was very much struck by an observation made to me many years ago by a well-known publisher and bookseller now dead. Speaking of the Patent-office Library he said, "It is your business to collect costly books, which few can afford to buy, and so-called 'rubbish' which few can afford to keep. The rest will take care of itself."

I have very little knowledge of the Dewey system of classification, but it appears to have one merit, for it can be worked out to any number of places of decimals. But after all it seems to me, as a practical librarian, that it matters little what system of classification be adopted, so long as a book can be readily found. The Patent-office Library is, as you know, housed in temporary premises, but when it is re-established in its permanent home I suppose that a copy of the catalogue of authors and subjects bearing the "press-mark" of each book will be provided for the use of readers. I do not see why a person who only wishes to consult a particular book or books, or to make a search on some restricted subject, should be called upon to master a complicated system of classification. The merits of Dewey's method did not seem to be so apparent to you on the 29th of July as they are now. I hope that some of your readers who have actual practical experience of the present arrangements will come forward and state their views on the matter. But, however elaborate the catalogue may be, and however minute the classification, the "living voice" of the intelligent librarian whose heart is in his work will still be useful as a guide, and this, I believe, will be found at the Patent-office.

75, Dartmouth Park-road, N.W., RICHARD B. PROSSER.
November 30th.

[We are sorry that Mr. Prosser should have so entirely mistaken the meaning of our article on the Patent-office Library. That article was intended to advocate the construction of a *complete* scientific library round the existing collection as a nucleus. There are at present limitations to the scope of the Patent-office Library which we wish to see removed. We do not question for a moment its usefulness, as far as it goes; but even Mr. Prosser, to whom very much of its present position is due, cannot claim that it covers completely all branches of science. It is the library of the inventor, not of the scientist. With regard to the catalogue, we wrote with the first volume of the latest edition before us. We have no hesitation in saying that it does not give the slightest direct indication of where a book is to be found on the shelves. Most large libraries have now-a-days card slip catalogues arranged on some system. If there is such a thing at the Patent-office, it is certainly not placed in a prominent position, and we imagine but few readers know of its existence. How Mr. Prosser has managed to construe a few words of praise of the British Museum into an unfavourable comparison between it and the Patent-office Library, we are at a loss to understand, and also we fail to see what grounds Mr. Prosser has for supposing that we advocate the removal of books that have once appeared on the shelves. Books under consideration might be put on special shelves. Our article of the 29th July was descriptive of the temporary premises, was in no sense critical, and was written before the new catalogue appeared. Read by an unbiassed person, we think no contradiction between the two articles in question will be found.—ED. E.]

SIR,—I have read your article on the Patent-office Library with much interest. Permit me to supplement your excellent comments with a few remarks and criticisms.

The Patent-office Library occupies a peculiar position. It is very largely a national institution, intended to subserve a special purpose. That purpose is to assist those who invent and take out patents. It is the easiest thing in the world to forget this. If it is kept properly in mind, it will be understood that the Library is not to be judged by ordinary rules. What might be very meritorious in a free library, for example, might be quite wrong here. What might answer admirably, or even be of vital necessity in the British Museum Library, or that of the Guildhall, may be quite out of place in the Patent-office Library. This last must be judged on different grounds. Take, for example, the British Museum system, by which a list has to be handed to the librarian, and the reader has to wait, sometimes for a long period, before he gets his books. That system would be quite out of place in the Patent-office Library, in which the reader ought to be able to help himself to what he wants with little or no aid from a librarian. The Patent-office Library is used by busy men for reference, far more than for reading, and everything should be done to reduce the labour and time spent in referring. It is not easy, with a due regard to your space, to make what I mean quite clear to those who do not use the Library for professional purposes. Those who do will recognise at once the force of what I say.

My memory easily carries me back thirty-five years to the time of the Great Exhibition of 1862. The whole of the books, specifications, and so on, of the Patent-office were then stowed away in the dismal corridors of the ground floor in Southampton-buildings. It was an old joke that access was obtained to the Patent-office from Quality-court through a passage, on one side of which was the office of the Commissioner in Bankruptcy, facing which was the office of the Commissioner in Lunacy. The intelligent foreigner regarded the Library with laughter and contempt. Then came the library nearly at the top of the house, and as years went on the indefatigable labours of Mr. Richard Prosser, assisted by the late Mr. Allison, worked wonders. Mr. Prosser had a terribly uphill battle to fight. Red tape bound the Patent-office. A do-nothing policy governed every one. But in the end Mr. Prosser triumphed, and the Library became worthy of the name. But up to the time when Mr. Prosser retired and Mr. Allison died, there was no adequate catalogue, and I think one reason was that Mr. Allison was a catalogue in himself. Everyone who wanted to consult books on any subject went to him. His courtesy was boundless, and knowledge of what was in the Library comprehensive and yet detailed. Mr. Prosser no longer guides; Mr. Allison no longer helps. Two special, peculiar, and invaluable features of the Patent-office Library are withdrawn. In their stead we must have ordinary methods of working. The patent-office must be run on orthodox lines, with librarians and clerks and a catalogue. The question to be decided then is reduced to this: Is the catalogue the best possible; is the arrangement on the shelves the best possible, for what is above and beyond all others a national reference library? I in common with many others who use the Library do not regard either the catalogue or the arrangements as the best. But I live in hope. I know that the existing premises are temporary. It is no disparagement to those who now control it if I suggest that when the new premises are ready and the transfer takes place, Mr. Prosser should be asked to give his assistance in completing the work which he began.

In saying that I am not satisfied that the Library is now all that it might be, it is probable that I shall lay myself open to censure. I regret this, but I cannot help it. A somewhat extensive knowledge of librarians convinces me, firstly, that every librarian has a system of his own; secondly, that his system is the best possible; thirdly, that the arrangement of his own library cannot possibly

be bettered until he gets more money; lastly, that no library ever has money enough spent upon it. I do not suppose that Mr. Hulme, the Patent-office librarian, is an exception to the general rule, and it is not likely that he will be satisfied with what I have written. I do not mean, however, to imply for a moment that he has not done his best, and I do not suppose that he holds that he is above criticism. I admit, however, that it seems scarcely fair to find fault and not particularise. But my excuse is that I could not possibly bring myself to make the demand on your space that a thorough overhauling of all the arrangements would need. I must rest content with the assertion that the Patent-office Library cannot be considered perfect while there remains to be done anything which can facilitate the labours of lawyers, engineers, chemists, patent agents, or indeed of anyone of that great army continually engaged in developing our national industries.

The Temple, December 3rd. THOMAS PINCH.

CEMENT SPECIFICATIONS FOR MARINE WORK.

SIR,—The usual specification for cement for this class of work insists upon a high tensile strain test, and also a high specific gravity. Four hundred pounds per square inch for a briquette made of neat cement at seven days, and a specific gravity of 3·15, are by no means uncommon stipulations.

A high tensile strain result can be obtained, to a certain extent, by hard burning and fine grinding; the hard burning also tends towards a high specific gravity, though the fine grinding is against it. A high percentage of lime, however, means high tensile strain results and high specific gravity, and is the means generally employed by manufacturers to obtain these results, and so make their cement conform to the engineer's specification.

As a precaution against too great a percentage of lime being employed, the engineer knocks up some thin cakes of cement, places them in water, and examines them from time to time, to see whether the cement shows signs of blowing; he is generally satisfied should such signs not be very pronounced. This test, to my mind, is very rough and ready, as a very heavy percentage of lime requires to be present before the cement cakes show marked signs of blowing. The fact of the test briquettes withstanding a tensile strain of 400 lb. or more, and having a specific gravity of 3·15, is sufficient in itself to prove that the cement contains a considerably greater percentage of lime than the silica and alumina can combine with.

The object of having an excess of lime beyond what is required for combination with the other ingredients is, I imagine, to make sure that each particle of silica, or alumina, shall have a particle of lime adjacent to combine with, when the proper time comes. Very intimate mixing of the ingredients will effect this to a certain extent; but there is always the probability, if only just sufficient lime is used, that part of the silica and alumina may escape contact with the lime. To avoid this an excess of lime is employed. This excess of lime, if not too great, may be of advantage in a cement which is to be employed in work hardening in the atmosphere, or in fresh water, but when the work or concrete is to be placed in sea water whilst in an unset condition, this excess of lime is highly injurious, delaying if not entirely preventing the hardening of the matrix.

It is important to remember that in the hardening of the faces of blocks and other concrete work exposed to the atmosphere, the element of the carbonic acid present plays an important part; a small excess of lime may here be an advantage, whereas the hardening of concrete below water containing no carbonic acid is quite a separate chemical process. What actually goes on in the process of the setting of concrete immersed in sea water, and the chemical changes that take place, have been fully investigated and described by Dr. W. Michaëlis, and it is to the discoveries of this eminent chemist that I wish to draw the attention of English engineers.

Dr. W. Michaëlis has devoted many years to the study of this subject, and written papers from time to time setting forth the results of his researches and experiments; yet, judging from the general character of the specifications for cement for sea work, very little notice has been taken of his work by engineers. Herr Nadory Nádor, a Hungarian engineer, has quite recently been drawing the attention of his continental brothers to the importance of Dr. Michaëlis' discoveries; so it would appear that it is not only in England that these discoveries have been somewhat neglected. Dr. Michaëlis discovered, and conclusively proved, by exhaustive experiments, carried on over a period of many years, that the disintegration of concrete placed in sea water whilst in an unset or plastic state was due chiefly to the presence of free lime; that the combination of the sulphates in the sea water and free lime in the cement not only set in motion agencies antagonistic to the hardening of the concrete, but opened up the way for the sea water, and naturally the injurious salts contained therein, to gain access to and abstract the lime already in combination with the silica and alumina in the cement, so in the process of time disintegrating the whole mass. He explains that the agencies at work may be classed under two headings, *i.e*, (1) those that tend to the hydraulic hardening, or, as I will put it, consolidation of the mass; (2) those which tend to crystallisation, or expansion of the mass. Free lime in the cement, and the sulphates in the sea water, come under the latter heading, and as the expansion increases they are gradually admitted to the heart of the work, which, if it has not become sufficiently consolidated to resist their attack, is finally dissolved and crumbles away.

Of course the chemical action that goes on in concrete immersed in sea water is very slow, and we do not expect to see the work go to pieces in a few months, or even years, after it has been placed *in situ*. But the action is going on nevertheless, and should the crystallisation forces predominate, which, with a large excess of lime in the cement, they are bound to do, the failure and destruction of the mass is only a matter of time.

I have examined a good deal of concrete in sea work, concrete only exposed at ebb of spring tides, and which was built *in situ*. My experience is that in most cases the matrix is not hard, but of a fairly tough putty-like consistency easily scraped away with the point of a penknife. I think that Dr. Michaëlis' experiments go to prove that this cement mortar will never harden, but on the contrary, little by little lose its toughness, and eventually become little better than mud.

In conclusion, I would invite those interested in this subject to read, if they have not already done so, Dr. Michaëlis' contributions to the Minutes of "Proceedings" of the Institution of Civil Engineers; also extracts from other publications—they can then judge for themselves whether I am right, or not, in suggesting that specifications for cement for sea work should take a very different form, or if this is not to be, that engineers should adopt the alternatives advocated by Dr. Michaëlis. JOHN L. WATSON.

Allen-street, Kensington,
November 28th.

SIR,—Mr. de Michele's statement about testing cement with sand is reasonable considering the different kinds of sand that exist. In his cement specification which he gives in THE ENGINEER of the 2nd inst., there are tensile strengths given for seven and fourteen days, showing an increase of 50 lb. on the square inch for the extra seven days. Would it not be preferable to specify a percentage of increase, as many cements give over 400 lb. per square inch for seven days, and even occasionally are over 450 lb?

Three briquettes appear to be scarcely sufficient, as even the most skilled tester at times has accidents in making experiments as to the strength of the cement under observation. The quicker the strain is applied the higher the result, and in most machines the greater jerk the weight gives on the bar, often giving a result 10 lb. higher than the truth. This seems to point to moderation of application of strain. The specification contains nothing about the specific gravity or even the weight per bushel of cement. Does Mr. de Michele claim that this is not necessary in a specification? It is high time that the constituents of concrete other than cement received more attention in drawing up specifications of important works than they often do, as the cleanliness, sharpness, size, and character of the ballast used affect the ultimate result quite as much as the quality of the cement does.

Bushey Heath, Herts., ALFRED E. HURSE.
December 5th.

SAFETY MOUNTINGS FOR EMERY WHEELS.

SIR.—I have naturally perused with great interest the correspondence you have been recently publishing on this subject. If it be true that there is nothing new under the sun, inventors are certainly the last people in the world to recognise it, and of re-inventions there is no end.

Your readers have been taken back to earlier and earlier periods, and I now beg to refer them to the Patent No. 3193 of November 11th, 1867, in the names of Frederick Ransome, Henry Bessemer, and Ernest L. Ransome, in the drawings attached to which may be seen the identical arrangement illustrated by Mr. Sterne. I have a copy here, but anyone can satisfy himself by a visit to the Patent-office.

One of my earliest experiences with this shape of emery wheel—viz., a thickened centre and a correspondingly-shaped side plate, which naturally permits of a very large hole—was in 1870, in which year I first became connected with Ransome's Patent Stone Company, of which Sir Henry Bessemer was chairman, and I well remember such shaped wheels being made for a large Liverpool firm. Later on, when a patent was taken out for a practically identical article, I wrote in a friendly way to call attention to this, and saying I should, of course, continue to use this shape whenever I thought fit, and I have, in common with other makers, constantly done so.

The idea is undoubtely good, and probably the only reason why it has not been more generally adopted is simply that there is practically no call from consumers for this or any other "safety device," because there is substantially no danger in the use of emery wheels running at the usual surface speed of about a mile a minute, and mounted in the common manner between two iron side plates; of course, if used with ordinary discretion.

If it be argued that accidents do happen, the reply is obvious:—"In what department of life do they not occur?" Statistics incontrovertibly prove that an actual workman is infinitely more likely to be damaged by a falling chimney pot, a restive horse, or even crossing an ordinary street, than by a bursting emery wheel; and the very fact of the attention that is excited by the very few occasions of personal injury is an added proof of their rareness. Natural grindstones come to grief infinitely more frequently than artificially-made emery wheels, notwithstanding that the makers of the latter are many and the experience of some of them is of a very superficial character. In my own twenty-eight years' experience of the particular trade, I am thankful to say the number of accidents of which I have become aware has been exceedingly small, and in almost every case has been clearly traceable to such a shocking disregard of the most elementary rules of mechanics and common sense as absolutely invited disaster. Most of the older makers could fill many of your columns with a recital of the startling experiences they have passed through in this direction.

While unwilling to obtrude too much personal remark, may I be excused for saying that with all the running, both for trueing and testing of certainly over 100,000 wheels, during the above-mentioned period, not a workman has been incapacitated by accident for an entire day, notwithstanding the inevitable contempt bred of familiarity.

Let us by all means guard against all kinds of danger to the utmost of our power, both on the moral ground of acting towards others as, under similar circumstances, we should wish them to act towards us, and on the more modern condition of the exigencies of Employers' Liability Acts; but let us also avoid talking too much of "safety devices," and thereby permit by implication an exaggerated idea of danger to creep into the minds of those who have not carefully studied an interesting and useful subject.

Westcombe-hill, Greenwich, S.E., A. H. BATEMAN.
December 3rd.

SNAKES AND SAFETY VALVES.

SIR,—The motto, "Truth is Stranger than Fiction," appears on the cover of one of your contemporaries, and the editor certainly does his best to live up to it. As the avowed object of the magazine in question is "to publish true stories of actual experience, avoiding fiction," perhaps you can find space in your columns for some remarks on one of the true stories which concerns engineers.

I happened to notice in the current number an illustration of a snake coiled round a safety valve, which is apparently discharging steam in considerable volume, and being somewhat curious to learn whether the snake did not find its position rather warm, I read the article through, with amusement if not profit.

We are informed that the engineer in charge of the boiler lights his fires, but that "scarcely had the water begun to bubble" when he is called away, leaving the boiler in charge of the hero, a lad "who had been about machine shops ever since his infancy, and therefore knew as much about engines as do many certificated engineers." The next few paragraphs go to show that the complaint sometimes made about the Lancashire boiler being a slow steam raiser is quite unfounded, for we learn that "in the few minutes that had elapsed since the engineer's departure" the steam was up to 110 lb. The "astounding photographs"—*vide* cover—show that the boiler is of the Lancashire type, none of your new-fangled "express" boilers.

The hero who knows so much about engines, on finding the pressure somewhat high, makes a "frantic dive" for the boiler-house door "intent upon saving his life," and when he cannot get out his only idea of reducing the pressure is to get up on top of the boiler and hold the safety valve open, this being, we are told, "his one chance." This evidently would require considerable courage, as the boiler is "roaring" and "making frantic lunges in his direction."

However, he is baulked in his intention, for there happens to be an enormous rattlesnake round the "supply pipe." One would suppose that the writer means this for the feed-pipe, were it not for the first-mentioned "astounding photograph," which shows the snake round the safety valve, and also for the fact that it does not seem clear why the hero did not get up somewhere else if the snake were on the feed-pipe. Further, this pipe gets "intensely hot" as the drama proceeds, so perhaps the photograph is right, but no explanation is forthcoming as to whether snakes like coiling round bare safety valves at a temperature of nearly 350 deg.

I need not take up your readers' time with the battle of the snakes, and will conclude by informing them that finally the hero, "with one mighty blow, *knocks off the safety valve*," and is saved.

December 3rd. RICHARD MCLAREN.

HIGH SPEED AIR PUMPS.

SIR,—The remarks of Mr. Dunlop on the Edwards air pump in your issue of the 25th ult. seem to imply that Mr. Edwards claims the entire credit of a valveless bucket and ports in the barrel side. These features, as is well known, are not novel. What Mr. Edwards apparently does claim is the mechanical propulsion of the water into the barrel in such a manner that the shock due to impact is minimised, and in a direction which will assist the free inflow of air. That these are recognised as distinct improvements is shown by the fact that the Edwards pump is being very largely adopted, and having had personal experience of its working, I am of opinion that it marks a distinct advance in steam engineering. The object of "Antiquarian's" interesting sketch in your last issue is, no doubt, not to depreciate Mr. Edwards' invention, but to illustrate the value of research and development.

If two pumps were made in accordance with the two designs, the difference in efficiency would, of course, be very great, as in the Bodmer design the air inlet, for example, is exactly where it should not be. This is, however, yet another instance of how little often stands between failure and success. MARINE.

LIVE STEAM FEED-WATER HEATERS.

SIR,—I believe that I have read all the articles which you have written on this subject since that written after your experience with the Oriole. Indeed, the interest created by reading some of these articles was such that I selected one of the best examples of machinery and boilers which I had, and fitted a Kirkaldy live steam feed-water heater. The example of machinery and boilers was produced by Messrs. Palmer's Shipbuilding and Iron Company, Jarrow-on-Tyne, than whose productions, for economical results, there are few to equal and none better.

Herewith I give you figures, taken from the chief engineer's log, for two voyages immediately

Number of voyages.	Time on whole voyage, days. hrs.	Distance steamed miles.	Steaming time, dy. hr. min.	Average speed, knots per hour.	Daily consumption of coal, tons cwt.	Total consumption of coal, tons.
19	64 5	12,414	50 18 50	10·47	37 0	1,958
20	72 11	13,110	51 11 35	10·93	37 7	2,072
Kirkaldy's Live Steam Feed-water Heater Fitted.						
21	65 19	12,743	51 20 30	10·7	37 12	2,018
22	67 6	12,414	50 4 37	10·47	37 0	1,954

after the feed-heater was fitted. An examination of these figures will show that, in this case, not the slightest reduction of coal consumption was obtained. Nor is this the only example; I have five others. But, nevertheless, a live steam feed-heater is useful, not because it sometimes won't save coal, but because boilers, when their feed is heated, behave themselves better than when it is not heated, and they look more refined when examined inside.

If steam must be used to heat feed-water, why not use Weir's, which is the only theoretically correct and practically perfect system, and about which there is no mystery?

