

THE ARTIZAN.

No. 12.—VOL. 1.—THIRD SERIES.

DECEMBER 1st, 1863.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. BIRCKEL.

(Illustrated by Plates 254, 255,* and 256.*—Concluded from page 241.)

Continuing our notice of the types of locomotives, figures 1, 2, 3, and 4, Plate 256, represent one of Mr. Sinclair's standard goods' engines, as in use upon the Great Eastern Railway. They work goods' trains, consisting of 35 waggons, weighing, loaded, 300 tons, at an average speed of 20 miles per hour, with a consumption of 36lbs. of coal per mile. They also work passenger trains, consisting of from 15 to 18 carriages, at an average speed of 25 miles per hour, with an average consumption of 25lbs. of coal per mile. Their dimensions and leading features are as follows:—

BOILER BARREL.—11ft. 5½in. long × 3ft. 11in. diameter, made of ⅞in. plates, single rivetted. Besides the dome which is placed on the crown of the barrel, there are two large hand holes placed underneath, provided with large blow-off cocks for facility of draining the boiler of the sediment from the water; height of centre from rails, 5ft. 10½in.

FIRE-BOX SHELL.—Flush at the crown with the barrel, 4ft. 8in. long × 3ft. 10½in. wide, made of plates ⅞in. thick; there are two 3½in. safety valves, placed one on top of the fire-box shell, and the other on top of the dome, each provided with a spring balance.

FIRE-BOX.—4ft. ⅞in. long × 3ft. 4½in. wide × 4ft. 8in. deep, made of ½in. copper plates, except the tube plate which is ⅞in. thick, provided with smoke-burning apparatus, described in our paper on the boiler.

HEATING SURFACE.—192 brass tubes, 1½in. diameter × 11ft. 8½in. long = 968·5 square feet; fire-box, = 72·3 square feet; total, 1040·8 square feet.

FIRE GRATE.—4ft. ⅞in. long × 3ft. 4½in. wide = 13·5 square feet. Fire bars and frame of the ordinary construction; the bars, made in two lengths, are 20 in number in the width of the fire-box, with a space of ⅞in. between them.

SMOKE-BOX.—2ft. 7½in. long × 2ft. 4in. radius, made of ⅞in. plates, enclosing the cylinders entirely; and provided with a man-hole at the bottom for facility of clearing out the cinders.

CHIMNEY.—15in. diameter at bottom, and 18in. at top; made of ⅞in. plate; 13ft. high, measured from the rails.

CYLINDERS.—Outside, 17in. diameter × 24in. stroke, with back bottom cast solid with the body; steam pipes, 4½in. diameter; steam ports, 12in. long × 1½in. wide; exhaust port, 3in. wide; blast orifice, 4½in. diameter; lap of valve, 1½in.; lead, ¼in.; piston rod and valve spindle made of Krupp's steel.

LINK MOTION.—Stationary link, as illustrated and described in detail, in our paper treating of the link motion (in THE ARTIZAN, of March, 1863). Link, 19in. long; eccentrics, 5½in. throw.

CONNECTING ROD.—6ft. long, made of best fagotted iron, with short fork at cylinder end; cross head pins, 2in. diameter × 2in. long; crank pin bearing, 3½in. diameter × 3½in. long; crank pins made of Krupp's steel.

FEEDING APPARATUS.—Two No. 8 Giffard's injectors, placed on each side of the fire-box.

REGULATOR.—Piston valve regulator, as illustrated and described in detail in THE ARTIZAN of April last, to suit a main steam pipe, 4½in. in diameter.

FRAMES.—Single inside plate frames, 4ft. apart; 10in. deep over driving fork, and 1½in. thick; made of best Yorkshire iron.

WHEELS AND AXLES.—Wheels, six in number, made of solid wrought iron; driving and trailing wheels, 6ft. 1in. diameter, with tyres 5in. broad × 2in. thick, made of Krupp's steel; leading wheels, 3ft. 7in. diameter; driving and trailing axles, 6½in. diameter × 7in. long in journal, and 6½in. diameter in the body; and made of Krupp's steel; leading axle, 6½in. diameter × 6½in. long in journal, and 6½in. diameter in body; made of the best Yorkshire iron.

* We are unavoidably prevented giving Plates 255 and 256 with the present number. They will be issued with the next number, to be bound up with the 1863 volume.

As a remarkable instance of the performance of Krupp's steel, Mr. Sinclair mentions that some driving and trailing wheel tyres have run from 60,000 to 70,000 miles without being turned.

WHEEL BASE.—Between leading and driving wheels, 6ft. 1in.; between driving and trailing wheels, 9ft.; total, 15ft. 1in.

SPRINGS.—Driving and trailing springs, 3ft. 3in. span, made of seven plates 5in. broad × ⅞in. thick, connected by means of compensating lever. Leading spring 2ft. 6in. span, made of nine plates ⅞in. thick and 6in. wide in centre, tapered to 4in. at the ends.

Weight of engine in working order:—On leading wheels, 10 tons 7cwt. 1qr.; on driving wheels, 10 tons 7cwt. 3qr.; on trailing wheels, 10 tons 1cwt.; total, 30 tons 16cwt. The engine carries a small tank under the foot plate in order to increase the weight upon the trailing wheels.

Width of engine over all, 8ft. 1in.; length over all, 26ft. 9in.

Figures 5, 6, 7, and 8 represent one of the four-wheel coupled express engine, as made by Messrs. Fairbairn & Sons, for the Manchester, Sheffield, and Lincolnshire Railway, upon the general design furnished by Mr. Sacré, the engineer of the line, modified in the frame connections, to realise the advantages of direct traction through the frames, independently of the boiler. These engines are daily running express trains upon gradients, varying from 1 in 100 to 150 and 200, with 8 and 10 carriages, at a rate of consumption of 20lbs. of coal per mile, from the South Yorkshire district.

The following are their main dimensions and leading features:—

BOILER BARREL.—10ft. long × 3ft. 8in. diameter; made of ⅞in. plates, double rivetted in the longitudinal seams; height of centre of barrel from level of rails, 6ft. 1½in.

FIRE-BOX SHELL.—5ft. 2½in. long × 3ft. 11in. wide, projecting 7in. above the crown of the barrel; made of ⅞in. plates; two 3½in. common safety valves, screwed down by means of spring balances, are placed on the crown of the shell.

FIRE-BOX.—4ft. 6½in. long × 3ft. 3in. wide × 5ft. 3½in. deep; made of ⅞in. copper plates, excepting the tube plate, which is ⅞in. thick; two rows of hollow stays are provided at the front of the box, with the object of assisting in the combustion of coal.

HEATING SURFACE.—150 brass tubes, 10ft. 3½in. long × 2in. diameter = 806·25 square feet; fire-box = 92·25 square feet; total, 898·5 square feet.

GRATE AREA.—4ft. 6in. × 3ft. 3in. = 14·62 square feet; fire-bars and frame of the ordinary construction.

SMOKE-BOX.—2ft. 5in. wide × 2ft. 3in. radius; made of ⅞in. plates.

CHIMNEY.—16in. diameter × 13ft. 3in. high, measured from level of rails.

CYLINDERS.—Inside, 16in. diameter × 22in. stroke, 1½in. thick in the body; steam ports, 14in. long × 1½in. wide; exhaust port, 3½in. wide; lap of valve, 1½in.; blast orifice, 4½in. diameter.

LINK MOTION.—Shifting link, 16in. long, with valve-rod suspension 13in. behind the link; eccentrics, 5½in. throw.

CONNECTING ROD.—5ft. 9in. long; bearing in cross head pin, 3in. diameter × 3in. long; bearing in crank 8½in. diameter × 4in. long; outside crank pins, forged solid with the crank, 2½in. diameter × 3½in. long.

FEEDING APPARATUS.—Two long stroke pumps, bolted against the inside frame, and worked from cross head; plunger, 1½in. diameter; pump barrel made of brass.

REGULATOR.—Horizontal slide valve regulator placed inside the smoke-box, and worked by means of a handle moving in helical grooves.

FRAMES.—Inside and outside frames; the inside ones are single plates, 12in. deep over driving fork × 1in. thick, placed 4ft. apart; the outside ones are made of a balk of pitch pine, 13½in. deep over driving forks × 3½in. thick, lined with two plates ⅞in. thick; distance from centre to centre 6ft. 5½in.

WHEELS AND AXLES.—Wheels, six in number, made of solid wrought

iron; driving and trailing wheels coupled, 6ft. diameter; leading wheels, 4ft. diameter; tyres, 5½in. broad × 2in. thick; the axles have all double conical outside journals; trailing and driving axles, 6in. and 7in. diameter × 9in. long in outside journals, and 6½in. diameter in body; inside journals of driving axle, 6½in. diameter × 5in. long; leading axle, 4½in. and 5½in. diameter × 10in. long in journals, and 5½in. diameter in body; driving and trailing axle boxes of brass, with wrought iron straps cast into them; leading axle boxes of cast iron with brass step.

WHEEL BASE.—Between leading and driving wheels, 7ft. 9in.; between driving and trailing wheels, 7ft. 3in.; total, 15ft.

SPRINGS.—Leading, trailing, and outside driving springs, 3ft. span, made of 16 plates, ⅞in. thick × 3½in. wide; inside driving springs, 2ft. 9in. span, made of 12 plates, ⅞in. thick × 3½in. wide.

Width of engine over all, 8ft. 8in.; length over all, 25ft. 6in.

Figures 1, 2, 3, 4, and 5, Plate 254 given herewith, represent one of the six-wheel coupled luggage engines, made at the works of Graffenstaden, near Strasburg in France, under the superintendence of Mr. J. Mesmer, engineer, for the Northern Railway of France. We have not been furnished with the particulars of the actual performance of these engines, but from the knowledge we have of the management of goods traffic on the continent, we may state that they are intended to draw very heavy loads at speeds probably not exceeding 15 miles per hour.

Their main dimensions and leading features are as follows:—

BOILER BARREL.—12ft. 1½in. long × 4ft. diameter; made of ⅞in. plates, single rivetted.

FIRE-BOX SHELL.—Flush at the crown with the barrel, 4ft. 7in. long × 3ft. 7½in. wide below the centre of the barrel; made of ½in. plates; height from rails to centre of barrel, 6ft. 4½in. Two safety valves, 4in. diameter, screwed down by means of spring balances, are placed upon the crown of the shell.

FIRE-BOX.—4ft. 2in. long × 3ft. ½in. wide × 5ft. 1½in. deep; made of ½in. copper plates, excepting the tube plate, which is 1in. thick.

HEATING SURFACE.—143 tubes (brass) 12ft. 4in. long × 2½in. diameter = 845 square feet; fire-box, 72·36 square feet; total 917·36 square feet.

AREA OF FIRE GRATE.—12½ square feet; there are 21 fire bars placed at a small angle to promote the consumption of smoke; besides these there are three transverse bars (the former not extending over the full length of the box), which may be readily removed by means of a handle and levers worked from the foot plate, to facilitate the operation of drawing the fire.

SMOKE-BOX.—2ft. 8½in. long, of same diameter as the barrel of which it forms a prolongation. It contains a light wrought-iron grating to prevent any cinders being carried away by the force of the blast.

CHIMNEY.—15½in. diameter × 13ft. 9½in. high, measured from the level of the rails.

CYLINDERS.—Inside, 15in. diameter × 24 in. stroke; fitted with wrought iron piston, having packings somewhat similar to Ramsbottom's. Steam-ports, 10½in. long × 1½in. wide; exhaust port, 2½in. wide; lap of valve, 1½in. at front, and 1½in. at back; double exhaust pipe provided with wing valve, for regulating the blast; blast orifice, 3½in. diameter.

LINK MOTION.—Shifting link, 17in. long; throw of eccentrics, 4½in.

CONNECTING ROD.—Forked, 4ft. 9½in. long; cross-head pins, 2½in. diameter × 2½in. long; bearing in crank, 6½in. diameter × 4in. long; crank pin journals, 2½in. diameter × 3½in. long.

FEEDING APPARATUS.—Two cast-iron pumps, 4½in. diameter × 4½in. stroke, worked from the same eccentrics as the link motion; and one Giffard's injector placed horizontally on the foot plate against the side of the fire-box.

REGULATOR.—Horizontal slide-valve regulator, placed on the crown of the barrel, with 4in. steam-pipes leading to the cylinders, round the outside of the barrel, on each side of it.

FRAMES.—Single inside plate frames, 8in. deep × 1½in. thick, placed 3ft. 11in. apart, with double axle-forks rivetted to them.

WHEELS AND AXLES.—Six wheels, made of solid wrought-iron, 4ft. 8in. diameter, all underneath the boiler; tyres, 5½in. wide × 2in. thick; driving axle, 6½in. diameter × 6½in. long in journals, and 6½in. diameter in body; leading and trailing axles, 6½in. diameter × 7½in. long in journals, and 5½in. diameter in body; axle boxes of wrought-iron with brass steps.

WHEEL BASE.—Between leading and driving wheels, 5ft. 11in.; between driving and trailing wheels, 5ft.; total, 10ft. 11in.

SPRINGS.—All 3ft. 1in. span, composed of 14 plates, 1½in. thick × 3½in. broad.

WEIGHT OF ENGINE IN WORKING ORDER.—On leading wheels, 6·77 tons; on driving wheels, 8·25 tons; on trailing wheels, 9·98 tons; total, 25 tons.

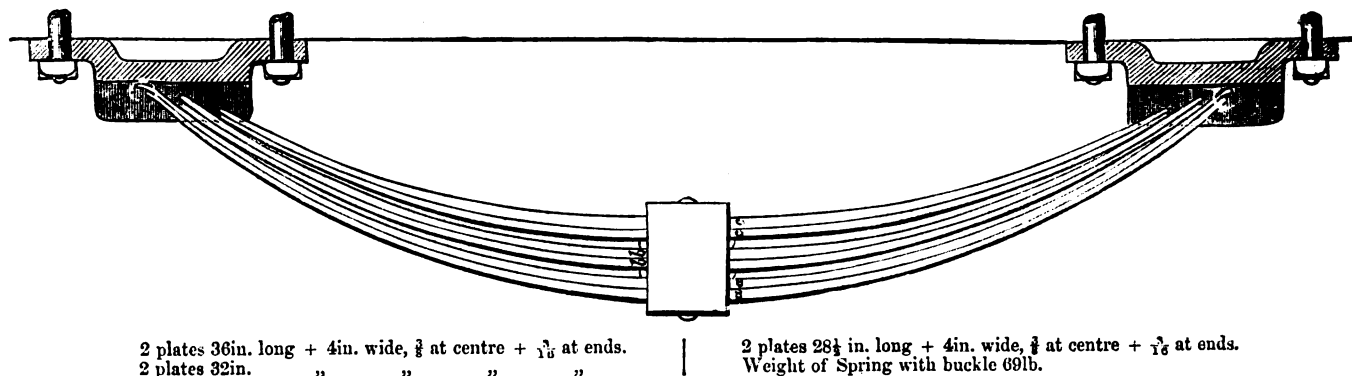
Width of engine over all, 8ft. 6½in.; length over all, 24ft. 3½in.

In our paper on the steam engine proper (ARTIZAN, April last), we have described and illustrated in detail the leading parts of the locomotive engine such as they are generally made in this country; and as we have illustrated in the accompanying plate, a very fair type of a continental engine, we have, in order to enable the reader to compare the construction of the detailed parts of the same with those made according to the practice of English engineers, given in Plate 255 some of the details thereof. Figs. 1 to 9 illustrate the connecting rod in detail; Fig. 10 the body of the piston, made of wrought iron, stamped solid; Fig. 11 illustrates the crosshead; Figs. 12 and 13 the eccentrics and rods, in which it will be noticed that the two sheaves are cast in one; and Figs. 14 and 15 illustrate the regulator. This latter part is a somewhat complicated casting, and the propriety of conducting the steam to the cylinders through pipes creeping round the boiler barrel outside seems to us very questionable, both on economical and on æsthetical grounds, with inside cylinders especially; this practice, however, is very prevalent abroad.

In our paper on the carriage treating of the wheel base and of the distribution of the load, in THE ARTIZAN of May last, we have illustrated various specimens of engines with the four hind wheels coupled, all taken from recent practice. Since then, Mr. Alexander Allan, who is well known in the locomotive world, has written to us, informing us that he was the first, at any rate in this country, to adopt this class of engines, which is gaining very much in favour now, and we have deemed it right here to record this fact in order to avoid misapprehension. Since the publication of our paper on springs, Mr. Allan has sent us also a drawing of an improved waggon spring, in which the object aimed at is constant sensitiveness under varying loads; and it seems to us evident, at first sight, that this object cannot but be realised here. The spring has already been adopted by various engineers, and, on the score of durability, appears to have given general satisfaction. We give an illustration of this spring in the accompanying woodcut.

SIX TON WAGGON SPRING FOR VARIABLE LOADS.

Scale ⅓th.



If now we cast a rapid glance upon the growth and progress of locomotive engineering, we find that, at the dawn of the present century, the problem was scarcely broached; and if some vague ideas concerning it were entertained in the minds of a few, these few were probably looked upon as wild dreamers by the sober many, believers in Pope's philosophy that

whatever is, is right, and therefore should remain so; while at the same time the attempts to put them into a tangible shape, when compared with the ultimate impersonation of those ideas, are characterised with a crudeness which is scarcely observable in the early examples of the stationary engine, some of which, though dating back to the latter quarter of last

century, still contrast very favourably both in stateliness of proportions and in economic working with the most recently promulgated ideas on this branch of engineering. The great saving, however, effected upon iron tramroads in the mineral traffic of the northern districts, by the introduction of inclined planes and stationary engines (the expense being only $\frac{1}{3}$ th of that by horses upon wooden tramroads) could not but foster the desire to realise the same economy in the traffic between places more remote from each other, and was likely to keep at work the intelligence of the inventive few immediately connected with mining works or with mining interests. The invention of spinning machinery, which may be said to be coeval with that of the steam engine, and which from the beginning of this century also has been the cause of that rapid development taken by the various industries in textile fabrics which still remains a matter of wonder and of curious speculation to the minds of economists—this circumstance also seems to have acted as a great stimulant to the search for a power of locomotion affording the means of swifter transit than that afforded by common roads, or even by canals. It seems to us, however, a singular fact that, although railway traffic was widely spread in the northern coal district (the Stockton and Darlington Railway being the oldest one extant of any considerable length), yet has the locomotive appeared, as it were, to accommodate the wants of the cotton trade, at a time too when Manchester and Liverpool were connected by a canal affording the cheapest mode of transportation known to the present day; and our astonishment is still enhanced when we remember that the locomotive, which fulfilled the conditions of the problem offered for solution, is the contrivance of one who had been all his days connected with that mineral traffic of the north. This circumstance, however, seems to point to the fact that the transit of goods for the more immediate want of man, and the intercourse of individuals engaged in the traffic with the same, has a natural claim to precedence over any other interests, how important soever in its ultimate bearings upon the welfare of mankind.

It is needless here to reproduce in detail the incidents connected with that trial of engines at Rainhill, which, after the fruitless attempts of a quarter of a century, was the means of giving a practical shape to, and of turning into reality, that which until then had only existed as a dream, or, at best, as a something that ought to have reality. These circumstances have all been duly chronicled, and there is scarcely a mechanic to be found who is not acquainted with them in a general way, while the result of that trial is a living, omnipresent fact which has become part and parcel of human existence on earth, alike on the banks of the Tyne and in the plains of Hindostan—along the rapids of the St. Lawrence and in the prairies of the Brazils. No human enterprise, we believe, either of the present or of any previous age, offers a more striking illustration of the well-known fact how great things may rise from small beginnings than that of railway communication; for while it may be said that in 1829, commercially speaking, railways did not exist, in 1862 they had reached in the British Isles alone a development of 11,550 miles, with a revenue of £29,128,550 sterling; and the aggregate development of the railways all over the world probably does not fall short of 25,000 miles, necessitating the maintenance of 12,000 locomotive engines, which alone represent a capital of £24,000,000 sterling. When Stephenson returned home victorious from that trial at Rainhill, sanguine though his hopes may have been as to the ultimate results of his labours, yet we presume these hopes must have been very modest indeed when compared with the figures just quoted. And such has been the case also with regard to the performance of the engine itself; for though Stephenson was laughed at when stating that he expected to be able to run at the rate of 13 miles an hour, yet is it no uncommon thing now, and quite practicable, to travel at five times that speed.

It is a gratifying circumstance to know that, unlike many other inventors or discoverers in branches of human industry or knowledge no less important than the one of which we have been treating here, the Stephensons have not become victims to this world's ingratitude, but that in their lifetime they have been partakers of a share of power and of wealth commensurate with the benefits for which the human race has been in a great measure indebted to them, while in their death their memory has been perpetuated, and their ashes honoured by being laid alongside with the greatest in the land. Great indeed is the contrast between the fate of the Stephensons and that of Crompton, in the art of spinning, of Jacquard, in the art of weaving, or of Cort, in metallurgy; but this contrast may not be unprofitable to the young ones among our readers, by way of teaching them that, although undeserved disappointments are of frequent occurrence, yet are there bright exceptions to this rule which ought to stimulate us all to persevere and conquer.

Having thus completed our task, we now have to perform the pleasing duty of publicly returning our thanks to those gentlemen who have favoured us with their assistance; among whom we should mention Messrs. Sharp, Stewart, and Co., Mr. Sinclair, Mr. Ramsbottom, Dr. Rankine, and Dr. Fairbairn, to whose ready answers to our several requests our readers are indebted as much as to our own labours for the interesting, and, we trust, useful information, which we have been able to lay before them.

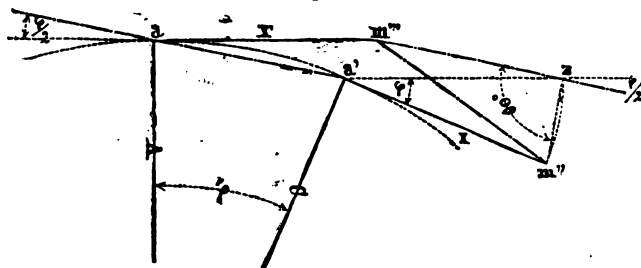
GOODS LOCOMOTIVE "STEIERDORF."

CONSTRUCTED AT THE WORKS OF THE I. R. AUSTRIAN STATE RAILWAY COMPANY, VIENNA.

(Continued from page 252.)

Let A (Fig. 17) be the tender axle, C the false axle, $a m''' = a' m'' = l \cos \alpha$ the horizontal projections of the curves; the length $m''' m'' = y$ will have to be determined upon. The horizontal projections $a m'''$, $a' m''$ of the circles which the cranks move in from an angle ϕ , as will be seen by

Fig. 17.



drawing $a' z$ parallel to $a m'''$. If we make $a' z = a' m''$, the actual length $m''' z$ will be $= a' a' = L'$, and the required length $m''' m''$ may then be determined by the triangle (in the space) $m''' m'' z$. This triangle will be a rectangular one, both in the space and in projection, as $m''' z$ is perpendicular upon $m''' z$.

The angle

$$m''' z a' = m''' a' a' = \frac{1}{2} \phi,$$

$$\therefore m'' z a' = \frac{1}{2} (180^\circ - \phi) = 90^\circ - \frac{1}{2} \phi$$

$m'' m'''$ being the hypotenuse, we have

$$m'' m''' = \sqrt{m'' z^2 + m''' z^2}.$$

As

$$m''' z = L', m'' z = 2 l \cos \alpha \sin \frac{1}{2} \phi = l \cos \alpha \sin \phi$$

we have

$$y = \sqrt{L'^2 + l^2 \cos^2 \alpha \sin^2 \phi} \quad (3)$$

The angle α in this formula being variable, the length of the draw-bar will also be variable while the crank revolves.

When

$$\alpha = 90^\circ \text{ or } = 270^\circ, \cos \alpha = 0$$

consequently,

$$y = L' \quad (9)$$

i.e. when the crank occupies a vertical position, the length of the draw-bar will be equal the distance of the centres of the crank circles.

If, however, $\alpha = 0$ or $= 180^\circ$, i.e., when the cranks are in a horizontal position, $\cos \alpha = 1$; therefore, if we call L'' the highest value of y , we have

$$L'' = \sqrt{L'^2 + l^2 \sin^2 \phi} \quad (10)$$

As the two cranks on both sides of an axle (i.e., both the false axle and the tender shaft) are at an angle of 90° , we have, if for the one crank

$$y = \sqrt{L'^2 + l^2 \cos^2 \alpha \sin^2 \phi}$$

$$\alpha' = 90^\circ + \alpha \cos^2 (90^\circ + \alpha) = \sin^2 \alpha$$

consequently, for the other crank,

$$y' = \sqrt{L'^2 + l^2 \sin^2 \alpha \sin^2 \phi}.$$

The difference of the length of both draw-bars will therefore have to be

$$y - y' = \sqrt{L'^2 + l^2 \cos^2 \alpha \sin^2 \phi} - \sqrt{L'^2 + l^2 \sin^2 \alpha \sin^2 \phi}.$$

If $\alpha = 0$ or $= 180^\circ$, $\sin \alpha = 0$, consequently,

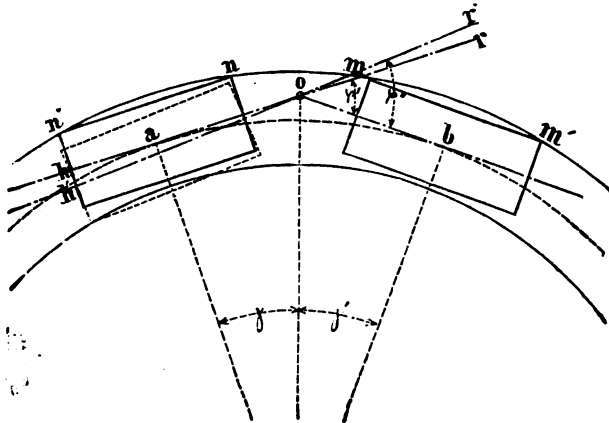
$$y - y' = \sqrt{L'^2 + l^2 \sin^2 \phi} - L' \quad (11)$$

If, however, $\cos^2 \alpha = \sin^2 \alpha$, i.e., if $\alpha = 45^\circ$ or 135° , we have

$$y - y' = L' - L' = 0 \quad (12)$$

To find, finally, the value of the angle ϕ , upon which the value of all the other expressions depend, let b (Fig. 18) be the axis of the engine frame, a the axis of the tender frame, both frames to be connected in 0;

FIG. 18.



$m m'$ the outside wheels of the engine frame, $n n'$ the outside wheels of the tender frame, $\gamma \gamma'$ the angles at the centres, corresponding to the lengths $a o$ and $b o$.