November 29th. ALEXANDER DALRYMPLE.

THE INSTITUTION OF CIVIL ENGINEERS' ENTRANCE EXAMINATION.

SIR,—I think your correspondents have overlooked the only real grievance in connection with the examination for election as associate members—I mean that no certificate is sent to a successful candidate.

It seems only fair that those who have been put to the trouble and expense of sitting for the examination should have something to show for it, more than those who have not had this to do. Of course, present associate members could sit for examination and so gain this certificate.

I hope you will find space to print this letter, and that the Council, while there is yet time, may see their way to put this right. ONE WHO HAS PASSED.

November 30th.

POSITION OF DRAUGHTSMEN.

SIR,—Will you kindly allow me a few lines in your valuable paper to invite any draughtsman who is willing to become a member of a society whose object is for the betterment of their position? I am quite prepared to receive any communications upon the subject, and shall be much pleased if a sufficient number of answers are forthcoming to warrant further steps being taken. All correspondence will be treated confidentially, although my own opinion is that employers as a body will not only encourage but substantially assist such an undertaking, and so venture to dub myself secretary *pro tem.* J. GILLAIRD.

34, St. Mary's-road, London, N.,
November 30th.

ANNUAL DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE tenth annual dinner of the Institution of Electrical Engineers took place on Wednesday evening at the Hotel Cecil, the President, Mr. J. W. Swan, F.R.S., being in the chair. There was a large gathering, numbering some 270, among whom were the Right Hon. the Earl of Dundonald, Lord Monkswell, Lord Greenock, the Right Hon. G. Shaw Lefevre, the Attorney-General, the Earl of Lichfield, General Sir R. Harrison (Inspector-General of Fortifications), Admiral Sir W. J. L. Wharton (Hydrographer of the Admiralty), Mr. W. H. Preece (President of the Institution of Civil Engineers), Sir A. K. Rollit, the Hon. W. P. Reeves (Agent-General for New Zealand), Sir Courtenay Boyle, Sir J. Crichton Browne, Professor Ramsay, Sir Edward Frankland, Dr. Ludwig Mond, &c.

The toast of the evening, that of "The Institution of Electrical Engineers," was proposed by Sir Richard Webster. The Attorney-General referred with emotion, as did several succeeding speakers, to the serious losses which the Institution had suffered during the past year by the deaths of Mr. Latimer Clark and Dr. John Hopkinson, paying a generous tribute to the value of each. Sir Richard then went on to remark that although electricity had been known to exist many years previously, yet it was only during the sixty years of her Majesty's reign that the science had made the great strides which it has done, and he gave a sketch of the progress of telegraphy by land and sea, and traced the history of electrical development through all the advances of succeeding times till the present day, and concluded by proposing the toast coupling with it the name of Mr. Swan, than whom, he said no man was better fitted to hold the post of president. Mr. Swan had frequently, he added, kept him straight in electrical matters in times gone by.

Mr. Swan, in his reply, said that whereas before the Victorian era the attention of electricians had been devoted to preventing electricity from doing mischief, the engineers of the present day were directing their energies towards bringing it into subjection, and making it a useful, obedient, and profitable servant. He alluded to the beginnings of electricity, and to the prominent position it now occupied, and said that throughout the world the number of miles of railway or trams worked by electricity could be counted in thousands, the number of horse-power transformed into electrical energy by hundreds of thousands, the length of telegraph and telephone lines in millions of miles, and the number of glow lamps in tens of millions.

Mr. Swan then proposed the toast of "The Navy, the Army, and the Reserve Forces," saying that though he was all for peace, yet he realised that some wrongs could only be righted by force.

The toast was responded to by Admiral W. Wharton and Sir Richard Harrison who, both testified to the aid which electricity afforded in the defence of the country, and also by Mr. R. E. Crompton, the newly-elected captain of the Corps of Electrical Engineers (R.E.) Volunteers, who deplored the loss of their original captain, Dr. John Hopkinson.

Sir James Crichton Browne proposed "Science," in an eloquent speech, which was replied to by Mr. Preece and Professor Ramsay, and the proceedings terminated after the final toast, "Our Guests," which was proposed by Major-General Webber, and replied to by the Right Hon. G. J. Shaw-Lefevre and the Hon. W. P. Reeves, Agent-General for New Zealand.

PORTABLE HAND-PUNCHING AND SHEARING MACHINES.

THE illustrations, Figs. 1, 2, and 3, given herewith, represent two ingenious portable appliances for shearing and punching joists, angles, tee, and channel iron by manual labour. The construction of both these machines is simple. Their operations, it will be seen, are based upon the same mechanical principles. The section to be sheared is introduced between suitable upper and lower knives in the open space shown, and intense pressure is brought to bear upon it at the desired point by the upper cutter through the medium of the pressure bar c^1, Fig. 2, and the system of levers $g\ m^1\ m^2\ l$, the bar c^1 being excentrically pivoted, as shown. The cutters are supplied of different shapes to suit the section to be operated upon. Those shown shear one-half of the H section at one operation. The upper cutter f^1 is lowered to its work by releasing a spring on the handle f^4; the pressure bar c^1 is brought to bear upon the cutter by releasing the lever c^2, a wedge b being introduced to make a close fit. The lever g is next depressed to an oblique position, similar to that shown in Figs. 1 and 3, so as to bring pressure to bear upon the cutter. On the top of the lever g are two pawls $i\ j$, which gear with the teeth of the ratchet levers $m^1\ m^2$. The serrations on both these levers are of different sizes, the lever having the larger-sized teeth being used to depress the lever



Fig. 1—HAND SHEARING MACHINE

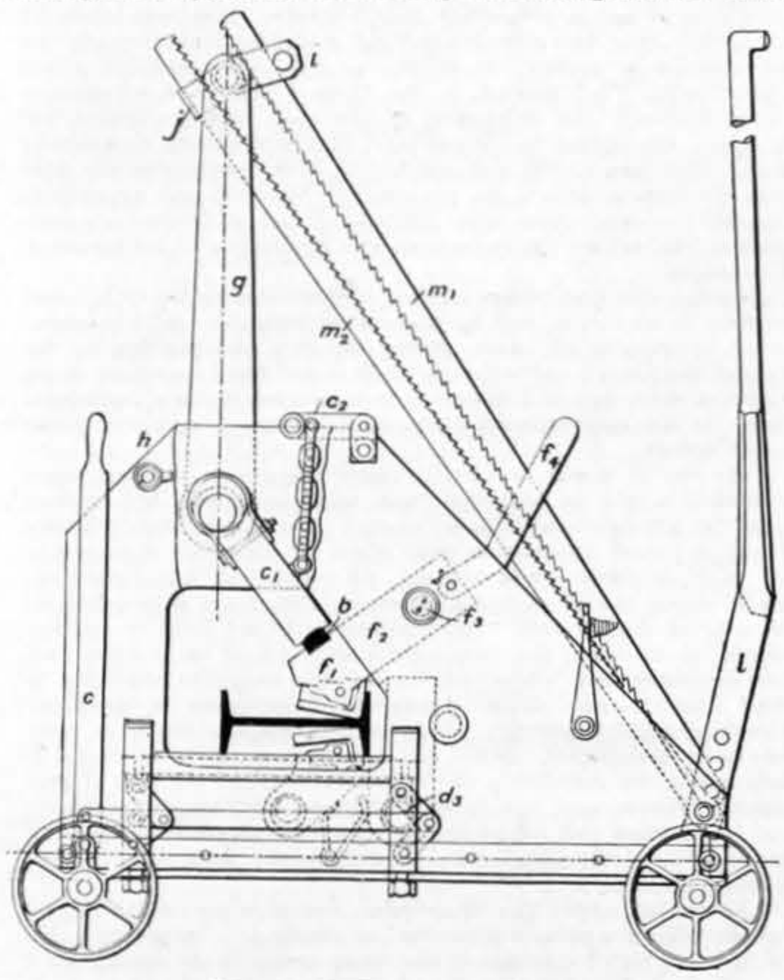


Fig. 2—SHEARING MACHINE

g by means of the hand lever l, while the lever m^2 serves to maintain the pressure on the article under operation, while

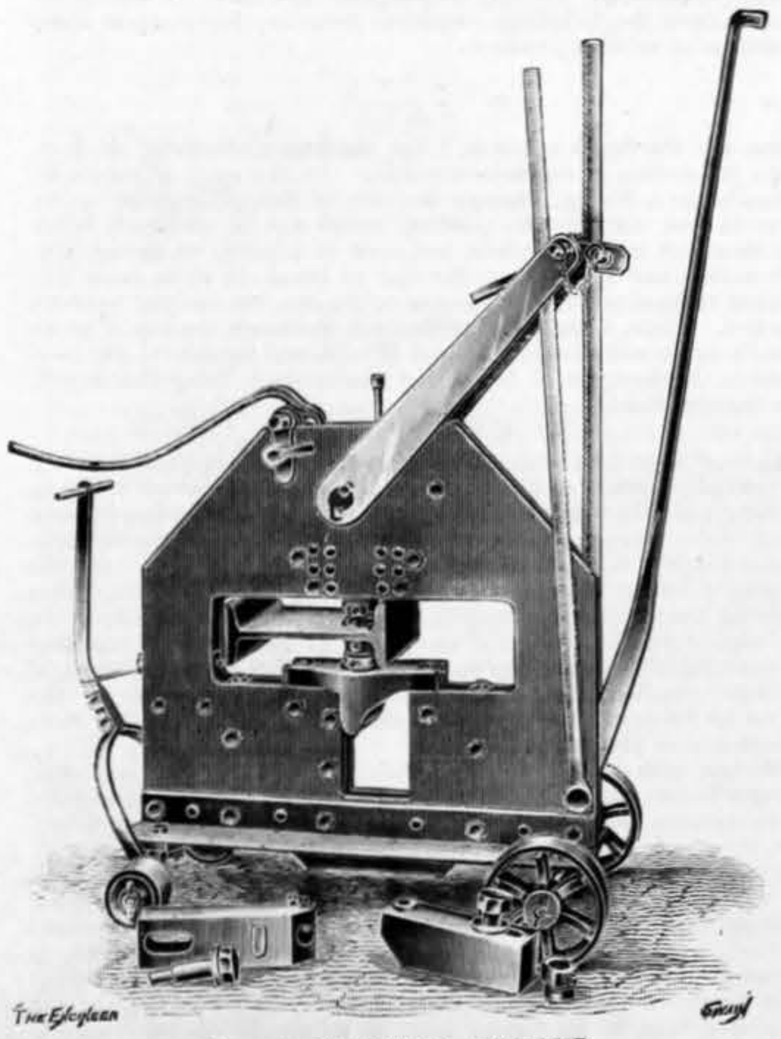


Fig. 3—PUNCHING MACHINE

the hand lever l is brought up again to its vertical position to start a fresh stroke. A roller support, shown in Figs. 1 and 2, is provided for raising and lowering the material to suit the cutters. Although it is claimed that a couple of men in cutting a 12in. joist bring a pressure of 120 tons to bear upon it, the speed of working is not nearly so slow as might reasonably be expected. It will be observed that the leverage obtainable is very great. The engraving of the punching machine shows the dies arranged for making holes in the web of a joist. The essential features of the machine are similar to that above described. There must be many conditions where such appliances as these would be a boon to engineers, contractors, bridge and shipbuilders, and others. The machines, which are substantially made, are being introduced into this country by Messrs. R. Becker and Co., Rivington-street, Curtain-road, London.

INSTRUMENTS FOR MEASURING SMALL TORSIONAL STRAINS.*

By E. G. COKER, B.A., B.Sc., M.I.M.E., Late Scholar of Peterhouse, Cambridge.

THE advances made within recent years in the scientific testing of engineering materials have caused great attention to be paid to the design of instruments for measuring small strains. By far the greater number of such instruments have been devised for measuring the small strains of extension or compression in bars subjected to a direct pull or push, and but little attention has been paid to instruments for the use of engineers, in the measurement of the small strains in a bar subjected to twist.

The object of the present paper is to describe two arrangements of apparatus intended for use in engineering laboratories and testing houses for measuring such strains, and for the determination of the modulus of rigidity.

Each instrument is wholly supported by the test bar, being secured thereto by screws, which grip the bar at two transverse sections separated by a known interval, and the relative angular displacement between these two sections is measured directly. The instruments are adapted to measure both large and small

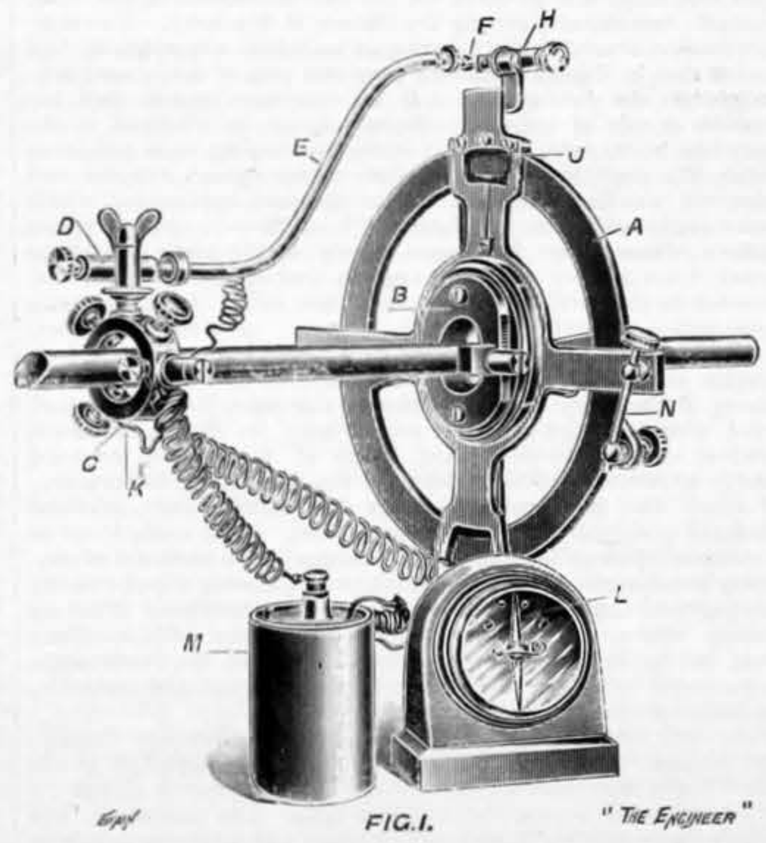


FIG. 1. "THE ENGINEER"

strains, and are self-contained, while they can be used in a horizontal, vertical, or inclined position.

One form of the apparatus is shown by Fig. 1, and consists of a graduated circle A, mounted upon a chuck plate B, provided with three centering screws adjustable by hand. A ring C, secured to the test bar by set screws at a known distance away, carries a swivel arm D, in which slides a tube E, so that the contact ball F at its outer end can be brought into position touching the centre of the faced end of a screw micrometer gauge H provided with a divided head. This micrometer screw is mounted upon a vernier plate J of the graduated circle, and can be clamped in any position, the final adjustment being effected by a screw N.

A silk-covered wire connects an insulated binding screw K upon the ring with the contact ball, and this wire is joined up in circuit with a simple form of galvanometer L and cell M to a second uninsulated binding screw on the ring. If the contacting pieces are touching a circuit is completed through the test bar, and the galvanometer needle is deflected. If now a twisting movement is applied to one end of the test bar the contacting pieces are separated, and the micrometer screw must be advanced until the circuit is again completed as indicated by the galvanometer needle. The number of divisions through which the screw has been turned affords a measure of the angular displacement, and it only remains to calibrate these readings in terms of angular measurement. The calibration is effected by reference to the graduated circle and vernier plate.

The micrometer screw is set tangentially to the radial arm, and therefore its indications are nearly proportional to the tangent of the angle moved through, but if the faced end of the screw is always maintained at or about its central position, the error introduced by taking the readings as directly proportional to the angular displacement is relatively small compared with the quantity under measurement, and may be neglected. To calibrate the instrument it is therefore only necessary to measure the number of divisions corresponding to a small angular displacement of, say, 10^1, and this is easily accomplished by setting the instrument in position with the circuit complete, and afterwards following up a known angular displacement of the vernier plate by the micrometer screw.

A single form of detector galvanometer, in circuit with a single dry cell, has been found to be a convenient arrangement for indicating when contact takes place, and the feeble current required does not injure the contacting surfaces. It is essential that the graduated circle be set accurately upon the bar, with its plane perpendicular thereto, and its centre coinciding with the longitudinal axis of the bar. An arrangement has been devised to effect this, consisting of two similar and equal clamp bars, the eyed ends of which take over outwardly-projecting cones arranged diametrically upon the chuck plate and ring. Each main piece

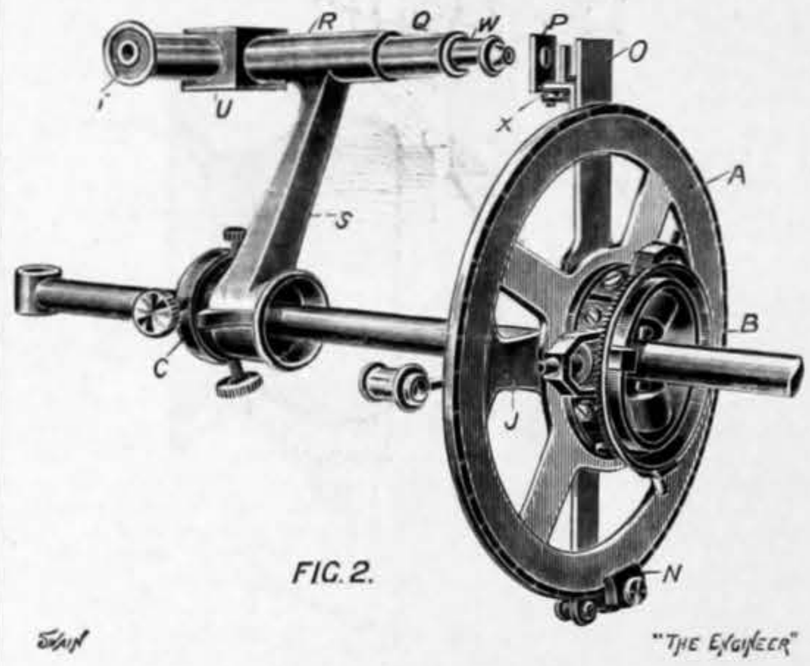


FIG. 2. "THE ENGINEER"

has one degree of freedom with respect to the clamp bars, and therefore two degrees of freedom with respect to the other; these degrees of freedom are suppressed by projecting plates fitting against corresponding projections on the main pieces, and this connection makes the apparatus a rigid whole. The bar is now inserted, and the screws adjusted by hand as accurately as possible. The clamp bars are afterwards removed, leaving the two main pieces accurately spaced on the bar, while the graduated circle remains perpendicular thereto, and very approximately centred. The light contacting arm is then clamped in position, and the bar may now be set in the testing machine. An improved clamp described with reference to the second form of apparatus may be used instead of the arrangement described above, and the hand-operated chuck plate may be replaced by a form of self-centering chuck described below. An example of tests made with this apparatus is given below. The test bar was adjustably secured at one end, and a balanced lever of fixed length secured upon the free end, and hung from the arm of a scale beam. The load was applied by placing equal weights in the suspended pans of the balanced lever and scale beam, so that bending movement was as far as possible eliminated. Before making a reading, the torsion arm was brought to a horizontal position by aid of a spirit level. The mean of the calibration tests gave 18·6 divisions of the micrometer screw as corresponding to an angular displacement of one minute of arc. Turned bar of Bessemer steel, length under measurement = 10·25in., diameter = 0·747in., torsion arm = 15in., a constant.

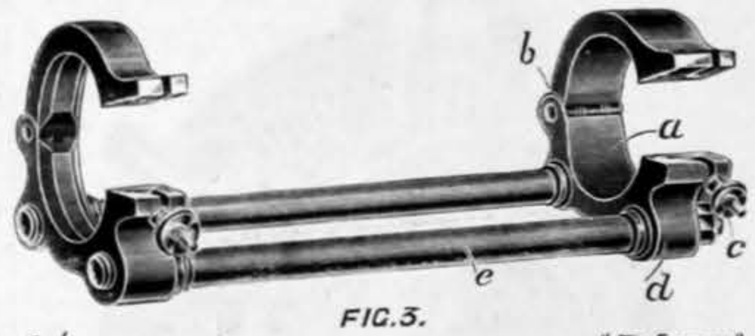


FIG. 3. "THE ENGINEER"

The figures in the first column give the load in the pan at the end of a constant arm:—

Load, pounds.	Reading.	Difference.
0	0	26
1	26	25
2	51	26
3	77	26
4	103	25
5	128	26
6	154	25
7	179	26
8	205	26
9	231	25
10	256	27
11	283	24
12	307	26
13	333	25
14	358	26
15	384	26
16	410	25
17	435	25
18	460	25
19	485	25
20	510	

If l = length of the bar,
d = diameter,
T m = twisting moment,
θ = relative angular displacement,
C = modulus of rigidity,
Then for bars of uniform circular section

$$C = \frac{32\ T\ m\ l}{\pi\ d^4\ \theta},$$

and we have for this test bar

C = 11,790,000 lb. per square inch.

A second test gave almost identically the same results.

The performance of the instrument is limited by the accuracy of the micrometer screw, and in the present instrument the smallest

* British Association, Section G.

angular displacement capable of measurement is about four seconds of arc. As the contacting bar is not heavy, no difficulty is experienced in balancing it, and therefore its length may be considerable. This form of instrument is therefore adapted for measuring the strains in long test bars.

The second form of apparatus differs from the preceding in employing a reading microscope to observe the relative angular displacement of a radial line upon the vernier plate. The edge of a thick wire is a very convenient line for observation, and has been used with notable success in an extensometer designed by Prof. Ewing—"Proc." Roy. Soc., May, 1895. The instrument is shown by Fig. 2, in which A is the graduated circle mounted upon a chuck B, and furnished with a vernier plate J, an arm O of which carries a wire P. A reading microscope is carried in the sleeve R of an arm S mounted upon the short cylinder C, which latter is gripped upon the test bar by screws. The reading microscope has an eye-piece T provided with a glass scale, and a right-angled prism U is interposed between this and the objective W, so that readings can be easily taken. The tube Q is free to slide or rotate in its guide R, but in order to readily focus the wire this latter is carried in a frame X, pivoted upon the vernier plate J, and adjusted by a screw.

The microscope arm S is secured to the cylinder C by a divided

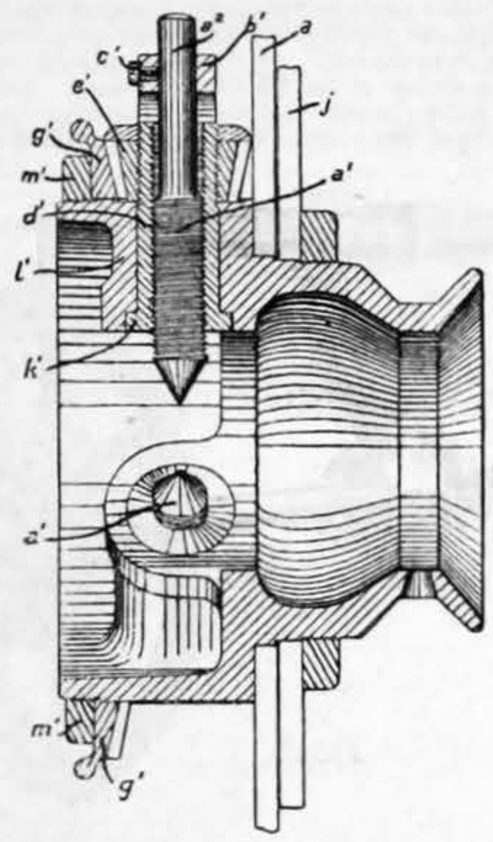


Fig. 4

collar, the two halves of which are pivoted on one side and the free ends are clamped by screws. If it is desirable that the telescope be turned round or released altogether the screw may be thrown out of engagement. Since the difference between an arc and its corresponding chord is an infinitely small quantity of the third order, when the arc is an infinitely small quantity of the first, the readings of the microscope scale may be taken as directly proportional to the angular displacement, and the calibration is effected by moving the wire through a definite angle of 10^1, and noting the equivalent reading of the micrometer eye-piece.

This instrument is furnished with an improved form of clamp—Fig. 3—consisting of a pair of divided collars a, the halves being pivoted together at b, and secured by nuts c. The collars are wedge-shaped in radial section to engage with corresponding wide-angled grooves upon the chuck plate and cylinder, only the angled sides being in contact, so that the collars are readily fixed when required. The lower halves d of the divided collars are connected by one or more distance pieces e, so that when the former grip their respective grooves each piece has one degree of freedom with respect to the clamp, and this can be suppressed by a pin or by the frictional grip of the collars, thereby causing the parts to act as one rigid whole for setting the instrument on the bar. The

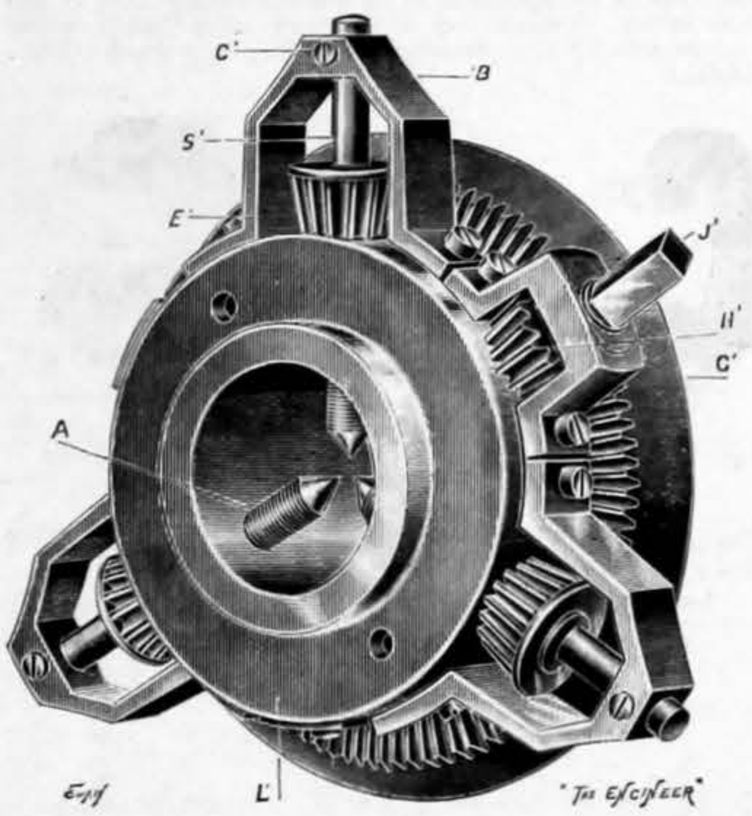


FIG 5.

graduated circle of this instrument is carried by a self-centering chuck of somewhat novel form, and a section through this is shown by Fig. 4, while a perspective view of the arrangement is shown by Fig. 5.

There are three centering screws A^1, the outer cylindrical ends of which are supported in guides B^1, and prevented from rotating by pins C^1 engaging with slots S^1, cut in the screws. The screws work in rotating nuts D^1, provided with bevel pinions E^1, gearing with a hand-operated bevel ring G^1, so that all the screws are advanced or receded together. An additional pinion H^1 is provided, operated by a key fitting on its squared spindle J^1, so that the screws are firmly gripped upon the bar. The inner ends of the nuts have a collar bearing K^1, so that the stresses are borne by the body L^1 of the chuck, and the bevel ring is prevented from seizing by bearing-plates and an adjustable ring M^1 at the back. This bevel ring can be slid back to allow any screw to be separately adjusted. Other modified arrangements of the chuck have been tried, in which the guide pins have passed bodily through slots cut through the inner ends of the screw, and the screw pairs have been inverted, but these modifications have not answered well.

An example of tests made with this form of apparatus is appended, the same Bessemer steel bar being used:—Mean value of calibration test, one minute of arc corresponds to thirty-six divisions of scale. Length under measurement, 8in.; diameter, 0·747in.; torsion arm, 15in., a constant:—

Load, pounds.	Reading.	Differences.
0	800	
1	759	41
2	718	41
3	677	41
4	636	41
5	596	40
6	555	41
7	513	42
8	471	42
9	430	41
10	389	41
11	349	40
12	309	40
13	267	42
14	225	42
15	283	42
16	143	40
17	103	40
18	62	41

And we have for this test bar C = 11,850,000 lb. per square inch.

A second test gave very approximately the same result. Angular displacements of 1in. can be measured with this form of apparatus. As the overhanging arm carrying the microscope is necessarily heavy, to afford the requisite stiffness, the length under measurement is limited. For the purpose of making the angular displacements visible to an audience, a magnifying arrangement is used, consisting of a tilting mirror, supported upon a tripod. Two legs of the tripod are supported by a hole and slot carried upon the vernier plate, and the third leg is supported upon a plane attached to the other main piece. The spot of light reflected from the mirror is caused to move over a fixed graduated scale, and the angular displacement is thereby made visible.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Economy of heavy goods engines.—The economy in transportation due to hauling as heavy train loads as practicable is leading many railways to put on goods engines capable of hauling heavier trains than those taken by the older engines. On the Burlington and Missouri River Railroad, 90-ton locomotives, which haul 600 tons, are replacing older engines which haul only 350 tons. The engines are all of the Consolidation type, having eight coupled driving wheels and a two-wheeled leading truck. They run on a division 107 miles long, with grades of 2 and 3 per cent. and curves of 360ft. and 573ft. radius. All the wheels are flanged, though usually blind tires are used on one or two pairs of drivers on such engines, but the wheels are set ⅛in. closer together and have slightly smaller flanges on the front and rear drivers. The engines have immense boilers, with Belpaire fire-boxes, and are so high that the safety valves are mounted on a separate fitting instead of on the dome. Sand is fed by an air jet. The leading dimensions are as follows:—

Cylinders	22in. by 28in.
Driving wheels	4ft. 4in.
Truck wheels	2ft. 6in.
Driving wheel base	15ft.
Total wheel base	23ft. 6in.
Weight on drivers	166,000 lb.
,, total	181,200 lb.
Boiler, diameter	6ft. 2in.
,, rail to centre line	8ft. 9½in.
,, pressure	180 lb.
Fire-box, length	9ft. 5⅜in.
,, width	3ft. 4in. to 5ft.
,, depth	5ft. 8⅜in. to 5ft. 11⅜in.
Tubes, 292; diameter	2¼in.
,, length	14ft. 6½in.
Heating surface, tubes	2486½ square feet
,, fire-box	188½ square feet
,, total	2675 square feet
Grate area	31⅞ square feet
Smokestack, 3ft. high; diameter	1ft. 5in.
,, height from rail	15ft.
Tender—	
Wheels	3ft. 1in.
Weight, empty	35,000 lb.
,, loaded	94,200 lb.
Length over frame	32ft. 3½in.
,, of tank	19ft.
Width of tank	9ft. 6in.
Capacity of tank	5000 gallons
,, coal space	17,500 lb.

Naval engineers.—Now that the war with Spain is over, it is hoped that steps will be taken for the final settlement of the "line and staff" controversy among the officers of the navy. The engineers receive a much higher degree of technical education in this country than in England, and the proposed plan of settlement is to amalgamate the two grades. It is sometimes urged that the executive power of engineer officers should be confined to the engine and boiler rooms, but this is not practicable, as in a modern warship the engineering department covers a great number and variety of auxiliary engines and mechanical appliances, which require engineers to manage them and keep them in order. If the engineer officers were in charge merely of the main propelling engines, these various auxiliary engines and appliances would be entrusted to line officers, who could not safely be given such charge unless properly trained as engineers. As a matter of fact, the junior officers of all grades are now necessarily giving a considerable amount of technical and engineering work, and the training of the two classes of officers is the same for a great part of the course. Line officers are already in charge of much electrical and mechanical plant, many of them have invented valuable apparatus and mechanism for the guns, range finders, &c., and some who have resigned from the service have attained prominent positions in the engineering field. The controversy is the outcome of an entire and radical change in the methods of conducting naval warfare, and the operations of a warship depend vitally upon engines, machinery, and engineers. The engineer is not an auxiliary officer, as in the days of sailing ships with auxiliary power, but he is as important as the captain and the lieutenants. The proposed solution, which is in every way logical and desirable, is to make all officers line engineers.

Three-stage air compressor.—The Boston and Martana Consolidated Copper and Silver Mining Company has installed at its West Colusa mine shaft a three-stage air compressor driven by a triple-expansion engine of the Corliss type. The compressor and engine were built by the Nordberg Company, which favours multiple-stage compression, and has adapted its design of Corliss engine to plant of this kind. The engine is of the triple-crank tandem horizontal pattern, with two fly-wheels, one on each side of the centre crank. The steam cylinders are at the rear end of the bed-plate, with the air cylinders placed tandem to them, the piston-rods of the latter cylinders carrying the connecting-rods. The steam cylinders are 15in., 18in., and 42in. diameter, by 42in. stroke, all having steam jackets and being fitted with the Nordberg-Corliss valve gear. The cranks are set at 120 degrees, and the intermediate crank is provided with an adjustable alignment box to compensate for any difference in the alignment of the shafts. The cut-off on the high-pressure cylinder is controlled by a static regulator, with pressure cylinder. The cut-offs on the intermediate and low-pressure cylinders are regulated by hand, and the operations can be accomplished while the engine is in motion. The air cylinders are 19in., 27in., and 39in. diameter, with a stroke of 42in. They are bolted to the frames, and have water jackets for cylinders and heads, these parts being separate castings. The air valves are of the Corliss type, and are fitted in the heads. The intercoolers are of the tubular type, set above and between the air cylinders. The cooling surface is so proportioned that air will leave each intercooler at a temperature only two or three degrees above that of the water. The mean effective pressure of the compressor is about 27 lb. per square inch. The receiver pressure is 90 lb. This machine runs fifty drills.

THE INSTITUTION OF CIVIL ENGINEERS.

THE EFFECT OF SUBSIDENCE DUE TO COAL WORKINGS.

At the ordinary meeting on Tuesday, November 29th, Mr. James Mansergh, vice-president, in the chair, the paper read was on "The Effect of Subsidence due to Coal Workings upon Bridges and other Structures," by Mr. S. R. Kay, Assoc. M. Inst. C.E.

The subject of the paper had frequent application in the busy industrial districts of the coal fields, where lofty buildings, heavy bridges, and costly tunnels were often found in the immediate neighbourhood of colliery operations. It was necessary, therefore, in designing works in such districts to know, first, the principles of subsidence following the working of coal, to determine the position and character of the works; secondly, an approximation to the area necessary to be left unworked for the protection of the same; and, thirdly, how the design may be suited to the supposition that the coal may afterwards be worked without any solid pillar being left for support.

Subsidence always followed coal working where no pillars were left, and was generally proportionate to the thickness of material excavated. The depth regulated roughly the duration of the movement. Subsidence might be modified by tight packing of the goaf, where no coal was left for support, under the area to be protected.

Faults were responsible for much of the damage resulting from coal working. Their lines were those of greatest weakness in the strata overlying the coal, and subsidence would sometimes travel many yards out of its ordinary course along such lines. They were, therefore, to be avoided in the erection of permanent works, even if pillars of coal were purchased for support, as it was impossible to guarantee against a possible "drag" or "pull over" of the strata, unless an abnormally large area of support was secured, and this on economic grounds was inadvisable. In the absence of faults, natural breaks and joints in the strata, within the limits of the dynamic effect of the subsidence, formed the lines of weakness. Fractures seldom found their way to the surface from depths greater than 100 yards, unless the thickness of the seam was considerable, or a thick bed of rock intervened. Workings had been safely carried under canals and rivers at that depth. Subsidence was slower in deep than in shallow mines, and surface breaks were rare save along lines of fault. The effect was felt in the case of buildings more in the nature of a "pull over" than of an actual break. The strain moved with the working face, and was not brought into play unless the working ceased for a sufficient time to cause it to become operative.

A series of levels, extending over five years, had been taken by the author over two separate colliery royalties under which the coal was being worked, at depths of 120 yards and 330 yards respectively. They proved, in the former case, that subsidence closely followed the extraction of the coal, and continued for 3½ years, amounting to 70 per cent. of the thickness excavated; in the latter case it followed somewhat later, continued for four years, and amounted to 64 per cent. of the thickness excavated. The strata in each case were fairly level and of the average coal-measure character; the movement was uniform, without breaking the surface.

Subsidence around pillars left for support was shown to be most irregular in its action, and no theoretical formulas could be enunciated to apply to all cases, giving the size and position of the support necessary. All rules for that object were therefore of an empirical character, and subject to modification by local considerations. If absolute immunity was to be secured, an ample pillar should be left.

If the site of works be over a fairly large area of goaf, even settlement might be expected, and when complete the surface would be left nearly as before, though at a lower level. Works should be placed away from goaf edges if possible. A period of two years or three years at least, after the coal was extracted, should elapse before commencing works, and more, if possible, in the case of deep mines. In building ordinary road or railway bridges, or viaducts, the form of the arch should be avoided and steel superstructure employed, having the requisite elasticity to adapt itself to any slight movement subsequent to erection. Waterworks and reservoirs, where certain heights above sea level were to be maintained, should not be constructed in mining districts unless the suitability of the site outweighed the cost of protection. Where coal was worked underneath canals the banks must be puddled and raised to the extent of about two-thirds of the thickness of the excavation. Locks should, as a rule, be protected by pillars.

In horizontal mines the theoretical line of break or subsidence over the edge of a pillar was vertical, or nearly so. In practice this was found to very to one side or the other, owing to the natural lines of weakness in the strata leading the breaks out of the theoretical course. This must be allowed for in setting out the pillar, which in horizontal mines should surround the structure equally on all sides. For the purpose of ascertaining the size of pillar, under normal conditions, for any depth and thickness of seam, the author gave the following empirical formula, based upon many examples of modern practice:

$$r = \frac{\sqrt{3\,d} \times \sqrt[3]{t}}{0{\cdot}8}$$

where d is the depth in yards, t the thickness excavated in feet, and r the radius of support in yards. In the case of mines inclined to, say, 30 deg., though the size of the pillar given by the formula was sufficient its position would not be vertically below the structure as in flat mines, but must be towards its higher side. The author had found that the line of break in such cases was neither vertical nor at right angles to the dip, but midway between the two. Thus, if the angle of dip be θ, the angle the line of break usually made with the horizon was $90 - \frac{1}{2}\theta$, and the lateral displacement in the direction of full rise of the seam, d being the depth, was represented by

$$d \operatorname{Tan} \tfrac{1}{2}\theta \operatorname{Cos} \theta.$$

Pillars of large area at depths of over 300 yards might with safety be partially worked or ribbed across by means of narrow banks or workings twenty yards wide, leaving solid pillars twenty or thirty yards wide between. This was found not to impair the strength of the support, the strata appeared to arch themselves over the worked portions, and there was practically no subsidence. This effected a considerable saving in the purchase of large pillars. In the case of bridges, where a succession of seams would probably be worked, it was necessary to consider whether the subsidence of level and possible rebuilding of the bridge, or the purchase of the mines for support in an increasing descending ratio, was the more economical or preferable.

Bridges with strong, well-bonded abutments and wings, and steel superstructure, were frequently worked under, and sustained little or no damage, especially in the case of deep mines. Where, therefore they must be built over an area to be subsequently mined, the intention being not to purchase support, they should be built in the manner described, and the girders should have a good bearing upon the beds. The subsidence to be expected, amounting to about two-thirds of the thickness excavated, should, if necessary, be provided for in the first height of the bridge; otherwise provision should be made for the eventual raising of the superstructure to its former level if required. Lofty viaducts should be protected by pillars; and lower structures should be built as indicated; the piers should be solid, and should not be pierced by an arch. In all cases, if possible, the goaf under the above should at the time of working be tightly packed.

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

(From our own Correspondent.)