If the engine works regularly, and the carriage next to the tender is connected with the tender as the latter is with the engine, the wheels $m m'$ $n n'$ will touch the outside rails with their brims, and the angle of the frames, which we will term ϕ' , will be equal the angles at the centre, i.e.,

$$\phi' = \gamma + \gamma'.$$

These angles being very small, their tangents may be substituted for them, and then we shall have

$$\phi' = \frac{o a}{R} + \frac{o b}{R} = \frac{1}{2} \frac{D + \Delta}{R} + \frac{1}{2} \frac{D' + \Delta'}{R}$$

(see Fig. 15); or, since in the locomotive "Steierdorf," $D = D'$, $\Delta = \Delta'$

$$\phi' = \frac{D + 2\Delta}{R} \quad (13)$$

If, however, the train is connected with the tender by a common chain, the back wheel of the tender running on the outside rails will tend to leave them, and thus the angle ϕ' will be increased by a quantity $h o h'$; and, if we term the increased angle ϕ'' , we have

$$\phi'' = \phi' + h o h'$$

$$h o h' = \frac{h h'}{h o} = \frac{v + w}{D + \Delta}$$

$$\therefore \phi'' = \frac{D + 2\Delta}{R} + \frac{v + w}{D + \Delta} \quad (14)$$

The value of ϕ'' is the utmost the angle of the engine and tender can reach during the normal working of the locomotive. To find its value in degrees and minutes, that given in 13 and 14 has to be multiplied by formula $\frac{180}{\pi}$.

The numerical values relating to Figs. 15 and 18 may be taken from the table of dimensions (THE ARTIZAN, March 1, 1863, pages 49 and 50), viz.:-

$D = D' = 7\text{ft. } 3.1189\text{in.}$	$L = 2\text{ft. } 0.8011\text{in.}$
$\Delta = \Delta' = 2\text{ft. } 4.5210\text{in.}$	$M = 4\text{ft. } 1.7822\text{in.}$
$2l = 2\text{ft. } 0.8911\text{in.}$	$N = 3\text{ft. } 10.9301\text{in.}$
$E = 2\text{ft. } 11.5217\text{in.}$	$R = 373\text{ft.}$
$F = 3\text{ft. } 5.4852\text{in.}$	$v = 1.2446\text{in.}$
$K = 5\text{ft. } 2.2278\text{in.}$	$w = 0.5186\text{in.}$

The inclination of locomotive and tender, for a curve of 373ft. radius, will then be, according to

$$\begin{aligned} \text{Formula 13} & \quad \phi' = 1^\circ 51' \\ \text{" 14} & \quad \phi'' = 2^\circ 43' \end{aligned}$$

For the same curve, the values denoted by the foregoing formulæ will be as follows:-

Formula.	Expression.	Numerical values for Curves of 373ft. radius.	
		If $\phi = 1^\circ 51'$	If $\phi = 2^\circ 43'$
No. 1	$\Delta \sin. \phi$	Inches. .9208	Inches. 1.3518
2	$F - \sqrt{K^2 - \Delta^2 \sin. 2\phi}$	.0102	.0220
3	$K - \sqrt{K^2 - \Delta^2 \sin. 2\phi}$	.0068	.0147
4	$F - K - \sqrt{T^2 - \Delta^2 \sin. 2\phi} + \sqrt{K^2 - \Delta^2 \sin. 2\phi}$	.0034	.0073
5	$\sqrt{L^2 - E^2 \sin. 2\phi}$	24.8040	24.8334
6	$\sqrt{L^2 + (N^2 - E^2) \sin. 2\phi}$	24.9108	24.8335
7	$\sqrt{L^2 + (N^2 - E^2) \sin. 2\phi} - L$	.0197	.0424
9	$y = L'$	24.9108	24.9335
10	$\sqrt{L'^2 + l^2 \sin. 2\phi}$	24.9140	24.9405
11	$\sqrt{L'^2 + l^2 \sin. 2\phi} - L$	.0032	.0070
12	$y - y' = 0$	0	0

The result obtained from these and further calculations as to the condition of the arrangement of the draw-bars in curves, proves to be the following:-

1st. When the frames become inclined towards each other in crossing a curve, the draw-bars and coupling gear will take up a position oblique to their previous one; this necessitates the employment of ball and socket connection of both frames.

2nd. The coupling apparatus can be constructed so that the length of all connecting and coupling rods, on crossing the curve, correspond with mathematical exactitude with the points to be connected, except a lengthening and shortening of the draw-bars between the false axle and the coupling axle of the tender during the revolving of the cranks; this difference, however, amounting only to .0067in. in curves of 373ft. radius, may be neglected, considering the unavoidable allowance at the points of coupling and the elasticity of the material employed.

3rd. The same defect exists with respect to the engine shaft, since on crossing a curve the false axle approaches the engine shaft more than the shortening of the oblique draw-bars between the driving shaft and the false axle tree purports. The maximum of difference is here likewise = .0067in., which may of course be neglected.

A further defect consists in the increase of the distance of the centres of the crank circles between the false axle and the coupling shaft on crossing a curve; the maximum of this error amounts to .0409in. This error, should it prove injurious, may be rectified by means of a joint to be employed on the vertical connecting bar between the false axle and the coupling shaft.

The trial journeys to which the "Steierdorf" was subjected last year proved very successful. Notes taken on this occasion show that gradients up to 1 : 40 and curves down to 103 yards radius can be traversed without disturbing the moving parts.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF
SCIENCE, NEWCASTLE, 1863.

ON BOILER EXPLOSIONS.

Mr. P. le Neve Foster read a paper on this most important subject by the Astronomer Royal. It stated—In considering the cause of the extensive mischief done by the bursting of a high pressure steam boiler, it is evident that the small quantity of steam contained in the steam chamber has very little to do with it. That steam may immediately produce the rupture, but as soon as the rupture is made and some steam escapes, the pressure on the water is diminished, a portion of the water is immediately converted into steam at a slightly lower temperature and lower pressure; and this, in the same way, is followed by other steam of still lower temperature and pressure, and so on, till the temperature is reduced to 212° F., and the pressure to 0. Then there remains in the boiler a portion of the water at the boiling point, the other portion having gone off in the shape of steam of considerably diminishing pressure. From this it is evident that the destructive energy of the steam, when a certain pressure is shown by the steam-gauge, is proportional to the quantity of water in the boiler. By the assistance of Professor Miller, of Cambridge, Messrs. Ransome, of Ipswich, and Geo. Biddell, Esq., I have been able to obtain a result which I believe to be worthy of every confidence. I will first state as the immediate result of Mr. Biddell's experiments, that when there were in the boiler of a small locomotive 22 cubic feet of water, at a pressure of 60lbs. per square inch, and the fire was raked out, and the steam was allowed gently to escape with perfect security against priming, the quantity of water which passed off before the pressure was reduced to 0, was $2\frac{1}{2}$ cubic feet or $\frac{1}{8}$ of the whole. In regard to the use made of Professor Miller's theory, Professor Miller had succeeded in obtaining a numerical expression of the pressure of the steam at twelve different measures of the volume occupied by water and steam, which expression I have succeeded in integrating accurately, and I have thus obtained an accurate numerical expression of the destructive energy of the steam. In regard to the use of General Didion's experiments, these experiments give the velocity of the ball, in cannon of different sizes, produced by different charges of powder. I have found by trial which of these experiments exhibit the greatest energy per kilogramme of powder, and have adopted it in the comparison. The result was as follows:—The destructive energy of one cubic foot of water at 60lbs. pressure per square inch, is equal to the destructive energy of two English pounds of gunpowder, in General Didion's cannon experiments. Gen. Didion's experiments were made, as I understand, with smooth bored cannon. It cannot be doubted that much energy is lost in the windage; some also from the circumstance that the propelling power ceases at the muzzle of the gun before all the energy is expended, and some from the coolness of the metal. If we suppose that, from all causes, one half of the energy is lost, then we have this simple result. The gauge pressure being 60lbs. per square inch, one cubic foot of water is as destructive as one pound of gunpowder. In one of Mr. Biddell's experiments, the steam valve was opened rather suddenly, and the steam escaped instantly with a report like that of a very heavy piece of ordnance. This is not to be wondered at, for it appears from the comparison above that the effect was the same as that of firing a cannon whose charge is 4lbs. of powder.

Mr. Wm. Fairbairn, F.R.S., said he himself had paid considerable attention to the subject of boiler explosions, and he was glad to find that Professor Airey had drawn attention to it. It was a most important subject, as about 150 persons were killed annually from boiler explosions. That was the reason they had formed an association in Manchester for the purpose of preventing boiler explosions. It had now been in operation for about eight years, and he believed there had only been one or two lives lost during that time by the explosion of boilers under the inspection of this association; whereas in other parts not under the inspection of this association, there had been two or three explosions lately. This association had done a large amount of good by preventing accidents of this kind; and he would earnestly recommend the establishment, in a district like that around Newcastle, where they had so many boilers in operation, of a similar association. He merely mentioned those facts to show that people having boilers should associate themselves for the purpose of preventing explosions, otherwise the Legislature might interfere to establish a system of inspection not so pleasant to those having boilers under their charge.

BOWN'S PATENT TYRE FASTENING.

The following is extracted from the paper read by Mr. Fothergill upon this subject:—

On each side of the rim of the wheel is turned, at the outer edge, an angular or undercut groove, leaving a dovetail projection on the outer periphery thereof. The tyre is formed of a diameter about $1\frac{1}{2}$ in., or 2 in. larger than the rim it is intended to embrace, and has also two angular or undercut grooves turned out of the edges of its internal circumference, leaving a

dovetailed projection similar to that on the rim; two wrought iron securing rings are then turned with angular projections corresponding to the angular grooves of the rim and tyre. One of these rings being laid down with the projections upwards, the wheel rim is placed upon it with one of its grooves taking the internal projection of the ring; the tyre then being laid with one of its grooves corresponding to the outer projection of the ring, an annular space of $\frac{1}{4}$ to $1''$ will be left all round between the rim and tyre; the other securing ring is then dropped into the grooves on the upper side of the tyre and rim respectively, and finally bolts are passed through the two securing rings and through the annular space left between the tyre and rim; these, being screwed up with nuts on the outer side of the wheel, hold the whole firmly together, and form a most compact and simple tyre fastening.

The first and most important advantage claimed for this system over the ordinary tyre fastening is its perfect safety; for, should the tyre become loose, or even were it to break into a number of pieces, no portion of it could possibly leave the wheel, for the securing rings would still have a firm hold of the dovetail projection on each piece of the tyre, and no force much short of the ultimate strength of the section of the two rings through the bolt holes could ever fracture them. This power could never be attained by the centrifugal force of a portion of a broken tyre carried round by the wheel, however fast it might be revolving.

Secondly, a large proportion of the accidents arising from broken tyres, occur during the period of severe frosts, when the contraction of the iron, due to the great reduction of temperature, is productive of a still further increase to the strain already exerted by the initial "shrinkage" of the tyre, and is owing to there being no provision made in the ordinary method of fastening to allow for this contraction and expansion. In this system of fastening, on the contrary, each part is possessed of a certain amount of elasticity, which, by the peculiar construction, admits of the contraction and expansion of one part without danger of fracturing any of the rest; each part also is so arranged that it is subject to the same degree of expansion and contraction as its neighbouring part, so that there can never be any severe opposition of forces due to that cause, tending to break any of the weaker parts of the wheel.

Thirdly, in consequence of the tyre not being shrunk on, as in the ordinary manner, but fixed to the wheel in a cold state, the malleable qualities of the iron are preserved quite unimpaired, and crystallisation (a frequent consequence of the heating and shrinking) is entirely prevented.

Fourthly, the injurious degree of constant tension is altogether obviated, as, instead of there being always a force tending to break the tyre, the force, as applied to this wheel, draws it uniformly, by the action of the dovetails, towards the centre, and therefore all unnecessary strain is removed from the tyre.

Fifthly, should Bown's tyre become loose, it can be re-fastened with the greatest facility, as it is only necessary to tighten up the nuts on the bolts, so as to draw the securing rings more tightly into the dovetail grooves, and thereby hold the tyre more firmly.

Sixthly, its lightness and flexibility, combined with its strength, being adapted to obviate the breakage of axles, a by no means uncommon occurrence with wheels of extreme rigidity, constructed under the common system.

Seventhly, the readiness with which this wheel can be repaired, should any part of it become damaged, without the whole having to be condemned, is a very important advantage, in an economical point of view, as the whole is so readily taken to pieces, and other spare duplicate parts adjusted to replace those damaged. A most favourable comparison may be drawn in this particular between the patent and ordinary fastening, as will be seen from the following statement of the weights, cost, and time required to replace one bad tyre by each system:—

Diameter.		Patent Fastenings.			Ordinary Fastenings.			Time.	
		Weight.	Net Cost.		Weight.	Net Cost.		Patent.	Ordinary.
ft. in.		C. qr. lb.	£ s. d.		C. qr. lb.	£ s. d.		hrs.	hrs.
3 6	Replacing one bad Tyre	3 0 3	3 1 8		3 2 19	3 11 0		2 4	
3 1	Do. Do.	2 2 20	2 15 3		3 0 20	3 3 3		2 4	

showing a saving in weight of 2qrs. 16lbs., of money, 9s. 4d., and of time 2 hours, for a wheel of 3ft. 6in. diameter; and of 2qrs., 6lbs. weight, 8s. in cost, and 2 hours of time for a wheel of 3ft. 1in. diameter. The difference in time is accounted for by the injured ordinary tyre having to be heated to get it off the rim, and the new ordinary tyre to get it on the rim; whereas, in the wheel under notice, the tyre is taken off and replaced by another by simply unscrewing the bolts, lifting off the old tyre, placing the new one, and re-screwing up the bolts.

Eightly, the extreme simplicity of construction is productive of great advantages, when it becomes necessary to re-tyre the wheels, which is a very important feature in the maintenance of rolling stock. The following comparison will show that the weight of a set of tyres and the cost of re-tyring by the patent fastening is considerably less than that for one fastened by the ordinary method:—For re-tyring a set of 3ft. 6in. wheels by the patent method the tyres will weigh 12cwt. 0qrs. 12lbs., against 14cwt. 2qrs. 10lbs. by the ordinary, giving 2cwt. 1qr. 26lbs. in favour of the former; while the respective costs for re-tyring a set will be, by Bown's patent, as shown, £13 15s. 6d., against £16 1s. 3d. by the ordinary, or a saving of £2 5s. 9d., per set in wheels of that size; and for wheels of 3ft. 1in. diameter, the weight saved per set is 2cwt. 0qrs. 24lbs., and the saving in cost £1 18s. 11d.; or, for the larger wheels, 14 per cent., and for the smaller 13½ per cent. below the sums expended for that process in the ordinary way, an item of very great importance in an extensive system of rolling stock.

Ninthly, another considerable advantage gained by this improved tyre is that it can be efficiently and economically applied to other ordinary wheels, which are in use, after the tyres are worn down, without having recourse to the necessity of condemning one class of wheel in order to introduce one of more modern construction, as all that is required to adapt them to the new fastenings, is to turn the dovetailed grooves in the rim of the old wheel; and the new tyre, with its securing rings, are dropped into their respective places and secured with far greater facility than by any other method hitherto adopted. By this means wheels of any class may be utilized; even those which have been condemned and put out of use by railway companies, as being too small, may be increased in diameter to the extent of from two to five inches; and it will also be seen that a larger wheel can at all times be obtained by the use of this method, from which a considerable saving in tractive power and in the wear and tear of journals and brasses will be effected. The weight of tyres with fastenings, and the net cost of preparing and securing one set of four tyres to old wheels ready for use, the tyres being put on cold, is, for a set of 3ft. 6in. wheels, weight 19cwt. 1qr. 4lb., and the net cost £11 4s., for a set of 3ft. 1in. wheels, weight 14cwt. 2qrs., and the net cost £8 19s.

The question of durability, as compared with the ordinary wheel, also inclines in favour of the patent tyre, doubtless in consequence of the elastic nature of the fastenings resulting from the particular arrangement of the parts in respect to each other. An example or two will illustrate this. A pair of each kind manufactured by the Kirkstall Forge Company were placed under a break van, the tare of which was 9 tons 3cwt., and after having made a mileage of 19,131 miles, the loss of weight in running that distance was, for the patent tyres 72lbs., and for the ordinary 96lbs., or 25 per cent. in favour of the former. A second pair of each, by the same makers, were placed under a break van, the tare of which was 9 tons, and after running 21,991 miles, the loss of weight sustained by the patent tyres was 30lbs. and by the ordinary ones 44lbs., or 31·8 per cent. again in favour of the patent tyres.

A large number of these wheels and tyres are now undergoing some of the severest tests possible in the regular course of railway working. There are already some 40 or 50 break vans furnished with patent tyres in constant work on the London and North-Western Railway. The pair under notice have been recently taken from under a break van running on the Chester and Holyhead line. The tyre of each wheel is cut into four segments, and is held in position on the periphery of the rim by no other means than those already described. In this condition they ran, between March, 1862, and June last, a distance of 46,973 miles. After running that distance, they were put into a lathe and the tyres turned up, and from that month to the 18th of the present they have run 8618 miles, making a total of 55,591 miles. The tare of the break van under which they were running is 7 tons 10cwt.

This is the most conclusive evidence of the perfect security assured by these wheels, as it is thereby demonstrated that, if even a tyre should be broken into several pieces, they will still be retained in their places; and no inconvenience whatever would be felt by the passengers, nor would a train be so much as detained. Other wheels of the same descriptions have run on the same line 80,000 miles under break vans, and some with tyres, only half an inch thick on the outside edge, have run upwards of 12,000 miles in that condition, which is perhaps the severest test to which a wheel could be subjected, and yet no single instance of failure has ever resulted from any one of these numerous trials.

The first cost of a complete set of wheels with Bown's patent fastenings is about that of the ordinary kind; but it must be borne in mind that in the former the expenses of repair and re-tyring are very materially less than is the case in the latter; therefore, proprietors of rolling stock would do well to consider the advisability of adopting such wheels, not only on the ground of safety, but also on that of economy; and no excuse hereafter can be satisfactorily advanced whenever any disaster may take place arising from the separation of a broken tyre from the body of a wheel.

ON THE APPLICATION OF MACHINERY TO COAL CUTTING.

By SAMUEL FIRTH.

Numerous efforts have been made during the last fifty years to bring coal cutting in mines under the influence of mechanical power, but in no case, I believe, except at the West Ardsley Colliery, has any continuous operation survived the experimental period. I do not expect that the introduction of machinery into coal mines for the purposes named would materially diminish the number of persons employed, but rather that the effect would be to meet the increasing consumption. That increase may safely be taken at two millions of tons per annum; and to supply that increase would require an annual increase of labourers, amounting to about 3500. Thus there will not be any violent displacement of labour.

The steam engine has a 20in. cylinder, and the air pump 18in. The air is worked at a pressure of about 50lb. to the square inch. The air is conducted down the shaft in iron pipes of 4in. diameter, and thence to the workings (about 800 yards) in gas piping, and down the face by India rubber piping of 1in. diameter, which is connected to the machine. The machine is moved on iron rails laid on cross iron sleepers, and is propelled a little, after each blow of the pick, by the handwheel. Generally the machine is passed three times over the face of the coal, each time with a longer "pick," to gain the requisite depth for taking down. The first cut being 18in. to 20in.; the second, 9in. to 11in.; and the third, from 6in. to 8in.; 36in. being the depth aimed at and accomplished. The actual quantity of work done in six consecutive days of eight hours each, by one man with one machine, was 618½ yards, or about 800 tons of coal.

The man is attended by two boys, who clean out the groove and remove the coal thrown out by the machine. In the West Ardsley seam a man will average 7½ yards of coal a day; so that, if the machine were worked by shifts of eight hours, three men and six boys would do the work of 40 men, and that, too, the most severe and trying work in the pit.

It must be understood that at West Ardsley the seam is somewhat favourable for the purpose. It is 4ft. thick, having a good roof and floor, and is worked on the *long wall* system, with a somewhat soft bearing part, about 12in. above the floor, and in this the pick works.

The machine thus far has only been put to "barring" or "kirving," but the proprietors expect to effect "straight work" by a different arrangement of the picks. The filling and all other work of the pit is untouched by this machinery. The air power works admirably, and its use gives a cool and refreshing stream of pure air to the far distant works, which issues from the cylinder at a temperature very little above freezing point.

It will not be necessary to say here that the air power is acquired by a much larger measure of steam power; but this is not a material item at a colliery, where so much engine coal is almost worthless. I am not prepared with the exact commercial results or saving in cost, but at West Ardsley this part of the question is, I believe, eminently satisfactory.

I have been informed that some experiments have been made, within the last few days, at the Hetton Colliery, by the West Ardsley machine; and although the seam is of a hard nature, the kirving was done 3ft. deep with a groove of 3in. at the face and 2in. at the back, giving an average cut of 2½in. high, whereas the average height of hand kirving in the same seam is about 1½in.

INSTITUTION OF CIVIL ENGINEERS.

DESCRIPTION OF LIGHTHOUSES LATELY ERECTED IN THE RED SEA.

By Mr. W. PARKES, M. Inst. C.E.

Having been instructed by the Board of Trade to make the necessary preliminary surveys for establishing lights to facilitate the navigation of the northern portion of the Red Sea, the author recommended three sites, 1. Zafarana Point on the Egyptian shore, 50 miles from Suez; 2. the Ushruffee reef, on the western side of the navigable channel of the Straits of Jubal, 150 miles from Suez; and 3. the Dædalus reef, in the centre of the Red Sea, 350 miles from Suez, and 180 miles from the entrance of the Gulf of Suez. These sites having been approved by the Egyptian Government, by the Board of Trade, and by the Directors of the Peninsular and Oriental Steam Packet Company, the immediate execution of the works was authorised, upon designs submitted by the author.

Zafarana Point being on the mainland, it was considered most advantageous to construct a tower and lightkeepers' dwellings of rubble stone, and to employ native labour entirely, under the direction of H. E. Linant Bey, the chief engineer of the Public Works department of the Egyptian Government. The design presented no feature calling for special remark, and the works had been carried out in a very satisfactory manner. The light was a fixed dioptric of the first order, visible, over five-eighths of a circle, at a distance of 14 miles. It was first exhibited on the 1st January, 1862.

The main features of the other sites were then described. The Ushruffee was a coral reef of which the sides sloped irregularly from the level of a few inches

under low water to a depth of from 8 to 10 fathoms, no part being above the water, and there being very little sand, even in the cavities of the coral. The Dædalus reef was a submerged island, with a flat top of an oval form 1200 yards in length and 450 yards in breadth, the sides being generally vertical, or in some places even overhanging. The actual surface of the coral was about 6in. under low water; but there was a small shifting bank of sand near the south-east end, which was dry at low water, and sometimes also to a small extent at high water. The range of tide was about 2ft. at springs.

The peculiar conditions which had to be considered, in designing the proposed constructions, were—First, the force of the sea would be completely broken at some distance within the edge of the reef. Secondly, the structures would have to be built upon the surface of the reef, and not be sunk into it, as no additional security could be thus obtained, while the advantage of the natural platform would be lost. Thirdly, in the absence of any definite experience as to the actual weight which the reefs would bear without being crushed, it was desirable to keep the weight per superficial foot of foundation as low as possible. Fourthly, the buildings had to be designed so as to mitigate the intense summer heat. And fifthly, in the case of the Dædalus, as the materials would have to be brought from Suez, and as there was no anchorage, it was necessary that a steamer should be employed, capable of keeping close to the reef in any wind, and of providing quarters for the workmen and storage room for the materials, until a proper dépôt and habitation could be formed on the reef itself. These requirements rendered it essential that the materials should be small in bulk, that the several parts should be light and easily handled, and that the mode of putting them together should be as simple as possible.

It appeared to the author that these conditions would be best attained by adopting a structure of wrought-iron supported on teak piles, resting on and the feet bedded in a layer of concrete, so as to distribute the weight, the surface of the concrete being a little above the level of high water; and that by filling in the wrought-iron framework with strong corrugated iron, so as to form a series of rooms one above the other, as a central column with verandahs, or galleries, around each room, likewise partially enclosed, a portion at least of the sun's rays would be prevented from falling on the walls of the rooms, whilst there would be a free admission of air.

As the Dædalus light had only to guard against the dangers of the reef on which it was placed, it was not necessary that that structure should exceed the limited height that would allow of four tiers of rooms, and of accommodation for the lighting arrangements. These together brought the light to an elevation of 62ft. above the mean level of the sea. As the Ushrufee light had to lead vessels past dangers 12 or 14 miles distant, a more powerful light, at a greater elevation, was required. The height fixed upon was 126ft. above the mean level of the sea. The framework was of the same description in both cases, but in the latter case there were eleven tiers, whereas in the Dædalus there were only four tiers. Details were then given of the Ushrufee structure, as being the larger of the two. It was stated that this structure was supported upon eighteen piles, each 18ft. long and 18in. diameter, arranged in two concentric circles. The inner circle consisted of six piles and was 15ft. diameter, while the outer circle was formed of six pairs of piles (the piles of each pair being 6ft. apart), 37ft. diameter at the top, and the feet spread outwards at a batter of 1 in 12. The feet of the piles, resting upon the natural surface, and there were shoulders on each side of the piles, resting on sleepers of teak, bedded on the concrete 2 to 3ft. above the surface of the coral. The heads of the piles passed through circular wrought-iron collars, to which they were accurately fitted, and any loosening by the shrinkage of the timber was provided for, by fitting a number of wedges of greenheart timber into corresponding grooves in the pile heads, in which they could be driven down when slack. A direct bearing surface was also given by iron screws 2in. diameter, which passed through each collar, and entered 2in. into the wood. The collars had projecting arms to which the bottom framing was riveted. The superstructure consisted of a repetition of three main parts, which might be called respectively standards, cills, and radiators. In each tier there were twenty-four standards, arranged in two concentric circles, and these were connected at the top and bottom by cills, thus forming two twelve-sided polygons, the corresponding angles of which were connected by the radiators. With the exception of a few parts near the bottom, no separate piece exceeded 4 cwt. in weight. The floors of the rooms were composed of cast-iron plates covered with concrete, and from the lowest floor there was suspended a hemispherical water tank, capable of holding 1500 gallons. The floors of the galleries were formed of open cast-iron gratings. The whole of the ironwork of the structure was erected on Messrs. Forrester and Co's. premises, at Liverpool, with the view of attaining the accurate fitting of the parts, and of testing its strength. While at its full height, with the exception of the piles at the bottom and the lantern at the top, but with the joints merely bolted together, it was exposed, in September and October, 1860, to two gales of wind of the registered force, respectively of 20½ lbs. and 24½ lbs. per square foot. There was no appearance of any straining of the joints, and a careful examination failed to discover any swaying movement at the top, though there was a sensible vibration. Since its erection on the reef it had been subjected to two severe gales, in June, 1862, and in January, 1863, with similar results; for although the top of the building had vibrated, there were no symptoms of straining having occurred.