HEAVY purchases of pig iron are characterising the Midland and Staffordshire iron markets, and makers are in some cases declaring that they are already booked over April and May, and in one or two cases even up to August next. Common South Staffordshire forge iron is quoted 45s. sellers, and 47s. to 50s. foundry. Part-mines are 50s. for forge, and 55s. for foundry; and best all-mines 65s. to 70s. for forge, and 75s. foundry. North Staffordshire pigs are strong, sellers having a demand sufficient to absorb all their make in their own district. The Shelton Iron Company quote 53s. for forge, and about 56s. for Nos. 1, 2, and 3; whilst about the same was asked for Fenton produce. The Lilleshall Iron Company, Shropshire, quote hot-air all-mine pig 58s. 9d., and cold-blast selected chill roll iron 95s. to 97s. 6d. Messrs. Pound Brothers are understood to be asking 65s. for good quality hot air pigs. High prices are demanded for hematites. The Carnforth Hematite Iron Company quote 72s. 6d. to 73s. 6d. for No. 1; 71s. to 72s. for No. 2; and 71s. to 71s. 6d. for No. 3; while their forge iron was quoted 69s. American pig iron is quoted in the Midlands 50s. for forge, 52s. 6d. for No. 3., and 55s. for No. 1, with a good sale. Midland foundry iron is in excellent call. Derbyshire foundry iron is 52s. 6d. to 55s. for No. 3, and 60s. for No. 1; Northampton foundry iron is quoted, 51s. to 53s. for No. 3, and 56s. to 57s. for No. 1. Lincolnshire pigs are 50s. to 52s. for forge, delivered at stations in this district net, whilst mixed numbers of foundry pigs are 55s. to 57s.

Steel sheets for stamping and working-up purposes from South Wales were quoted to-day (Thursday) in Birmingham, £7 10s. for 24 w.g., £8 10s. for 26 and 27 w.g., and £8 7s. 6d. for 28 w.g. Some of the Staffordshire makers were asking 5s. per ton more. Annealed Siemens best sheets for deep stamping were £10 for 24 w.g., £11 for 26 w.g., and £12 for 28 w.g. Steel sheets finished suitably for enamelling and bright tinning were quoted by Midland firms £7 for 16 or 17 w.g. There is a large engineering demand for basic steel girders; singles at £6 5s. to £6 10s., and for plates at £7 to £7 5s.

A healthy and strong tone is maintained by manufactured iron. Galvanised corrugated sheets are £11 to £11 10s. f.o.b. Liverpool; marked bars, £8; second grade, £7 10s.; merchant bars, £6 15s. to £7; and common unmarked, £6 7s. 6d. to £6 15s. For black sheets, singles, £6 15s. to £6 17s. 6d. is asked, with £7 to £7 5s. for doubles, and £7 15s. to £8 for trebles. Nut and hurdle iron is £6 5s. to £6 10s.; and rivet iron, £8 10s. Channel iron is £7 10s. at works; sash iron, £7 10s. to £8 for basis sizes; and angles 5s. extra for ordinary sizes.

The copper market has still further "climbed down" this week from the pinnacle of a fortnight ago, and quotations are now about as here:—G.m.b. cash, £55 3s. 9d. to £55 8s. 9d.; three months about the same as cash; tough, £58 to £58 10s.; best selected, £59 to £59 10s.; strong sheets, £66.

At a mass meeting of the operatives engaged in the chain trade at Cradley Heath it has been decided to move early in the New Year for a 10 per cent. advance in wages.

The South Staffordshire Mines Drainage Commissioners have approved this week a report of the Sub-committee on the new electrical scheme. This shows that steps have been taken for the best available design or designs for a semi-portable pump for mines drainage purposes, to be laid before the Committee at their next meeting; and that the proposal to borrow £10,000 at once for gravity works upon the surface, and £10,000 for electric pumps on the surface when electric power is available, was approved. The chairman and general manager have been empowered to take the necessary steps with a view to the suggested arrangement being carried into effect.

The Parliamentary Committee of the Warwickshire City Council have been instructed to investigate and report upon the proposal to construct a railway from Reading to Coventry, as also upon any other scheme for improving the railway facilities of the city. The General Works Committee of the Council have accepted the tender of Messrs. Wingrove and Stanley, of Northampton, amounting to £11,276, for the erection of pumping station and buildings in connection with the Lodge Farm sewage-disposal scheme.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Throughout the engineering trades of this district the very satisfactory position reported for some time past is being fully maintained. In isolated cases some slackening off is reported, but in most cases this is due mainly to special circumstances that have no direct relation to the actual condition of trade. The leading establishments connected with the principal branches of engineering, such as machine tool making, stationary and locomotive engine building, boiler making and all sections of hydraulic and electrical engineering, are mostly full of work to carry them well over next year, and generally report new orders offering in larger quantity than they can entertain, at any rate to comply with requirements of delivery put forward by their customers. All branches of the iron and steel trades also maintain a sound, healthy position, but the impression seems to be gaining ground in some quarters that the maximum point as regards prices has been touched, and one or two of the speculative operators are showing a disposition to undersell for delivery next year. The opinion generally, however, is that any easing down in prices, such as the weakening in warrants during the past week, can be only temporary, and in most cases merchants are very cautious about entering into anything like low-priced engagements, whilst makers and manufacturers of both iron and steel are mostly so fully booked into next year that they are indifferent about new orders, and certainly there is no inducement at present to entertain business at anything under their full rates.

A steady business was doing on Tuesday's iron market at Manchester, but the general tone was scarcely so strong as recently. Here and there representatives of pig iron makers reported only a very small weight of orders offering, whilst finished iron manufacturers did not appear to be securing new work quite so freely as of late, and merchants in some instances complained that specifications from customers on account of contracts were not coming forward very satisfactorily. Taking business all through, however, there was a very fair inquiry for pig iron, and although in the open market prices were rather easier, where some low quotations mentioned for delivery next year, there was no real giving way on the part of makers except that they were perhaps not holding to the special and practically prohibitive quotations which some of them were a week or two back quoting very firmly where any new inquiries came forward. For Lancashire foundry pig makers are firm at 53s. 6d., less 2½, but district makers have scarcely succeeded in establishing the full prices they have been asking, and where business is actually done, Lincolnshire could hardly be quoted above 52s. for foundry, with Derbyshire ranging from 52s. 6d. to 54s. net delivered Manchester. For forge qualities there is not that rush of inquiry which was noticeable last month, but except to the extent already referred to, prices are well maintained. For Lancashire forge pig iron makers are not quoting under 49s. to 49s. 6d., less 2½d, with Lincolnshire 48s. 6d. to 49s. net delivered Warrington. Middlesbrough is easier, 54s. 4d. net by rail Manchester being the average quotation for prompt delivery, with sellers at quite 1s. under this figure for delivery net year. Scotch iron remains firm, owing to the small stocks at the Lancashire ports, and the difficulty in obtaining vessels; delivered Manchester docks, Glengarnock could scarcely be bought under 54s. 6d. to 54s. 9d., and Eglinton 55s., with American pig iron, of which fairly large quantities are arriving, 50s. to 52s. net.

In the finished iron trade bars meet with a satisfactory demand, and the minimum quotations are £6 10s. for Lancashire and Yorkshire to £6 15s. for North Staffordshire qualities delivered here. Sheets are only in moderate request at about £7 5s., and in hoops business is slow, but list rates unchanged at £7 for random to £7 5s. for special cut lengths delivered Manchester district, and 2s. 6d. less for shipment. Nut and bolt makers have put up list rates 10s. per ton, and are getting the full prices on new business.

A strong healthy tone is maintained in the steel trade, but prices are without material change. Hematites are steady at 65s. 6d. to 66s. 6d., less 2½. Local billets are perhaps scarcely firm at the full quotation of £4 15s. net, but all descriptions of manufactured material fully sustain the recent advance, steel bars averaging £7 to £7 5s., with plates, which show a continued hardening tendency, quoted £7 2s. 6d. to £7 7s. 6d. for common, and £8 2s. 6d. to £8 5s. for boiler-making qualities, delivered in this district.

Mr. Stephen Wrightson, who has occupied the position of Secretary to the Carnforth Hematite Iron Company, Limited, for the last thirty years, died very suddenly at his residence on Saturday last.

The condition of the coal trade here shows further very satisfactory improvement. Notwithstanding the continued exceptional mildness of the season, all descriptions of fuel are in active request, with pits generally working an average of ten to eleven days per fortnight, and all the output going away. Although there is no actual pressure on the better qualities of round coal suitable for house fire purposes, the absence of stocks at many of the large collieries, which have usually to be drawn upon at this time of the year, throws the demand almost exclusively upon the output, which is not more than sufficient to meet present requirements, and prices are exceedingly firm at the full list rates. For the lower qualities of round coal there is also an active demand both for inland requirements and for shipment, which is taking away all this class of fuel that is coming upon the market, and prices are tending to harden, good qualities of steam and forge coal for inland sale fetching from 7s. 9d. to 8s. 3d., whilst for shipment, orders for which have been increasing during the past week, prices are stronger, 9s. to 9s. 3d. being about the minimum for ordinary qualities of steam coal, with some special sorts fetching 9s. 6d. up to 10s., delivered Garston docks or High Level, Liverpool. The pressure of demand reported last week for all descriptions of engine fuel is fully maintained, the advance in prices having in no way checked inquiries coming forward, and the full rates have been obtained without difficulty. It is only in exeeptional cases where the commoner sorts of slack are quoted anything under 4s. to 4s. 6d., with good medium sorts 4s. 9d. to 5s., and the best qualities 5s. 3d. to 5s. 6d. at the pit mouth. There is a large inquiry for coke, and prices have shown a considerable advance during the last two or three months, 16s. being now readily got for Lancashire coke at the ovens.

Barrow.—The hematite pig iron trade is very brisk, and orders are coming in freely from all sources; but makers are not in a position to accept orders for early delivery, and they are very well sold forward on immediate account. Makers are quoting 58s. to 58s. 6d. per ton for parcels of mixed Bessemer numbers, net f.o.b.; while warrant iron is at 57s. 1½d. net cash, sellers; 57s. 1d. buyers. Stocks have been further increased during the week by 2850 tons, making the stock in hand 138,163 tons, or 46,287 tons less than at the beginning of the year. Makers are blowing forty furnaces, as compared with forty-one furnaces in the corresponding week of last year. There is not much doing in forge or foundry iron, and business in these qualities is naturally quiet when prices are high.

Iron ore is in very brisk demand, and the output is still very much below the needs of consumers. Prices are steady at 14s. per ton for good average qualities net at mines. Common sorts are quoted at 11s. per ton, and best descriptions are selling freely at 17s. 6d. per ton. Spanish iron is selling at 17s. 6d. per ton net at West Coast ports.

Steel makers are very briskly employed, and orders are coming to hand freely from all sources. The rail trade is well employed, and makers are well off for orders, and are likely to remain so for some time to come. Heavy rails are brisk at £4 12s. 6d., while heavy steel plates are in brisk request at £6 15s. per ton, and orders are very plentiful. There is a good business doing in billets, tin-plate bars, hoops, and heavy steel castings.

Shipbuilders and marine engineers are very busy, and orders are plentifully held. There is every prospect of a very good business in the future, as inquiries are strong, and prospective orders are alike good and numerous. Marine engineers are very busily employed, and orders are coming in freely from all sources, with the result that the shops are not only very fully employed, but are likely to be even more so in the immediate future.

Coal and coke are in very good demand, and prices are high and firm.

The shipping trade at West Coast ports is very briskly employed. Last week 8520 tons of pig iron and 11,780 tons of steel were shipped, as compared with 7100 tons of pig iron and 7430 tons of steel in the corresponding week of last year, showing an increase of 1420 tons of pig iron and 4350 tons of steel. The total for the year now amounts to 491,572 tons of pig iron and 496,525 tons of steel, as compared with 411,982 tons of pig iron and 437,796 tons of steel in the corresponding period of last year, showing an increase of 79,590 tons of pig iron and 49,728 tons of steel.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE pits in the South Yorkshire coal district continue to work steadily, and large as the output is, there is a market for every ton of it. The district is thus in the happy condition that, although the tonnage brought to bank is exceptionally heavy, the stocks at the pits have rarely been so light as they are at present. Colliery owners complain somewhat that the men do not work as they might do, and in three or four districts it is stated that their neglect has the effect of increasing the working costs by at least 10 per cent., through the number of places which have to be kept in working order being larger than would otherwise be required. The recent short snap of cold weather has caused house coal to be in greater demand, and although mildness has again set in, the season is too far advanced to run any risks, and householders will not further delay completing their winter supplies. This accounts for a good tonnage being forwarded to London, and a brisker aspect put upon the house-coal trade all round. The demand previously noted for secondary grades of coal is sustained. Best Silkstones are this week quoted 9s. to 10s. per ton; ordinary from 8s. per ton; Barnsley house, 8s. 6d. to 9s. per ton; seconds, from 7s. per ton.

For steam coal the demand continues very brisk, the railways being very large customers, their requirements much exceeding the quantities contracted for, while the activity in the iron trade necessitates larger supplies. These circumstances, coupled with the prolongation of the export business through the Baltic ports being kept open later than usual, all combine to make steam coal very firm. Values are steady at 8s. to 8s. 6d. per ton; for Barnsley hards, seconds from 7s. per ton. For engine fuel Lancashire and the manufacturing towns of the West Riding continue to be exceptionally heavy customers. Nuts are at 6s. 6d. to 7s. 6d. per ton; screened slack from 5s. per ton; pit slack from 3s. per ton. The exceptional call for coke previously noted continues to be fully maintained, the demand for North Lincolnshire being especially noteworthy, and likely to be increased. Best qualities of coke have been sold at from 12s. to 13s. per ton, ordinary coke being about 2s. less.

In the heavy trades the whole of the plant and machinery is actively employed, and energetic work is proceeding with a view of increasing the output, more particularly in armour plates, in which the three firms employed in this important speciality are now engaged in extensions which will cost several hundred thousand pounds. In all the railway branches, with the exception of steel rails, work is abundant. The wagon firms are full up, and orders are constantly coming in, while the manufacturers of nuts, bolts, and other accessories have so much work in hand that they are not greatly concerned about further orders this side of 1899, and anything now being taken will not be for immediate delivery. A feature of local trade at present is the demand for iron pipes for carrying electric cables and telephone wires, as well as for gas and water mains. In regard to the iron trade, which continues exceptionally brisk, it is rather surprising that values do not rise quicker than they do; but as iron is scarce, and stocks, alike in the hands of makers and consumers, are very light, it is extremely probable that several blast furnaces which have long been idle may soon be re-started; and, in fact, this step has already been taken in some directions. It is gratifying to know that the greater weight of iron now being made is on account of home work, chiefly in respect of shipbuilding, railway material, and pillars and girders for building contractors.

Mr. W. T. Lemmon, of the Constructor's Department, Portsmouth Dockyard, has accepted an appointment from Messrs. John Brown and Co., Atlas Steel and Ironworks, Sheffield.

In the general run of the lighter industries there is a good deal of work in hand, but it is very unequally divided. The larger firms in the cutlery and silver trades are well employed, but several of the smaller houses are by no means pressed with orders. The Christmas and New Year requirements are likely to be below the average, owing chiefly to the indifferent business done last season, when a good deal of stock was left unsold.

The Midland Railway Company have acquired a considerable area of land in the Abbeydale district, a short distance from Sheffield, for the construction of carriage works. The site is near Ecclesall, one of their stations on the main line, two and a-half miles from Sheffield.

NORTH OF ENGLAND.

(From our own Correspondent.)

WHILE the manufactured iron and steel trades, the shipbuilding, the engineering, and all the industries allied thereto, are almost unprecedentedly prosperous, and have excellent prospects for next year, the pig iron business is dull, there being comparatively few sales. This, however, is one of the results of the artificial state of affairs brought about in October and November by the "rig" in Cleveland warrants. There was bound to be a reaction, and buyers have not recovered confidence after the disorganisation that was brought about. They buy from hand to mouth, and wait to see how far prices will drop for pig iron. There is now some reason to believe that the bottom has been reached; at any rate, the prices have been more settled this week than for over two months, No. 3 having remained at one figure nearly all the week, which, as things have been, is a somewhat long period for quotations to be stationary. Merchants have been asking 45s. per ton for prompt f.o.b. deliveries of No. 3 Cleveland G.M.B. pig iron, and buyers have been paying this. Makers have quoted 45s. 6d., and they would accept this not only for prompt, but also for spring delivery, and they have sold at the figure for delivery over the first quarter of 1899. Cleveland warrants have kept about 45s. per ton cash, sellers; this is 7s. per ton less than was paid during the latter part of November, when the "rig" was coming to a close, when some holders of warrants asked 54s. The price of warrants is still 2s. per ton above the figure that ruled when the recent speculative movement commenced, and is 5s. above the price that ruled in the summer. No. 1 Cleveland pig iron is sold at 46s. 6d.; No. 4 foundry at 44s. 6d.; grey forge at 42s. 9d.; mottled, 42s. 3d.; and white, 41s. 9d.; but 3d. per ton more has been realised by some firms for No. 4 foundry and white, as these qualities are rather scarce.

Mixed numbers of East Coast hematite pig iron are quoted at 55s. per ton, though some makers will not sell under 55s. 6d., as cost is increasing. Rubio ore is stronger in price, on account of the disquieting news from Spain anent a probable revolution of the Carlists. That would interfere very seriously with the ore trade, because the chief seat of the war would almost certainly be among the mountains of Asturias in the neighbourhood of the largest ore mines. The North of Spain is the district in which the Carlist faction finds the most supporters. In the civil war which lasted from 1872 to 1876 the ore trade was very much hampered, though it was of small extent compared with the industry as now carried on. Consumers here, in view of the state of affairs that is being developed, have ceased to draw largely on their heavy stocks of ore, but are importing more freely, and are paying 15s. per ton for average Rubio delivered in this district.

This month shipments of pig iron from the Cleveland district are somewhat better than they were during the latter part of November, and up to the 7th they reached 18,630 tons, as compared with 19,445 tons last month, and 18,458 tons in December, 1897, to 7th. Less iron is going into Connal's stores, since the necessity for making warrants has disappeared. On Wednesday night Messrs. Connal and Co. held 125,392 tons of Cleveland pig iron, an increase for the month of 1648 tons, while of hematite pig iron they had 35,711 tons, a decrease for the month of 947 tons.

As stated last week, the shipments of pig from the Cleveland district during November were poor. The lessened trade was nearly all with the Continent, Cleveland iron getting to a price which was too high for it to be profitably used abroad, as native iron was considerably cheaper. To Germany only 21,938 tons were sent, as compared with 36,989 in November, 1897; France had only 730 tons, against 2680; Belgium 1775, against 3061 tons; and Italy 3650 tons, against 7879 tons. The eleven months' exports fell short of those of 1896 and 1897, but exceeded those of any other year. They amonnted to 1,035,908 tons, this being 133,111 tons, or 11½ per cent. less than last year. The chief decrease was in the deliveries over sea, which reached 541,586 tons, or 116,640 tons (18 per cent.) less than in 1897, while the coastwise deliveries were 494,052 tons, decrease three per cent. Last year Germany had in the first eleven months 363,290 tons of pig iron from the Cleveland district, this year only 285,729 tons; Belgium's receipts were 27,463 tons this year, as compared with 52,308 tons last year; France's 29,459 tons, as compared with 38,290 tons. To Scotland 382,024 tons have been sent, only 1400 tons less than last year.

The manufactured iron and steel industries are unprecedentedly brisk, and the production could easily be larger if the works were equal to it, for more orders are offered than the manufacturers can really undertake. Further than this, most firms have enough work on their books to keep them fully occupied for the whole of next half year, and it is extremely difficult to procure either finished iron or steel for anything like early delivery. Manufacturers seem to be doing consumers a favour where they accept orders, even when premiums on the regular market prices are paid. The prospects for 1899 are most encouraging, and there is every reason to believe that next year trade will be more prosperous than it has been even this year. The sellers have now pretty much their own way in regard to the regulation of prices, and foreign competition is of small account, because enough work can be had from home consumers to render producers largely independent of continental business at least. There is no cause for complaint in regard to the business with our Colonies. The combination of steel plate makers have advanced their minimum price of steel ship plates to £6 15s., less 2½ per cent., but they are all so full of work that it is scarcely possible to buy at that figure, most producers quoting 2s. 6d., and some 5s. more than the minimum above named. For steel boiler plates £7 5s. is the minimum; for iron ship plates £6 10s. Steel ship angles £6 10s. is now asked; for iron ship angles £6 2s. 6d.; for common iron bars £6 2s. 6d. All the above-

named prices are less 2½ per cent. discount, and are f.o.t. Steel sheets, singles, have been advanced half-a-crown, and are now at £7 17s. 6d., less 2½ per cent. Manufacturers of sheets in this district, both black and galvanised, are much better off than their competitors in Staffordshire; they are very well booked for some months ahead. Heavy steel rails are firm at £4 12s. 6d.; cast iron chairs, £3 5s.; and steel sleepers, £5 17s. 6d., all net at works. The Erimus Steel Works, between Stockton and Middlesbrough, have now been completely dismantled, and the site is to be utilised as a timber yard by the owners of the Middlesbrough Estate, whose present yard is required by the North-Eastern Railway Company in connection with the enlargement of Middlesbrough Dock.

At this week's meeting of the Tees Conservancy Commissioners a very important scheme of railway extension was announced, viz., a railway along the north bank of the Tees over the reclaimed land similar to the line on the south side of the river. This will open up excellent sites for new works. The Commissioners will make the railway and also a roadway from Greatham Creek to Billingham Beck, and the North-Eastern Railway Company will continue the line from Billingham Beck to Stockton, where it will terminate by a junction with the company's Stockton and Hartlepool branch, near to Messrs. Blair and Co.'s engines works. The North-Eastern Railway Company will hereafter continue the line from Greatham Creek to Hartlepool. The Corporation of Stockton will construct a road from Billingham Beck to Stockton by way of Portrack in continuation of the Tees Commissioners' road. It is expected that the North-Eastern Railway Company will commence the construction of the line from Stockton to Billingham Beck next spring. There will thus be offered facilities for establishing shipbuilding yards, chemical works, ironworks, &c., on the north side of the Tees, similar to those existing on the south side.

The shipbuilding industry is very active, and more orders are offered than the builders can undertake. Messrs. Wigham Richardson and Co., Newcastle-on-Tyne, have just booked an order for a twin-screw steamer of 10,000 tons for the North German Lloyd Company, and also a single-screw steamer. Both vessels will be fitted with quadruple-expansion engines, working to 210 lb. pressure, on the Yarrow, Schlick, and Tweedy system. Sir W. G. Armstrong, Whitworth, and Co. are reported to have received an order for another ice breaker for Northern Russia. They are also to fit the guns and torpedo tubes on the Japanese cruiser Kosagi, which has been built by Messrs. Cramp, of Philadelphia. Messrs. Jno. Blumer and Co. are about to extend their shipyard at Sunderland, as are also Messrs. William Doxford and Sons.

The coal trade is generally satisfactory, there being much more business passing in the steam-coal branch than is usual at this season of the year, and so well are the coalmasters supplied with orders for this month's execution that they have very little coal available for sale for this month's delivery. Collieries are very well employed, there being little lost time in view of the approaching holidays. Best steam coal is about 9s. 9d. per ton f.o.b.; smalls, 4s. 9d.; best gas coal, 8s. 6d. to 9s. f.o.b. Shipments are heavy. Coke for next half-year's delivery averages 15s. 6d. per ton, delivered at the Middlesbrough furnaces. At Pegswood Colliery a new seam of coal, 7ft. thick, has been found, and a new shaft is being sunk to work it.

The death, at the age of eighty-six, is announced of Mr. William Salkeld, who was long connected with survey work in connection with railways. He took part also in the survey for the Tithe Computation Commission, in 1834. He made the preliminary survey for the Carlisle and Penrith section of the Lancaster and Carlisle line, now part of the London and North-Western system. After that he was engaged on the survey for a projected extension of the Stockton and Darlington Railway, through West Durham into Cumberland. Afterwards he became one of the permanent staff in the engineering department of the Stockton and Darlington Railway Company, and in that capacity he was engaged surveying for several of its extensions. When the Stockton and Darlington was amalgamated with the North-Eastern Railway, in 1873, Mr. Salkeld continued his connection with the Darlington office, and retired about twelve years ago.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

So far as the warrant market is concerned, business in pig iron has been unsatisfactory this week. The recent squeeze in the Cleveland branch of the market is still severely felt. Indeed, scarcely any business is being done in Cleveland warrants in the open market. A few transactions have taken place at 44s. 10½d. to 44s. 9d. for delivery in ten days, but there have been practically no cash sales of Cleveland warrants.

The market for Scotch warrants broke away rather badly towards the end of last week, and prices again went considerably lower in the early part of the present week.

The position of the manufacturing branches, however, is so favourable that it is thought prices will almost certainly go higher. Business has been done in Scotch warrants from 49s. 6d. to 49s. 0½d. cash, and 49s. 9½d. to 49s. 3½d. one month.

The market for Cumberland hematite opened very dull, but there was afterwards some improvement, although, upon the whole, prices for warrants have been lower. Sales have been made at 57s. 1½d. to 56s. 10d. cash, and 57s. 5d. to 57s. 0½d. one month. A long time has elapsed since there was any business in this market in Middlesbrough hematite, but this week a few lots have changed hands at 55s. down to 54s. 9d. for delivery in ten days.

Scotch hematite meets with a strong and steady demand, the output having been increased since last report by about 600 tons per week. Prices of this iron are quoted by merchants at 60s. 6d. per ton for delivery in railway wagons at the steel works.

The prices of the special brands of makers' iron are somewhat higher, the values of the common brands being, of course, regulated by the fluctuations in warrants. Monkland and Govan are quoted f.o.b. at Glasgow, Nos. 1, 50s. 1½d.; Nos. 3, 49s. 4½d.; Wishaw and Carnbroe, Nos. 1, 50s. 3d.; Nos. 3, 48s. 6d.; Clyde, No. 1, 55s. 6d.; No. 3, 50s. 6d.; Gartsherrie, Nos. 1, 56s.; Nos. 3, 51s.; Calder, No. 1, 57s.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s. 6d.; Coltness, No. 1, 58s.; No. 3, 51s. 6d.; Glengarnock at Ardrossan, No. 1, 55s.; No. 3, 50s.; Eglinton at Ardrossan or Troon, No. 1, 52s.; No. 3, 50s. 6d.; Dalmellington at Ayr, No. 1, 51s. 6d.; No. 3, 50s. per ton; Shotts at Leith, No. 1, 56s.; No. 3, 51s.; Carron at Grangemouth, No. 1, 56s.; No. 3, 51s.

The shipping demand for Scotch pig iron does not improve, and it is fortunate that there is such a good sale for consumption at home. In the past week the quantity despatched was 3190 tons, against 2685 in the corresponding week of last year. To Holland 240 tons were despatched, Germany 230, Russia 160, India 100, United States 25, Australia 10, France 65, Belgium 30, China and Japan 152, other countries 50; the coastwise shipments being 2135 tons, compared with 1750 in the corresponding week.

For malleable iron there is a steady market, and a comparatively good business is being done. Common bars are quoted £6 17s. 6d., and best bars £7 5s. per ton, less the usual 5 per cent. for cash in one month.

The demand for steel is ahead of the current means of supply; which means that in not a few instances deliveries are in arrear. Inquiries are numerous, and the prospects altogether highly favourable. Mild steel angles are quoted £6 10s.; tees and bars, £7 10s.; ship plates, £7; and joists, £6 5s. per ton, all less the usual 5 per cent. discount for delivery in the Clyde district.

There is an active business in the coal trade; but great inconvenience is being experienced from want of an adequate supply of railway wagons to transmit the coals. The current quotations at Glasgow Harbour are:—Main coal, 8s. 3d. to 8s. 6d.; steam, 9s. 9d.; ell, 9s. 3d. to 9s. 6d.; splint, 9s. 9d. to 10s. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE animation in the steel trade is being attended with large imports of ore from Spain. There has also been an increase in pig iron from Spain, principally to Swansea, and some consignments of steel bar from the Baltic for Newport. The principal cargoes of pig iron that came in last week were from Ulverstone and Ardrossan. Old rails were also received from Southampton and Bridgwater. The list of miscellaneous imports to the Welsh ports included quantities of scrap iron from Cornwall, Aberdeen, and London to Briton Ferry, 1750 tons iron pyrites to Swansea, and spiegel from Mostyn, North Wales, to Dowlais. I have referred in the past to great and unworked tracts of manganese in North Wales, which may yet prompt a rather flagging industry.

In the Swansea Valley last week the output of steel was exceptionally heavy. This was chiefly due to the re-starting of the Upper Forest Steelworks. At least 1500 tons of steel bars were rolled last week in excess of the total for the same period last quarter. Bars have also figured largely at the Bessemer works of the hills, Cyfarthfa being very marked. I have not heard of further iron and steel shipments to Wales from America. Rails to Ireland and pipes to London figured in last week's consignments, but none to Wales.

During the month the prices of bar have gone up 2s. 6d. per ton, prices closing at £4 15s. for Bessemer steel.

On 'Change, Swansea, mid-week, business was animated, and buyers were present from London and the Midlands. Pig iron was stated to have fallen off on the week to the extent of 6d. per ton in Scotch, 1s. per ton in Middlesbrough, and 1s. 1½d. per ton in hematite. It was reported that the finished iron and steel branches of trade had been affected by the fall in pig iron, and that sellers showed a greater desire to enter orders for forward delivery, but that hitherto buyers had held off in the expectation that with the decreased value of pig iron a corresponding reduction would take place in tin-plate bars. The Bessemer steel works were stated to be fully employed on rails and billets, and to be quoting 5s. higher prices.

Closing figures are as follows:—Glasgow pig iron warrants, 49s. 3d. to 49s. 2d. cash buyers; Middlesbrough No. 3, 44s. 10½d. prompt; hematite warrants, 56s. 11d. for mixed numbers f.o.b. Cumberland, according to brand; Middlesbrough hematite, 55s.; Welsh bars, £6 7s. 6d. to £6 10s.; angles, &c., at usual extras. Sheet iron and steel sheets, £7 to £7 2s. 6d. Steel rails: Heavy sections, £4 15s. to £4 17s. 6d.; light, £5 to £5 12s. 6d. Bessemer steel: Tin-plate bars, £4 12s. 6d. Siemens bars: Best, £4 15s., all delivered in district net cash. Tin-plates: Bessemer steel cokes, 10s. 9d. to 11s.; Siemens, 11s. to 11s. 3d.; ternes, 19s. 3d. to 21s. 6d.; best charcoal, 12s. 9d. to 13s.; finished black plates, £8 to £8 10s.; Canadas, £7 to £7 10s. Block tin, £81 6s. 3d. to £81 16s. 3d.; lead, £13 7s. 6d.; Spanish, £13 5s.

Tonnage did not come into Cardiff last week quite so freely as desired, and this caused a slightly diminished export; yet the tone of the trade continues vigorous, and coalowners would seem to be holding back, in order to improve prices. Steam coal shipments from Cardiff to coaling stations continues very marked, and to France are well maintained. On one day last week 14,100 tons went to Port Said. This week, again, on the 5th, 4300 tons were despatched to Port Said, 5000 tons to Singapore, 4300 tons to Aden, and 3000 tons to Malta. India is buying largely. In anthracite some noticeable shipments have been made to London, from the Great Mountain Colliery, Llanelly. Good coal business appears certain at all the Welsh ports up to the end of the year.

Notices of contracts may now soon be expected. I am informed that those with the Cunard line are being made.

Pitwood is ruling a little easier, large cargoes coming to hand.

Prices remain much the same. In smalls there are signs of higher figures, and any day this may be the case with best large steam. Closing figures, Cardiff, this week were as follows:—Best steam, 13s. to 13s. 6d.; seconds, 11s. to 12s. 6d.; drys, 10s. 6d. to 10s. 9d.; best Monmouthshire, 10s. 9d. to 11s. 3d.; seconds, 9s. 6d. to 10s.; special steam smalls, 6s. 3d. to 6s. 6d.; best ordinary, 5s. to 5s. 6d.; seconds and inferior, 4s. 3d. to 4s. 6d.; best households, 13s. to 14s.; No. 3, Rhondda, 12s. 6d. to 13s.; No. 2, Rhondda, 8s. 6d. to 9s.; smalls, 5s. to 5s. 3d. Swansea prices:—Anthracite, 14s. to 14s. 6d.; seconds, 12s. 6d. to 13s.; ordinary, 11s. to 11s. 6d.; small rubbly culm according to position on stem. Steam coal, 11s. to 11s. 3d.; seconds, 9s. 6d. to 10s. 3d.; bunkers, 7s. 9d. to 8s. 3d.; small, 4s. 6d. to 5s. 9d. Bituminous coal: No. 3, Rhondda, 12s. 6d. to 13s.; No. 2, 9s. 9d. to 9s. 6d.; through, 7s. 9d. to 8s.; small, No. 2, Rhondda, 5s. to 5s. 6d., all delivered Swansea, cash, thirty days, less 2½. Patent fuel, 10s. 9d. to 11s. Cardiff prices, 11s. to 12s. At both ports this is in good demand. Cardiff last week sent 3300 tons to Vera Cruz, a large quantity to Genoa and to Puerto Capello. Coke is active; Cardiff prices, 16s. 6d. to 17s. 6d. for furnace, 18s. 6d. to 24s. 6d. foundry, according to quality.

I am informed that the Great Western railway management contemplates a connection with Nantyglo and district. This would seem to an outsider rather late in the day, considering that this was the scene of Evanshay Bailey's success almost half a century ago as an ironmaster, and the subsequent attempt to re-start the whole concern by a company. But the old ironmasters were not great in coal working, and doubtless there is a good future yet in that neighbourhood, together with a large tin-plate industry, &c. The enginemen of the Cardiff district are agitating for a schedule of standard wages to be adopted by coalowners. There is a dispute at the Californian Collieries, East Bristol, and the manager has given orders to terminate contracts, which will expire on Saturday.

In the "restless district of Llanelly" the "cold roll boys" at the Old Castle Tin-plate Works, to the number of fifty, struck work on Monday, and did not return on Tuesday. It is feared that unless a speedy settlement is brought about, the whole works may be closed.

The production of tin-plate last week at Swansea was considerably in excess of shipments; receipts from work 64,269 boxes; shipments 31,492 boxes; present stock 201,763 boxes, compared with 106,831 boxes this time last year. The outlook at Swansea is recorded as brighter. Ten mills are now at work which have been standing some time. The whole of the mills at Upper Forest are now at work; Foxholes, all busy. The tin-house department at Glantawe is idle owing to a dispute, and the millmen are on day-by-day contracts.

Experiments are still carried on with the revolving calcining furnace at Llansamlet Lower sulphide ore establishment, and the metal is being sent to London for analysis.

A fair average business in tin-plate, steel bar, and ingot is being done at Briton Ferry.

At Llanelly regular work is going on, and the repairers are busy at Morewoods, but no start is announced. A project is on foot for reforming the "Union." Wages questions are relegated to the spring.

The resignation of Mr. John Boyle, chairman of the Rhymney Railway, has been announced. In connection with the Bute Trust, and in the early days of the Rhymney Railway and its conflicts, and generally interesting career, he has been a leading mind, vigorous and to the front until advancing years necessitated first lessened action, and then withdrawal.

The late audit of the sliding scale declares an advance to the colliers of 2½ per cent. This, with the 5 per cent. granted, now makes the colliers' condition 7½ per cent. better than in April last. If good, steady work be persisted in, there is every likelihood of improving wages. At the audit some objection was raised to the irregular election of the working men's section of the scale. This will again be brought to the front.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE brisk business already reported in previous letters continues on the Rhenish-Westphalian iron market; in all departments full employment is maintained; and though output increases, buyers in many cases are experiencing considerable difficulty in obtaining the supplies they want. Makers of pig iron and the producers of blooms and ingots find themselves frequently unable to meet the requirements of their customers, and sales in raw material of English or American make have again been pretty extensive.

Bars and plates are in vigorous demand, and the trade in all sorts of structural iron is brilliant. Foundries, machine and wagon factories are all very busy, and hopes are expressed that the satisfactory position in these departments will further increase. Next month an order for 300 locomotives will be given out by the Prussian State Railways, and within the course of next year no less than 1000 locomotives are to be ordered, so that the shops are indeed looking forward to a lively period. If the prices obtained are not extraordinarily good, they are at least paying and firm; and, moreover, a rise may take place soon, the present fair position of the market causing a hopeful upward tendency throughout the iron trade.

There is a brisk business doing in Silesia in raw and in manufactured iron. The rolling mills of Upper Silesia have officially raised the basis export quotation for bars M. 5 p.t.

The coal trade in the Rhenish-Westphalian, Silesian, and Saar districts keeps exceptionally brisk, especially where engine classes of fuel are concerned. The mild weather of the last few weeks has caused the demand for house coal to decrease slightly.

The Austro-Hungarian iron business is in much the same state as before, a very moderate demand coming in for raw and finished iron. Bars have here and there been offered at reduced rates; in Prague, for instance, they are reported to have been sold at 95 fl. p.t., while in Budapest even less was asked. The machine and locomotive shops, which have been satisfactorily engaged until now, are likely to remain well employed for some time ahead, the Kaiser Ferdinand Nord Bahn having given out twenty-six locomotives and 920 load cars. The Austrian Lloyd contemplates the building of three large steamers of 4000 t. carrying capacity, for the Levant service; this will help to keep a good many works in regular activity for some time, as all the iron and steel required is to be supplied by inland firms.

The demand for structural material has shown a falling-off on the Bulgarian iron market, but for other articles of iron and steel a regular inquiry was coming forward during this week and last; supplies from Austria-Hungary are fairly large. In merchant iron 1330 q. have been imported from that country, while 1020 q. were bought in Germany. There was a specially good inquiry noticed for cast iron stoves. The wire nails imported (214 q.) came from Germany.

A very limited trade was done in iron to Servia, only one wagon hardware and two wagons wire nails from Austria-Hungary having been imported during the past few weeks.

The Belgian iron industry is, generally, very active. Nearly all branches report an improving tendency, both as regards demand and quotations. Export has been steadily increasing of late, and pretty good prices are being realised.

The reports given of the French iron market are, on the whole, satisfactory, employment in the various departments of the iron and steel industries being lively, if not very brisk. Large sales have not been effected upon the week, but there is a steady tone maintained all through. Quotations for bars are still the same as before, 160f. to 165f. p.t. being quoted, while girders remain at 175f. to 180f. p.t., Paris.

ROYAL INSTITUTION.—A general monthly meeting of the members of the Royal Institution was held on the 5th inst., in the afternoon, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding. The following were elected members:—Mr. Herbert William Allingham, F.R.C.S.; Mr. T. Newbold Piddocke; Mr. Edward Preedy; Mr. William Munro Tapp, LL.D.; the Hon. William Frederick Cuthbert Vernon; Mrs. Adela Wetzlar, and Dr. Charles Theodore Williams, F.R.C.P. The special thanks of the members were returned to Dr. George Wyld, for his present of a portrait of Dr. Thomas Garnett, first Professor in the Royal Institution.

THE AUTOMOBILE CLUB OF GREAT BRITAIN AND IRELAND.—Forthcoming arrangements:—Thursday, December 8th, 1898, at 8.30 p.m., ladies' concert. Wednesday, December 14th, 1898, at 7.30 p.m., house dinner, at which Mr. B. Redwood, F.R.S., will preside; discussion on "The Practical Working of the Benz Motor," to be opened by reading a paper by Mr. John Henry Knight. Wednesday, January 11th, 1899, at 7.30 p.m., house dinner, Mr. W. H. Preece, C.B., in the chair: discussion on accumulators, to be opened by the reading of a paper, entitled "Some Notes on the Employment of Accumulators in Electrically-propelled Vehicles," by Mr. Percy Northey. Wednesday, February 8th, 1899, at 7.30 p.m., house dinner; 9.0 p.m., paper and discussion. Wednesday, March 8th, 1899, at 7.30 p.m., house dinner; 9.0 p.m., paper and discussion. Mr. R. E. B. Crompton has promised to open a discussion on "Traffic Regulations," and Mr. Lyons Sampson on "Brakes," but dates have not yet been fixed for the events.