The general principles of the construction of the Dædalus lighthouse were the same as those of the Ushrufee, with such modifications as its smaller size demanded; thus there were only twelve, instead of eighteen piles, and the dimensions of the parts of the framework were the same as for the upper tiers of the Ushrufee. The building was stated to be very stiff, scarcely any vibration being perceptible under a strong breeze.

The lanterns were of the same construction for the three lighthouses. Those for the Ushrufee and the Zafarana, being for first order lights, were identical in every respect. That for the Dædalus, being for a second-order light, was of reduced size. In construction, they were similar to those generally manufactured for the Trinity Corporation, but with special arrangements for mitigating the

powerful effects of the sun. At the suggestion of Professor Faraday, a wind-guard was substituted for the ordinary revolving vane and cowl. The lanterns and light apparatus were furnished by Messrs. Wilkins and Co., the optical portion having been manufactured by Messrs. Chance, Brothers, whose improvements in lighthouse illumination deserved special notice. The Zafarana and the Dædalus were fixed lights, while the Ushrufee had a revolving light frame.

The whole of the materials of the two iron lighthouses, and of the three lanterns and light apparatus, were, with some trifling exceptions, despatched from Liverpool within ten months from the date of the author receiving instructions to proceed to survey the sites, at a distance of nearly 3000 miles from Great Britain.

As the structures were designed with a special view to the peculiar circumstances of the sites upon which they were to be erected, it was considered desirable to give some account of the operation of erection. The Peninsular and Oriental Steam Packet Company granted, gratuitously, the services of the *Union*, a screw steamer of 300 tons and 60-horse power, the Egyptian Government paying for all wages, stores, and coal. The materials arrived at Alexandria on the 12th of November, 1860, but it was not until the 20th of December following that they were all received at Suez, and placed on board the *Union*, which then sailed for the Ushrufee reef. The expedition thus commenced was unfortunately not successful. The causes of the failure were given at length in the paper, but it would be sufficient to state the results of the season's labour, which lasted three months. The piles were erected on the reef, and their heads were connected by the bottom iron frame. The whole of the ironwork was landed, and laid out in order upon one of the neighbouring islands. This was not originally intended, as the plan decided upon was to moor the ship as near as possible to the reef during the progress of the works, and to land and sort the materials upon the concrete base of the lighthouse itself. After a full inquiry into the circumstances which had led to this failure, the author was instructed to make arrangements for a new expedition, and he readily assented to the suggestion that he should remain on the spot, until the operations as to which difficulty had been anticipated were completed. The permanent superintendence was intrusted to the late Mr. C. W. Scott (Assoc. Inst. C.E.), Captain W. Kirton being in command of the *Union*. As the materials had been landed on the Ushrufee Island, it was determined to form a land establishment for the working party there, rather than to quarter the men on board. This left the steamer free to carry a working party to the Dædalus, without interfering with the operations on the Ushrufee. The staff was re-organised, and the list of plant and of materials revised; but owing to several causes the operations were not resumed on the Ushrufee until the 8th November, 1861. The first step was to form the shore establishment. This occupied three weeks, owing to the want of skill of the native carpenters, in getting the huts ready for occupation. During this time, however, some progress had been made at the lighthouse. The caisson of iron plates to enclose the concrete base had been set up, and about 200 tons of gravel had been placed upon the reef, where it was exposed to a wash sufficient to remove some of the clayey particles. The process of depositing the concrete was then commenced, the plan adopted being to deposit it upon sheets of tarpaulin, which sunk with the weight and protected the soft material from the action of the water, until a mass of several tons was collected. When the whole space was covered in this way up to above low-water mark, the remainder was deposited, as the state of the tide allowed, until the whole height of 5ft. from the surface of the coral was complete. The first half of the concrete was formed of six measures of gravel to one of Portland cement, mixed in the lighters moored alongside the caisson. The second half was formed of lime, puzzolano, and broken stone, in the manner usually practised in the country. The latter was mixed dry at Suez, and was wetted on being deposited.

When the success of the process of depositing the concrete was well assured, the author turned his attention to the Dædalus, which was reached on the 26th of December. A site for the lighthouse was chosen near a small sandbank of triturated coral, as it was determined to use the sand for the concrete, and as it was also convenient for beaching boats, &c. The surface of this reef was very irregular, there being numerous hollow places, varying from 1ft. 6in. to 2ft. in depth. A four-legged shears was set up on the intended site, and a platform fixed upon it at the level of the underside of the pile collars. Upon this platform were bolted together the plates forming the polygon to complete the inner circle of piles. The six piles were then successively raised on end, and the collars were bolted to the polygon. When the six piles were fixed, the original stage was removed, and a new one was formed, to receive in a similar manner the outer polygon. This having been fixed in place, and the two polygons connected by the radiators, the outer piles were raised. The caisson plates were set up, being first bolted together, and then partially riveted. The whole of these operations occupied seven days and a quarter, the staff employed consisting of four workmen, and parties of from six to eight men from the crew. The lighter Ushrufee was then moored upon the reef, and the steamer proceeded to whence it returned with 50 tons of cement and twenty Arab labourers, under a native foreman, for depositing the concrete, and having a second lighter in tow. The concrete here used consisted of three and a-half measures of coral sand to one measure of cement. The first operation was to fill up the holes between the coral lumps with coal bags filled with concrete, so as to make an even surface to lay the tarpaulins upon. The deposit was then carried on in the same manner as at the Ushrufee. The quantity of cement, above alluded to, was only sufficient to complete three-fourths of the required height of the block. This occupied just eight days, and then the author returned to Ushrufee, and finding five tiers of that lighthouse erected and partly riveted, he handed over the entire charge of both works to Mr. Scott, who shortly after proceeded with a party of four mechanics, two riveters, four labourers, and ten Arabs, in all twenty, besides the crew, to the Dædalus. With these, in twenty-six days, the work being carried on only on twenty-one days, the whole framework was erected and riveted together, two floors and the water-tank were completed, and the lower room was enclosed.

Two mechanics and four seamen were then placed in the building, with provisions and water, to continue the work, and the *Union*, with Mr. Scott and the remainder of the working party, returned to Ushuffee. Thus in thirty-seven working days, the main portion of the building, now 57ft. in height, was so far finished as to be habitable for a party sufficient to complete the remaining details. Had the ship been of larger burthen, it was believed that these thirty-seven days might have been continuous, and that the whole would have been accomplished during an absence of about seven weeks from Suez. The author referred in terms of the highest praise to the manner in which what might be termed the nautical part of the undertaking had been carried out by Captain Kirton. Subsequently the materials for the lantern and the lighting apparatus were deposited in the building, and afterwards one leading mechanic, two labourers, and five seamen, completed the work between November, 1862, and the 1st of February, 1863, when the light was exhibited.

At the last mention of the Ushuffee the concrete base had been completed, and five out of eleven tiers of framing had been erected. During the absence of Mr. Scott and his party at the *Dædalus*, a European boat's crew of six men was engaged in conveying the remainder of the materials to the reef, and in sorting them there. On the return of the working party the erection was rapidly proceeded with, in the face of much difficulty from almost constant high northerly winds. The time actually taken in erecting the skeleton frame work, 106ft. in height, was two months, and the riveting was completed within three months. The two succeeding months were occupied with the erection of the lantern and lighting apparatus, and completing the details of the building, and on the 1st of July, 1862, the light was first exhibited.

In connection with this undertaking the profession had to regret the loss of a very promising young member, Mr. C. W. Scott, who towards the close of the operations was attacked with symptoms, which developed the seeds of a disease of long standing, under which he succumbed after an interval of five months.

With regard to the cost, a mere statement of the total amount expended upon the two lighthouses, £55,211 in all, would convey an erroneous impression, unless accompanied by an explanation. The cost of the whole as an engineering work, independently of the employment of the steamer, might be taken at £32,079, including all contingencies, supposing the reefs to have been within a boating distance, say one mile and a half and half a mile from Suez. If the steamer had been equipped at Suez, and had been continuously employed, then, on this supposition, the cost might have been £42,082. The remaining expenditure, £13,029, was entirely exceptional, arising mainly from the steamer being equipped at Bombay.

ON THE DUTY OF THE CORNISH PUMPING ENGINES.

By MR. W. MORSHEAD, JUN.

It appeared from a tabular statement prepared by the proprietor of "Lean's Engine Reporter," for the years 1841 to 1860 inclusive, that the average duty of these engines had fallen off from 68 millions in 1844 to 52 millions in 1860, or 25 per cent.; also that less interest was now felt in the performance of these engines, as while fifty were reported in 1841, only fifteen were reported in 1858 and twenty-five in 1860. Although the nominal, or reported duty showed this marked diminution, it was not asserted that there had been an actual falling off to the extent thus indicated;—for the duty paper did not take into account the quality of the coal, which was certainly inferior to that used twenty years ago; besides which the present practice of sinking the engine shaft, for the whole, or part of its depth, in an inclined direction upon the course of the lode, must have tended to increase the friction of the pitwork, and the mines were also deeper than formerly. Nor was expansion of steam adopted to so great an extent now as it was some years ago; it was then carried further than was compatible with safety, as was evidenced by the repeated breakages of the main rod, the piston rod, and the other principal parts of the engine. But after allowing for all these legitimate causes of the falling off of duty, it was thought that the average duty of the county was still at least ten millions below what it should be.

The Author next examined the causes of this decline, and then discussed the means by which it might be remedied. The primary cause he believed to be, the indifference of the mine proprietors to the performances of the engines. So many accidents attended the use of high steam, cut off at an early part of the stroke, that economy of fuel came to be regarded as synonymous with repeated breakages; but it was quite possible to raise the duty considerably above the present average, without resorting to an undue rate of expansion. This might be accomplished by a more perfect and extended system of reporting the engines, and by a new form of duty paper, embracing the following additional items:—First, that the load upon the piston should be taken from an indicator diagram, and from the load thus ascertained the duty should be computed, the difference between the load upon the piston and the weight of water actually lifted, that was the loss by the friction of the pitwork, &c., being placed in a separate column. Secondly, that the part of the stroke at which the steam was cut off, as well as the vacuum obtained, should be stated opposite each engine. Thirdly, that a notice of the quality of the coal used, as far as it could be ascertained, should be added. And lastly, that the engines should be separated into two classes, those which might reasonably be expected to give a good duty, and those which, from the time they had been at work, their small size, or other causes, could not fairly compete with the former. By taking the load upon the piston from an indicator diagram, a fair estimate of the work actually done by the engine could be formed, while by placing the difference between the load upon the piston and the weight of water actually lifted in a separate column, encouragement was offered for improvement in the construction and fixing of the pitwork.

At present, only about one-tenth of the engines at work in Devon and Cornwall appeared in the monthly reports. If nine proprietors would co-operate in supporting a good form of duty paper, there was little doubt but that there would be a rapid and marked improvement in the duty of the Cornish engines.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

MR. JOHN IVES IN THE CHAIR.

At the ordinary monthly meeting of the above society, on the 6th ult., Mr. Oubridge read a paper on "A Method of Casting Guns Hollow, and Cooling them from the Inside by a Current of Air."

The reader remarked that the subject which he proposed to consider that evening was one upon which much had been already said and written. He believed, nevertheless, that it was not exhausted, for it was a fact that, as yet, no heavy gun had been produced which answered all requirements. Brass guns had had their day, cast iron guns had been long used, were at one period almost totally condemned, but were now cropping up again, and much might be adduced in their favour. Wrought iron, in multifarious forms, had been employed in the manufacture of guns, each form having peculiar advantages; but the results, on the whole, were not satisfactory. Steel has also been introduced for the purpose; but in spite of its great cohesive strength, it had been found impossible hitherto to make from it good, sound, and serviceable guns of large calibre. Many practical difficulties stood in the way of its employment in this direction, although certainly some very successful efforts had been made to construct light and small pieces of ordnance of that material. Compound guns, composed of cast and wrought iron—the one encasing the other—had also been tried, with variable and uncertain effects; but as yet no absolute rule had been deduced for the guidance of those whose duty it was to manufacture heavy guns. Time, and the expenditure of much more of the public money, might effect this great desideratum, but it had not yet been achieved, and it was, therefore, the duty of practical and scientific men to endeavour to solve the problem "how best to manufacture heavy guns?" He intended to contribute a few items to the mass of existing information on the subject, and he might state that such knowledge as he had to impart had been gained from his own experience and experiments in the iron foundry. It was required in the production of large pieces of ordnance that the material used should be made to offer the fullest possible resistance to the bursting strain to which it would eventually be exposed, and that the cohesive strength of that material should be completely maintained. Perhaps, before advancing his own views, he might be permitted to refer to the method of casting heavy guns, which had been largely practised during the unhappy contest which still raged in America. The name of Dahlgren would no doubt be familiar to his hearers in connection with the American civil war, and the guns which were known as "Dahlgren's" possessed some distinguishing features. They were cast hollow, the theory of their inventor being that it was desirable "to reduce the neutral axis of his gun as nearly as possible to the centre of the thickness of the metal of which it was formed." If, on the contrary, the gun was cast solid, the cohesive power of the metal would be diminished as it approached the centre. By casting the gun hollow, this deteriorating process would be lessened by the pressure of the core in the mould. Dahlgren had evidently well considered the laws of cohesion and disintegration which governed these results. He had also adopted the plan of assisting the cooling and contracting, by pouring a stream of cold air through a tube of iron inserted in the core barrel. In this he was perfectly right, for it ought to be understood that if the cooling process operated entirely from the outer portion of the casting it was, to use a familiar illustration, like casting an iron ring upon a mandril—an operation which they all knew would be a senseless proceeding. This plan had, however, been persistently followed until the Armstrong gun was introduced. He (Mr. Oubridge), had, several years before, submitted to the select committee of the Board of Ordnance a scheme for casting heavy guns hollow, but the reply of that body was, as usual in such cases, unsatisfactory. At the same period an American gentleman made some attempts to accomplish, in this country, the same thing, but without success. For his purpose six cupolas were erected near to the Charlton Pier, on this side of the town of Woolwich, and the experiments there conducted were of a costly character. The theory was not the less a true one—the defect lay in its imperfect realisation.

Mr. Oubridge stated he had no doubt in his own mind that homogeneity would be obtained to a far higher degree in large iron castings if they were made hollow in place of being solid. He had had an opportunity a few months back of demonstrating the fact. A large hydraulic cylinder, requiring seventeen tons of metal to cast it, had to be produced. It was to have a very small hole through the bottom end, where the iron would be 15in. thick. He saw that the intense heat would inevitably melt the core barrel long before the metal composing the cylinder ceased to be fluid. He therefore assumed it to be a favourable opportunity for putting to the test his cherished theory, and Messrs. Simpson, of Pimlico, and he, determined to cool the core of the casting produced at their foundry, by means of an internal current of cold air. The plan of operation was very simple. A perforated tube was inserted in the core barrel, and then communicated, by means of a pipe and valve, with the blast. As soon as the mould was filled with metal the valve was opened, and the cold air forced into the tube found an outlet through the perforations when it impinged upon the barrel. This latter was also perforated so as to allow of the escape of gases from the interior of the core. The result was a complete success, and the cylinder was as sound and homogeneous as could be desired. The cooling process had thus gone on from the centre, instead of the exterior of the casting. When he had considered that the operation had lasted sufficiently long to prevent the metal remaining in a fluid state, he caused the blast valve to be shut, and in half an hour the core barrel was found to have melted in one place, leaving an aperture 3in. in diameter. The blast was then again turned on, and in less than ten minutes the barrel became black. By this method, which was of the most easy application, it was possible to reduce the temperature of the interior of a casting to almost any extent, and in a very short space of time. Mr. Oubridge's paper was listened to with attention, and was well illustrated by diagrams.

THE WRECK REGISTER AND CHART FOR 1863.

The following is a synopsis of the returns made by the Board of Trade to Parliament, of the wrecks and casualties which have taken place on the coasts, and in the seas, of the British Isles during the past year.

It may here be observed that the materials from which these valuable documents are compiled are derived from reports furnished by the Officers of Coast Guard, and Receivers of Wreck, resident on the shores of the United Kingdom.

When we remember that the number of vessels which entered inwards and cleared outwards from different English ports in the course of the past year was 268,462, and that these ships had on board, probably, 1,610,000 men, it becomes almost a matter of certainty that a large number of casualties should take place amongst them every year.

The coasts of the British Isles extend upwards of 5000 miles, and on looking at the wreck charts which accompany the register, it is observed that there are few parts of that continuous shore which are not studded with the usual wreck marks; and thus it is that on nearly every page of the register this startling fact constantly presents itself—that during the year no less than 1827 wrecks and casualties took place on our coasts, with the loss of 690 lives.

Compared with previous years the register informs us that the wreck experience of the past year is very unfavourable. But the number of lives lost is fortunately considerably under the average, owing chiefly to the valuable and prompt services of lifeboats and other means employed on occasions of wrecks on our coast. The wrecks and casualties in the year show a large increase on the average of those during the preceding eleven years. The number of wrecks in the last eleven years was 13,657, while the total voyages made to and from the British ports in that period were 2,745,910—so that 1 ship was wrecked out of 201. During the past year, as previously stated, the number of voyages of vessels to and from ports in the United Kingdom was 268,462, and out of this large number 1827 casualties occurred—or 1 in every 147.

In the past eleven years, from the above wrecks 8775 persons were lost, or nearly 800 each year. Last year, it appears from the returns that the lives of 4729 persons were imperilled on the coasts of the British Isles, of which number 690, or 14·59 per cent. were lost. The wrecks and disasters for the year 1862 may be thus classed:—

	Vessels.
Totally wrecked	455
Seriously damaged	695
Totally lost in collision	66
Damaged seriously by collision	272
Injured by collision	339
Total.....	1827

This number of disasters for last year is at the rate of five per day.

The months of January, February, March, October, November, and December were the most destructive to ships.

The startling facts which the Wreck Register discloses each successive year have succeeded in drawing general public attention to this important subject, and it is frequently referred to in Parliament. On a recent occasion, when Lord Ravensworth alluded, in the House of Lords, to the necessity of constructing harbours of refuge on the north-east coast, he caused to be suspended in their Lordship's library a large wreck chart lent by the National Lifeboat Institution.

The fearful scenes represented on that chart naturally excited their Lordships' attention. Indeed the dreadful havoc which storms commit every year in the seas and on the shores of the British Isles can only be fully realised by the aid of such a chart.

It is, however, satisfactory to find that the publication of the "Annual Wreck Register" of the Board of Trade, and other means of publicity, have materially contributed to the establishment on our coasts of a system of life-boats and life-preserving apparatus, which reflects the greatest credit on the philanthropy of the age in which we live, and on the energy with which these means have been placed on our shores, by the joint action of the National Life-boat Institution and the Board of Trade.

Amidst the desolating scenes which the Wreck Register and Chart reveal, it is consolatory to know that by means of life-boats, the life-preserving apparatus, ships' own boats, and other means, 20,158 lives have been saved from a watery grave during the past seven years, of which 4039 were rescued last year.

The following is a summary of the means used in saving the 4039 lives from wrecks on the coasts of the United Kingdom during the past year:—

By life-boats and rocket and mortar apparatus.....	637
By ships, ships' own boats, shore boats, steamers &c.	3389
By individual exertion.....	13
Total	4039

As usual, ships, ships' boats, and smacks have saved more lives in that period than the life-boats and the rocket and mortar apparatus. This apparent discrepancy is susceptible of easy explanation. When a disaster takes place in British waters, it frequently happens that either a ship or smack is fortunately at hand to render assistance to the crews of the distressed vessels. Such help is seldom attended with any very great danger (although sometimes it is so), and the men are often brought ashore before any tidings at all have reached a life-boat station. But the great value of the services rendered by life-boats can only be appreciated by considering that they are mostly performed on occasions when no other craft could be launched from the shore with safety.

Schooners and brigs were, as usual, the most numerous description of vessels that were lost during the past year on our shores. These are usually employed in our coasting and coal trade, and the destruction of hundreds of them even in moderate gales is now reduced to a matter of certainty.

In December last seven vessels foundered off the east coast of England—with the loss of all hands—while engaged in coasting voyages. One of them was a collier sloop 71 years of age! Another collier brig also foundered in October last, and 7 out of 9 of her crew were drowned. She was 99 years old!

The following is an analysis of the tonnage of the ships lost last year:—

	Vessels.
Vessels under 50 tons.....	341
51 and under 100 "	441
101 " 300 "	784
301 " 600 "	186
601 " 900 "	44
901 " 1200 "	20
1201 and upwards "	11
Total.....	1827

The most destructive gales of wind were those that blew from S.W., S.S.W., W.S.W., and N.W.

We find that the ages of some of the vessels that were hurried out of existence were as follows:—

Under three years.....	122
3 and not exceeding 7 years	271
8 " " 10 "	131
11 " " 14 "	155
15 " " 20 "	216
21 " " 30 "	266
31 " " 40 "	125
41 " " 50 "	59
51 " " 60 "	25
61 " " 90 "	14
91 " " 100 "	1
Unknown.....	442

Total..... 1827

We also remark that, in perfectly calm weather, 23 vessels were wrecked; in light airs, 28; in light breezes, 56; in gentle breezes, 43; in moderate breezes, 110; in fresh breezes, 187; in strong breezes, 195; in moderate gales, 75; in fresh gales, 170; in strong gales, 199; in whole gales, 218; in storms, 63; in hurricanes, 69; and in unknown and variable weather, 52.

We, moreover, observe that 321 vessels were wrecked that were under the command of masters holding certificates of competency; while 720 were wrecked that were commanded by others who were not required by law to hold such certificates; and 266 that were commanded by foreigners not having British certificates.

We observe that of the total wrecks during the past year on our shores, irrespective of collisions, 60 vessels foundered; 41 vessels were driven or run on a lee shore; 66 parted their cables, or dragged their anchors and went on shore; 40 were wrecked from damage to hull, or the loss of masts, yard, or sails; 3 were actually capsized; 72 were wrecked from inattention, carelessness, or neglect; 25 from defects in ships or equipments; 7 from a combination of causes, while 13 arose from accident.

Of the total wrecks that took place from collisions, 18 were from bad look-out; 22 because the rule of road at sea was not observed; 1 from the want of sea-room; 4 in thick and foggy weather; and 4 from neglecting to show lights; but it is worth observing that only 1 collision with total loss occurred from the error of the pilot who was on board; 4 occurred from negligence and want of caution.

It is also a lamentable fact, in regard to collisions, that 141 took place in fine and clear weather; the whole number of collisions during the year being 338—102 in the day time and 236 in the night. Last year 11

collisions occurred between the steamers, and 190 between sailing-vessels, while both were under way. 32 collisions also took place between sailing-vessels, one being at anchor and the other under way at the time; but no collisions occurred between steamers under these circumstances. 46 collisions likewise took place between steamers and sailing-vessels, both being under way; and 6 only when sailing-vessels at anchor were run into by steamers. 53 collisions also occurred by vessels breaking from their anchors or moorings. We earnestly trust that the admirable regulations which the Board of Trade have just published to prevent collisions at sea will materially tend to lessen the number of these fearful disasters.

The most disastrous wrecks, with the greatest loss of life, occur between that part of the coast extending from Skerries and Lambay to Fair Head and Mull of Kantyre. During the past thirteen years 1641 lives were lost in that district. The next is from the North Foreland to St. Katherine's Point, which during the same period claims 1136 lives.

The estimated loss of property involved in the destruction of a portion only of the vessels wrecked in the last six years amounted to four and a half millions of pounds sterling, although the total amount, being unreported, cannot be ascertained; but who can appreciate the value of the precious lives lost in those terrible disasters, except those at our seaports and fishing villages who are now widows and orphans or friendless, who have bewailed with unutterable anguish the loss of a husband, father, or near relation?

On the other hand it is most gratifying to find that in these six years 4169 lives were rescued from the jaws of death by life-boats and the life-saving apparatus *alone*. It may be proper to observe that these means of saving life are rarely used except under the most perilous circumstances.

One can hardly conceive a more pitiable sight than a noble ship stranded on a sandbank during a gale of wind, with her crew in the rigging, or firing minute-guns as signals of distress, so that they may obtain help from the shore. On observing these signals the crew of the lifeboat immediately put off. Indeed we know of no spectacle more sublime, or more calculated to send the blood thrilling through the veins with admiration and awe than the cool, determined courage and the lively charity that sends these poor and often half-starved fisher fellows out in the dark night, in the midst of bitter frost and snow, into a tumultuous sea and surf, hungry for their bodies, in the very teeth of a furious wind with death threatening them on all sides, and nothing but their coolness and skill to rely upon to preserve their own lives, to say nothing of the lives of others—leaving wives and families of little ones at home who may never see them in life again. What stout hearts those must be as, yard by yard, they struggle away from the dim shore, lost in an obscurity of scud and surf, and snow, thinking of nothing but their duty—the errand of mercy and charity before them—through the raging tempest—winning their way through seas that to the landsman are fearful to gaze on, even from the safe standing on the beach, momentarily threaten to overwhelm them! Out further and further yet into the dark void a speck on the waters. Another flash of the minute-gun points out where the vessel is lying aground upon a shoal, the sea making a clean breach over her, and the scud and spray flying sheer over her mastheads, which threaten to go every moment. Stand to it, stout hearts! a few more minutes of the heavy toil and the boat will be well in to leeward of the wreck, when the most dangerous part of the whole operation will commence; for there is danger of her being stove in momentarily, either by contact with the wreck itself, or with the floating spars which may be hanging loosely around her. The relief of a wreck is no mere child's play—it often occupies hours of hard, dangerous, and unremitting toil. It is no mere sudden flash of generosity that is required—no enthusiasm burnt out as soon as kindled; but that steady, undaunted "pluck" which distinguishes frequently the highest as well as the lowest class of Englishmen in times of danger. How important then is the work of the National Lifeboat Institution in providing these messengers of mercy on our coasts, and in encouraging noble deeds of daring in the rescue of our fellow-creatures from an awful death.

It may be interesting here to recapitulate briefly the operations of the National Lifeboat Institution, which has now 125 life-boats under its management. During the past year, in addition to saving twenty-one vessels from destruction, 358 lives were rescued by the life-boats of the society. For these services rewards amounting to £915 18s. 6d. were voted. The number of lives saved by the life-boats of the society, or by special exertions, for which it has granted rewards since its formation, is 13,220. For these services 82 gold medals, 733 silver medals, and £17,220 in cash have been granted as rewards. The institution has also expended £75,380 on life-boats, life-boat transporting carriages, and boat-houses. Surely a society which has thus been productive of the greatest services in the cause of humanity, will not have to appeal in vain to the public for help to enable it to continue its merciful work on our dangerous sea-board! We may add that contributions in aid of the great and important work of the National Lifeboat Institution are received by all the bankers throughout the United Kingdom, and by the Secretary at the Institution, 11, John-street, Adelphi, London.

CLAPP AND COATS' IMPROVED ARMOUR PLATES, &c.