THE PATENT LAWS.—The monthly dinner and debate of the Article Club were held at the Trocadero Restaurant last night, Mr. J. Fletcher Moulton, Q.C., M.P., presiding. The subject of the after-dinner debate was "The Patent Laws and the Trading Community." Among the company present were Lord Justice Vaughan Williams, Lord Suffield, Mr. McKinnon Wood, chairman of the London County Council, Sir A. Noble, Sir H. Tozer, Agent-General for Queensland, the Hon. E. H. Wittenoom, Agent-General for Western Australia, the Hon. E. Blake, Q.C., M.P., Sir A. Sullivan, Mr. C. N. Dalton, Controller of Patents, Mr. W. Murton, of the Board of Trade, Mr. Alexander Siemens, Mr. J. Cutler, Q.C., Mr. C. M. Warmington, Q.C., Mr. R. W. Wallace, Q.C., Mr. Lewis Edmunds, Q.C., Sir J. R. Heron Maxwell, Mr. J. Scott Wood, and Mr. Lesser Columbus, hon. secretary. The toast of "The Queen" having been honoured, the Chairman said that they had to consider, not the use, but the abuse of the patent laws. Many people held that the real evils to the trading community were the patents which were held *in terrorem* over the heads of subsequent inventors. It was unquestionably a matter of serious interest to the trading community that trading should go on, not only uninterfered with, but that this system of threatening should not be carried on with impunity, and he thought the state of things would be intolerable if there was not some remedy for this misuse of patent rights. He thought, however, that one addition to the remedy under Section 32 of the Patent Act would be effective. A little more should be done in the way of empowering the Courts to make what he might call sensible arrangements by which justice might be done after the rights had been settled. He also referred to the case of people living abroad who took out patents in England, by which new manufactures were sometimes entirely excluded in England, as an abuse of the patent laws which required to be remedied. With regard to the question of compulsory licences he felt there was a serious question of fact—namely, whether or not a man had used his patent rights unreasonably—a question which ought to be left to the Courts of Law. Lord Justice Vaughan Williams remarked that such questions as that last referred to were eminently questions for a jury. If they were left to judges alone the inevitable result would be that they would lay down hard-and-fast rules as to the sort of conduct which amounted to the forfeiture of a patent. That, he thought, would be a great misfortune. Other speakers followed.

ENGINEERING NOTES FROM SOUTH AFRICA.

(*From our own Correspondent.*)

THE gold mining industry of the Transvaal is still in a condition of restricted activity, notwithstanding the fact that the October output showed an increase of 14,715 ounces over the figures for September. On the other hand, things are brisk in the Rhodesian mining centres, and large orders for plant and machinery are being placed. As is usual at this period of the year, serious rumours are being spread concerning the scarcity of water on the Witwatersrand mines. As the closing down of some of the properties is already threatened unless a heavy storm or two come speedily to their relief, this annual difficulty really ought to awake the directors of the mines to the necessity for some endeavour being made to provide an adequate water supply. The existing dams are in many cases mere masonry enclosures of natural surface depressions, and no attempt has been made to give them a proper depth. Naturally the loss from evaporation in such structures is enormous. It should be quite possible for the mining people on the Rand to form a water trust or commission, representing the various companies. Such a body could buy up water rights and construct a huge dam on the watershed to the north of Johannesburg. The cost of pumping would be inconsiderable, and the annual loss of many thousands of pounds would be averted.

The revenue of the Orange Free State Railway for the year ending June 30th was £410,517, or £4839 above the estimates. This should encourage railway extension in the States, the agriculture of which stands pressingly in need of new markets for its produce.

Electric lighting contracts have been given out by the public officials of Kimberley and Laurenço Marques. In both cases the orders for machinery and plant will go to English firms.

The Cape Parliament is discussing the revision of the mail contract. The chief question in dispute is whether the contract should be thrown open to public tender, or be determined by private negotiations with the existing mail lines—the Castle and Union Companies. There is a strong body of opinion amongst the mercantile community that the new subsidy should only be granted upon the condition of the abolition of the shipping "ring," and the rebate system of freights upon which it is established. The Government, however, appears to be strongly opposed to introducing this question of freights into the arrangements of the mail subsidy, and it takes up the position that it ought not to interfere in the bargains made between the steamship companies and their customers. It is proposed, under the new contract, to establish a mail service of fourteen days between Southampton and Cape Town. One shipping company has even made an offer to undertake a twelve-day service, but this would mean an enormous increase in the subsidy. One suggestion made in the course of the debate was that the Cape Government should provide itself with steamers, instead of paying subsidies to private companies.

The sewerage scheme at Cape Town, which has been undertaken at a total cost of £250,000, is making good progress, and 54 miles of sewer have now been laid. The works include the providing of five of Shone's patent ejectors for raising the sewage from the lower levels of the town. The compressed-air plant for these ejectors consists of two horizontal duplicate double-acting engines, with steam cylinders 7in. in diameter, and air cylinders 10in. in diameter by 14in. stroke.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal: The market is quiet, owing to the want of prompt tonnage, the boisterous weather keeping steamers back. House coal: The same remark applies to the house coal shipping. Exports for week ending December 2nd were:—Coal, foreign, 54,125 tons; coastwise, 18,391 tons. Imports for week ending December 1st were:—Pig iron, 1220 tons; iron ore, 5339 tons; pitwood, 2760 loads; steel bars, 252 tons; old iron, 345 tons; three cargoes potatoes; one manure; one cement; 1200 tons phosphates.

Coal: Best steam, 10s. 6d. to 11s.; seconds, 9s. 6d. to 10s.; house coal, best, 13s.; dock screenings, 6s. 9d.; colliery small, 5s. 3d. to 5s. 6d.; smith's coal, 7s. to 7s. 6d. Pig iron: Scotch warrants, 49s.; hematite warrants, 56s. 10d., f.o.b. Cumberland; Middlesbrough, No. 3, no quotation; Middlesbrough hematite, 54s. 9d. Iron ore: Rubio, 14s. to 14s. 3d.; Tafna, 13s. 3d. to 13s. 6d. Steel: Rails, heavy sections, £4 15s. to £4 17s. 6d.; light ditto, £5 to £5 12s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 12s. 6d.; Siemens steel tin-plate bars, £4 15s., all delivered in the district, cash. Tin-plates: Bessemer steel, coke 10s. 9d. to 11s.; Siemens—coke finish—11s. to 11s. 3d. Pitwood, scarce. London Exchange Telegram: Copper, £55 3s. 9d.; Straits tin, £82 5s. Freights: Freights remain firm, both foreign and coasting.

LAUNCH. — Turkistan; steel screw steamer, spar-deck type; built by, Messrs. W. Gray and Co., Limited; to the order of, Messrs. Frank C. Strick and Co., Limited; dimensions, 362ft. by 45ft. by 26ft. 8in.; engines, triple-expansion, 28in., 43½in., and 72in. by 48in.; constructed by Central Marine Engine Works; trial trip, December 5th; 15 knots.

TRADE AND BUSINESS ANNOUNCEMENTS.—Consequent upon the appointment of Mr. W. H. Radford to the position of bridgemaster for the county of Lancaster, the business of Messrs. William Radford and Son, Brazenose-street, Manchester, has been transferred to Mr. Joseph Swarbrick, of Temple-chambers, Manchester.—Messrs. Uhlmann and Keutgen have secured larger premises at No. 207, Pentonville-road, N.—Messrs. L. Gardner and Sons have removed to new works at Barton Hall Engine Works, Patricroft, Manchester.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

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

24th November, 1898.

24,840. GENERATION of MOTIVE POWER, V. Tournier and the New Motive Power Syndicate, Limited, London.
24,841. SECURING ENDS of CORDS, O Imray.—(*W. W. Cabena, Victoria.*)
24,842. DISPLAYING STEREOSCOPIC TRANSPARENCIES, J. Rose, London.
24,843. CONNECTING DYNAMOS to SWITCHBOARDS, W. C. P. Tapper, London.
24,844. TANNING, J. V. Koch, London.
24,845. ROTARY EXPLOSION MOTORS, J. B. M. A. Coard and E. A. Charpentier, London.
24,846. APPARATUS for CARBURETTING GAS, W. Irwin, Manchester.
24,847. COATS, A. M. Burberry, London.
24,848. TREATING DECAYED RUBBER, M. Zingler, London.
24,849. BURIAL CASKETS, W. H. Moore, London.
24,850. BRACKETS, E. J. Matthews, London.
24,851. ROTARY MOTOR, L. Deflesselle, London.
24,852. WATER-TUBE BOILER, J. Mazières, London.
24,853. THREAD TENSION DEVICE for SEWING MACHINES, H. H. Lake.—(*J. E. Bertrand, United States.*)
24,854. BOOT FASTENINGS, F. J. Stohwasser and G. B. Winter, London.
24,855. ELECTRIC SIGNALLING APPARATUS, A. U. Alcock, London.
24,856. MOTOR CAR FRAMES, T. Myers, London.
24,857. CHANGING PHOTOGRAPHIC FILMS, A. L. Adams, London.
24,858 BURGLAR ALARMS, B. J. P. Roberts, London.
24,859. ELECTRIC SPARKING PLUGS, F. R. Simms, London.

25th November, 1898.

24,860. SCAB WASH, A. Robertson, London.
24,861. GUARDS for CIRCULAR SAWS, W. A. Webster, Manchester.
24,862. GENERATING ACETYLENE GAS, A. Dickson and H. Wallace, Glasgow.
24,863. SPEED INDICATORS for VEHICLES, J. Grosart, Glasgow.
24,864. BED-POST ATTACHMENT, C. J. Bigger, Bristol.
24,865. SWIVEL LOOMS, E. Hollingworth. — (*G. F. Hutchins, United States.*)
24,866. MACHINE for BORING OVAL HOLES, C. Janssen, Birmingham.
24,867. ROTARY STEAM ENGINES, D. Morell, Manchester.
24,868. CONNECTING MATTRESSES to BEDSTEADS, L. Johnston, Walmley, Warwickshire.
24,869 COPPER FURNACES, W. Kerridge, Ipswich.
24,870. HORSESHOES, J Kemp, Eastbourne.
24,871. FIREMAN'S HEADGEAR, R. McBurnie and J. Mason, Manchester.
24,872 ELECTRIC DYNAMOS and MOTORS, J. Atkinson, Marple, Cheshire.
24,873. JAM-BOILING PANS, W. Brierley, Rochdale.
24,874. CONFECTIONERY CUTTING MACHINES, W. Brierley, Rochdale
24,875 CRICKET BAT HANDLE, B Warsop, London.
24,876. INCREASING the POWER of DRIVING GEAR, J. McKane, Belfast
24,877 TEA INFUSER, W. H Ratcliffe, Derby.
24,878 ALLOY of ALUMINIUM and MAGNESIUM, A. G. Brookes —(*L Mach, Germany*)
24,879. PANELS for BASSINETTES, J. Harrop, Manchester.
24,880. SHIPS' RUDDERS, W. R. Lawson, London.
24,881. DEVICE for WINDOW CLEANING, J. Webster, Exmouth, Devon.
24,882. SCISSORS. H. Cheesman, Newcastle-on-Tyne.
24,883. SPEED GEARS for VEHICLES, C. H. Shacklock, London.
24,884. FOLDING SHAFTS of MAIL-CARTS, J. Carr, Bradford.
24,885. GAS GENERATORS, W. Riley and A. Kershaw, Bradford.
24,886. FIRE-LIGHTERS, A. J. Roberton, Manchester.
24,887. ALARM CLOCK, T. Millar, Glasgow.
24,888. BICYCLE, J. Cochran and C. Watkin, Armagh.
24,889. RIVETING APPARATUS, J. MacE. Ross, Glasgow
24,890. VALVES, J. Chalmers, Glasgow.
24,891. RETORTS for DISTILLING SHALE, W. Young and J. Fyfe, Glasgow.
24,892. LOCKING INDICATING DECK-PLATE, T. White, Glasgow.
24,893. GUIDE-BARS for AXLE-BOXES, D. J. Morgan, Barry, Glam.
24,894. WINDOW WASHER, R. H. Dunn, Street (S.O.), Somerset.
24,895. SEALING the MOUTHS of BOTTLES, R. G. Nash, London.
24,896. WATER-TUBE BOILERS, G. N. Philip, London.
24,897. SUPERPOSED CARDERS, P. Bastin, London.
24,898. POCKET STANDS for CAMERAS, R. de Columbier, London.
24,899. AUTOMATIC LIFE-SAVING RAFT, R. de Columbier, London.
24,900. HARNESS, V. P. Berrurier, London.
24,901. COAL-WASHING APPARATUS, H. St. J. Durnford, London.
24,902. HOISTS, S. Bändel and C. Klinik, Birmingham.
24,903. APPARATUS for TANNING SKINS, T. H. L. Bake, London.
24,904. STRAINING PAPER PULP, W. W. Beaumont, London.
24,905. PREPARING HYDROCYANIC ACID, R. Bayer, London.
24,906 NITRO-SUBSTITUTION under PRESSURE, C. Schneider, London.
24,907. SHIPS, F. G. Sennett and W. G. Williams, London.
24,908. ATTACHING GAS BRACKETS, &c., J. Lewis, London.
24,909. MAKING CALCIUM CARBIDE, H. Walker, London.
24,910. DOORS for GAS FURNACES, B. A. Burrell, London.
24,911. CURVED TYPE, R. J. Day and A. Collins, London.
24,912. ELECTRIC FITTINGS, C. S. Bradford, Kingston-on-Thames.
24,913. CONNECTING-RODS, J. T. Norris, Kingston-on-Thames.
24,914. ELECTRIC HINGES, F. E. Chandler, Kingston-on-Thames.
24,915. SHAVING the SURFACE of SKINS, E. E. Pullman, London.
24,916. INDICATOR for COOKERY RECEIPTS, E. Howe, London.
24,917. TEACHING PERSONS to CYCLE, W. J. Blaxton, London.
24,918. MATCH BOX HOLDER for CYCLES, J. J. Snow, London.
24,919. CLOSING SHUTTERS, &c., J. H. Dierickx, London.
24,920. BALING PRESSES, H. H. Lake.—(*C. L. Hovden, Norway.*)
24,921. FACILITATING DRAWING from MODELS, H. Sheaf, London.
24,922. SUSPENDING PAPER BAGS, &c., A. McCabe, London.
24,923. OIL LAMPS, H. Lane, London.
24,924. BOOT LACES, E. H. Ludlow and A. Whittall, London.
24,925. CYCLE HUBS and BEARINGS, W. Woodhead, London.
24,926. HINGES, A. J. Boult.—(*G. Weber, Germany.*)
24,927. PENCIL-SHARPENING MACHINES, R. M. Jones, London.
24,928. BRICK-MAKING MACHINES, G. Austin, London.
24,929. COMBUSTION of LIQUID HYDROCARBONS, O. Meurer, London.
24,930. AIR-TIGHT COVERS for VESSELS, A. Schmalenbach, London.
24,931. BURNING LIQUID HYDROCARBON, F. R. Blount, Liverpool.
24,932. COMPOSITION for PAINTING, A. Nevin and T. Bulfield, Liverpool.
24,933. SULPHURIC ANHYDRIDE, W. P. Thompson.—(*G. Wischin, Russia.*)
24,934. PACKING for SCREW TAPS, T. Garner, Manchester.
24,935. WATERPROOFING FABRICS, G. T. Oliver and W. Derby Manchester.
24,936. SOLDERING IRON, G. P. W. Richards, London
24,937. TRACTION ENGINES, W. Foggo, London.
24,938. PREVENTING WINDOWS being OBSCURED by MOISTURE, L. Pinner and W. Ornstein, London.
24,939. CLOSETS, C. H. Martini, London.
24,940. UNLOCKING EMERGENCY EXIT DOORS, T. E. Hewitt, London.
24,941. DRYING BRICKS O. Howl, London.
24,942. CYCLE SIGNAL BELLS, J. H. Thieme and O. O. Alt, London.
24,943. NEEDLE-CASE, K. F. Koch and G. Schmiedeken, London.
24,944. LOCKING the WHEELS of VEHICLES, H. S. T. Wildman, London.
24,945. BALL BEARINGS, G. E. Mittinger, jun., and F J. Schweitzer, London.
24,946. OPTICAL PROJECTION APPARATUS, J. G. Lorrain.—(*H. O. Foersterling, Germany.*)
24,947. BICYCLES, T. G. Psimenos, London.
24,948. AMMUNITION HOISTS for SHIPS, A. T. Dawson, T. Thackeray, and J. Horne, London.
24,949. REGULATING TRANSFORMER for ELECTRIC INSTALLATIONS. Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktiengesellschaft, Germany.*)
24,950. PIVOTS for SWINGING WINDOW SASHES, W. Nicholson, London.
24,951. GEAR for COMMUNICATING POWER, C. L. Kline and C. L. Kline, jun., London.
24,952. CARRYING BICYCLES, H. L. Webster, London.
24,953. GENERATORS for ACETYLENE GAS, L Morris, London.
24,954. INCANDESCENT GAS LIGHTING, W. B. Smith, London.
24,955. UTENSILS for SHAVING-WATER, F. R. Begbie, London.

26th November, 1898.

24,956. ANTI-VIBRATOR for OIL LAMPS, R. H. Smith, London.
24,957. PIPES, J. R. W. Woodward and N. Collier, Derby.
24,958. UNDERCLOTHING, W. H. Stevens, Leicester.
24,959. AUTOMATIC BRAKE, T. H. and E. Mitchell, Manchester.
24,960. ENGINE BEARINGS, T. H. and E. Mitchell, Manchester.
24,961. TRAVELLERS' SAMPLE CASES, T. A. Sands, Birmingham.
24,962. STEERING FLYING MACHINES, J. Vreugdenhill, London.
24,963. CORSETS, H. A. R. Champness and R. H. Mitchell, Manchester.
24,964. STOPPER ATTACHMENT, J. Bourey, Bristol.
24,965. ELECTRICAL INSTRUMENT, G. T. Hanchett and F. B. Sage, Manchester.
24,966. WHEELS, R. W. Macculloch and F. Gash, West Kirby, Cheshire.
24,967. PISTONS, J. G. A. Kitchen, Manchester.
24,968. BEARING, S. Walker and W. Morris, Radcliffe, Lancs.
24,969. METHOD of FASTENING SHOES, T. Sargent, Bristol.
24,970. STARTING GAS and OIL MOTORS, S. Griffin, Bath.
24,971. DRESS FABRICS, H. B. Priestman and S. H. Rawnsley, Bradford.
24,972. CYCLE BRAKE, T. Adamson and F. W. Barlow, Bolton.
24,973. GRINDSTONE TOOL TIPPING REST, A. Thackwray, Leeds.
24,974. RESTS for SCREW-CUTTING TOOLS, J. T. Dunstan, Dristol
24,975. GENERATORS for ACETYLENE, E. L. Levetus, Leeds.
24,976. EXPANDING CORSET, R. Fairhurst, Wigan, Lancs.
24,977. CYCLE FRAMES, W. Andrew, Manchester.
24,978. CRYSTALLISING SODIUM CARBONATE, J. Dekker, Glasgow.
24,979. TIRES, R. Mitchell, jun., and J. Mitchell, Glasgow.
24,980. COG-WHEEL BRAKE for BICYCLES, J. Tiffen, Carlisle.
24,981. SCENT BOTTLE and FAN, J. C. B. Townsend, London.
24,982. OVERHEAD ELECTRIC TRACTION, W. R. Smith, London.
24,983. SOFTENING WATER for ENGINES, E. J. Davis, London.
24,984 OIL RESERVOIRS for LUBRICATORS, E. J. Davis, London.
24,985. CHAIN ADJUSTERS for CYCLES, F. G. Griffith, London.
24,986. CONNECTING ENDS of BANDS, J. McKechnie, London.
24,987. SOCKETS for CARRIAGE LAMPS, W. J. Coplestone, London.
24,988. INCANDESCENT MANTLE FOUNDATION, R. M. Shelley, London.
24,989. VEHICLE for COMMON ROADS, F. W. Giller, London.
24,990. DEVICE for FILLING PNEUMATIC TIRES, B. Cahn, London.
24,991. SHIPS, R. Wesch, London.
24,992. AUTOMATIC TELEGRAPH APPARATUS, G. Giorgi, London.
24,993. PISTONS, C. Lockwood, London.
24,994 OPTICAL APPLIANCE for FINDING VIEWS, W. Mallett, W. Watson, C. W. Beevor, and A. L. Adams, London.
24,995. BURNERS, E. E. Crook and M. A. Hunting, London.
24,996. PERAMBULATORS, &c., F. J. McKenzie, London.
24,997. TWISTING THREAD, M. Beaumann and A. Kryszat, London.
24,998. WASHING LINEN, F. Moll and M. P. O. Dickhuth, London.
24,999. FOLDING DESKS and SEATS, S. Akbroit, London.
25,000. PURIFYING SEWAGE, W. P. Thompson.—(*C. G. Gsell, Germany.*)
25,001. SIDE SCUTTLES for SHIPS, W. Mullan, Liverpool.
25,002. PRESSES for BALING COTTON, J. Conder, Liverpool.
25,003. BRUSH, G. Stiehle, Liverpool.
25,004. BRAKES for VELOCIPEDES, A. C. Shergold, London.
25,005. INSTRUMENTS for DRAUGHTSMEN, A. J. Boult.—(*H. Herberg, Germany.*)
25,006. INTERNAL COMBUSTION ENGINES, J. B. Lafond, London.
25,007. MIXING and KNEADING MACHINE, P. Küpper, London.
25,008. PREVENTING SHIPS from SINKING, A. E. Broquet, London.
25,009. LAMP, C. Vernier, London.
25,010. EXHAUSTER for CORROSIVE GASES, J. Müller, London.
25,011. HAT PINS, O. Cholerius and A. Herrmann, London.
25,012. STEAM ENGINES, B. Gee and R. Webster, London.
25,013. ELECTRIC ARC LIGHTING, A. Vosmaer, London.
25,014. AUTOMATIC LIGHTING of GAS MANTLES, L. Moris, London.
25,015. TREATING RESIDUE from PLATINUM, L. Moris, London.
25,016. ACETYLENE GAS GENERATORS, A. Schwass, London.
25,017. DYEING HAIR and FURS, C. D. Abel.—(*The Actien-Gesellschaft für Anilin Fabrikation, Germany.*)
25,018. TREATING VEGETABLE FIBRES, F. Hasselmann, London.
25,019. VEHICLES, C. E. Sibley and R. Bryan-Haymes, London.
25,029. TREATING BICHROMATE of SODA, A. Goldschmidt, London.
25,021. SECURING the BASIS of BOXES, J. W. Claughton, London.
25,022. CYCLE SADDLE, W. E. Carmont and H. de Stedinhk, London.
25,023. TRAMWAY CARS, O. Brennecke and I. Timar, London.
25,024. CARDBOARD BOX, F. T. Austin, London.
25,025. TEETHING APPLIANCE, A. J. Tempère, London.
25,026. METAL SUPPORT for COUNTERDIES, R. J. Copas, London.
25,027. MANUFACTURE of BARYTA, H. H. Lake.—(*La Société Bonnet, Ramel, Savigny Giraud et Marnas, France.*)
25,028. TIRES, E. Kempshall, London.

28th November, 1898.

25,029. MEASURING the EFFICIENCY of GEARING, A. Sharp, London.
25,030. CARBURETTING, C. Bingham, London.
25,031. CULTIVATORS, W. E. Martin, Huntingdon.
25,032. COVERINGS for BABY CARRIAGES, G. A. Barnard, Winchester.
25,033. GEARING for VELOCIPEDES, H. J. Bagley London.
25,034. SOAP, S. V. Dardier, London.
25,035. CONTROLLING RAILWAY PLATFORM TROLLEYS, A. B. Payne, Sketty, near Swansea.
25,036. CARDBOARD BOXES, A. W. Stevenson and G. Donaldson, Manchester.
25,037. LOCKING the DOORS of TRAINS, J. Marshall, Glasgow.
25,038. DIVIDING CIRCLES into PARTS, R. C. Craig, Glasgow.
25,039. SHUTTLE OPERATING MECHANISM for LOOMS, L. Cheesebrough, Keighley.
25,040. RAILWAY PLATFORM TRUCKS, G. P. Edwards, Wolverhampton.
25,041. FIXING LIDS to BOXES, J. Mowat and J. Watt, Helensburgh.
25,042. COMPASS CARD, E. Gruby, Hull.
25,043. PHOTOGRAPHIC PRINTING, A F. Hargreaves, Midlothian.
25,044. MECHANISM for COIN-FREED GAS METERS, J. Milne and H. O'Connor, Edinburgh.
25,045. MECHANICAL TOY, A. W. Pocock, London.
25,046. HEATING KILNS or OVENS, J. T. Cope, Birmingham.
25,047. MACHINERY for CRUSHING ORE, R. A. White, London.
25,048. SADDLES for HORSES, T. B. Sharp and G. Miner, Birmingham
25,049 BACK-PEDALLING BRAKES for VELOCIPEDES, R. Riddle, Birmingham.
25,050. SOWING ARTIFICIAL MANURES, R. and W. Wallace, Glasgow.
25,051. ELECTRIC ALARMS, C. A. Gillespie, Glasgow.
25,052 CYCLE SELF-LOCKING APPARATUS, F. L. Jeyes, London.
25,053. WASHERS for PIPE FLANGES, C. H. Jolliffe and H. H. Deacon, London
25,054. SILK-HOLDING DEVICES, C. A. Allison.—(*S. Sweeney, United States.*)
25,055. SOUNDING APPARATUS, J. O'Neil, London.
25,056. WOVEN STUFFS with SILK IMITATIONS, H. Edelhoff, Germany.
25,057. EXCENTRIC SWIVELLING CHAIRS for SHIPS, A. Robertson and J. Rowan, Glasgow.
25,058. AUTOMATIC FUSE REPLACER, H. G. Solomon, London.
25,059. TORPEDO GUN, J. O'Kelly, M.P., London.
25,060. DRAG for VESSELS, M. D. Cvetkovich, G. Kukac, C. Mingotti, and A. Sirola, Glasgow.
25,061. PORTABLE BALANCE THERMO-REGULATOR, R. H. Cox, Shanghai, China.
25,062. The "COMPREHENSIVE" CALENDAR RULE, G. Stevenson, Accrington.
25,063. HOT-WATER HEATERS, A. J. Boult.—(*W. J. Walsh, G. M. Ryckman, and M. H. Le Hane, Canada.*)
25,064. WEIGHING MACHINES, J. Joynson, London.
25,065. MATCH-BOXES, &c., for HOTELS, J. A. Firth, London.
25,066. FIRE EXTINGUISHER, J. W. Naylor and W. Harrison, London.
25,067. COIN-FREED MECHANISM, C. F. Stahlecker, London.
25,068. CONDENSERS and EVAPORATORS, S. Puplett, London.
25,069. SEATS for WATER-CLOSETS, A. L. Trotman, London.
25,070. TOOTH-BRUSHES, A. Worringen, London.
25,071. SADDLE SEAT, W. F. Hole.—(*J. I. Knight, New Zealand.*)
25,072. AUTOMATIC COIN REGISTER, The Globe Cashier, Limited, and W. D. Rowlingson, London.
25,073. SOUP POWDER, A. W. Turner and J. Tibbitts, Birmingham.
25,074. RACKS for CYCLES, T. Hewitt, London.
25,075. REFLECTORS for LAMPS, G. Huebner.—(*A. Müller, Austria-Hungary.*)
25,076. DISPLAYING PICTURES, A. R. Upward and R. Dalmer, London.
25,077. CHANGING SURFACES for ADVERTISEMENTS, A. R. Upward and R. Dalmer, London.
25,078. MACHINE CUTTER HOLDER, M. L Tucker and Disc and Easy Churns, Limited, Chesham.
25,079. BURNERS for HEATING and LIGHTING, M. Crawford, London.
25,080. RAILWAY SIGNALS, C. Brawn, London.
25,081. REVOLVING DOORS, T. V. Kannel, London.
25,082. BAND for HOLDING TOGETHER the RIB ENDS of UMBRELLAS, G. Kurschner, London.
25,083. WALL ATTACHMENT for HOLDING BICYCLES, A. F. Smith and W. Mays, London.
25,084. PHONOGRAPHS, L. Wolff, Liverpool.
25,085. FLUSHING CISTERN for WATER-CLOSETS, J. W. T. Brain, Birmingham.
25,086. SYPHON-HEAD DEVICE, R. Ebersbach and G. Rakovan, London.
25,087. ARC LAMPS, W. Crudgington, Birmingham.
25,088. SHIP LOG APPARATUS, T. F. and T. S. Walker, London.
25,089. BREAD KNIFE with a GAUGE, H. Eisenmann, London.
25,090. LOOMS for WEAVING PILE FABRICS, A. Webb, London.
25,091. FLEXIBLE STAYS for AIR CUSHIONS, A. A. Young, London.
25,092. ROTARY PRESSURE ENGINE, S. A. E. Hickson, London.
25,093. SWING GATES, J. H. Hannay, London.
25,094. SEALING CASK VENTS, R. Haddan.—(*J. D. y Farrés, Spain.*)
25,095. CONDUCTOR for SUBMARINE CABLES, G. G. M. Hardingham.—(*The Firm of Felten and Guilleaume, Germany.*)
25,096. REMOVING DUST from CHAFF, A. S. F. Robinson, London.
25,097. ALLOYS of COPPER, W. L. Wise.—(*J. Burns, United States.*)
25,098. ELECTRIC TRAMWAYS, S. P. Thompson, Liverpool.
25,099. GRIPPING DEVICE for MINE CAGES, P. G. Kelly, London.
25,100. ADVERTISING BAGS for GOODS, E. de Vernoys, London.
25,101. TREATING YEAST, R. Rückforth, London.
25,102. IGNITION MATERIAL for MATCHES, R. E. A. Gans, London.

25,103. STIFFENERS for SHIRT FRONTS, R. Williams, London.
25,104. FOLDING BOXES, A. S. King, London.
25,105. SALT CELLARS, H. Binley, London.
25,106. ROCK-BORING APPARATUS, F. Baker, London.
25,107. MACHINERY for PRODUCING CARDBOARD BOXES, S. Cropper.—(*Partly by T. L. Cornell, United States.*)
25,108. APPARATUS for TAKING PHOTOGRAPHS, E. J. Ball, Plymouth.
25,109. ELECTRIC HOISTING MACHINERY, J. W. Brown and A. J. G. Simpson, London.

29th November, 1898.

25,110. BIFOCAL SPECTACLE LENSES, W. E. Debenham, London.
25,111. DRIVING GEAR for VELOCIPEDES, G. Brown, Plumstead, Kent.
25,112. HORSESHOES, J. G. Hunt and F. C. Boden, Southampton.
25,113. PNEUMATIC HAMMERS, D. Longworth, Banbury, Oxon.
25,114. DIVISIBLE HANDLE-BAR, K. E. Norie, London.
25,115. MODEL PRESSER, W. Robinson, Luton.
25,116. NON-SLIPPER, E. de V. Buckingham, Gainsborough, Lincolnshire.
25,117. TOOL HOLDER, S. J. Spurling, Plumstead, Kent.
25,118. TREATING COKE OVEN GASES, B. H. Thwaite, London.
25,119. HARNESSES for WEAVING, W., D., and J. T. Hardaker, Bradford.
25,120. FOLDING CHAIRS, O. L. Story, Kingston-on-Thames.
25,121. PRUNING IMPLEMENTS, A. H. Knight, Kingston-on-Thames.
25,122. SEAMLESS TUBES, B. F. McTear and W. Lindsay, Liverpool.
25,123. WEATHER PROTECTORS for CYCLISTS, R. Slack, Manchester.
25,124. LAMPS, A. W. Turner and J. Adie, Birmingham.
25,125. ADJUSTABLE GRIPPING DEVICE, B. Smith, Bristol.
25,126. CHURNS, S. C. Jones, Sheffield.
25,127. GONG ALARM, W. Baily, Malvern Wells.
25,128. HEATING WATER by STEAM, L. Marshall and S. Naylor, Halifax.
25,129. BEDSTEADS, J. E. Hoskins and G. R. Payne, Birmingham.
25,130. IRONING MACHINES, J. McAllister, Glasgow.
25,131. EMERY ROLLERS, J. G. Bamforth, Huddersfield.
25,132. DRIVING MECHANISM for BICYCLES, W. E. Taft, London.
25,133. ALBUMS, O. Firth, Bradford.
25,134. SCHOOL DESKS, F. H. Fisher, Birmingham.
25,135. WALKING STICKS, E. Clarkson, Bradford.
25,136. ENVELOPES, S. Bearder, Bradford.
25,137. ADVERTISING, C. W. Hollis, Nottingham.
25,138. METALLIC PACKINGS, J. G. A. Kitchen, Manchester.
25,139. PRODUCING GASES, J. M.-L. Messerli, Leicester.
25,140. EDUCATIONAL GAME, E. Hagen, Manchester.
25,141. APPLIANCES for KEEPING the MOUTH CLOSED DURING SLEEP, H. L. S. Cocks, Bristol.
25,142. ATTACHING INDIA-RUBBER SOLES to BOOTS, P. M. Matthew and J. M. Chalmers, Leith.
25,143. BICYCLES, G. Caddick, London.
25,144. ROAD VEHICLES, J. Clulow and H. E. Orton, London.
25,145. MAIL-CARTS for CHILDREN, H. Thomsett, London.
25,146. TIRES, J. F. Child and W. O. Collingwood, London.
25,147. RECEPTACLES for HOLDING CIGARS, A. Kyd, Glasgow.
25,148. CUTTING WEFT VELVET, A. Eppinger, Manchester.
25,149. NON-INTOXICATING DRINKS, J. H. Brodrick, Birmingham.
25,150. PNEUMATIC TIRES for CYCLES, J. Robinson, Ipswich.
25,151. PROJECTILES, &c., G. Roth and C. Krnka, Glasgow.
25,152. WIRE HEALDS for WEAVING, B. Lee, Colne, Lancs.
25,153. COOKING UTENSIL, G. MacMurdie, G. Wright, and J. H. Borrett, London.
25,154. SPRING SADDLE for CYCLES, A. Woodmansey, London.
25,155. ARTIFICIAL MARBLE, T. W. James, Birmingham.
25,156. APPLIANCE for TEACHING SWIMMING, J. Wilson and W. Walker, London.
25,157. CYLINDER PUMPS, A. Rigg and J. C. Bayley, London.
25,158. RECOVERING SULPHURIC ACID from GASES, T. R. Shillito. — (*The Actiengesellschaft für Zink-Industrie vormals W. Grillo and M. Schroeder Germany.*)
25,159. BLIND-ROLLERS, F. W. Phillips and E. Nash, London.
25,160. PRODUCTION of ACETYLENE GAS, C. Barnett, London.
25,161. CYCLE LOCK, F. M. Boclet and A. Turner, London.
25,162. LOCKS, A. H. Walker.—(*The Universal Lock Company, United States.*)
25,163. LOCKING COCKS, J. and T. H. Nodder, Sheffield.
25,164. RECEPTACLES for PACKING FRUIT, J. H. Arkwright, London.
25,165. BURNING GAS, C. G. Hemsley and P. S. Squirrell, London.
25,166. LOCKING CARRIAGE DOORS, C. E. Cooper, London.
25,167. COMBINATION FURNITURE, J. Brustmann, London.
25,168. CUTTING-OFF VALVES, A. Langhammer, London.
25,169. BEDSTEADS, A. Stromberg, London.
25,170. CHIMNEY SHAFT, A. Krüger, London.
25,171. ASBESTOS, L. Grote London
25,172. JOINING RAILWAY SIGNAL RODS, T. S. Lewis, London.
25,173. IRON and STEEL CHAINS or LINKS, W. Roberts, London.
25,174. ENGINE, T. King, London.
25,175. CHOPPING FIREWOOD, J. Robbins and H. C. Burton, London.
25,176. GUN MECHANISM, A. Reichwald.—(*F. Krupp, Germany.*)
25,177. GUN MECHANISM, A. Reichwald.—(*F. Krupp, Germany.*)
25,178 TENSION-CONTROLLING DEVICES, S. H. Wheeler, London.
25,179. BALL BEARINGS, C. H. Ferguson, London.
25,180. ARITHMETICAL CALCULATORS, W. A. Drake, London.
25,181. HORSESHOES, T. Allwood and V. A. Bailey, London.
25,182. POST-MARKING MACHINES, H. H. Lake.—(*E. R. Malmborg, United States.*)
25,183. SIRENS, W. T. Purchase, London.
25,184. DRIVING CHAINS, R. Abell, London.
25,185. CLAPPERS for BELL BUOYS, W. T. Elliott, London.
25,186. FASTENING BICYCLE TIRES, J. McAlpine, Leytonstone, Essex.
25,187. WATER VAN and SWEEPING MACHINE, F. J. Wakeling, London.
25,188. TANNING, A. E. Vidal, London.
25,189. VENTILATING TAP, J. Charman, Crawley, Sussex.
25,190. BICYCLES, L. B. Gaylor, London.
25,191. CAMERAS, H. Hill, E. G. Price, and Photo, Ltd., London.
25,192. FLEXIBLE TUBE JOINERS, W. Puzey, London.
25,193. MACHINES for CUTTING STIFFENERS for BOOTS, H. H. Lake.—(*W. F. O'Brien and D. S. Keith, United States.*)
25,194. PREVENTING OVERTURNING of FLOWER POTS, J. E. Austin, London.
25,195. SMOKE CONSUMERS, J. McDonald, W. H. Klock, and C. A. Hall, London.
25,196. SHOES for HOOFED ANIMALS, W. H. Wakfer, London.
25,197. SCREW NUTS, O. Imray.—(*W. H. Carruthers, United States.*)
25,198. PACKING RABBITS, J. B. Zander and J. Cooke, London.
25,199. BURNER, A. Rammoser, E. Röhrs, and H. Röhrson, London.
25,200. HOLDERS for BILLIARD CHALK, R. W. Hodges, London.
25,201. UTILISING HEAT, R. Haddan.—(*J. E. Whiting, India.*)
25,202. ELECTRIC ALARM CLOCKS, L. Schott, London.
25,203. CLOSETS, J. Duckett and Son, Limited, and J. Duckett, Burnley.
25,204. STEAM-GENERATING APPARATUS, G. C. Fricker, London.
25,205. RADIOGRAPHIC APPARATUS, J. Wertheimer, London.
25,206. NECK WEAR, E. A. Roskilly, London.
25,207. TUBES for VACCINE LYMPH, J. H. Montague, London.
25,208. BOOTS and SHOES, H. Brown and G. Hall, London.
25,209. PRODUCING GAS, E. Pilous, G. Ottermann, and E. Nauheim, Liverpool.
25,210. APPARATUS for NECKING VIALS, J. B. Conde, Liverpool.
25,211. TUBULAR SECTIONS of GLASS, J. B. Conde, Liverpool.
25,212. PROJECTILES, S. V. Buskirk, London.
25,213. TURNING VESSELS, C. J. I. Ker and R. F. Bolton, London.
25,214. CRUTCHES, R. Schwarting, London.
25,215. MAKING MATCHES, G. C. Marks.—(*F. W. Mead, United States.*)
25,216. TRUEING UP EMERY STONES, H. Laucks, London.
25,217. PRODUCING ELECTRIC CURRENTS, R. Echtermeyer, London.
25,218. GULLY GRATINGS, F. G. S. Ham, W. E. Baker, and C. M. Sansom, London.
25,219. MAKING YARN, J. Y. Johnson.—(*W. H. Drurg, United States.*)
25,220. LUBRICATORS, N. Bick, London.
25,221. ARC LAMPS, J. J. Rathbone, London.
25,222. FIRING MECHANISM of GUNS, W. and A. Cashmore, Birmingham.
25,223. EYELET FASTENERS, K. H. Otto, Barmen, Germany.
25,224. STEAM ENGINE, O. E. Graham, Kingston-on-Thames.
25,225. CUTTING TWINE, J. Crandall and O. W. Sherwood, Kingston-on-Thames.