One of the most recent plans proposed for armouring vessels, turrets, forts, &c., is that jointly invented and patented by Messrs. Clapp and Coats. As shown in the accompanying woodcuts, it will be seen that the inventors propose using plates of iron or other suitable metal with curved and with flat portions, and through the flat portions pass bolts or rivets to secure the same to the framing of the vessel, turret, target, fort, or structure, in such manner that other curved plates may be placed over the flat portions of the first-mentioned plates and over the joints thereof, to cover and protect such bolts or rivets first-mentioned, the last-mentioned curved plates being bolted or riveted through the first-mentioned curved plates or otherwise, or secured in any equivalent manner, by which means additional strength is obtained and the principal (and, if desired, the major part of) the joints and bolts or rivet heads are protected, so that a single plate shall not receive all the force of any projectile or striking body, but such force be distributed over the whole of the plates, thereby rendering them impregnable if constructed of proper thickness. It is preferred that the plates should be produced by rolling or compressing.

Fig. 1 is a plan view showing how the main plates and completing plates are put together; fig. 2 is a section on the line *a b*, showing com-

FIG. 2.

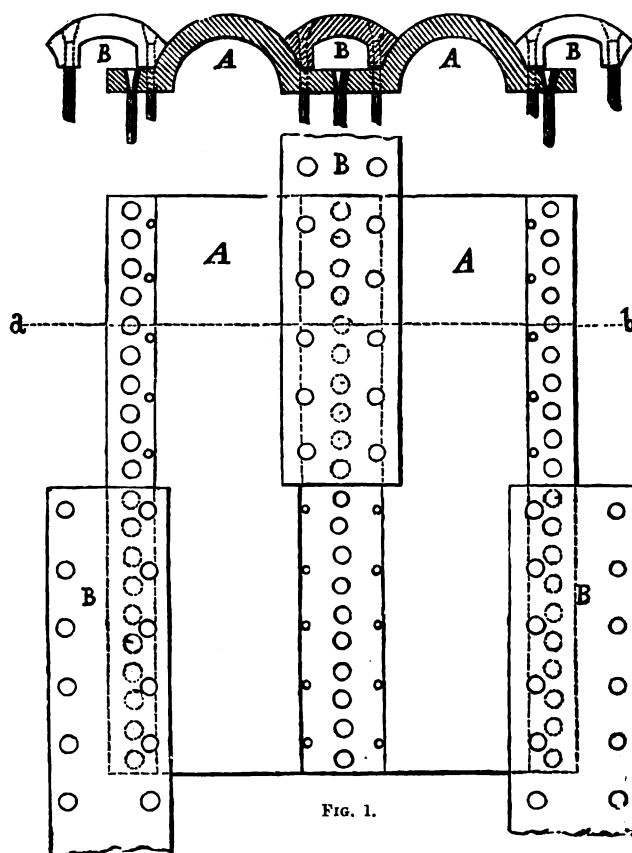


FIG. 1.

pleting plates bolted through from outside; fig. 3 is a section of an arrangement in which a long perforated plate or tongue is fitted in the top of a whole line of the bolts which pass through the main plate, and which plate



FIG. 3.

or tongue takes into a groove. The completing plates may also be secured by an eye-bolt passing through the main plate; a smaller cross bolt or rivet passing through the eye of the said eye-bolt, and fitting into a groove inside the completing plate; or, as a modification of this arrange-

ment, the cross bolt may have an eye, and is fixed on top of the principal bolt. Fig. 4 is a part section of vessel with plates fitted to the side; fig. 5 is an exterior view of part of a ship or vessel with plates fitted.

In the accompanying figures A denotes the main plates, which are bolted to the framing of the vessel, as shown in fig. 1, and then the completing plates B are slid in between them (as in fig. 1 showing this partly effected). The completing plates if to be bolted or riveted through from the outside, to have the bolt or rivet holes brought over the holes in the main plate.

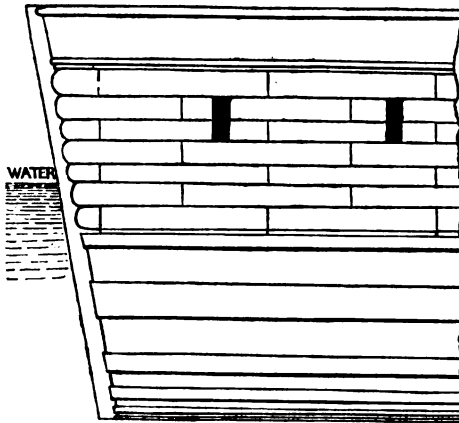


FIG. 5.

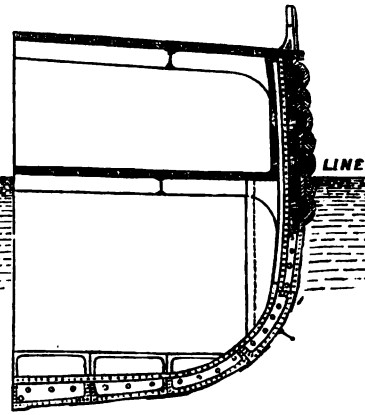


FIG. 4.

PREVENTION OF DECAY AND OXIDATION IN SHIPS.

As the prevention of decay in the timbers of wooden-built ships, and the fouling and oxidation of the plates of iron ships, have received considerable attention from the Admiralty and Merchant Shipowners, the following *resumé* of all the specifications at the Patent-office bearing on this subject is given:—

Dipping timber in boiled oil is a very ancient practice, and it would be difficult to trace its origin. In 1739, Alexander Emerton took out the first recorded patent for preserving wood from decay. He prepared the planks or boards with boiling oil in the then old way, and afterwards coated them with compounded poisons, powdered glass, and sand, cemented with painting colours and oils, laid on as paint. The next patent, which was for preserving copper, or plates of which copper is a basis, was granted in 1790 to Collins and Wyatt. They covered the plates with lead or tin. In the early part of the present century several chemists recommended decoctions, in the form of vegetable poisons, for saturating timber, and thus destroying all animal life in the green wood. None of these poisonous solutions seem to have succeeded, for, had they been found efficacious, their application would have been continued. There was then an interval, during which the stoppage of decay seems to have been abandoned, and dry rot allowed to take its course. In 1822, John Oxford secured a patent, whereby he undertook to prevent oxidation or decay in iron or wood, by preparing tar in such a manner as to stop the evaporation of the oil contained therein, saturating it also with chlorine gas. This purified oil is then mixed with 100 parts of white lead—or of the red oxide—25 parts of carbonate of lime, and 25 parts of purified coal tar added to the oil of tar. These ingredients are then applied as a paint. In the first days of iron in shipbuilding, rust was found to be a drawback to its general introduction. Scientific men saw the disadvantage, and sought to remedy the effect. Galvanic action, it was considered, would set all right, and the earliest patent in this direction was taken out by G. G. Bompas, in 1830. He sought to preserve metals from corrosion by an electric or galvanic process. For copper to be protected in sea water, he attaches an alloy of 9 to 10 parts of zinc with 100 parts of copper. In protecting iron he employed an alloy of tin, consisting of from 10 to 150 parts of tin combined with one of zinc. Following in the footsteps of Mr. Bompas, in the same year, Mr. John Revere patented an invention for fixing zinc protectors to the brace or stud of chain cables, and other iron surfaces exposed to the action of salt water. These galvanic zinc protectors were riveted or soldered on according to requirement. It is known that one of the most distinguished of our electricians is in favour of inserting strips of zinc in the plates of ships; but if this principle proved correct in practice, it would long since have been univer-

sally adopted. Zinc plays an important part in patents for the prevention of oxidation. In 1837, Jacob Perkins got protection for a plan of coating copper tubes of boilers with a preparation consisting of two-thirds of zinc with one-third of copper; but he had been preceded in 1832 by Captain H. W. Craufurd, R.N., who proposed to preserve copper and iron from oxidation by coating with zinc paint in a fused state. Over this he laid a second covering of pure tin, or tin alloyed with lead. Captain Craufurd explains in detail his method of compounding the ingredients. In 1838, Le Comte de Fontainemoreau, considering Captain Craufurd's mode of fixing or adapting the zinc to this purpose as erroneous, applied for a patent of a more comprehensive description, for applying the zinc coating to metals. Again, in 1839, Mr. Thomas Dowling patented what he terms a conservative bath, applied to metals after grinding. He describes the machinery by which he effects this, the chief of which is a zinc wheel and galvanic vapour furnace.

In 1840, Mr. J. R. Neilson came forward with his invention for the application of a coating of copper, or copper alloyed with zinc or tin, or both, to the surface of iron. This was done by covering the mould to be cast with the material. In malleable iron, dried borax or flux is spread over the iron, which is then prepared with alloy heated to a temperature sufficient to melt copper, and, in its heated state, plunged into cold water to detach the scale of oxide. Mr. Arthur Wall, likewise in 1840, mixed 20lbs. of the strongest muriatic acid diluted with three gallons of water, then added 12lbs. of steel or wrought-iron filings. The filings were heated to redness before mixture. The whole was then subjected to heating in a pan, &c., and the composition was then applied to prevent corrosion. In 1841, Mr. W. E. Newton employed silicates of potash, or soda, for making a plaster or coating to prevent iron from becoming rusty. After him came Professor Mallet, engineer, of Dublin, whose varied processes are of the most complex character. Finding that iron covered with zinc, when immersed in sea water, and certain fresh waters, gathered to itself a coating of carbonate of lime, destructive to the protective power of the zinc, and affording a surface for the attachment and growth of marine animals of the molluscos and testaceous classes, and aquatic plants, he applied chemical means to detach the scales of oxide from iron, and then plunged it into a preparing bath. After undergoing a series of processes the metal is coated with an alloy or zoofagous paint, which paint is rendered poisonous by admixture of salts of metals, by means of which he sought to render the zinc effective, as an anti-corrosive protector. In 1841, also, Mr. E. Morewood endeavoured to preserve iron from oxidation or rust by tinning it, and then dipping the tin covering or surface in molten zinc. Mr. Moses Poole, in 1845, claimed to possess an invention whereby he rendered iron more hard and durable, and free from oxidation, by the use of ferrocyanide of sodium, calcium, barium, or any other alkali, or alkaline earthy base; to be used in a manner fully set forth in his specification.

* "Journal of the Society of Arts."

In 1846, Mr. Andrew Smith improved upon the plans for melting the zinc. He employed a bath of lead or tin, or any composition or medium that melts at a lower degree of heat than zinc, by which means the heat from the fire of the furnace is taken up and transmitted to the receptacle containing the zinc for melting. Baron Wetterstedt, in 1846, added the regulus of antimony to lead sheets, combined copper with antimony, made sheet metal by using lead and tin, and lastly, protected metals by paints thus prepared:—1st. One part of regulus of antimony to three parts of copper, mixed, melted together, run out into water, and then heated gently. Two parts of oxide of copper are added, and moistened with naphtha. The whole is then added to a composition of tar and naphtha. 2nd. Another paint is compounded of 3lbs. of tar, 30lbs. of pitch, 20lbs. of dried soot, 4lbs. of tallow from sperm oil, and naphtha added for consistency.

Mr. C. H. Paris, in 1849, coated metals with glass or vitreous matter. The metal went through a cleansing process. Gum water is then applied, and over this the dry or powdered glass is shaken, and then fused by heat till a glass surface is formed. Mr. Paris claimed the application of carbonate of soda for applying glass in this manner. Mr. J. Mactintosh, in 1852, made a paint from decomposed india-rubber, in combination with oils or fatty matters, saponified by metallic salts, with lime for thickening the liquid. For bottoms of ships he recommends the india-rubber, when in a fluid state, to be combined with metallic soap, thickened with lime and coloured by pigments. Messrs. Hughes and Firmin, in 1852, manufactured lamp black from the vapour of coal tar, dead oil, dead oil salts, coal pitch, naphtha, linseed oil, and other materials. From the products a fuel is produced, and this residue has by another inventor been mixed with oils, ground, and made into a paint. In 1852, also, Mr. R. M. Glover took out a patent for a preparation of arsenite of lead and arsenite of copper, and the red and yellow sulphurets of arsenic. The proportion of each were as follows:—Two parts, by weight, of arsenite of lead, one of realgar, one of orpiment, and one of arsenite of copper. In the same year, Mr. J. Murdoch invented a variety of driers for zinc when the white of zinc is employed instead of white lead. The protoxides are manganese, cobalt, iron, tin, and nickel; for acids the benzoic, urobenzoic, and the boric. In 1852, Mr. Binks patented a substitute for linseed or drying oils, in the products derived from dissolving what are called insoluble soaps. A pigment is then ground in this solution, and the paint is ready for application. The pigment may be white lead, oxide of zinc, lamp black, or any other. J. C. Medeiros, in 1853, proposed the use of mercury or quicksilver on iron plates for sheathing ships. The salts of mercury are dissolved, then a bath is formed, and the plates allowed to remain in the solution till their surface is equally and regularly amalgamated.

Mr. Newton, in 1854, made a paint from ground plumbago, pulverised charcoal, and the black soot formed by the burning of bituminous matter, along with ivory-black, or bone or lamp black. Mr. Ryder also, in 1854, described a method for mixing gutta percha with common resin, or tar, or pitch, or asphaltum, dissolving them in impure benzole or coal naphtha. Mr. Newton took out a second patent, in 1854, for the production of a sicative black, brown, or grey pigment or colouring matter, by the admixture with the gas tar, or other organic substance to be carbonised for the purpose of the oxides of potassium, sodium, calcium, aluminium, or other alkaline or earthy bases for paints. Mr. F. Ransom, in 1854, patented a mixture, consisting of ground oxides and carbonates of lead or zinc, and carbonate or sulphate of barytes with soluble silica. Mr. J. Rogers, in 1855, to prevent oxidation, deoxidizes metallic ores by a revolving cylinder, fitted with helical or screw formed divisions to receive the ores in a pulverised state, and then submits the same to heat, and constant agitation by the revolution of the cylinder. Mr. B. Rosenburg, in 1855 manufactured a paint as follows:—100lbs. of triturated white lead, 2½ gallons of copal varnish, 1½ gallons of spirits of turpentine, 1½ gallons of linseed oil, and for colouring, a small quantity of red lead. Before the metal is painted it is subjected to the fire for cleansing, and when cool the preparation is applied, then varnished with copal, and dried by a hot air process. Mr. J. E. Cook, in 1855, proposed a composition consisting of gum shellac, dissolved in methylated spirit or in wood spirit. In 1856, the patent of Messrs. Bancroft and White claims the manufacture of oils from petroleum, for preserving metals and ships sheathing. Mr. A. F. Mennons, in 1856, obtained a patent for a non-conducting and inoxidable composition for metals, made thus:—

Argillaceous elays, containing a certain proportion of alumina	100	parts
Oily substances and residues	6	"
Oil sediment	5	"
Fat	2	"
Animal charcoal	2	"
Mucilaginous substances, such as glue, &c	2	"
Wood sawdust, already employed in the purification of oils in the process of dyeing	10	"
Waste hair well beaten	4	"

To the preceding materials a decoction of logwood and soot is then added.

Mr. J. M'Innes, in 1856, was granted a patent for coating metals with powdered emery stone mixed with a varnish of shellac dissolved in spirits of wine, with the addition of castor-oil. As emery contains 87 per cent. of aluminium, Mr. M'Innes considered that this paint would be solid enough to resist all action in the water, and never decompose. Mr. R. D. Atkinson, of Hull, in 1856, invented a plan for coating and protecting metals from oxidation, by depositing copper or brass upon surfaces of prepared iron, the deposit to be melted in conjunction with carbonic acid gas, the coating to be put on by a brush, or through the medium of galvanism. Depositing brass on iron is now being successfully carried out at Portsmouth, by Mr. Wielan, on armour plates and other iron surfaces. Mr. A. Reid, mineralogist, in 1856, describes in his specification what he deems a sure way of preventing oxidation. He places the iron in a properly constructed furnace, then covers the metal with soot, or other matters possessing the like element; the temperature is then raised to red or white heat, and continued for half an hour, or according to the size of the iron operated upon. It is then suffered to cool, the surface is cleaned, and Mr. Reid asserts that a coat impervious to rust is formed. If this is verified by positive experiments, the cheapness and simplicity of the plan deserve to be widely known. Mr. Joseph Poleux, of New York, communicates, in the same year, a plan to overcome oxidation. He employs muriatic acid, nitric, or sulphuric acid, of the ordinary degrees of concentration in commerce, without dilution, combined with the introduction of spelter into the cleansing process. In 1857 Mr. G. Bedson patented a new process. He melts a quantity of pitch derived from mineral tar, and a proportion of tar oil, with caoutchouc tempered with tar oil and shellac, the substance to be solid and elastic when cold. Mr. C. F. L. Oudry claims depositing copper on a preservative or intermediate coating instead of on the metal. He deposits copper in a pure state to any thickness on all metals. Mr. C. Iles, in 1857, described a means of applying earthy cements to metals. In 1858, Mr. J. Conits received a patent for applying the following pigment by heated air:—

Carbonate of baryta	...	...	...	...	650
Litharge	...	...	...	...	665
Arsenious acid	...	...	...	...	030
Asphaltum	...	...	...	...	050
Oxide of calcium	...	...	...	...	030
Creosote (oil of tar)	...	...	...	...	175

Perhaps the most novel introduction is that patented here by Messrs. Bouchard and Clavel, the Paris bankers, in 1853. On the estate of La Gruerie, in Charney, Department of Yonne, France, is found an earth of the ochre description, called "Burgundy Red." This earth contains most valuable properties, and is said to be an exceedingly good preservative against rust. It is used as a cement and paint by admixture with the following:—

Burgundy red	...	...	...	...	66 parts
Grease or oil	...	...	...	...	15 "
Lime	...	...	...	...	11 "
Unburnt earthenware, chalk, or Roman cement	...	...	...	...	8 "
					100 "

This is said to prevent oxidation if the earth is merely diluted with volatile oil. D. M'Crae, in 1858, was allowed a patent for preserving bottoms of ships from fouling or decay. He applies grease from the cells of boiled bones, kitchen-stuff, and butter without salt; a poisonous matter is mixed with these fatty substances. Mr. G. P. Lock, in 1858, made a composition for the under coating of iron ships, made from iron ore ground in boiled linseed oil 50 per cent., and oil of turpentine 50 per cent., well mixed. For the outer coatings, white lead 40 per cent., blue mineral or coppers 10 per cent., and oil of turpentine 50 per cent. In 1859, Mr. Henry, on the part of Moisant and Co., sought protection for bituminous products and compounds of bitumen for preventing oxidation. Mr. T. J. Labelle made a preparation of caoutchouc paints and colours for vulcanising. Mr. J. Crawford, of Liverpool, in 1859, applied for a patent for a metallic paint or varnish, composed of plumbago, or black lead, fine or gum varnish, arsenic, and spirits of turpentine mixed. Mr. F. W. Emerson, in 1859, prepared an anti-corrosive paint from oxichloride of lead, mixed and ground with oil, turpentine, varnish, or other vehicle. Mr. Weild, in 1859, sought to economise time and labour by a mechanical machine for applying paints to metals on large surfaces. Mr. James Meikle, in 1859, proposed coating iron ships with asphalt. In the same year, M. Auguste Pin dissolved sugar in muriate of zinc, then added wax and soap, in which was incorporated calcareous stones, phosphate of soda, sulphate of zinc, and copper, and the syrup of potatoes or sugar, with powdered marble, quartz, or felspar.

In 1859, Mr. F. G. Spilsbury, of Louvain, applied for a patent for the

manufacture of a paint. He took sulphate of lead, and heated it to a red heat, either by itself or mixed with alumina or other earths; the pigment thus obtained to be washed first with sulphuric acid, then with water, when it is finally dried. Previous to drying the pigments they are digested with salts of tungstic acid, molybdic acid, titanio acid, tantalio acid, arsenic acid, acid of antimony, or other metallic acid, or with mixture of the above salts. A combination between the sulphate of lead and the metallic acid or acids is obtained, and the resulting pigments are dried in like manner after having been cleared from all adhering salts. The pigments may then be mixed with oil and used as a substitute for white lead. Mr. J. F. F. Lecocq, in 1860, prepared a calcareous varnish for coating iron and the bottoms of ships. Mr. H. Kemp, in 1860, patented a composition consisting of peat tar, wood tar, methylated spirit, peat oil, or linseed oil, arsenic, resin and carburet of iron, for preserving ships' bottoms. Mr. Allen's plan of making a coating or anti-corrosive paints for metals is thus given:—Ammoniacal liquid obtained from coal tar or gas tar, prevents incrustation of boilers, and is applicable to painting the inside plates. Messrs. Piie and Smyth, of West Hartlepool, took out a patent in 1860. They employ a red composition and enamel, consisting of a combination of litharge, Venetian red, and pine varnish. Over this composition is applied a coating of resin, gums, or any pitch or bituminous substance, with the addition of coal tar or oil. This is put on in a hot lavastate, and the process is called enamelling. An impermeable oil varnish was patented by M. Antoine Bonet in 1860, composed of 100 parts of alcohol, 100 parts of spirits of turpentine, one part of sulphuric ether, and one of carbonate of soda.

Mr. Robert Smith, shipowner, of Finsbury, applied to the Patent-office, in 1860, to protect his system for keeping vessels from fouling and worming. He applies equal parts of pitch, tar, resin, and turpentine, with any other adhesive compound. Assafetida to be mixed with the foregoing, as a poison to destroy life. When the coating is laid on, and dry, the whole to be covered with paper or cloth. Mr. G. Hallett, in 1860, in his patent explains his method of protecting metal. He grinds the oxide of antimony to powder, then dries it, and mixes with it 12lbs. of linseed oil to the hundred weight of powdered oxide. Mr. Richardson, 1861, to prevent oxidation, would cover the metal with vulcanised india rubber, cloth or gutta percha, the object sought being to provide for unequal expansion of the metal and coating. Mr. Francis Pluz, chemist, 1861, causes oxygen to be passed through sulphuric acid, to render the oxygen more active as an oxidising agent, as it combines when so treated, with other substances for which it has an affinity for manufacturing purposes. Mr. Pluz also, in a second patent, submits oily matters to this oxidising agency, by causing the sulphurated gas to pass through them when in a liquid state. Mr. Martin Miller sends a communication, in 1861, for coating metals or alloys in different ways. Mr. John Hay, in 1861, patented a drying oil. He lays a non-conducting coat, and then makes a paint by grinding in linseed oil the black or protoxide of copper, which is then boiled till reduced to the sub-oxide, and by thus oxygenating the oil he claims to have formed a quick drying cupreous oil. Mr. John Snider, of the United States, patented here a compound, in 1861, for coating metal. He reduces amorphous graphite to fine powder, and then mixes it with ore by the agency of a heated steam pipe. When cool and dry, one pound of oil is added to three pounds of the powder, and when the ingredients are combined, hot pure beeswax, in the proportion of one of wax to 10lbs. of graphite, is mixed. Afterwards linseed oil may be added. Mr. Snider details his manner of manipulating and preparing the graphite and ore. Messrs. Hallett and Stenhouse, in 1861, obtained a patent for the manufacture of pigment for coating surfaces. They employ native oxide of antimony, chemically treated in ways too intricate for explanation in this abbreviated outline, and mixed with red lead or litharge. They sometimes take type metal or worn out types, reduce them to a coarse powder, and then mix them with their own weight of zinc, and calcine them. This produces a yellow pigment.

SHILLITO AND MOOR'S IMPROVEMENTS IN GENERATING HEAT AND MOTIVE POWER.

The importance of being able to burn off usefully fuel from a very small area of grate bars is a desideratum well known. With the view of effecting this desirable object—and of utilising the highly heated gaseous and other products resulting from the combustion of fuel within a closed furnace, coupled with the ability of superheating steam without the necessity for a separate and special superheating apparatus—Messrs. Shillito and Moor, of Hull, have recently invented an arrangement of furnace in which, instead of constructing steam engine and other furnaces in the usual way, and effecting combustion by admitting a free current of atmospheric air beneath the furnace bars alone, or partly beneath the furnace bars and partially through or above the furnace door and on to the burning fuel; (or, as is otherwise usually done) and regulating the combustion of the fuel

by the admission of the current of atmospheric air alone, or aided by a steam blast or jet of steam, and with or without the use of a damper, the furnace is so formed as to burn off the fuel within an air-tight enclosure and the amount of atmospheric air necessary for effecting the combustion of the fuel is forced in under the requisite pressure. The emission or escape of the products of combustion from the furnace and flues and passages is regulated by means of a valve, damper, or regulator, or by valves, dampers or regulators capable of being closed air-tight, and the hopper, door or other means of admitting the fuel into the furnace is closed air-tight to resist the requisite pressure. The shape or internal form, and the dimensions of the furnace must be varied, to suit the particular form of boiler, or the purpose to which it has to be adapted, and the air may be compressed to any extent by the well-known means at present in use, such as by pumps, fans and such like apparatus; and, the pressure at which the air is to be employed within the furnace, as also the rate of combustion, is regulated by the escape of the products of combustion through a regulator in the emission pipe or flue.

The air forced into the furnace, under pressure, may be heated to any required extent before it is brought into contact with the fuel.

The gaseous and highly heated products of combustion arising from the burning off of the fuel within the small close furnace may be passed into the boiler and mixed along with the steam and the mechanical force due thereto thus be utilized.

Instead of employing directly the steam, or the steam and highly heated products of combustion combined together, for the purpose of producing motion in the engine, the boiler and its furnace constructed according to this invention may be placed as closely as convenient to a boiler of the ordinary or any suitable kind, and the highly superheated steam or steam and gaseous products combined (generated in the smaller boiler constructed according to this invention) may be passed into the water contained in the larger boiler and so generate steam of sufficient pressure and temperature for the purpose for which it is required to be employed.

The fuel may be fed into the close furnace by means of a hopper with chambers or drop spaces closed with air-tight slides or valves, or the fuel may be fed in by means of a screw or screws, or any other of the well-known mechanical means, enclosed within a chamber or tube.

In every case it is important to thoroughly protect and encase the boilers and furnaces constructed according to this invention, to prevent the great loss arising from the radiation of heat; and as the employment of compressed air for promoting the combustion of the fuel within the air-tight furnace necessitates a furnace with but a very small cubical capacity as compared with the heat abstracting surfaces, these latter should be of as great an extent as possible, and of the best form calculated to abstract the heat and transmit to the water to be converted into steam.

We may add that some experiments, made with this apparatus, have, we understand, proved of a satisfactory nature; and, as the questions involved are of very considerable importance, we shall hope to be able to again refer to this subject, and lay before our readers the further particulars of the results obtained, when the experiments are concluded.

RAILWAY STATISTICS—LOCOMOTIVE POWER.

Next to traffic charges, the cost of locomotive power is the largest item of the expenses of a railway company. In 1862 the aggregate cost of the railways of Great Britain of locomotive power, including the expenses of all stationary engines, was £3,966,005, or 27·79 per cent. of the gross expenditure of the lines. Locomotive power, of course, includes all the expenses attending the working of the engines by which the trains are drawn; but so much has the cost been felt to depend upon the engine driver, that one of our great companies, not many years ago, entered into a contract with their engine drivers for the working of their locomotives. They were to be paid so much per train mile for working their engines, and were to purchase from the company out of that amount all the fuel and stores they required for the purpose at a fixed scale of prices. Such was the effect of this contract that it was soon found that some of the drivers were netting as much as £20 per week. Of course, the mileage rate was thereupon reduced; and we believe the reductions went on until the drivers at last declined to work at the rates proposed to them. But effect was to bring the locomotive expenses of the company in question to a minimum, to economise the use of stores, and to make the enginemmen doubly careful of their engines.

Fuel forms so large a proportion of the cost of locomotive power, that this item of expenditure is, to some extent, affected on different lines of railroad by the facilities of access which the lines possess to coal fields. It is also somewhat affected by the quality of the fuel consumed. There has been much dispute recently as to the relative cost of coal and coke in working locomotive engines; but the cost of locomotive power on those lines which have used the largest proportion of coal does not appear to show so large a disparity as to justify any decided inference in favour of coal over coke. Accessibility to sources of good supply would seem to be

the principle which should rather govern companies in the employment of fuel. Where a supply of good steam coal can be readily obtained there would seem to be little advantage in using coke; but where there are no coal fields, and the engines have to be supplied with fuel carried over long lengths of railway, the lighter the load of fuel to be conveyed, the less will be the cost to the company for its conveyance.

It must be admitted, however, that there are some disadvantages in the use of coals which do not apply to coke. A considerable item of expenditure under the head of locomotive power, consists of wages to engine cleaners. There can be no doubt that coal is the dirtier article, and that the cost of engine cleaning is increased where coal is used. Whether the employment of coal is more injurious to the engine itself is a disputed question, on which present experience does not, perhaps, justify a decided opinion. Complaints have recently appeared in some of the papers that the use of coal is an annoyance to passengers, from the smoke and dust emitted by the engine in which it is employed. But as to this, it should be observed that where coal is most largely employed, as on the South-Western Railway, it is used in engines which consume their own smoke. Certainly it ought not to be used by any engines that do not consume their own smoke. It is easy enough to apply a smoke-consuming apparatus to a locomotive, and the Railway Clauses Consolidation Act (8 and 9 Vic., c. 20) provides that "every locomotive used on a railway shall, if it use coal or other similar fuel emitting smoke, be constructed on the principle of consuming, and so as to consume, its own smoke," under a penalty of £5 for every day on which such engine is used. But this Act, it should be observed, only applies to railways constructed since 1845.

There is one other inquiry with regard to power that is of great importance. From time to time we hear reports, generally of a vague and unsatisfactory character, of some power having been discovered that is likely to supersede the power of steam as a means of locomotion. Now there is one infallible test which may be applied to all proposals to substitute any other power for the power of steam. The test is cost. Locomotive power applied to railway costs, as already stated, something less than 9d. per train mile. Can any power be invented that is cheaper? At present the disparity in favour of steam, as compared with the cost of employing any other power at our command, is much greater than is generally known. Taking coal as an unit, it has been established that the relative approximate cost of employing the power at our disposal stands thus:—

Coal...	...	...	...	1
Horse power	...	...	...	10
Electric power	...	...	...	70
Manual power	...	...	...	90

Or, to put it in another form, there may be raised for every shilling spent by:—

Manual power	...	600,000lb. 1ft. high.
Electro-magnetism	...	900,000 "
Horse power	...	3,600,000 "
Steam power	...	56,000,000 "

Until, therefore, a power is obtained that can raise more than 56,000,000lb. 1ft. high for a shilling, we may rest satisfied that steam power will continue the great motive power of the world. It was observed at the outset that the cost of locomotive power included the working stationary engines. These are now very few and far between on railways, and employed only for the purposes of hoists, or for the working of inclines. For all purposes of traffic, experience has proved the stationary engine to be more costly than the locomotive, as well as less efficient. In working traffic a stationary engine expends an immense amount of its power in counteracting the friction of the rope by which it has to haul the train; and, besides this cause of expense, it has to be kept in readiness to work both night and day, which necessitates double machinery, so that two stationary engines are required where one locomotive would suffice. In addition to these considerations a stationary engine can only work traffic over a space of some three miles at the most, so that on a railway of one hundred miles in length, more than thirty stationary engine houses would have to be erected, and each with duplicate engines; and each train would have to stop at each station house, in order to detach and affix its ropes. Hence, engines of this class are inapplicable to a continuous system of railway traction, and where they were at one time established, they have been abandoned. On the Blackwall Railway, where the stationary engine system lingered last, it was found that engine power equal to the power of 400 horses was required to draw the train on a level, by means of a rope, the distance requisite for its passage over that line. The cost of working would have, alone, compelled the abandonment of the system had not the exigencies of the traffic otherwise necessitated it.

The locomotive engine is, therefore, the cheapest as well as the most effectual form of applying the cheapest and most effectual power with which science has acquainted us; it will work best and cheapest where the road is the most perfect, and where the least resistance is offered from adverse gradients. The more perfect the surface of the line the less the

tractive power needed, and the less the tractive force, the less the necessity for size, which implies dead weight, in the machine. This naturally leads to the consideration of the next item of railway expenditure—the sum annually spent upon the maintenance of permanent way and works.

Maintenance of Way and Works.—The annual outlay of the railway companies under this head of charge is £2,708,638 a year, or nearly 79 per cent. of the total expenditure. The cost of maintenance of permanent way varies on different railways from 4d. to 8½d. per train mile, the average being about 6d., at which figure some of our largest railways stand. High speed must be regarded as the main governing cause, at the present time, of the expense of maintaining permanent way; and a calculation of the relative outlay of different railway companies under this head certainly appears to bear out this conclusion. Contrasting the cost of these works upon four of our railways, over which trains are run at very high speeds, with the cost on four lines which have equally heavy traffic, but on which trains are run at more moderate speeds, we find the following results:—

Railway.	No of miles.	Cost of maintaining open way, &c.	Average per mile.
South-Eastern.....	286	£105,254	£368
Great Northern	414	141,670	342
North-Western	1196	393,664	321
Great Western	730	232,040	314
South-Western	515	131,775	256
Midland	647	161,645	250
North-Eastern	895	181,099	202
Great Eastern.....	660	132,805	201

This table is somewhat remarkable as showing the effect of speed alone; because it may be fairly assumed that as regards the weight of the load, the four last-mentioned railways are pretty much on a par with the four first mentioned—the South-Eastern with the South-Western, the Great Northern with the Midland, the North-Western with the North-Eastern, and the Great Western with the Great Eastern; and yet it will be observed that the disparity in respect to the average cost per mile per annum for maintenance of way between the highest speed and the more moderate speed lines is very considerable.

In the case of some lines the exigencies of permanent way have been so much felt as to necessitate experiments of new materials. In the last report of the London and North-Western Railway Company it was stated that they had made a trial of a new description of rail made of steel:—

"The results are important and satisfactory. Some of the rails were laid down at Rugby, Stafford, and Crewe, in March, 1862, and are wearing well. In May, 1862, some were laid down at Camden parallel with the best description of iron rail. So severe was the test that the iron rails speedily gave way, and had to be frequently renewed, worn out, whilst the steel rails continue to show little appearance of wear. Having regard to the importance of procuring the most efficient rail, so as to avoid the frequent renewal now found necessary on the main line and at the principal stations, the directors have found it expedient to adopt and substitute the steel rail to that extent at least, and having agreed with Mr. Bessemer as to the royalty to be paid for the use of his patent, they have made the needful arrangements at Crewe for the production of steel to the extent of 10,000 tons per annum."

Opinions may, and probably will, differ as to the advisability of producing these rails at Crewe, where a first expenditure of no less than £38,000 is required to be incurred for the "erection of steelworks," besides £16,000 for "additional water supply;" items that the shareholders may expect to see very largely swollen in future "requests for votes." But there will be but one opinion as to the desirability of adopting upon this important railway the very best and most lasting description of rail, that which will stand the hardest work, and necessitate the least interruption of the line during renewals. To the North-Western, almost beyond all other lines, it is important to have a durable permanent way; but other companies will watch with no little interest the experiment which the London and North-Western are about to make in adopting "Bessemer's patent" for the passage of "limited mails" and "monster engines."—*Mining Journal*.

REVIEWS AND NOTICES OF NEW BOOKS.

Chemical Technology: or Chemistry in its applications to the Arts and Manufactures. By THOS. RICHARDSON, M.A., Ph. D., F.R.S.E., M.R.I.A., &c., and H. WATTS, B.A., F.C.S., Ed. "Journal of the Chemical Society." Second Edition. Illustrated with numerous wood engravings. Vol. I. Part 3. Nos. 1 and 2. London: H. Baillière, 219, Regent-street, 1863.

The rapid strides which during very few years have been made in the application of chemistry to the arts and manufactures, and the numerous and important innovations constantly occurring in chemical technology, having rendered valueless the few good works of reference to which the chemical student and the manufacturer were wont to turn for reliable technical information, the absolute necessity, therefore, of such a work as that under notice cannot be over-estimated, and by no abler hands could the task have been undertaken than Dr. Thos.

Richardson and Mr. H. Watts. The several processes described in the two parts under notice are treated in the most able, clear, exact, and comprehensive, yet succinct manner, and are illustrated by numerous woodcuts interspersed throughout. In fact, the book is excellent in every particular.

A Practical Treatise on the Science of Land and Engineering Surveying, Levelling, Estimating Quantities, &c., with Illustrations. By H. S. MERRETT, Architectural and Engineering Surveyor. London: E. and F. N. Spon, 1863.

We congratulate the author of this book on the successful result of his labours. He has treated of land and engineering surveying in so admirable and complete a manner that there really seems—after a careful perusal of his book—nothing left undone, or for future writers on the subject of surveying to do. The student will find Mr. Merrett's work a perfect *vade-mecum*.

Industrial Biography.—Iron Workers and Tool Makers. By SAMUEL SMILES, author of "Lives of the Engineers," &c. London: John Murray, Albemarle-street, 1863.

Whatever the subject Mr. Smiles essays to treat, success beyond the utmost aspirations of mortal authors invariably attends upon his efforts, therefore, it is needless to inform our readers that the present work, by Mr. Smiles, is a highly interesting book, treating of men to whose genius this country mainly owes its proud pre-eminence amongst the civilised nations of the earth. Amongst those selected by Mr. Smiles for biographical notice, we find mention of the great and well-known names of the Darbys and Reynoldses, Benjamin Huntsman, H. Cort, D. Mushet, J. B. Neilson, and others connected with the production of iron and steel, and of Joseph Clement, Fox of Derby, Murray of Leeds, Roberts and Whitworth of Manchester, James Nasmyth and William Fairbairn, as mechanical engineers and inventors.

A Record of the Progress of Modern Engineering: Comprising Civil, Mechanical, Marine, Hydraulic, Railway, Bridge and other Engineering Works. Edited by WM. HUMBER, Assoc. Inst. C.E., Mem. Inst. M.E. Part 10 and 11. London: E. and F. N. Spon.

In the part for October 1st, besides giving two plates of details connected with the Lambeth Suspension-bridge, we perceive a great improvement, to our mind, has been introduced for the first time by Mr. Humber into "The Record." He has given some external views and sections of "The Allen Engine" (American), which engine, by-the-by, at first sight, appears to be a "screwed and lop sided" sort of thing, and having apparently scarcely any other peculiarity or merit, except, perhaps, that of difference, as compared with the best designs of properly disposed material, and balanced moving parts in horizontally arranged engines, with which we are familiar. We hope Mr. Humber will continue to issue the parts of "The Record" monthly, as heretofore, instead of (as we perceive it is announced in the November part) in a half-yearly or annual volume.

Experimental Researches in Steam Engineering. By F. ISHERWOOD, U.S. Navy. Vol. 1. Philadelphia: William Hamilton, Hall of the Franklin Institute, 1863 (and to be had of H. Baillière, Regent-street, London.)

The author of this elaborately got-up work, the first volume of which has just issued from the press, is already favourably known to the readers of THE ARTIZAN as the chief of the bureau of steam engineering in the navy department of the U.S. Service, and an extensive experimenter in steam economics.

The books previously written by Mr. Isherwood, and noticed from time to time in THE ARTIZAN, are, in a sense, fragmentary works, although possessing great interest; but the present work appears to have been undertaken by the author "with an exhaustive intent;" and judging by the quality and quantity of the matter presented in Vol. 1, he must have laboured hard and successfully to have strung together the results of so many experiments—some of them long continued, and many of them faultlessly conducted.

The branch of steam engineering to which Mr. Isherwood, in his present work, more especially addresses himself, will be best conveyed by citing from the front page. "The experimental researches have been made principally to aid in ascertaining the comparative economic efficiency of steam used with different measures of expansion, and the absolute cost of the power obtained therefrom in weights of fuel and steam; the causes and quantities of the condensations in the cylinders; the economic effect of steam jacketing, and steam superheating, and of various proportions of cylinder capacity for the same weight of steam used per stroke of piston; the economic and absolute evaporative efficiencies of boilers of different types and proportions; the comparative calorific values of different coals as steam generators; the performances of U.S. war screw steamers, &c. The whole being original matter, composed of extensive experiments made by the U.S. navy department."

Amongst the various experimental researches, of which exact details are given, we may quote the following:—

"Comparative experiments on steam in the saturated state, and adheated according to Watermann's system, made with a view to determine their relative economic efficiency in support of fuel to power developed by a steam engine."

In these, as in all the following experiments, very ample details are given, and the dimensions of the engine and apparatus, boilers, &c., a description of the manner of making the experiments, and tabulated results are so well arranged as to readily and correctly present the whole to the mind of the reader.

The pumping engine of the Brooklyn Water-works is described, and the results in the same methodical manner.

Then follows a report made to the navy department by the Board of the U.S. Naval Engineers, convened on board the U.S. steamer *Michigan*, at Erie, Pa., Nov. 19th, 1860, to determine the relative economy of using steam with different

measures of expansion. Additional remarks in connection with the foregoing report are given, and some pertinent observations on the truth of the indicator as a meter of power, on the dynamic value of one pound of steam, used without expansion, the causes of the condensation of steam in the cylinder, the value of steam jacketing and steam superheating, and on the application of the laws of Mariotte to vapours and gases.

A very interesting series of experiments on the evaporation given by the vertical water tube boilers of the U.S. steamer *Michigan*, with the Ormsby and Brookfield coals, and with the anthracite used in the experiments made with the machinery of that vessel, to determine the relative economy of using steam with different measures of expansion. The results here defined, and those made with boilers, &c., of other ships are valuable.

A large number of details are given of the U.S. screw frigates *Merrimac*, *Wabash*, *Minnesota*, *Roanoke*, and *Colorado*, and their machinery, and the logs of these vessels when working under various conditions; and a comparison of their performances are deducible therefrom.

The U.S. screw sloop *Brooklyn* is described, and her dimensions, and that of the engines, boilers, and machinery, and their respective performances are given in detail.

The experiments to determine the evaporative efficiency of the boiler of the U.S. steamer *Jacob Bell*, with anthracite, are given in detail, and the results tabulated.

Experiments to determine the evaporative efficiency of the U.S. steamer *Mount Vernon*, with anthracite, and with Cumberland semi-bituminous coal and experiments to determine the evaporative efficiency of the U.S. steamer *Valley City*, with anthracite, and with Cumberland semi-bituminous coal, and experiments to determine the evaporative efficiency of the U.S. steamer *Crusader*, with anthracite, will have great value assigned to them by the English marine engine builders.

Experiments to determine the relative evaporative efficiency of the boiler of the U.S. steamer *Wyandotte*, with the usual arrangement of furnace, and with the "Amory-bridge" applied. Also to determine the relative evaporative efficiency of the boiler with Blackheath anthracite, and with broad top semi-bituminous coal, under various conditions of thickness of fire, and of admission and suppression of air through holes in the furnace doors, are all useful in their way, and will prove valuable when contrasted with the results of English experiments.

Experiments to determine the evaporative efficiency of the *Underwriter*, with Anthracite and Cumberland semi-bituminous coal, and experiments to determine the evaporative efficiency of the *Young American* with anthracite.

The foregoing very comprehensive experiments upon the several steam boilers of vessels in the U.S. navy will prove of the highest possible interest to our engineering friends "on this side Jordan."

A series of experiments were made on the machine shop boilers of the New York navy yard, with Locust Mountain and Blackheath anthracite, to determine their relative evaporative efficiency; and, also, the effect produced upon the economic evaporation of the boiler by continuously diminishing its heating surfaces and calorimeter by stopping up successive rows of tubes; and another series of experiments made with the machine shop boiler of the New York navy yard, on the anthracites, semi-bituminous, and bituminous coals from the principal localities mined for the New York and Philadelphia markets in 1862, to determine their comparative evaporative efficiency, are useful, particularly when the exact character of each fuel used is known, and can be compared with the various English coals.

Experiments made with the machinery of the U.S. iron-clad steam battery *Monitor*, to determine the cost of the indicated horse-power in pounds of steam and fuel per hour, when using the steam expansively and without expansion; and to determine the evaporative efficiency of the boiler with anthracite; and, finally, experiments made with the machinery of the U.S. iron-clad steamer *Pasaic*.

Each series of experiments is completely worked out and generally tabulated; and wherever it is possible to give an illustrative diagram or a plate engraving, the author has introduced it.

Mr. Isherwood has been unsparing in his labours to render the work complete, and he has succeeded; and we shall hail with considerable satisfaction the appearance of the next, and of any additional volumes of "Experimental Researches in Steam Engineering."

BOOKS RECEIVED.

"The Glasgow University Calendar for the Session 1863-4." Glasgow: Geo. Richardson. University Press, 55, Glassford-street.

"Description of Richards' Improved Steam Engine Indicator," with directions for its use. By CHARLES T. PORTER. London: Elliott Brothers, 440, Strand, 1863.

NOTICES TO CORRESPONDENTS.

J. B.—Your communications are attended to. We have given the necessary instructions, and shall be glad to hear from you from time to time.

INQUIRER.—We have now in course of preparation some particulars of steam vessels, which we purpose giving in an early issue. The vessel to which you refer will, if possible, be included in our list.

J. W. W., Newcastle-on-Tyne.—We await receipt of your decision, and the particulars promised.

R. Y.—There is a system of working railways by stationary engines, which should meet the requirements of the case to which you allude. We refer to

that of Messrs. R. and W. Hawthorn, of Newcastle-on-Tyne, who read a paper upon the subject at the last meeting of the British Association. You will find a description and illustrations of the plan in THE ARTIZAN of last month.

W. C. R.—Communications received, and the particulars used with thanks.

X.—The steam trap to which you refer is the invention of a Mr. G. W. Furnan, of New York, and we have, at your request, given illustrations of the apparatus. Figure 1 is a sectional view of the trap. A, the outside shell; B, the globe or float; C, a slide valve on the stem; D, the passage through which the water

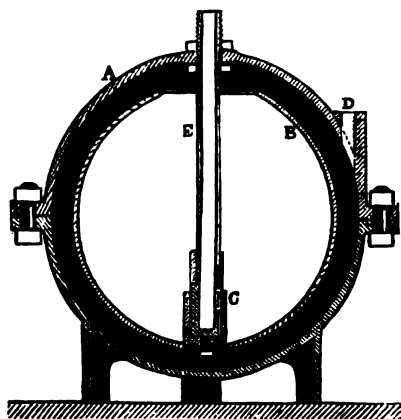


FIG. 1.

enters the trap; and E, the stem through which it is passed off. When the trap is set, there is water enough poured into the outside shell A, to float the globe B, and close the valve C, which will remain closed, preventing the passing off of either steam or water until the latter has filled the globe and sunk it, when valve C opens, and the pressure of steam forces the water through pipe E. So soon as the water has passed out of globe B, it will rise and valve C close, preventing the passage of steam as before. Fig. 2 illustrates the mode of attaching the trap to the steam chest of a vertical engine.—*Directions for using the Trap.* When this instrument is attached to an engine, the check-

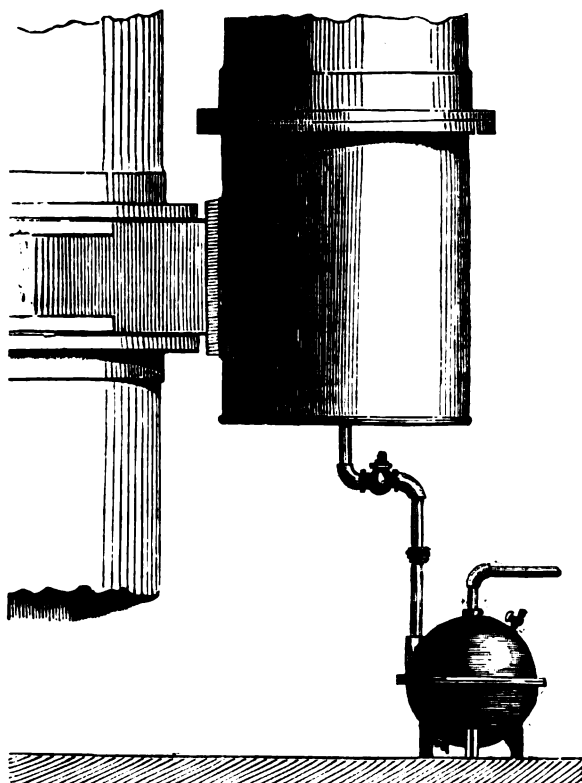


FIG. 2.

valves must be placed horizontally, so that the water will flow freely through them. The same end of the valve that is placed next to the pump for feeding the boiler, must be placed nearest to the flow of water from the engine. It

requires to be so far filled with water, before first getting up steam, that globe B will float. If, by any accident, the slide-valve C becomes obstructed, and the steam blow through, it will be necessary to add sufficient water to again float globe B, which may be done by closing the cocks in the connexions, so far as to permit the water to pass into the trap in small quantities, or by pouring it through the hand-hole. Before starting the engine, after lying idle for several hours, open the air-cock on the top of shell A, and let it remain open until the air collected in the engine has passed through it. The valves connecting the trap with the engine *should always be open*. When much lubrication is resorted to in the cylinder, the check-valves may occasionally require to be cleaned of gum or grease. If, from the same cause, the slide-valve C becomes obstructed, it may be relieved by putting a small quantity of

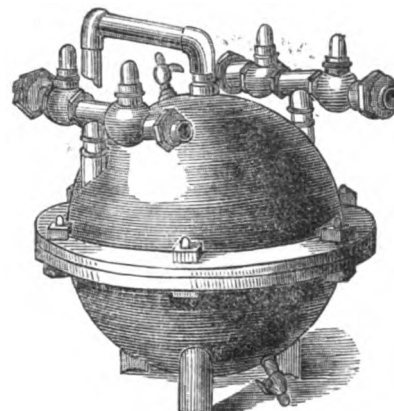


FIG. 3.

potash in globe B. So, too, if there ever be an accumulation of grease in shell A, it can be cleaned in the same manner. The trap can be relieved of dirt by removing the bonnet from the lower hand hole, and blowing steam through it. Fig. 3 illustrates the manner of attaching the trap to locomotive engines.

ERRATA.

In THE ARTIZAN for November, the following *errata* occurred at page 247, descriptive of Messrs. R. and W. Hawthorn's Method of Working Railways by Stationary Engines. Paragraph 6 from top, line 4, for *guard*, read *driver*. Paragraph 10 from top, line 3, for *bridges*, read *bogies*. Second column, line 2 from top, for *unmeaning* read *unnecessary*. In the Discussion, paragraph 9, line 1, for *using* read *wearing*.

RECENT LEGAL DECISIONS AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artisan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

SPENCER v. JACK.—This was an appeal from an order of the Master of the Rolls. The plaintiff was an engineer at Newcastle, and in July, 1880, he took out a patent for an improved method in condensing steam for working steam-engines on board ships. It appeared from the specification that the plaintiff claimed as his invention a new combination of well-known matters—namely, surface and jet condensers of steam, which produced new and valuable results. The bill was filed to restrain an alleged infringement of the patent of the defendant's engineers at Liverpool, and, upon the application to the Master of the Rolls for an injunction, his honour directed issues at law to try whether the patent of the plaintiff was a new and useful invention, whether it had been sufficiently described in the specification, and whether there had been any infringement of it by the defendants. The jury found in favour of the plaintiff on all the issues, and an application for a new trial was made to the Master of the Rolls on the following grounds: First, that there had been a misdirection of the Lord Chief Justice of the Common Pleas; second, that the verdict was against the evidence; third, that there had been a miscarriage; and fourth, that the defendant had been taken by surprise. The Master of the Rolls granted a new trial, and, upon appeal from that order to the Lords Justices, their lordships suggested that the matter should be brought before the Lord Chancellor. The Lord Chancellor said that, looking to the facts as submitted to him, he must find for the validity of the plaintiff's patent, at the same time he did not consider that there had been an infringement of it by the defendant such as would come within the term of the plaintiff's specification. He must reverse the order of the Master of the Rolls for a new trial, but dismiss the plaintiff's bill without costs.

CLIMIE v. BUCKLEY RAILWAY COMPANY.—AWARD OF ARBITRATORS.—The plaintiff in this case had constructed the defendants' railway upon a contract, but there being a large claim for extras, a dispute arose, and the matters were referred to arbitrators, who

awarded that the defendants should pay the plaintiff £10,624 7s. 1d., and £902 4s. 5d. A few days ago the court granted the usual rule calling upon the defendants to show cause why they should not pay the above sum pursuant to the award. Mr. Lush, Q.C., and Mr. Watkin Williams, in showing cause, stated that one of the conditions of the contract was that the plaintiff should accept in part payment any number of shares not exceeding 400, at their nominal value of £10 each. The plaintiff, however, now contended that he was not bound to take the shares, because the arbitrator had awarded him so much money; but it was submitted to the court that the arbitrator had simply fixed the amount due, without in any way interfering with the mode of payment settled by the contract. Mr. Gray, Q.C., in support of the rule, stated that there had been certain proceedings in parliament varying the formation of the company, so that the existing shares were not the same things as those mentioned in the contract. Besides, all the shares had been allotted, but after the award the company went into the market and bought shares to tender to the plaintiff. After some discussion it was arranged that the question whether the plaintiff was bound to accept the shares, should be tried by an action or a special case, and that the remainder of the amount awarded should be paid.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, as early in the month as possible, to the Editor.

MISCELLANEOUS.