30th November, 1898.

25,226. LOCKING DOORS, W. S. Jervois, Blackrock, Co. Dublin.
25,227. ACETYLENE GAS GENERATORS, D. Thubron, Scarborough.
25,228. SLIPPER for FISHING-GEAR BOARDS, E. Bacon and G. Jackson, Grimsby.
25,229. MACHINES for JIGGING ORE, W. A. Green, Aberystwith.
25,230. RAILWAY TRUCK and TROLLEY, W. F. W. Ellis, London.
25,231. STEAM or AIR ENGINES, J. Gemmell, London.
25,232. PAPER BAGS, J. Ralph, Wolverhampton.
25,233. FURNACES, W. Burgan and B. W. Winder, Sheffield.
25,234. FILTER BEDS for SEWAGE PURIFICATION, W. Foster, Leeds.
25,235. FOLDING CARDBOARD BOXES, E. P. Fenton, Manchester.
25,236. VELOCIPEDE-STEERING HANDELS, E. B. Killen, Manchester.
25,237. TABLES, A. Anderson, Glasgow.
25,238. DRIVING HORSES, T. Dunnachie, Glasgow.
25,239. COMBINED COMMUNICATION SHEET, A. Waters, London.
25,240. CALICO PRINTING, R. McKechnie and A. Hodge, Glasgow.
25,241. WINCHES, T. Downie, Liverpool.
25,242. ENGINE GOVERNORS, J. Davidson and T. R. Hampson, Liverpool.
25,243. ENGINE GOVERNORS, J. Davidson and T. R. Hampson, Liverpool.
25,244. DRIVING BELT, W. H. Hoyle and T. Barker, Bolton.
25,245. PUMP CLIPS for CYCLISTS, S. Greenwood, Liverpool.
25,246. SHIELD for HORSE COLLARS, C. McCallum, Glasgow.
25,247. FIREPLACES, W. H. Sherburn, Belper, Derbyshire.
25,248. RUBBER TIRES for VEHICLES, R. Mitchell, jun., Glasgow.
25,249. SAW GUARDS, W. Stevenson and H. Toogood, Stockton-on-Tees.
25,250. LAMPS, J. Aide, A. W. Turner, and T. Roberts, Birmingham.
25,251. CALCULATING APPLIANCE, J. Massel.—(*A. Massel, Russia.*)
25,252. PUZZLE BRICKS for CHILDREN, E. H. Carlyon, Birmingham.
25,253. HORSESHOES, J. Riley, F. J. Astbury, and I. Fisher, Manchester.
25,254. LIFEBOATS, D. J. Morgan, Barry, Glamorgan.
25,255. CYCLE CRANKS, A. Kerfoot and J. J. Kerr, Cappoquin, Co. Waterford.
25,256. TREATING SAP, E. J. C. Christie and R. Anderson, Glasgow.
25,257. CUTTING LOZENGES, T. and J. Morton, Wishaw, Scotland.
25,258. ACETYLENE GAS GENERATORS, P. Harrison, Birmingham.
25,259. ELECTRICAL REVOLUTION INDICATORS, K. Obst, Liverpool.
25,260. ELECTRICITY METER, A. Nunns, Halifax.
25,261. CAMERAS, H. Hill, E. G. Price, and Photo, Limited, London.
25,262. PNEUMATIC TIRES, C. A. Morrison and H. Bausor, London.
25,263. DISINFECTANT FLUSH TANK, A. T. Handley, Hove, Sussex.
25,264. WINDOW SASHES, H. Callow, London.
25,265. LOCOMOTIVE SIGNAL APPLIANCE, D. Wilson, London.
25,266. WORKING JOINERS' VICES, D. F. Dowey, Middlesbrough.
25,267. CIRCLES, J. C. Fergusson, Vancouver, British Columbia, Canada.
25,268. AUTOMATICALLY-IGNITING MANTLES, A. Rammoser, E. Röhrs, and H. Röhrson, London.
25,269. MONEY-BOX, J. Clarke, London.
25,270. FISH-HOOKS, C. E. O. Coleman and J. B. Wright, Birmingham.
25,271. WATER HEATERS, W. Boby, London.
25,272. MUZZLE, J. Hammond, Reading.
25,273. PUMP, G. Kimber, London.
25,274. WEAVING MATS, K. Walker, London.
25,275. FIRE-PROOF PAINT, A. J. Boult.—(*P. Carré, France.*)
25,276. FIRE EXTINGUISHERS, A. J. Boult.—(*P. Carré, France.*)
25,277. WATER-GAS, A. J. Boult.—(*G. Nicolini, Italy.*)
25,278. AIRING LINEN, R. Rainsford.—(*G. W. and C. A. Hall, United States.*)
25,279. OPENING WINDOWS, R. Rainsford.—(*A. Christianson, United States.*)
25,280. SHOE PROTECTOR, C. Hutcheson, Edinburgh.
25,281. OPENING ENVELOPES, F. H. Walker, London.
25,282. TROUSERS CLIP for CYCLISTS, F. H. Walker, London.
25,283. STEAM ENGINES, J. T. Rossiter, London.
25,284. BOTTLE, G. D. Howard.—(*H. Starck, United States.*)
25,285. EXHIBITING PICTURES, J. Schiele, London.
25,286. OIL COMPOSITION, C. J. Grist, London.
25,287. CLEANSING COMPOUND, W. P. Thompson.—(*J. Fitzgerald, jun., and J. C. Mahon, Canada.*)
25,288. RAILWAYS, J. Perry, London.
25,289. ROTARY MOTOR, M. Reisacher, Liverpool.
25,290. WINDING APPARATUS, J. W. Smith, Manchester.
25,291. ACETYLENE GAS APPARATUS, N. A. Aubertin, London.
25,292. PRODUCTION of WATERMARKS, T. A. Goodchild and A. C. T. Bond, London.
25,293. SUPPORTING BICYCLES, F. Green and G. Hunt, London.
25,294. SADDLE-SUPPORTING DEVICES for VELOCIPEDES, T. S. Cadet, London.
25,295. SAFETY LOCKS for VELOCIPEDES, M. Badoni, London.
25,296. SEPARATING MOISTURE from MATERIALS, C. E. Kreiss, London.
25,297. GENERATING ACETYLENE GAS, P. Bucher, London.
25,298. MACHINERY for UNLOADING COKE, J. Woodward, Manchester.
25,299. BALL BEARINGS, M. Foidart, London.
25,300. MANUFACTURE of CARBURETS, M. Kandler and C. Wehner, London.
25,301. FURNACE GRATES, V. Spinette, London.
25,302. SUPPLYING WATER to MOTORS, J. Y. Johnson.—(*A. L. Riker, United States.*)
25,303. METALLIC BEDSTEADS, S. I. Whitfield, Birmingham.
25,304. ARTIFICIAL STONES, R. Haddan.—(*R. Koepp and Co., Germany.*)
25,305. COATING MOULDS, H. Stanning and T. Aldcroft, London.
25,306. HAIR WAVERS, W. L. B. Hinde, London.
25,307. ENGINES, J. Brundrit, London.
25,308. TIRES, B. H. Thwaite and S. J. Mowbray, London.
25,309. FURNITURE CASTORS, A. C. D. Seifert, London.
25,310. BUTYROMETER, A. Mercier, London.
25,311. WINDOW FRAMES and SASHES, C. Carduck, London.
25,312. BLACK DYESTUFF MANUFACTURE, C. D. Abel.—(*The Actiengesellschaft für Anilin Fabrikation, Germany.*)
25,313. ROTARY PUMPS, Siemens Bros. and Co., Limited. — (*Siemens and Halske Aktiengesellschaft, Germany.*)
25,314. TRANSFORMING CURRENTS, C. D. Abel.—(*La Société Anonyme pour la Transmission de la Force par l'Electricité, France.*)
25,315. COLOURED MARKING INK PENCILS, A. Roberts, London.
25,316. SMOKE-CONSUMING STOVE, A. Lacolle, London.
25,317. ACETYLENE GAS GENERATORS, G. Dillberg, London.
25,318. TORPEDO BOAT or EJECTOR, G. C. y Elias, London.
25,319. MAKING INNER PARTS of CIGARS, J. Reuse, London.
25,320. RIM BRAKES for CYCLES, J. R. Trigwell, London.
25,321. BOTTLE STOPPERING, C. Kemper and F. Salomon, London.
25,322. DOOR-CONTROLLING MECHANISM, R. A. Fraser, London.
25,323. JOINT RINGS for PIPES and TUBES, P. Hulburd, London.
25,324. ELEVATOR for GRAIN CEREALS, H. Mayan, London.
25,325. CYCLE-DRIVING GEAR, H. Cablanc and L. Burle, London.

1st December, 1898.

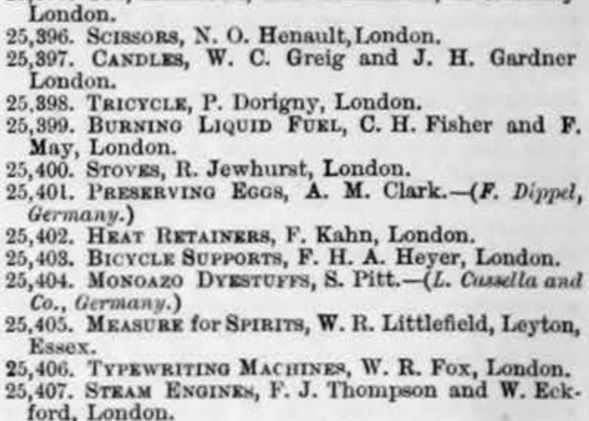
25,326. GAUGES for SAW FENCES, T. Thornton, Bury.
25,327. ELECTRICAL TERMINAL, L. Ridout, London.
25,328. DOBBIES for WEAVING, G. H. Hodgson, Halifax.
25,329. PENCIL and INK ERASER, F. W. Pickering, Pontypool, Mon.
25,330. MEASURING BREAKING STRAINS, J. Hogarth, Glasgow.
25,331. RING SPINNING FRAMES, T. Holden, Manchester.
25,332. TOASTING FORKS, E. S. Browett, Coventry.
25,333. FURNITURE CASTORS, W. Evans, Manchester.
25,334. DISCS, A. J. Stokes, Glasgow.
25,335. TUBES for HEATING and COOLING HALLS, T. Scotland, Tolcross.
25,336. SAW GUARD, J. C. Barnes and C. Cotton, Derby.
25,337. GEAR for PRODUCING ROTARY MOTION, W. Dick, Glasgow.
25,338. ORNAMENTAL COMB for LADIES' HAIR, A. Donnelly, Glasgow.
25,339. ATMOSPHERIC GAS BURNERS, T. Redman, Bradford.
25,340. TABLE KNIVES, J. R. Hunt, Sheffield.
25,341. METALLIC PACKING for PISTON-RODS, A. Shaw and A. Bland, Halifax.
25,342. WATER-WASTE PREVENTERS, G. Hunt, Burnley.
25,343. WORKING BAR IRON by STEAM HAMMER, C. J. McIntyre, Barrow-in-Furness.
25,344. "PICKS," W. J. Edwards and T. Thomas, Treharris, Glam.
25,345. WATER-REGULATING CRANES, J. Murrie, Glasgow.
25,346. LADIES' SKIRTS, J. M. Gower, London.
25,347. CYCLE FORK ENDS, D. K. C. Russell, Edinburgh.
25,348. MECHANISM of LOOMS, J. Ireland, Dundee.
25,349. SWINGING BABIES' COT, A. E. Hartley, Bradford.
25,350. LABEL HOLDER, I. T. Swarts, London.
25,351. STRETCHING TROUSERS, I. T. Swarts, London.
25,352. SAFETY GEAR for COLLIERY CAGES, J. Morgan, London.
25,353. BICYCLES, L. A. Chauvin, London.
25,354. FIRE-GRATES, G. G. Brodie and J. D. Prior, London.
25,355. TRANSING PLATES for VEHICLES, W. Mills and E. D. Mincher, London.
25,356. APPLYING SKID-PANS for ROAD VEHICLES, W. Mills and E. D. Mincher, London.
25,357. COIN-FREED MACHINES, F. Hutchins, London.
25,358. CONTRIVANCE for TRAWL NETS, G. F. and F. W. Stevens, London.
25,359. FACING WALLS with GLASS, C. Marson, London.
25,360. ARTIFICIAL STONE for BUILDINGS, C. Marson, London.
25,361. SHADE for SHIP'S TELEGRAPH, J. O. Dolman, London.
25,362. DIAPASON PIANOFORTES, W. G. and E. Munt, London.
25,363. DOUBLE RUBBER CONDENSERS of CARDING MACHINES, J. Crampton, T. Kitchen, and W. Allerton, London.
25,364. GUN CARRIAGES, A. Reichwald.—(*F. Krupp, Germany.*)
25,365. WHEEL BRAKES for GUN CARRIAGES, A. Reichwald.—(*F. Krupp, Germany.*)
25,366. DRIVING CHAINS for VELOCIPEDES, A. and W. Hunnable, Ilford, Essex.
25,367. CLOCKWORK TOYS, J. Cross, London.
25,368. ACETYLENE GENERATOR, C. J. and C. E. Watts, London.
25,369. GAS-LIGHTING INSTALLATIONS, A. J. Boult.—(*L. H. Karger, Germany.*)
25,370. STEAM GENERATOR FURNACES, T. Lowe, London.
25,371. FERMENTING TEA LEAF, W. P. Hurst, London.
25,372. DISPLAYING FABRICS, H. Bennett, London.
25,373. SCRAPING MUD OFF CLOTHES, J. Oppenheimer, London.
25,374. MARKING SOAP, E. W. Sargeant, London.
25,375. TOBACCO PIPES, W. Stevens, London.
25,376. WHEELS, R. S. Lovelace, London.
25,377. CONTROLLING MECHANISM for MOTORS, J. H. Hoadley, London.
25,378. PHARMACEUTICAL COMPOUNDS, H. E. Newton.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
25,379. PREVENTING TROLLEYS FALLING from PLATFORMS, E. W. Lees, London.
25,380. CASED METAL, W. P. Thompson.—(*G. Parent, France.*)
25,381. STOVES for BURNING-OFF PAINT, G. Roberts, Liverpool.
25,382. TAPS, G. Roberts, Liverpool.
25,383. TREATMENT of SEWAGE, C. A. Atkinson, Liverpool.
25,384. STEAM DERRICK CRANES, T. Whitaker, Manchester.
25,385. PRINTING MACHINES, G. D. Stewart, Edinburgh.
25,386. CLEANERS for PNEUMATIC TIRES, W. Glasgow, London.
25,387. RAILWAY POINTS, J. Grimme, London.
25,388. GENERATING OZONE, W. Elworthy, London.
25,389. PEGGING MACHINES, E. Duplessis, London.
25,390. PUMPING MACHINERY, W. H. Booth, London.
25,391. TIRES, J. F. and L. Gommeret, London.
25,392. BALL RETAINERS and SEPARATOR, E. F. Creager, London.
25,393. FILE CASES, F. Macey, London.
25,394. WEIGHING SCOOPS, B. McKiernan, London.
25,395. COT, HAMMOCK, and STRETCHER, L. C. Bailey London.
25,396. SCISSORS, N. O. Henault, London.
25,397. CANDLES, W. C. Greig and J. H. Gardner London.
25,398. TRICYCLE, P. Dorigny, London.
25,399. BURNING LIQUID FUEL, C. H. Fisher and F. May, London.
25,400. STOVES, R. Jewhurst, London.
25,401. PRESERVING EGGS, A. M. Clark.—(*F. Dippel, Germany.*)
25,402. HEAT RETAINERS, F. Kahn, London.
25,403. BICYCLE SUPPORTS, F. H. A. Heyer, London.
25,404. MONOAZO DYESTUFFS, S. Pitt.—(*L. Cassella and Co., Germany.*)
25,405. MEASURE for SPIRITS, W. R. Littlefield, Leyton, Essex.
25,406. TYPEWRITING MACHINES, W. R. Fox, London.
25,407. STEAM ENGINES, F. J. Thompson and W. Eckford, London.
25,408. HIGH-SPEED ENGINES, J. M. McLean and A. Sykes, London.
25,409. TREATMENT of SEWAGE, C. A. Sahlström, London.
25,410. OZONE-PRODUCING BATTERIES, C. A. Sahlström, London.
25,411. LOCKING CYCLE SPROCKET WHEELS, F. Mennich, London.
25,412. INDICATING in RAILWAY CARRIAGES the NAMES of STATIONS, M. Keller, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

609,808. ROTARY STEAM ENGINE, *C. A. Holcomb, Beloit, Wis.—Filed March 18th*, 1897.

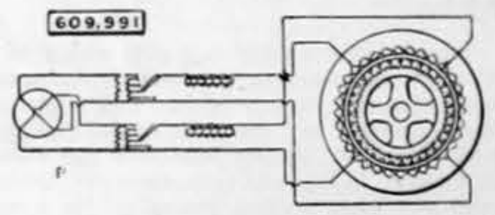
Claim.—The combination of a supporting frame having circular projections extending toward each other, a casing having ends supported by the projections, a shaft supported by the frame excentrically to the casing, a series of cylinders rotatable with the



shaft radiating therefrom and located within the casing, each cylinder supporting a piston, and each piston supporting a roller bearing against the inner face of the casing, means for admitting steam to the cylinders and allowing it to exhaust therefrom, the cylinders and casing rotatable together in the same direction.

609,991. METHOD OF AND MEANS FOR SECURING CONSTANT TORQUE IN POLYPHASE MOTORS, *B. G Lamme, Pittsburgh, Pa.—Filed February 10th*, 1898.

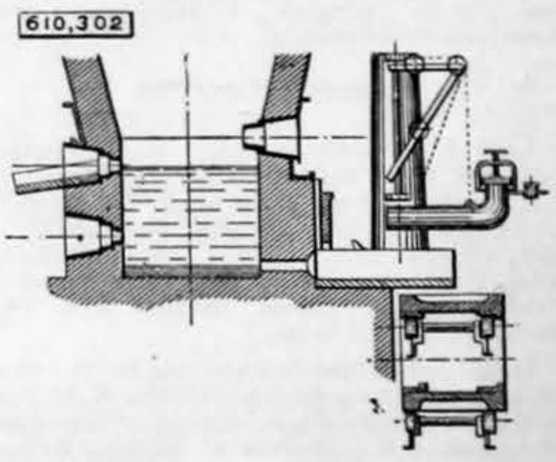
Claim.—(1) The combination with an induction alternating-current motor, having a comparatively high-resistance secondary winding and a low degree of magnetic leakage, of a reactive coil in each of the supply circuits, the core of which becomes saturated by a predetermined amount of current, whereby a



substantially constant torque is secured. (2) The method of producing and maintaining constant torque in alternating-current motors having rotary fields produced by out-of-phase currents, which consists in subjecting such out-of-phase currents to self-induced counter electromotive forces which vary with the current up to a given point, and which vary at a materially different rate beyond that point.

610,302. NOTCH GUN FOR BLAST FURNACES, *J. M. Hartman, Philadelphia, Pa. — Filed May 12th*, 1896.

Claim.—(1) An iron notch gun for blast furnaces, having a tapered nozzle and of sufficient length and size to hold enough plastic material to effectually plug the notch in a single discharge; in combination with means substantially as set forth for admitting fluid pressure into the rear of said gun behind said plastic material and directly in contact therewith without the intervention of any piston, substantially as described. (2) An iron notch gun for blast furnaces,



having a tapered nozzle and of sufficient length and size to hold enough plastic material to effectually plug the notch in a single discharge; in combination with means substantially as set forth for admitting fluid pressure into the rear of said gun behind said plastic material and directly in contact therewith without the intervention of any piston; a removable door arranged at the rear end of said gun, substantially a described.