STEAM HAMMER.—Messrs. Thwaites and Carbott, of Bradford, Yorkshire, have recently finished a 15-ton steam hammer of large size. It has an 8ft. stroke, and the standards, which are on the hollow box principle, are 20ft. wide and between 18ft. high, so as to give ample room for the men to work under. The hammer itself weighs nearly 70 tons; the anvil, block, and bed plate, 150 tons. Although it is made on the Nasmyth principle, it has a few novelties about its construction. The great width and height between the standards, necessitates a means of staying the two together, to prevent them from spreading, in consequence of which they were brought together and bolted up the middle; and instead of a rectangular tup, these have been bored out, and a round tup used; also, by this means, greater resistance is interposed to the strains of a side blow. To insure lightness and strength in the piston, so as to lessen the strain on the piston rod, it has been made of steel lin. thick, with a double corrugation.

SUPPLY OF COTTON.—Mr. Cheetham gives the following estimate of the amount of cotton likely to reach next year:—India, 1,500,000 bales; Egypt, 300,000; Brazil, 185,000; America, 100,000; West Indies, 35,000; Turkey, 150,000; China, 150,000; Italy, 25,000; total, 2,445,000 bales. The final and practical conclusion drawn by Mr. Cheetham is that, instead of four days and a half work per week, as Mr. Ashworth believes, the mills will work only four days. He also conjectures, in opposition to Mr. Ashworth, that the month of January at any rate must be expected to pass before any considerable portion of this supply will be available, so that, upon the whole, instead of seeing the cotton trade revive at the very beginning of the year, and continue active at the rate of four days and a half a week, we must expect to wait till spring for the recovery, and then deduct half a day per week from the average working time of the mills.

STEAM ENGINES.—It appears that, notwithstanding the great progress which the colonies and continent have made in the production of steam engines of late, the demand for British motors of this description was larger last year than ever. Thus, the value of steam engines exported in 1849 was £234,182; in 1849, £152,519; in 1850, £423,977; in 1851, £403,637; in 1852, £338,222; in 1853, £459,378; in 1854, £568,789; in 1855, £683,370; in 1856, £819,067; in 1857, £1,069,246; in 1858, £1,097,279; in 1859, £937,340; in 1860, £1,238,333; in 1861, £1,258,164; and in 1862, £1,631,781. Probably the demand for locomotives for Indian and Australian railways has swelled the figures of late years; but, whatever the cause, the state of affairs indicated must be regarded as satisfactory.

NEW PIER AT BANKSIDE, SOUTHWARK.—On the 2nd ult. a new and commodious pier, constructed by the Conservators of the River Thames, in compliance with a requisition from a large body of traders and inhabitants of the Southwark side of the river between London-bridge and Blackfriars-road, was opened for the landing and embarkation of steamboat passengers. The new pier communicates with Emerson-street, Southwark, and is nearly opposite St. Paul's Pier, Queenhithe. It will open up the river communication for a long time required between the north and south sides of the Thames, and supply the deficiency of accommodation caused by the removal of the pier at Southwark-bridge. It is understood that steps will be taken for extending similar pier accommodation to other points and places on the Surrey side.

COTTON CULTURE IN SICILY.—Professor Francesco Tornabene, manager of the Simeto Embankment Company of Catania, has just published his report, addressed to the Commissioners of Agriculture of Sicily, on the results of the irrigation works connected with the embankment of the above river. It appears from this return that on the shores of the Simeto 2263 "salme," equal to 877.43 acres of land, are at present planted with cotton, 68 "salme," or 250.3 acres of which belong to the order of the Benedictines. The irrigation of the ground takes place four times per month, at a rate of 1.566 litres of water per "salma legale," i.e., 22.147 cubic inches of water per acre of ground. The quantity of seed used has been hitherto 13 quintals on each salma, or 0.99 lbs. per acre. The species of cotton planted is the white and red Siam (Gossypium Siamense). The report does not state what results have been derived hitherto from the culture of cotton on the Simeto.

THE RIVER TEES.—An important work has been commenced at the mouth of the river Tees. The foundation-stone of an extensive breakwater has been laid. The object of the breakwater is not only to improve the navigation of the river Tees, but also to increase the safety of the estuary of that river, so that it may serve as a harbour of refuge for shipping which may be caught in the many gales which prevail on the north-east coast. The work, which it is calculated will cost several hundred thousands of pounds, will be performed from plans by Mr. John Fowler, engineer, under the auspices of the Tees Conservancy Commissioners, who have obtained £30,000 from the Public Works Loan Commissioners. Although the foundation-stone of the breakwater was not laid until very recently, the work of the breakwater itself was commenced more than a year ago. Many thousands of tons of "slag," or refuse, from the ironworks of the district have been deposited on the line of the intended pier, the "slag" wall now stretching a mile or so across the beach from the water line, a mile west of Redcar towards the sea. The "slag," it is said, has been obtained at the nominal cost of 4d. per ton.

THE LONDON COAL TRADE.—For the month ending the 31st of October last, 503,205 tons 4 cwt. of coal and coke were entered in the port of London, against 438,301 tons 16 cwt. for the corresponding month of 1862, showing the large increase of 64,903 tons 4 cwt. Of this quantity 192,859 tons 14 cwt. came by railway, viz., Great Northern, 74,199 tons 8 cwt.; London and North-Western, 72,743 tons 1 cwt.; Great Eastern, 22,538 tons 8 cwt.; Great Western, 10,733 tons; Midland, 8596 tons 13 cwt.; South-Western, 3251 tons 7 cwt.; Chatham and Dover, 684 tons 17 cwt.; and Tilbury and Southend, 58 tons. Up to the 31st of October for this year the quantity by railway has been 1,430,013 tons 12 cwt. against 1,186,450 tons 17 cwt., so that 243,562 tons 15 cwt. more coal has been received at London this year than in the first 10 months of 1862. The canal receipts have been 631 tons 10 cwt., against 1190 tons 15 cwt. for October, 1862, and this year this particular traffic has declined 8101 tons 15 cwt., as against 10,200 tons up to October 31st, 1862, or a decline of 2088 tons 5 cwt. The seaborne coal reaches 306,614 tons, being a slight advance upon the tonnage of October last year, when 302,845 tons were entered. The quantity from Newcastle-upon-Tyne was 118,065 tons; Seaham, 17,407 tons; Sunderland, 97,318 tons; Middlesbrough, 6931 tons; Hartlepool and West Hartlepool, 53,033 tons; Blyth, 1519 tons; from Wales, 6218 tons; from Yorkshire, 3115 tons; from Scotland, 1451 tons; and from Duff, 317 tons. Small coal, 2727 tons, and 1585 tons of cinders. Comparing the present year with the last, the seaborne coal has declined considerably, for whilst, in the first 10 months of 1862, 2,770,469 tons of coal came to hand in 8540 ships, this year it has been 2,692,908 tons in 7963 ships, or a diminution of 576 ships and 77,561 tons.

GOVERNMENT EXPERIMENTS WITH STEAM COAL.—In consequence of the repeated applications made by the North country proprietors, a series of experiments, extending over five weeks, have been concluded at the Devonport dockyard. The Admiralty were induced to make these experiments in consequence of the assertion of the North country owners that a judicious mixture of the North country or Hartley coal with the South Wales steam coal was far superior for the purposes of steam than either taken separately. The South Wales proprietors, feeling the importance of the issue, appointed Mr. Tomlinson, locomotive engineer to the Taft Vale Railway, as their representative; and, although some time must elapse before the official report is printed, it may be stated that the results will show that in no way has the superiority of the Welsh coal been affected, but, on the contrary, none of the mixtures experimented upon came up to the generating powers of the Welsh coal taken alone. This must be a gratifying result to the South Wales owners, who, in addition to the navy, have been supplying for some time past large private steamship companies—such as the Royal Mail, Peninsular and Oriental, and Cunard lines, which fact may be taken as presumptive evidence of the superiority of the Welsh coal, as these companies have every inducement to purchase the best article in the market. It is probable that when the official report of these trials is published the question of Welsh v. North country steam coal will be permanently settled.

TURBINES ON A SMALL SCALE FOR DOMESTIC AND TRADE USE.—In a house at Manchester, a water-wheel 4ft. in diameter, consuming fifteen gallons of high-pressure water per minute, formerly employed to work the bellows of an organ in the drawing-room over the cellar wherein the water power was produced, has been replaced by Mr. Schiele, with a turbine only 12in. in diameter, with a 3in. case 12in. wide, supplied by a 1in. pipe, and consuming less than a gallon of water per minute. By a simple regulator the organist can supply his instrument with the required wind by simply giving a turn to a handle near the organ. By availing themselves of the ample supply of high-pressure water in Manchester and other towns, "all persons using machines requiring a small amount of power, now appear to have supplied to them by this invention the means of working their machines with no trouble and at a trifling cost, while at the same time this kind of turbine appears to be equally well adapted for turning large mills and works, even when they require several hundred of horses' power."

THE MIDDLE LEVEL.—It appears from the accounts for the financial year ending April 6, 1863, that the sum of £86,671 was disbursed during that period—£57,714 in reference to works consequent on the failure of the out-fall sluice. A leakage and some disturbance at the syphon dam and works have lately occurred, and Mr. T. E. Harrison, C.E., came down for the purpose of making an examination with Mr. Lunn, the resident engineer. Mr. Lunn has given directions to have some puddle prepared, and the men employed will open out as far as they can the course of the water, and will then fill the excavated space in with puddle. It appears from the accounts that in the commissioners' last financial year the amount taken up on loan was £71,000, the bonded debt of the commission being thus increased to £461,000. The amount paid for interest was £16,693, and the sum received in taxes was £24,091, while the other ordinary necessary receipts of the year were £820. A temporary loan of £20,000, contracted in 1862-3, has been paid off.

PNEUMATIC DESPATCH TUBES.—The Pneumatic Despatch Company are about to lay down an enormous tube for the transmission of letters and parcels from their station in Holborn to a station to be established near the General Post-office, in St. Martin's-le-Grand. It appears a tube of that kind already exists between the North-Western district post-office, in Eversholt-street, and the Euston terminus of the London and North-Western Railway, and that the letters have been carried between those parts since the beginning of February last. It is now proposed to lay a tube from the Euston Station, through Woburn-place, Southampton-row, and King-street to Holborn, and thence along Holborn, Skinner-street, and Newgate street, to the General Post-office. This tube is to be of cast iron, 4ft. high and 4ft. 6in. wide, internally. At the city boundary it will be 11ft. 6in. deep, and at Hatton-garden 18ft. 6in., from which point its depth decreases. The tube will pass over the Fleet sewer at a depth of 6ft., and then under the London, Chatham, and Dover Railway. At the west end of Newgate-street it will be 25ft. deep, and at the east end 14ft.; its mean depth in St. Martin's-le-Grand being 12ft. When completed, the transmission of all letters in bulk between the General Post-office and the North-Western Railway will be effected by its agency, as will also large parcels of goods. An arrangement has been made with Messrs. Pickford to forward parcels from their depot in Gresham-street to the North-Western Railway, and an extension of the tube into their premises is ultimately contemplated. This line of tubing, moreover, is understood to be but the commencement of a system which is to be eventually extended to the various metropolitan railway stations, and probably to connect all the district post-offices in London. The Pneumatic Despatch Company have powers under their act to lay down tubes within the city, subject to certain control or direction on the part of the Commissioners of Sewers.

HOLBORN VALLEY IMPROVEMENT.—Notice of intended application to Parliament in the next session has been given, to authorise the Corporation of London to make a viaduct

for the purpose of a high-level street commencing on Holborn-hill, near Ely-court, passing Hatton-garden, Ely-rents, Ely-place, and terminating in Skinner-street, near the Old Bailey. The following improvements are specified in connection with the scheme:—A new street, commencing near the junction of Hatton-garden with Holborn-hill, and terminating in Farringdon-road, near West-street; a new street, commencing near St. Sepulchre's Church, Skinner-street, and terminating in Farringdon-road, about 50 yards to the north of Snow-hill; a new street, commencing by a junction with Shoe-lane, near St. Andrew's Church, passing under the viaduct, and terminating in the intended new street, at a point about about 45 yards west of its intended junction with Farringdon-road; a widening on the western side of Farringdon-road, commencing near Newcastle-street and terminating about 230ft. north of New Charles-street; power to alter and improve the levels of the western approach to the Metropolitan Meat and Poultry Market in Smithfield; to widen the western end and northern side of Newgate-street, commencing at the corner of Giltspur-street, and terminating at and including No. 105, Newgate-street; and to widen King-street, commencing near its junction with Snow-hill. Powers are also sought to charge the expenses of the works to be authorised upon the duty referred to in the 2nd section of the London Coal and Wine Duties Continuance Act, 1863, to authorise the appropriation to that purpose of any monies arising from that duty, and to authorise the corporation to raise money on mortgage or annuity, and to apply for the above purposes any monies under their control.

NAVAL ENGINEERING.

TRIAL OF THE SCREW LAUNCH "EXPERIMENT."—The official trial of this little craft, which has been fitted by the steam factory department of Portsmouth dockyard expressly, by order of the Admiralty, in order to obtain certain data relative to the merits of the double or twin screw system, has taken place. The *Experiment* is a first-class line-of-battle ship's launch, 42ft. in length, and of proportionate breadth and depth. Her engines and boilers have been made for her according to the designs of Mr. Andrew Murray, the engineer of Portsmouth dockyard, and are models of workmanship and compactness of form. Boiler and engines occupy a space in the centre of the boat of only 6ft. 11in. by 4ft. 4in., the nominal horse-power of the engines being 3, the length of the stroke of the piston 6in., and the diameter of cylinder 4in. The total weight of engines and boilers, with platform, coal-boxes, &c., and with boilers fitted, is 24 tons. The cylinders are brought on to each side of the boiler and drive their independent shafting through each quarter with screws attached to the latter of four blades, each screw having a diameter of 2ft., and a pitch of 3ft. 4in. The draught of water of the launch, at the commencement of the trial, was 2ft. 6in. aft., and 1ft. 9in. forward. The following was the result of the trial:—

	Time.		Pressure of Steam.	Rev. of
	m. s.	Knots.	lbs.	Engines.
First run	8 3	7.463	55 to 50	290
Second run	10 57	5.479	55 to 50	290
Third run	7 15	8.275	60 to 55	290
Fourth run	11 28	5.232	60 to 55	280
Fifth run	7 19	8.200	60 to 55	290
Sixth run	11 10	5.373	59 to 55	290

Mean speed of the six runs, 6.742 knots.

The revolutions of the engines averaged 290 at 60lb. pressure of steam, and with that pressure the *Experiment* will realise a good seven knots. On this occasion, from a cause which can be easily remedied in future, the steam, as will be seen by the foregoing figures, could not be kept at 60lb., and consequently the vessel lost speed. On the conclusion of the speed trials the vessel was next tested in making circles as follows:—With both engines going ahead at full speed, with the rudder acting, a complete circle was made to starboard in 1min. 9sec., and to port in 1min. 13sec. The circle was next made with one engine shut off, and with the port engine standing (the helm still being brought into use) a circle was made in 1min. 31sec., and with the starboard engine shut off in 1min. 27sec. Reversing the motion of the respective engines, and with the starboard engine going ahead and the port astern, the circle was made in 2min. 9sec. Repeating this experiment, but with the starboard engine astern and port ahead, the circle was made in 1min. 43sec. The diameter of the circles made, as near as could be ascertained without actual measurement, was, with both engines going ahead and rudder acting, rather under three times the length of the launch; with one engine shut off, rather over that distance; with engines reversed, and screws, therefore, working opposite ways, the launch turned on a pivot just abaft her centre, and within her own length, gradually working spirally and astern. The screw launch *Experiment*, made her second official trial, on the 7th ult. On reaching the measured mile in Stoke's-bay four runs were made, with both propellers working, with the following results:—1st run, 6.394 knots, steam pressure 60lbs.; 2nd, 7.114 knots, steam pressure 62lbs.; 3rd, 6.428 knots, steam pressure 62lbs.; 4th, 7.128 knots, steam pressure 62lbs. The mean speed of the four runs was 6.790 knots. The revolutions of the engines ranged from 302 to 304. Two runs were next made with one propeller (the port) only working, the results being:—1st run, 4.551 knots, steam pressure 60lbs.; 2nd, 4.875 knots, steam pressure 60lbs. The mean speed was 4.613 knots; the revolutions of the engines ranged from 320 to 360. These results being found sufficiently conclusive as to the boat's speed, using both or only one propeller, she was next tested in making circles, which was completed as follows:—With both propellers going ahead—Half circle to starboard, 35sec.; to port, 32sec.; full circle to starboard, 1min. 8sec.; to port, 1min. 8sec. The diameter of the circle was nearly three times the boat's length. With one propeller driving ahead and the other astern, the following results were obtained, the boat, as will be anticipated from previous trials with twin screw vessels when driving their screws in opposite directions, revolving after the fashion of a turntable, but with a spiral motion astern:—Half circle, to starboard, 35sec.; to port, 32sec.; full circle, to starboard, 1min. 57sec.; to port, 1min. 37sec.

"THE CALEDONIA."—This armour-plated ship is of the same class as the *Royal Oak*, the only difference being that the engines of the *Caledonia* are of 200-horse power more than those of the *Royal Oak*, and the build of the *Caledonia* is of much greater strength. The backing of the armour-plates of the *Caledonia* is composed of 8in. of teak planking, which also forms the external planking of the ship. The backing is firmly bolted to the usual frame timber 12in. square, near the ports, and is composed of English oak. The clamps, or internal planking of the ship, are also of teak 8in. thick. Great care has been taken in the *Caledonia* to give unusual strength to the fabric. Among others may be enumerated the diagonal iron riders, which are placed on the outside of the frame timbers instead of on the inside, the better to resist the impact of shot on the armour. The space between the shelf pieces and water ways, generally a source of weakness, has been filled in solidly, and secured to the beams and frame timbers. Great additional strength has also been given to the ship by means of an iron deck secured to the beams of the upper deck, underneath the usual wood deck of 4in. thick. The main deck beams are of oak, 16in. square, with deck planks of Dantick oak 4in. in thickness. The upper deck beams are of the Buttery Company's best iron. The port-lids are of iron secured with wrought iron hinges and bars with screw bolts and nuts. The ship is to be rigged with three masts, the lower masts to be of iron; the foremast 77ft. above the deck, and 3 in. in diameter; the foretopmast 78ft. in length, and 19in. in diameter. The fore and main yards are 91ft. long and 22in. in diameter, and the other masts and yards in proportion. She will be fitted with double topsail yards, together with the usual topgallant yards. The boats of the *Caledonia* will be armed with the usual Armstrong 20-pounders. They will consist of two launches, each 42ft. in length; one gig, 30ft.; one jolly boat, 16ft.;

and one dingy, 14ft. long. The armour plates, which have proved to be of excellent quality, were supplied by three different manufactories, and at various rates, from £30 to £40 per ton, some of the plates being hammered and others rolled. Messrs. Brown and Co., of the Atlas Works, Sheffield, and Messrs. Beale, of Rotherham, were the manufacturers of the hammered plates. The *Caledonia* has been fitted with two towers on her upper deck for the officer of the watch and the captain and master to stand in during the time of action. These are considered to be preferable to the single tower with which the *Warrior* was supplied, as they are clear of the masts and funnels, which obstruct the view from the single tower. These towers are to be plated with iron casing 4in. thick, and are accessible through a scuttle from the main deck. To prevent the oxidation of the lower tier of armour-plates from the galvanic action of Muntz's metal two strakes of teak wood lining have been fitted, so that the lower edge of the plates is nearly 2ft. from the upper edge of the metal.

THE "LORD WARREN" IRON-CLAD WOODEN FRIGATE.—The following will be the dimensions of the armour-plated wooden frigate *Lord Warren*, the preparations for building which have been commenced beneath No. 7 shed at Chatham dockyard, where she is to be constructed:—Length between the perpendiculars, 280ft.; length of keel for tonnage, 233ft. 11in.; extreme breadth, 59ft. 9in.; breadth for tonnage, 59ft. 2in.; depth of hold, 20ft. 9in. Unlike the other vessels of her class hitherto built, the *Lord Warren* will be provided with the same thickness of armour-plating throughout, and the principle of furnishing our vessels of war with guns at the bow as well as at the broadsides will be practically recognised for the first time by the Admiralty by the construction of a bow battery at the fore part of the *Lord Warren*. The stem will project some 8ft. or 9ft. below the water, which will render the *Lord Warren* more formidable as a ram than any of the existing iron and iron-clad war ships. It does not appear to be finally settled whether the twin-screw principle is to be adopted in the *Lord Warren*, or whether she will be constructed to carry merely the ordinary single screw, though, from the marked success which has attended the introduction of the double screw in those ships in which it has been tried, it is probable that the *Lord Warren* will be constructed to carry two independent screw propellers, both working by means of separate engines. The sheds adjoining that under which the *Lord Warren* is to be laid down are being fitted with overhead tramways to facilitate the removal of the timber and iron plates.

VARIATIONS OF THE COMPASS.—A French paper publishes a letter on the deviations to which the needle is liable in consequence of the substitution of iron for wood in ships. One of the latest contrivances for diminishing this serious inconvenience is the correcting compass, which affords the means of taking the sun's position, whereby the deviation may be corrected. It has sometimes been supposed that fogs and certain other states of the atmosphere could influence the needle; but this has not been borne out by observation. Lightning alone exercises a decided influence on the needle by reversing its points so that north becomes south, and conversely. When a vessel is nearing land, the needle is said to be affected; and certain rocks there are that exercise a decided magnetic influence on the compass, volcanic rocks especially, but this influence is not felt on board ships. But the action of the iron forming the ship's sides is far different; nothing, not even the interposition of a thick non-magnetic body, will stop its influence; far less, as some have believed, a copper coating or thick paint. But the real danger proceeds from another source, since the ship herself, under her weight of canvas, may increase the deviation of the needle. From experiments made on board an iron-built sailing vessel, provided with iron rigging and lower yards of steel, and with two binnacle compasses on her poops, and a third placed between the mizen and mainmasts, the lower part of which was all of iron, the deviation of the needle were respectively 56 deg., 24 deg., and 35 deg. Without entering into further details on this matter, the writer of the article concludes with condemning the imprudence of those who freight an iron vessel before she has been at sea for a considerable time, in order to ascertain how her compass behaves. Moreover, a captain undertaking the command of an iron ship should be called upon to show that he has previously been on board such a vessel on a long voyage, so that he may know how to deal with the deviation observable on board the vessel to be commanded.

WARREN'S "IMPERGNEABLE AND UNSINKABLE FLOATING CASEMATE BATTERY," &c.—Mr. William W. Warren proposes a system of construction for an "impergneable and unsinkable floating casemate battery, submarine gun and armour plating adapted for stationary batteries, and for conveying troops," &c. In an abridged, but still a lengthened description, he says:—"I prefer constructing the centre portion of the vessel of rolled wrought-iron double-flanged vertical ribs, from 12in. to 18in. wide, and from 2in. to 4in. thick, firmly rivetted and bolted together, or of angle or T iron, solidity and stiffness being the great object,—on which are placed the various layers of malleable metals, taking care to stop all chemical or galvanic action, by means of bituminous composition, mixed with hair; and were it not for the cost I would prefer using the finest copper-plating only over the iron, so as to act on the principle of a gradual tenacity of resistance, thereby easing and stopping the momentum, and distributing the shock, and thus prepare the iron-plating to finally resist, without splitting or destroying the plate; or the roof-deck and sides of centre position of battery can be protected with oak, or other wood, compressed in short lengths, and confined, the cross-grain of wood being opposed to the action of fire." Mr. Warren's invention has been presented to the Admiralty, and he has permission to erect a target at Shoeburyness on his compressed wood cross-grain principle; but the cost, which is £5000, prevents him.

DOUBLE-BOTTOM SHIPS OF THE ROYAL NAVY.—The iron war frigate *Bellerophon*, recently commenced at Chatham Dockyard, will be constructed on what is termed the double-bottom principle. Throughout the central portion, in which the engines, boilers, magazines, &c., are placed, the bottom will be double, the inner and outer bottoms, or hulls, being placed from 3 to 4ft. apart, in order that there may be ample space between for cleaning and painting. As this space, between the two bottoms, will not be required for use, it will be divided into numerous water-tight compartments in the usual manner, and will, consequently, form a series of buoyant cells, any one or more of which may be injured without the sea being admitted to the others or to the ship. Beyond the central portion of the ship, at either end, Mr. Lungle's principle will be introduced, the lower deck being used as an interior bottom, and the space below it made available for stowage by means of iron water-tight trunks rising above the water line. It is this combination of water-tight trunks with water-tight decks—the former being intended as a means for entering below the latter—which constitutes what is known as "Lungle's unsinkable principle," by aid of which not only is the division of the vessel into water compartments accomplished without obstructing ventilation, but the vertical trunks themselves form ventilating apparatus. In addition to the above the *Bellerophon* will be constructed with water-tight internal walls, completing the double bottom, and thus will, in fact, be made a double ship from end to end. With this system of construction the necessity for internal bulkheads is almost entirely done away with, since no ordinary injury could, in any way, jeopardise the safety of a ship so built. The *Bellerophon* is, however, to be furnished with some few bulkheads of the ordinary kind, but these will be so placed as not to interfere with the free and ample circulation of air throughout the ship.

THE "FALCON," 17, screw corvette, made her official trial of speed at Portsmouth on the 10th ult., under the superintendence of Captain H. Broadhead, commanding the reserve at the port. The ship drew 14ft. 9in. of water forward, and 15ft. 8in. aft, on getting under weigh. The wind was moderate from S.W., but squally at times. Six runs were first made at the measured mile with the following consecutive results in knots:—8.090, 8.051, 8.911, 8.275, 9.350, 7.610. The mean speed of the six runs was 8.653 knots. At half boiler power four runs over the mile gave 5.769, 5.042, 4.748, 6.061. The

mean speed of the four runs was 5.148 knots. In testing the engines to ascertain the time in which they could be worked, in obedience to a transmitted order, they were stopped dead in 11 seconds from full speed, from the time of moving the telegraph handle on the bridge; started ahead in 13 seconds, and astern in nine seconds.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—J. Campbell, supernumerary in the *Asia*, promoted to First-class Assist. Engineer; H. B. Fabian, Engineer, W. E. Grigg, and G. Anderson, Assist. Engineers to the *Royalist*; F. W. Sutton, Engineer, to the *Indus*, as supernumerary; O. Jones, Chief Engineer, to the *Liverpool*; T. H. Punshon, promoted to Chief Engineer, and re-appointed to the *Chanticleer*; O. L. Carlisle, W. Curran, and C. Read, promoted to Chief Engineers, and discharged to half-pay; T. McFarlane and P. Foulis, of the *Scout*, to be First-class Assist. Engineers; G. Rigby, First-class Assist. Engineer to the *Peiorus*; J. Slater, of the *Curacao*; G. T. Ludlow, of the *Himalaya*, J. Pickles and J. Adams, of the *Asia*; J. Buchart, of the *Cumberland*, F. T. Russell, of the *Indus*, T. M. Thompson, of the *Blenheim*, for the *Charon*; Geo. A. Moses, of the *Geyser*, and J. McGarahan, of the *Der*, promoted to be First-class Assist. Engineers; J. Bell (b), of the *Challenger*, S. T. Sugden, of the *Wanderer*, and L. P. Lewis, of the *Hecate*, promoted to be acting First-class Assist. Engineers; C. Ively, Chief Engineer, to the *Cumberland*, for the *Caledonia*; J. Rose, Assist. Engineer, to the *Satellite*; J. Caspall, Assist. Engineer, to the *Stromboli*; T. McIntosh, Assist. Engineer, to the *Alecto*; J. Grant, Assist. Engineer, to the *Triton*; R. G. Foster, Assist. Engineer, to the *Doterel*; W. E. Shingleton, Assist. Engineer, to the *Doterel*; A. M. Brumage, Assist. Engineer, to the *Victory*, for the *Sprightly*; G. Bain, Assist. Engineer, to the *Asia*, as supernumerary from the date of his arrival in England; J. Weir, Engineer, and J. G. Boyd and J. Murray, Assist. Engineers to the *Wasp*; J. B. Liddell, in the *Shearwater*, promoted to Acting Engineer.

MILITARY ENGINEERING.

TESTING ARMOUR PLATES AT PORTSMOUTH.—Some experiments at armour-plates took place on the 14th ult., at Portsmouth, and resulted in favour of the plates over the gun. The plates were bolted on the sides of the *Monarch* target ship in the ordinary manner, with 2-inch bolts, and were fired at with the 95 cwt. 68-pounder gun, at a distance of 200 yards. There were four plates, comprising one 4½ in. plate from the Thames Ironworks and Shipbuilding Company for the *Minotaur*; one 4½ in. plate from Messrs. John Brown and Co., of the Atlas Works, Sheffield, for the *Ocean*, and one 5½ in. plate from the same firm, as an experimental plate, being made from Arcadian charcoal iron; one 5½ in. plate, and one 4½ in. plate from Messrs. Cammell and Co., of the Cyclops Works, Sheffield. Messrs. Brown's Arcadian iron plate received nine shots, one of which struck the right lower corner, and broke a piece off 16 in. in length by 15 in. in width. There were three other slight cracks, but the plate was not materially injured except in its broken corner, and where the backing also was afterwards found to be deficient. The metal, however, with which Messrs. Brown manufacture their own plates is undoubtedly superior to the Arcadian iron plate, the latter being apparently too hard for the manufacture of armour-plates of the first-class. The Thames Company's plate for the *Minotaur*, hammered, was the smallest of the four, but was one of superior manufacture and metal. Like Messrs. Brown's Arcadian plate, it was severely damaged on one of its corners by shot, and the iron being there unsupported, necessarily gave way. The two plates sent in as test plates by Messrs. Cammell, of Sheffield, were "rolled," and gained for their manufacturers a position never before surpassed by any other plates on their first trial as test plates. The 5½ in. plate, in its left centre, received six shots in a space measuring 19 in. horizontally and 2 ft. 10 in. vertically. Over this space and through the indents of the shot marks there was nothing beyond three slight surface cracks. The plate received 11 shots in all. The 4½ in. received 8 shots, and was possibly one shade inferior in quality to the 5½ in. The metal of these two plates, as well as that of Messrs. Brown's 4½ in., was beautifully fibrous. At the conclusion of the trials of the four plates several shots were fired at a French manufactured 4½ in. plate that was bolted on to the target ship's side with Arcadian iron bolts. One of these shots struck the French plate in a comparatively unimportant part, and penetrated clear through into the ship's side, presenting a contrast to the stubborn resistance offered to the shot by the two English 4½ in. plates that had but just been through their trial.

MR. PARSONS'S BREACH-LOADING 6-POUNDER underwent, on the 16th ult., a final trial at the proof-butt in the Royal Arsenal, by firing 100 rounds. The entire test occupied 52½ minutes, including a delay which took place at the sixth round. The ninety-four rounds fired from that time were completed in 43 minutes, or one round in 30 seconds. Although, from the rapid firing, the gun at its termination was so hot that the hand could not touch it, the breach action worked with perfect freedom, and maintained the breach quite gas tight. Mr. Parsons suggests the adaptation of his plan to guns of large calibre, as by it the sphere that serves the place of the vent-piece can be made of any size and strength necessary, as it has not to be lifted out of its place in the operation of loading. In a 110-pounder it may be made 800 lb. weight, and it will have corresponding strength.

RUSSIAN FORTIFICATIONS AND ORDNANCE.—Cronstadt is being strengthened under the superintendence of General Todleben and General Zareva, by placing the old forts in a better state of defence, and at many points covering up the masonry by earthworks. On the main island of Cronstadt, seaward, large earthworks are being thrown up, some of which are nearly finished. From the sea, they will be scarcely visible, and they not only enfilade the channel, but some of them, being connected by parallels one with another, will be able to hold guns to take in reverse any ships which may run the gauntlet of their fire and that of the forts. Some of these earthworks, more exposed than others, are to be covered with 7½-inch plates, placed on an angle of 45 deg., and curved over the top, so as to form a cover from vertical fire, and at the same time obviate the necessity of having bolts or any other fastenings to retain the plates in position. The embrasures will be closed immediately the gun is fired by a slide of 11-inch iron, or by a drop door. The guns to be placed in these iron-clad and other earthworks are to be 9-inch rifled cast steel, carrying a 300 lb. rifled shot, or a 250 lb. shell, 23 in. long. For the protection of the granite forts, enormous supplies of earth and fascines are placed at different points. To provide further against the possibility of a fleet passing up to the back of Cronstadt by the south channel, about 300 lighters, laden with stones, have been sunk, so that now in no part is there more than four feet of water. Supposing a possibility of some hostile fleet passing the outer forts and earthworks they are prepared to lay 300 infernal machines in the channel, each of which will contain 70 lb. of powder, and explode by a slight touch from a vessel passing over. Yet, still further, the enemy, presuming to have passed Cronstadt, and arrived some ten miles up, to the head of the bay, and wishing to pass the bar and enter the Neva here are fresh earthworks thrown up, which will be capable of mounting, in all, about 50 guns of the largest calibre, and enfilade the entrance to the river at a point where it is about 3000 ft. wide. A supply of infernal machines is also to be kept ready to sink in the narrow channel of the bar. Another means of defence is also in course of preparation—a submarine boat of colossal dimensions, in the construction of which about 200 tons of iron and steel are to be used. This boat, it is stated, is to have engines worked by compressed air, to have a very strong beak, with provision for attaching large cylinders charged with powder to the bottoms of vessels, to be fired by electricity. The parties navigating the vessel will see what they are doing by means of bulls'-eyes, and they will be able to regulate the depth at which they swim, keeping quite close to the surface. The Emperor has approved of the plans, and some months since signed the decree appropriating about £27,000—say, 175,000 silver rubles—for this monster. By the 1st of June, 1884, the Marine Department expects to have at Cronstadt sixteen iron-clad vessels. There will be four vessels of larger size, all in many respects alike, in-

cluding the *Pervenets*, built in England, and which is receiving her armament and being finished off at Cronstadt. The second is building in St. Petersburg, under contract, by Messrs. Mitchell, of Newcastle. All her armour-plates are on the spot, from Messrs. John Brown and Co.'s works, and she should be ready at the time named, and is to be called "Ne Troa Menya" (Touch me not). The third is building in St. Petersburg by Messrs. Semenikoff and Poltka, and progresses fast towards completion. Her armour-plates are also supplied by Messrs. John Brown and Co. The fourth is building by the Marine Department in the new Admiralty-yard, and her armour-plates are also from the same firm. The general dimensions of these vessels are as follows:—Length over all, about 240 ft.; breadth, 53 ft.; depth, 27 ft.; builder's measurement, 2900 tons; the armament is not exactly settled, but will be rifled guns of heavy calibre. The remaining 13 vessels are all *Monitors*, but only one will have solid armour-plates, supplied by Messrs. Beale, and building by Messrs. Mitchell. She is from Capt. Cole's design, and very nearly a facsimile of the Danish vessel *Rolf Kruke*, built in this country, particulars of which recently appeared in THE ARTIZAN. Her length is 175 ft. between perpendiculars; breadth, 39 ft.; depth, 14 ft.; tonnage (b.m.) 1250. The remaining 11 vessels are building by Messrs. Carr and Macpherson, two; Semenikoff and Co., two; Kondratzoff, two; and the Government, five. They are to be clad with four and five one-inch plates, rolled in long lengths, following the American plan. The towers are to be of 11 one-inch plates bolted together, although a question has just arisen whether it would not be advisable to tap them through and through, and by that means strengthen them. The covering of these vessels with lin. plates results partly from the haste with which the resolution to build was taken, and partly from the want of machinery in Russia to roll heavier plates. Great exertions are being made to obtain the requisite quantity of guns, with suitable ammunition, for all the forts, earthworks, and ships. The large rifled cast-steel guns which they are obtaining from Krupp, and which they will shortly commence making themselves in St. Petersburg, are good, and the smaller sized cast-steel guns which are being produced rapidly in the Ural, and also in Pootieff's works in St. Petersburg, on Aboukoff's system, are found to be a great step in advance. They are not, perhaps, all that could be desired; yet they sustain a large amount of work, and their defects seem to arise from a want of hammer power, which want will be shortly supplied. Guns are now being produced in about a dozen factories, working night and day. Its production will be solid cast-steel guns, from the six-pounder to the eleven inch gun, which latter is to fire a 500 lb. shell. To provide the necessary shot and shell for these guns all the foundries around St. Petersburg have orders varying from 15,000 to 60,000 each. All the shot and shell from 13-pounders upwards are for rifled guns. The shot are from 2 to 2½ diameter, are round-nosed, and are provided with soft metal bearings to fit the grooves of the guns. The production of steel shell of the same description is also increasing fast, and great exertions are being made to deliver large supplies. Round hammered steel shot are also being prepared to suit the naval 60-pounder gun. One firm alone has in hand 30,000 of these. The land artillery forces are also adopting the steel guns for their service, and find them well adapted by their lightness. A gun of the same calibre is about one-third lighter than a brass gun.

EXPERIMENTS AT SHOEBURNESS.—TRIAL OF THE ARMSTRONG MONSTER GUN.—A preliminary trial of Sir William Armstrong's monster gun, lately manufactured at Elswick for the War Department, was made on the 19th ult., at Shoeburness. This gun weighs over 22 tons, and is mounted on an ordinary gun carriage. Its length over all is 15 ft., that of the bore being 12 ft. Its internal diameter is 13½ in., and it is rifled on the "shunting" principle. The grooves are 10 in number, and turn once in 65 calibres. The thickness of the walls of the gun at the breech is 20½ in., the total diameter at the trunnions being 55 in. It carries a conical cast-iron hollow-headed shot, weighing 510 lb., or a shell of ordinary construction weighing 600 lb., and capable of containing a bursting charge of no less than 40 lb. of powder. The charge used with shot was 70 lb., with shell 60 lb. The conical cast-iron hollow-headed shot first fired measured nearly 30 in. in length, by 13½ in. in diameter. The shot is first placed in a cradle and lifted to the mouth of the gun by means of movable shear legs provided with blocks and pulleys. The cradle hinges on to a couple of hooks on the mouth of the piece, and holds the ponderous shot in the proper position for being rammed home. The gun was given one degree of elevation. The first shot struck the sand at about 700 yards from the shore, leaping and dashing onward, ricocheting five or six times, and finally burying itself near the 4000 yards' target. An attentive examination of the gun then proved that not the slightest injury had been sustained by it in any part. Two more shots were then fired at the same elevation, the second and third reports being apparently rather less loud than the first. The next three rounds were fired at an elevation of 2 deg., after which followed three at 5 deg., and three at 10 deg. Three dead shells weighing 600 lb. each were then fired with charges of 60 lb., a 300 lb. round shot with a charge of 70 lb. completing the day's experiments. The following are the tabulated results:—

Round.	Charge.	Shot or Shell.	Range.	Lateral Deviation.	Elevation of Gun.
	lb.		Yds.		Deg.
1	70	510 lb. shot.	748	1 yd. left	1
2	70	"	785	1-5 yd. left	1
3	70	"	789	0	1
4	70	"	1160	1-2-5 yds. left	2
5	70	"	1143	1-5 yd. left	2
6	70	"	1184	0	2
7	70	"	2400	4 yds. right	5
8	70	"	2338	2-5 yds. left	5
9	70	"	2308	0	5
10	70	"	4080	2 yds. right	10
11	70	"	4176	0	10
12	70	"	4187	4 yds. left	10
13	60	600 lb. shell.	1890	2 yds. left	10
14	60	"	1893	3-3-5 yds. left	10
15	60	"	"	"	10
16	70	300 lb. round shot	"	"	10

Up to the sixth round the initial velocity was taken by Captain Noble with the very ingenious electro-ballistic apparatus invented by Major Navet, of the Belgian army. The mean initial velocity as determined by this delicate instrument was found to be as nearly as possible 1260 ft. in a second. It will be noticed in the above table that no ranges or lateral deviations are given for the last two rounds. This was merely on account of the tide having covered the spots where the shots touched before they could be measured.

EXPERIMENTS AT SHOEBURNESS.—TRIAL OF THOMAS'S GUN.—The 9-inch muzzle-loading gun made at the Royal Gun Factories, Woolwich, and rifled on the plan proposed by Mr. Lynam Thomas, was tried at Shoeburness, on the 20th ult. This gun, which carries a 300 lb. shot, closely resembles an ordinary muzzle-loading Armstrong in outward appearance, the muzzle, however, being more prolonged. Mr. Lynam Thomas's invention consists in substituting a series of ribs for the usual grooves. The shot are made with grooves coated with soft alloy to fit the ribs of the gun, and are similar in form to those

used in the Armstrong, but appear to be slightly longer. The "shunt" principle is not employed by Mr. Lynam Thomas. To test the range and accuracy of the gun 10 rounds of cast-iron shot were fired from it at 2 deg. elevation, 10 at 5 deg., and 10 at 10 deg., the charge being 40lb. in every instance. The initial velocity of the projectiles was ascertained in the case of those fired at 2 deg. elevation by Major Navez's electro-ballistic apparatus. It was intended to repeat the experiments with cast-iron shells, but Mr. Thomas objected to those upon the ground as being too long; a similar objection to the shot was also urged by him during the course of the experiments. He also stated that the ribs were finished too abruptly at the spot where they join the chamber of the gun. The following table will show that both the velocity and range of the shots fired are very unequal. This is accounted for by Mr. Thomas by the facts mentioned above, and by the powder not being always rammed home to exactly the same mark. Whether the latter circumstance has any weight or not is doubtful, as in other rifled guns the ramming home of the powder to the same place within a few inches does not seem to affect materially the flight of the shot. Notes were taken at each round of the exact depth to which the charge was rammed; it will, therefore, be seen hereafter whether this circumstance has any influence on the projectile or not:—

At 2 deg.			At 5 deg.		At 10 deg.	
No. of round.	Initial velocity.	Range.	No. of round.	Range.	No. of round.	Range.
		Yds.		Yds.		Yds.
1	1075 feet	948	11	2008	21	3635
2		928	12	1883	22	3768
3	to	955	13	2073	23	3775
4		1029	14	1957	24	3795
5	1217 feet	999	15	2082	25	3921
6		958	16	2142	26	4006
7	per	928	17	2123	27	3569
8		939	18	1945	28	3963
9	second.	971	19	2161	29	3680
10		1092	20	2066	30	3791

The table shows that at 2 deg. elevation the difference in the range is 164 yards; at 5 deg. 278 yards; and at 10 deg., 437 yards—all large numbers compared with those obtained in experiments with other rifled guns at similar elevations. The difference in the velocities is also large, being 142ft. per second.

ENGLISH v. SWEDISH IRON.—Experiments have recently been made at the fortress of Carlberg, in Sweden, upon the respective merits of armour-plates made in England, France, and Sweden. Messrs. John Brown and Co., of Sheffield, sent two plates, one 12ft. by 2ft. 6in., and one 6ft. by 3ft. 8in. Messrs. Petin, Gaudet, and Co., of Lyons, sent two plates, each of 7ft. 6in. by 3ft. 3in. The Montana Ironworks Company, of Sweden, sent two plates of 12ft. by 2ft. 6in., and one 6ft. by 3ft. 8in. All the plates were of 4in. thickness, and then bolted to a teak target backed with iron plating, and supported by a massive stone pier. The two upper plates in the target were the French, and each was secured by 11 bolts. The next plate below was the longest, Swedish, and this was secured by 29 bolts. Below this was a tier of two short plates, one Swedish and one English, secured, like the Swedish, by 29 bolts. Each plate received six shots from the ordinary 68-pound naval gun. The French and Swedish plates broke to pieces, and the English plates remained uninjured and free from cracks. The shots used were of Swedish iron, and of great toughness as compared with the shots used in the English service—the core or centre of the shot, after striking, being of double the weight of the core of the English shot.

EXPERIMENTS WITH A NEW SUSPENSION-BRIDGE.—Some trials have recently taken place on the Royal Engineers' field-works, Chatham, for the purpose of testing a new description of suspension-bridge, for military purposes, the invention of Sergeant-major J. Jones, Royal Engineers. The bridge on which the experiments were made was formed of the galvanised iron bands with which the new description of iron gabions now in use in the service are formed. These bands, which are about 3in. in width, and the thirtieth part of an inch in thickness, were joined together at the end, by means of a button and eye; and, notwithstanding the apparent slenderness of the material, bore an enormous weight. Eight widths of the iron bands, each four bands thick, formed the "chains" of the suspension-bridge, and on these were laid the chesses, used in pontooning, which served as the floor of the bridge, the whole being steadied by means of guy ropes, fastened to stakes, answering to anchors in a river. With these materials a bridge having the span of 130ft. was formed by thirty Sappers and Miners in six hours. A battery of mounted field artillery was marched across with the greatest ease, the bridge having only a very slight oscillation. A body of about thirty Royal Engineers were next marched across, in step, and this was the greatest strain to which the structure could be put. Notwithstanding this, however, the only perceptible defect was the great oscillation of the bridge, which ultimately loosened one of the guide ropes.

STEAM SHIPPING.

THE "WILL O' THE WISP." Iron paddle steamer, 600 tons, and 180 horse-power, was tried on the 7th ult., on the Clyde. The builders had engaged to carry 200 tons dead weight, at the speed of 17 miles an hour, under a considerable penalty, the owners engaging to pay a premium of the same amount if the vessel exceeded that speed. With the 200 tons dead weight the vessel accomplished the distance between the Cloch and Cumbræ Lights in 52 min. 11 sec., being over 18 miles an hour. The *Will o' the Wisp* was designed, built, and engined by Messrs. W. Simons and Co., London Works, Renfrew.

STEAM SHIPBUILDING ON THE CLYDE.—Messrs. W. Denny and Brothers, of Dumbarton, have completed a screw of 750 tons, built for the New Zealand trade. Messrs. W. Simons and Co., of Renfrew, have launched a paddle of 600 tons, named the *Will o' the Wisp*, which took the water with her engines on board; she has been purchased by a Liverpool firm for a trade where speed and strength are of the greatest importance. Messrs. Caird and Co., of Greenock, have launched a paddle named the *Lord Clyde*, built for the Glasgow and Dublin Steam Navigation Company, and intended to run as a consort to the *Lord Gough*. Messrs. Kirkpatrick, McIntyre, and Co., of Port Glasgow, have completed the *Greyhound*, a screw, built for Mr. R. Little, of Greenock. She is 200ft. long, 23ft. beam, and 13ft. depth of hold, is flush decked, and is divided into seven water-tight compartments. She is being fitted with engines by Messrs. Caird and Co., of Greenock. Messrs. J. and G. Thomson, of Govan, have launched the *Pampero*, a screw of about 1000 tons register, built for London owners. Messrs. Tod and McGregor, of Patrick, have launched the *Caledonia*, a screw of 1360 tons, for Messrs. Handyside and Henderson's line of Quebec and Montreal steamers. The *Caledonia* is being fitted with a pair of direct acting engines. Messrs. Randolph, Elder, and Co., of Govan, have completed the *Quito*, a paddle, of 1400 tons, built for the Pacific Steam Navigation Company, of the following dimensions.—Length between perpendiculars, 286ft.; breadth between paddle boxes, 32ft. 6in.; depth to spar deck, 20ft.; ditto to awning deck, 28ft. The engines of the *Quito* are on Messrs. Randolph, Elder, and Co.'s patent double-cylinder

surface condensing and steam-superheating principle; they are the twelfth pair constructed by the firm for the Pacific Steam Navigation Company, and are of 400 horse-power. As coal costs from £3 to £4 per ton in the Pacific, special attention has been devoted to the economising of combustible. Messrs. Randolph, Elder, and Co. have secured an additional shipbuilding yard at Fairfield, in consequence of their increasing business. Messrs. Blackwood and Gordon have launched at Port Glasgow a screw of 500 tons, named the *Wellington*, and intended for the passenger trade of the New Zealand coast line. The *Wellington* is being fitted with engines of 90 horse-power. Messrs. J. and G. Thomson, of Govan, have launched a screw of 700 tons and 180 horse-power for the Tasmanian Steam Navigation Company. She has been named the *Southern Cross*. Messrs. Barclay, Curle, and Co., of Stobcross, have launched a screw named the *Albatross*, built for Messrs. Cowan and Co., of Edinburgh, and intended for the Australian coasting trade. The *Albatross*, which will be fitted with engines of 125-horse power, is 210ft. in length, 27ft. in breadth, and 14ft. 6in. in depth; her burden is 750 tons. Mr. T. B. Seath has launched a screw of 150 tons, named the *Protector*, and now being fitted with engines on Mr. Seath's patent by Messrs. A. Campbell and Son. Messrs. Aitken and Mansell, of Whitechapel, have launched a paddle of 600 tons named the *Arrow*. She is being fitted with her machinery at Finnieston-quay, by Messrs. J. Aitken and Co., Cranston-hill, and will shortly leave for Nassau. Messrs. W. Denny and Brothers, of Dumbarton, have purchased a large field situated between the Castle-road and the Leven, for the purpose of converting it into a shipbuilding yard. The Cunard Company have just completed a contract with Messrs. J. and J. Thomson for the construction of three large screws, to be named respectively the *Jura*, the *Aleppo*, and the *Trinidad*; one is intended for service on the Atlantic mail line and two for the Mediterranean.

THE "WASP," screw corvette, 974 tons and 100 nominal horse-power, underwent her official trial at the measured mile at Stoke's Bay, on the 13th ult. The ship's draught of water was 13ft. 8in. forward, and 14ft. 2in. aft., with an immersion of the screw's upper edge of 7in. The screw, which is of the common pattern, with the leading corners cut, has a diameter of 11ft. 3in. and a pitch of 14ft. 10in. The mean speed of the *Wasp*, with full boiler power, was 8.176 knots, and with half boiler power 5.785 knots, the indicated horse-power being 290.

THE "FAR EAST," iron screw steamer, has been launched from the yard of Messrs. Dudgeon, at Millwall. The *Far East* is intended for the China trade, and her principal dimensions are:—Length between perpendiculars, 227ft.; length of keel, 210ft.; breadth of beam, 34ft.; depth moulded, 22ft.; depth of hold, 20ft. 6in.; depth of load water line, 17ft.; displacement of hull, 2200; builder's measurement, 1270 tons. She is fitted with engines of 150 horse-power nominal, which drive a two bladed lifting screw, under each quarter. The engines have annular combined cylinders, the diameter of the high pressure cylinder being 24in., and of the expansive cylinder 50in., with a stroke of piston of 2ft. The screws have each a diameter of 8ft. 2in., and a pitch of 16ft. The two boilers have each six furnaces, with 109 square feet of fire-bar surface, and a tube surface of 1893ft. The shafting of the screws project through a wrought-iron tube of great strength, which is bolted on to a false iron bulkhead, clear altogether of the ship frame. This tube at its outer end is connected with a massive wrought-iron slide, which guides the screw to the well when being lifted, or to the shafting when being lowered. The ordinary "cheese-coupling," by which the screw is connected with the shafting, is superseded in the shaft by a square head at the end, which fits into a corresponding recess in the boss of the screw, which is connected by a thrust block fixed on a sliding rest. The screws are lifted by a worm and barrel.

TELEGRAPHIC ENGINEERING.

THE SUBMARINE TELEGRAPH ACROSS THE BRISTOL CHANNEL.—The British and Magnetic Telegraph Company have successfully laid a submarine cable across the Bristol Channel at New Passage. This cable, which contains several wires, is intended to enable the Bristol and South Wales Union Railway Company to communicate from the Gloucestershire to the Monmouthshire shore, and *vice versa*, the Telegraph Company laying down additional wires, in order to afford greater facilities for the increasing business requirements between South Wales and Bristol.

RAILWAYS.

A SAFETY LOCOMOTIVE FOR SHARP CURVES.—Mr. Cross, the engineer of the St. Helen's Railway, Lancashire, has been for some time occupied with the construction at the company's works of a new class of engine, the result of which in practice so well corresponds to sound theory that it is likely to exercise a material influence on the structure of new railways, by the substitution of sharp curves for tunnels in mountain regions, and also for facilitating junctions between lines and the entrance into cities. The St. Helen's line, running through a hilly mineral district, is a remarkable sample of sharp curves and gradients. In a length of about 30 miles it has a constant succession of curves, varying from 500ft. radius down to 170, and it has gradients from one in 85 to one in 35, and it has, moreover, a large number of "points and crossings" opening into the various mineral deposits. This line has been usually worked by short engines on six wheels with four coupled wheels as drivers, and connected to separate tenders for the supply of fuel and water, the length of the wheel base of the engines being about 12ft. Even this comparatively short length of engine was disadvantageous on curves, involving much impedimental friction; and a still greater disadvantage was that tender engines are only adapted to run safely with the tender behind, and in the working and shunting the loss of time and labour, and expense, was considerable. For this reason Mr. Cross set about the construction of an engine that should be capable of running freely and without impedimental friction in a straight line, and either end foremost, and also pass with free rolling movement round curves of as sharp a curve as a radius of 132ft., or two chains. The engine is on eight wheels, covering a base of 22ft. in length, and the length of a solid frame resting on it 32ft. The four central wheels have their axles passing through, before, and behind the engine fire-box as usual, the axles being about eight feet apart. It is obvious that so long an engine could scarcely pass round curves at all, even at any cost of friction, with the ordinary construction of wheels and axles. The difficulty is obviated by a very simple process. The four central wheels have their axles rigidly parallel to each other. Consequently, in the ordinary mode of construction, they could not move in a curved line without a great amount of impedimental friction. This friction is avoided by a simple process of construction. The wheel tires are applied on hoop springs of elastic steel placed between the wheel and tire. On these springs the tires can slip or revolve without sliding on the rails, and thus the revolutions of the tires are adjusted to the varying length of the rails on curves by self-action. This sliding of the wheels on the tires is not found in any way to impede the tractive power of the engine, but the contrary. The extreme wheels at either end have their tires applied in the same mode, but another movement is also supplied—the axles have very long bearings, and the boxes in which they run, instead of being parallel to the axles, are formed in curved lines struck from central points, and are permitted to move in this curvature through the hornplates and axle-guides beneath the spring shoes. The result of this is that the wheels and flanges are free to follow the course of the rails both on the straight line and on curves, with the very important advantage in point of safety that the extreme axles on curves always point truly to the centre of the curve, and consequently are square to the rails, even though the curve may be in the form of an S, requiring the axles to radiate in opposite directions. There is, therefore, no tendency in the wheels to escape from the rails either on curves or straight lines, and, though adapted to such small radii, the great

length of the frame governs and controls the action of the pistons on the cranks, and prevents both vertical and lateral oscillation, while the wheels are deprived of their vicious irregularity by the removal of the costly and dangerous friction, and the wear of tires and rails is reduced to the minimum.

CHEAP RAILWAYS IN THE NORTH OF SCOTLAND.—Sir J. D. Elphinstone, in an account of the great length of railways made in the north of Scotland at a cheap rate, says:—"For the last fifteen years I have been engaged in carrying out a system of railways to supply the wants of the counties of Aberdeen and Banff, which is now almost completed. The whole will extend, in main line and branches, to above 190 miles, of which 180 miles are open and in full operation, completely exhausting the wants of these counties." Among them is "the main line from Aberdeen to Keith, forming part of the through line from that city to Inverness, 53½ miles: it is double for seven miles; from there, land taken and over bridges constructed for a double line, two long viaducts over the rivers Don and Deveron, heavy rock cuttings, expensive town property in the vicinity of Aberdeen, and £285,000 preliminary (Parliamentary) expenses, cost £14,000 per mile." There is also the "Strathspye Railway, 32½ miles,—two expensive crossings of the River Spey, one of the largest, and certainly the wildest, river in Scotland; two of the Fiddoch, also a very unruly stream; a short tunnel, heavy rock cuttings, and other works,—£7500 per mile. This railway, considering the works, is probably the cheapest line that has ever been executed." The other lines range from £2500 to £3000 a mile. "The majority of the works on these lines are of granite, most solid and substantial."

CITY TRAFFIC.—The Ludgate-hill railway station will be placed between Bridge-street and Earl-street, Blackfriars, and its carriage approach will be from Earl-street. The latter thoroughfare is about to be widened by the Board of Works, and to be continued in a direct course towards Cannon-street, whereby there will then not only be an easy and brief cut towards London Bridge and the eastern parts of the City, but the great thoroughfare up Ludgate-hill, round St. Paul's, and down Cheapside, will be considerably relieved. The line of railway from Ludgate-hill station will run in a north-easterly direction, passing under Skinner-street, Snow-hill, to a junction with the Metropolitan Railway near Charles-street, Smithfield; and there will also be a spur line from it, in a still more easterly course, to meet the line of the Metropolitan Railway Extension to Finsbury, at a point near the northern extremity of King-street, Smithfield.

RAILWAY ACCIDENTS.

ACCIDENT ON THE LONDON AND NORTH-WESTERN RAILWAY.—An accident, unattended with serious consequences, happened on the 3rd ult., at Weedon, on the London and North-Western Railway. As the goods train was being shunted from one line of rails to another the axle of one of the carriages broke. It then became impossible to remove the carriages quickly, and in the meantime a second goods train arrived, and came into collision with the carriages which blocked the way.

ACCIDENT ON THE GREAT EASTERN RAILWAY.—On the night of the 2nd ult., a collision occurred on this company's line between the goods depot station at Brick-lane and the passenger station at Shoreditch. It appears that the engine attached to the 10.40 p.m. down goods train had moved out of the up siding line from the goods station a short distance up the main line, when it suddenly came into collision with the last up passenger train from Loughton, due at the Shoreditch station at 10.45. The engine of the Loughton train was thrown off the rails, with the guard's break van and two carriages, all of which were severely damaged and broken. There were few passengers in the train, but they were all severely shaken, and more or less confused.

BOILER EXPLOSIONS.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the ordinary monthly meeting of this association, held on October 27th, 1863, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 300 engines and 440 boilers. Of the latter, 52 have been examined specially, 7 internally, 31 thoroughly, and 370 externally, in addition to which 2 of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 6 (1 dangerous); corrosion 18 (2 dangerous); safety valves out of order, 8; water gauges ditto, 19 (4 dangerous); pressure gauges ditto, 14 (1 dangerous); feed apparatus ditto, 5 (1 dangerous); blow-out apparatus, 43; fusible plugs ditto, 4; furnaces out of shape, 5 (2 dangerous); over-pressure, 3 (3 dangerous); blistered plates, 2. Total, 127 (14 dangerous). Boilers without glass water gauges, 11; without pressure gauges, 3; without blow-out apparatus, 13; without back pressure valves, 43. The three furnaces reported above as out of shape, all became so from overheating, consequent upon shortness of water, the injury in each case being observed for the first time, on setting to work in the morning, after the boiler had been standing during the night with the fires banked up, while two of the cases of injury were first observed on a Monday. Each of the boilers had but a single glass water gauge, two of which were of the pillar construction, while all the boilers were fitted with fusible plugs, which proved inoperative in every instance. One of the boilers was fitted with a fusible plug in each furnace, both the crowns of which came down; the second was fitted with a fusible plug in the right hand furnace only, and that was the one injured; while the third was fitted with a fusible plug in the left hand fire box, and the right hand was the one injured. But in neither case did the fusible metal melt or give any sign. There are several ways in which the water supply may run short in a boiler left standing for the night with the fire banked up, all of which should be guarded against. Where there is only a single glass gauge, the attendant may be deceived as to the actual amount of water in the boiler; and thus the supply be left short overnight, unawares. It is well, therefore, to add a duplicate gauge, so that one may act as a check upon the accuracy of the other; this would frequently prevent mistake. Again, leakage may occur at the feed back-pressure valve, or at the blow-out tap, either from their importance of examining these as a precaution, but leave them untouched until proved to be actually defective, whereas the feed back-pressure valve should be frequently taken out, and its free action ascertained; while the blow-out tap also should be examined, the plug cleaned and greased, as well as ground up, if necessary. A considerable safeguard also to furnace crowns would be found in a low water safety valve, which lets off the pressure of the steam on a deficiency of water occurring within the boiler. It may be true that it would not necessarily prevent the furnace crowns from becoming over-heated, since the fire would go on burning if left to itself, after the water supply had run short; but as the valve would not admit of any accumulation of steam, the injury would be confined to the plates over the fire; unless, by excessive carelessness, the attendant should let in the water and get up steam in the morning without observing the distorted furnace crown. Such, however, could not occur without the most culpable blindness, against which it is impossible to provide. Five boilers, not under the inspection of this Association, have exploded during the past month, from which eight persons have been killed and four others injured. Three of the boilers have been personally examined since the explosion. No. 33 explosion. The particulars of this explosion may be briefly told. The boiler, which was not under the inspection of this Association, was the outer one of the three working side by side and connected together, all of them being of the balloon or haystack class. Each of these boilers was of large diameter, the one in question being about 18ft. at the base, the sides swelling to a still larger diameter at the springing of the hemispherical domed top. The bottom, which was arched, but had no stays to tie it to the crown, was worked into the sides by the plates being bent, and was

seated upon a circular kerb of brickwork. Each of the boilers was fitted with a single safety valve, of rather a rough description, while it was stated that the working pressure had not exceeded 5lb., but that the exploded boiler, which was twenty years old, had already been repaired several times. Immediately over the brickwork seating, the plates for some distance round the boiler had been seriously affected by external corrosion, and reduced in places to one-eighth of an inch in thickness. It was from this cause that the rent occurred, the rent running circumferentially for a distance of ten or twelve feet, parallel with the seating, and for the most part through the body of the plate. A portion of the bottom was blown down into the ashpit, where it remained, the rest of the shell flying to a distance of about 70ft. across a public road adjoining, and carrying away a portion of the boiler shed in its flight. The engineer, as well as another man lying near to the boiler at the time, were both scalded, the latter dying shortly after in consequence. No. 35 explosion, from which one person was killed, arose from the collapse of the internal flue of a plain Cornish boiler, which was not under the inspection of this Association. The diameter of the shell was about 5ft. 6in., that of the flue 3ft., the length of both 28ft., the thickness of the plates generally three-eighths of an inch, but in the flues barely as much, while the steam pressure was 45lb. per square inch. The collapse had extended from one end of the flue to the other, the portion over the fire being the least affected, while the remainder behind the bridge was completely flattened down. The boiler had not, however, stirred from its seat, or broken a steam pipe joint, and all that was needed to resume work with the other two boilers, to which this was connected, was to close the junction valve. A rupture in an externally-fired boiler would have led to the dislocation of the whole series. The cause of the explosion in question was, viz., weakness of the flue. No flue of such dimensions as those just given can be safely worked with steam of a pressure of 45lb. on the square inch, unless strengthened either with hoops or flanged seams, or stayed in some other suitable manner. It may be true, however, that some such flues, though unstayed, are working, and have done so for years with steam of an equal or even a greater pressure than the above; still they are continuing to do so only at a risk, and their past immunity from collapse is no security against its occurrence in the future. Some flues gradually work themselves out of the circular shape, and thus become considerably weakened; while all should be placed beyond the suspicion of danger, especially as this can be done at so trifling an expense. No. 37 explosion occurred to a Cornish boiler with a single flue, internally fired, and not under the inspection of this Association. No one was injured, the explosion occurring during the dinner hour, when the men usually working near it were all absent. The boiler was set on two side walls. It was 23ft. long; its diameter in the shell was 6ft.; and in the furnace 3ft. 6in., which was reduced behind the fire bridge; while the thickness of the plates was seven-sixteenths of an inch. The cause of the explosion was external corrosion, the plates having been so eaten away as to be reduced to one-sixteenth of an inch in thickness. Two complete belts, the entire circumference of the boiler, and a plate wide, had severed themselves from it; while a third, which had rent in a somewhat spiral direction, and considerably overlapped a single circumference, lay opened out, and still attached to the shell.

AN ASTRONOMER ON BOILER EXPLOSIONS, &c.—We quote the following from a recent number of the *Scientific American*:—"A somewhat confused account is given of some experiments made with a boiler, and conclusions are drawn as to the comparative destructive powers of water heated under a pressure of 60lb. to the inch, and gunpowder. The conclusions are entirely irrelevant to the question of boiler explosions, for the destructive effect of an expansive agent is in proportion to the suddenness of its action as well as its expansibility, and yet not a particle of information is given by the Astronomer Royal as to the time occupied by the heated water in giving off its vapour so as to compare it with the instantaneous expansive action of ignited gunpowder. We can take the same materials of which a charge of gunpowder is made, and by simply altering their form into coarse or fine grain, a gun may be shattered to pieces by instantaneous ignition of the charge, or fired without danger, owing to the slower ignition of the charge. And the same law holds equally good in the case of heated water generating steam. The evaporation of heated water into steam, when relieved of pressure, goes on very slowly compared with the instantaneous expansion of ignited gunpowder; and its disruptive effect is low in proportion. A pound of anthracite coal under combustion will develop more power than a pound of gunpowder, but it will not produce the same disruptive effects; because its combustion was more slow, and the expansive gases resulting from it do not therefore generate pressure so instantaneously. The statements contained in the extracts from the paper of Professor Airy seem to confute the conclusions. It is stated that the disruptive results witnessed in boiler explosions are not due to the initial pressure of the steam, but to the quantity of highly heated water in a boiler, generating a great quantity of steam, when relieved from pressure, such as by a rupture. The quantity of water converted into steam, when relieved of pressure, is given in one case, and yet it is admitted that such steam is of a lower pressure than that which first escapes and lowers the pressure in a boiler by a rupture. The cause of a rupture in any boiler is due to the pressure being greater than the part that falls can withstand. Now supposing the pressure in a boiler is 60lb. on the inch, and that it is instantly lowered to 30lb. or 15lb., by a large quantity of steam suddenly escaping through a rupture, all the steam which is generated afterward from the heated water in the boiler is of the pressure under which it is generated. There can be no doubt about this. It therefore follows that if 60lb. pressure of steam only produced a rupture in the boiler, the 30lb. or 15lb. pressure of the steam afterwards generated from the water, cannot produce a greater disruptive effect, for a lesser cannot produce a greater result. The Astronomer Royal appears to have mistaken quantity of steam for intensity of pressure. Mr. Fletcher, Engineer of the Manchester Association for the Prevention of Boiler Explosions, stated some time since that he intended to undertake some experiments to test this theory of explosions. We trust his intentions will be carried out, and that William Fairbairn, F.R.S., may be associated with him in the undertaking. If the theory of boiler explosions above set forth is correct, then it is high time the engineering fraternity ceased to construct boilers with safety valves for the purpose of letting off steam and reducing its pressure, because such devices must produce the very results they are intended to obviate."

BOILER EXPLOSION AT GLASGOW.—On the 13th ult., a boiler explosion, accompanied with fatal results, occurred in the chemical works of Messrs. Charles Tennant and Co., St. Rollox, Glasgow. The portion of the establishment in which the accident took place is an extensive shed-like building, where the manganese recovery process is carried on. A good deal of machinery is employed in this portion of the works, and the engine which affords the necessary power is supplied with steam from a set of boilers placed within the building. The boilers, which are five in number, have been in use about three years, and seemed to be of the most substantial construction. At the time when the accident occurred only three of the boilers were in use. It was about a quarter to four o'clock when the men employed about the works and the men in the neighbourhood were startled by a pretty loud report, and presently those in the immediate vicinity found themselves enveloped in clouds of steam and exposed to streams or splashes of scalding water. When the catastrophe had partially subsided, and the steam had begun to clear away, the nature of the accident became apparent. It was discovered that the boiler had been lifted bodily a foot or two from its bed, and had settled down again on the ruins of the brickwork which had enclosed it. The brickwork at both ends was blown down and lay in two heaps of debris, and a considerable portion of that which had supported the west side of the boiler was also displaced. The boiler itself seemed externally to have sustained no damage; but on looking inside it was found that the flue had been torn to pieces. Giving way in this manner, the boiler had belched forth the boiling water, with which it was

charged, through the flue apertures at both ends. At the north end, the scalding steam was arrested in its course by the opposite wall of the firehole; while at the opposite extremity the wall of the kiln above referred to interposed an equally effective barrier to its passage.

BOILER EXPLOSION AT TUDMORDEN.—On the 3rd ult. a boiler explosion took place at one of the three cotton-mills of Messrs. Ingham and Sons, on the side of the canal at Tudmorden. The mill is a five-story stone building, with the engine-house and boilers at one end. It had been left standing idle for a few days, but on the morning of the above date steam was got up for the purpose of starting, and many of the workpeople were inside the mill. It is supposed that, through some oversight, the boiler was not sufficiently filled with water, and some of the plates had got nearly red-hot, when, the first stroke of the engine causing some cold water to be injected, an explosion occurred. One end of the boiler was blown out to a distance of 30 yards, and lodged against a wall. The mill was at the same time filled with steam, and shaken so severely as to loosen the floors, cause the roof to fall in, and to become almost a wreck.

BOILER EXPLOSION AT GREENWICH.—On the morning of the 18th ult., a boiler explosion took place at the creosote and alum works of Mr. John Bethell, situate in Greenwich marshes, by which the engineer was instantly killed and four other men were severely injured. The boiler was lifted from its position, and carried forward a distance of some 20 yards, and the fragments were thrown in all directions. The timbers of the long line of shed in which the business was carried on took fire, and, notwithstanding the arrival of the Deptford floating engine and that of the parish, the building was destroyed.

GAS SUPPLY.

GAS COALS OF GREAT BRITAIN.—The following is an extract from a table of analyses of various Scotch Canals, made by Dr. Penny, of Glasgow, from which may be gathered some useful information respecting the relative composition of these coals:—

Locality, or Name of Coal.	Specific gravity.	Volatiles Per cent.	Fixed Carbon Per cent.	Ash. Per cent.	Sulphur. Per cent.	Water. Per cent.	Coke. Per cent.
Roch Siles, 1851	1.146	33.7	4.9	38.8	1.6	1.0	43.7
Boghead, 1851*	1.160	71.06	7.10	21.2	0.24	0.4	29.3
Boghead, 1851†	1.218	62.7	9.25	26.5	0.35	1.2	35.75
Torbanc Hill, 1853	1.189	67.11	10.52	21.0	0.32	1.05	31.52
Boghead, 1846	1.155	71.3	11.3	16.8	0.34	0.6	29.10
Bathfiville	1.201	64.35	12.6	22.2	0.25	0.6	34.8
Metthill	1.300	49.23	17.57	29.7	...	3.5	47.27
Capeldrae	1.360	45.73	19.97	31.5	...	2.8	51.47
Wemyss	1.183	58.52	25.28	14.25	...	1.85	39.53
Leamnahog	1.199	56.23	36.7	4.3	0.55	2.22	41.00
Leamnahog	1.228	49.34	40.97	6.34	1.35	2.0	47.31
Knight's Wood	1.234	44.77	41.13	11.06	...	3.06	52.18
Calnbroe	1.247	42.83	42.67	8.5	...	6.0	51.17
Kelvinale	1.231	40.17	53.42	1.9	0.21	4.3	56.32
* Brown.	† Black.	‡ Auchinheath.	§ Southfield.				

The following are the quantities of gas in cubic feet per ton obtained from the principal British gas coals:—

	Cubic feet per ton.
In SCOTLAND—Boghead	15,000
Leamnahog	13,500
Capeldrae	14,400
Armlston	13,600
Ramsey	10,300
Wemyss	14,300
In ENGLAND—Pelton	11,000
Pelton Cannel	11,500
Levenson ditto	11,600
Washington ditto	10,500
Pelaw	11,000
New Pelton	10,500
Dean's Primrose	10,500
Ponesfield	10,500
Gosforth	10,000
West Hartley	10,500
Hasting's Hartley	10,300

PETROLEUM GAS.—A writer in the *American Gas Light Journal* observes that the laws governing the destructive distillation of petroleum and its distillates are the opposite to those so successfully applied to the manufacture of coal gas. They are as follows:—1st. Graduation in the application of the heat, in order to vapourise the oil only as fast as the means provided to convert the vapour formed into gas can so act upon it; otherwise there must be great waste of material.—2nd. As, on the one hand, to convert vapour into gas requires its actual contact with red-hot iron, and, on the other, such contact, if continued, again decomposes the gas (the cause of the carbonaceous deposit so often found in gas retorts, which comes from the destruction of gas, not vapour or tar, as many suppose), the apparatus must be so arranged as to compel the vapour in its passage out of the retort to come into contact with its red-hot surface, and while in such contact to travel so rapidly as to leave little or no time for the decomposition of gas. When treated according to these laws, petroleum will yield to the gallon 125 ft. of gas, of surpassing richness, and there will be no clogging in the pipes or deposit in the retorts. But to make the manufacture profitable for gas companies, a third condition is required—to wit, dilution of the gas to secure its combustion without smoke, and enable it to be sold at the prices charged for coal gas. This condition is fulfilled by distilling the oil in connection with wood. The hydrogen thus obtained, while it dilutes the olefiant gas from the oil, also conserves it while the two gases are passing together over the red-hot surface of the retort. In truth, this process requires so little oil, most of the gases being made from the wood, that, perhaps, the proper classification of petroleum in the manufacture of gas is not as the basis of the process, but merely as the means of enriching hydrogen gas obtained from wood. He limits the material from which the hydrogen is to be obtained to wood, because the objections to the use of water for such a purpose are fatal, and wood alone affords a residuum of equal value with the coke obtained from coal, and which hitherto has been regarded as its great safe-guard against competition. It appears that from each gallon of petroleum, or petroleum tar (which when treated with wood answers the same purpose as the oil), and 155 ft. of hard wood, 300 ft. of gas of equal illuminating power with coal gas, and nearly two bushels of good clean charcoal (worth the cost of the wood) is produced; the cost of the gas, consequently, being only that of the tar or oil used.

THE CORPORATION OF STOCKPORT have expressed their intention to reduce the price of their gas (24 candles), manufactured entirely from Wigan Cannel, on the 1st January next, from 5s. per 1000 ft. beyond the borough limits, and 4s. 6d. per 1000 ft. within the borough, to one uniform rate of 4s. per 1000 ft., with a progressive scale of discounts, commencing on a quarterly consumption of 200,000 cubic feet. Their engineer, Mr. Frederick Leslie, has extensively altered the plant and mains, having laid a 24-inch trunk main, and several miles of mains of all sizes during the past spring and summer season.

The Corporation propose next year to spend between £15,000 and £20,000 in new works and mains.

THE SURREY CONSUMERS' GAS COMPANY have declared a dividend of 7 per cent. for the last half-year, or 14 per cent. per annum, comprising 5 per cent. for the half-year and 2 per cent. on account of back dividends.

In **STOURBRIDGE**, at a public meeting, it was resolved to request the local commissioners to erect new gas works for the town. The consumers appear to be willing to compromise the matter with the local gas company if the latter will consent to a uniform maximum price of 3s. 9d. per 1000 cubic feet in the township, and 4s. 2d. out of it.

THE SHEFFIELD GAS COMPANY have declared a dividend of 10 per cent. per annum on class A shares, and 8 per cent. on class B.

THE ROTHERHAM GAS COMPANY have declared a dividend after the rate of 10 per cent. on A stock, 8 per cent. on B stock and on D shares (so far as the latter are paid up), for the past half-year; and that half a year's arrear of dividend, at the rate of 2 per cent. (unpaid in former years), on A stock be also paid free from income-tax.

THE BRECON GAS COMPANY have resolved to reduce the price of their gas from 6s. to 5s. per 1000 ft.

READING GAS WORKS.—The extensive alterations and additions that have been going on for some time at these works are nearly completed. About £10,000 have been expended. At King's-road, the works have been almost entirely remodelled, and the most modern improvements have been introduced. A new retort-house has been erected, capable of producing something like half a million cubic feet of gas per diem. An immense chimney has been raised, and condensers upon a new principle have been added. The retort-house is covered with an iron roof, the work being executed by Mr. Williams, and the retorts have been set by Mr. Lloyd, of Wandsworth. Various other improvements have been effected.

In **WALSALL** a further reduction in the previously low price of gas has been determined on by the Local Gas Committee, the gasworks in Walsall being the property of the town, and managed by the Improvement Commissioners.

At **BRIGHTLINGSRA**, gasworks have been opened. The expenditure actually incurred has been about £2000, for works somewhat larger than were originally contemplated, in order to meet an increased consumption in future years without the heavy expense of additional buildings. The works are situate at the bottom of Sydney-street—a new thoroughfare leading to the Hardway. The iron gas-holder will contain 9000 feet. The works were designed by, and carried out under the direction of, Mr. Church, the engineer. The contractors for the buildings were Messrs. Gull and Lake, of Brightlingsra, and the apparatus, machinery, and mains were supplied by Mr. Cliffe, of Huddersfield.

DOCKS, HARBOURS, BRIDGES, &c.

FIRST WIRE SUSPENSION BRIDGE IN BRITISH COLUMBIA.—This suspension bridge crosses Fraser River at a point three quarters of a mile below Chapman's Bar, and is admirably situated at a contraction of the river, where the bed-rock rises almost perpendicularly on both sides, the towers springing up almost immediately over the water, the bridge having a clear span of 269 ft. At low water the roadway of the bridge will be 90 ft. above the stream. The tower timbers for this work are each 20 in. square. Supporting the cables are 16 of these timbers, each 26 ft. 6 in. long, four timbers being framed together by means of 14 girth timbers and 17 1/2 in. wrought iron bolts, spread at the bottom, resting on heavy sills, and coming together at the top, forming a pyramid of massive timbers. On the summit is fitted a heavy cast-iron saddle, covering the whole of the timbers, and keeping the cable which rests on it in position. These towers, of which there are four, are enclosed in massive granite piers, the piers being 32 ft. long by 12 ft. wide on top. The two cables are 1/4 in. in diameter, 528 ft. long, and are composed of 1264 wires, laid up in line oil, and protected externally by a coating of tar, pitch, and oil boiled together, and payed on while hot; each of these cables weigh 12 tons. These cables are secured on the west side by means of bolts 3/4 in. in diameter, each set 4 ft. into the hard bed rock; and on the east side by means of granite masonry, built underground 60 ft. in the hill from the roadway. The cables hang with a deflection of 20 ft. attached to each cable. Equi-distant and 5 ft. apart are 52 suspension rods, 1 1/2 in. in diameter, of various lengths, shortening towards the centre in such a manner as to give the roadway below a curve of 2 ft. rise in the span. Attached to the lower end of these rods and sustained by two nuts are 52 beams, each 17 ft. long, 14 by 6 in., set up edge-wise. On these beams the platform is built, with 7 sets of stringers, 3 by 10; firmly bridged on the top of which is the planking, 1 in. thick. This is all bolted together by means of 1/2 in. bolts, no nails or spikes being used in the platform. Attached direct to the cables and platform, and on each side of the bridge is an arrangement of diagonal bracing, very light in appearance, forming an effective truss, and rendering the bridge perfectly rigid. From the platform four wire guys are fastened to the rock on each bank. Thus, by means of the truss and guys, all undulation or oscillation is prevented. The distance between the cables is 14 ft. The designer and constructor of this bridge, Mr. A. S. Hallidie, of San Francisco, was on the ground during the entire period of its construction.

At **BELFAST** A FLOATING AND A GRAVING DOCK, of extensive size, are about to be constructed, the contractors for the graving dock being Messrs. Thomas Monk & Co., of Birkenhead; and for the floating dock, Messrs. Smith, Kent, and Browne, of Belfast. The plans and other particulars have been prepared by Mr. Wm. H. Lizar, the resident engineer (under whose immediate supervision the works will be carried on), and approved of by Mr. George Smith, C.E., and conservator of the port and harbour. When these improvements are completed, Belfast will be enabled to give accommodation to a much larger class of vessels than at present, a circumstance that will aid to a great extent the marine interests and general commercial prosperity of this enterprising port.

NEW BRIDGE AT PEEBLES.—An iron suspension-bridge of one arch, the length of which is about 120 ft., has recently been erected near the Tweed at Crownhead, Stobo. The expense of its erection is to be borne partly by the Broughton and Peebles Railway Company, who are to have a station near it, and partly by the landed proprietors of the district. Formerly at this point there was only a ford, with a wooden bridge for foot passengers, the approach to which floods often rendered impassable during winter.

PROPOSED HARBOUR IN THE DOWNS.—A meeting of the promoters of this undertaking has been held in the Guildhall, Deal. Mr. Alfred Giles, C.E., attended and explained the plan of the proposed works. A basin of 30 acres in extent has to be constructed on the waste ground near Sandown Castle, to be connected with Sandwich by a canal 100 ft. wide, through which the water of the River Stour can be diverted when necessary to flush out the entrance to the basin. The estimated cost of the works is £200,000. Mr. Giles explained that there will be an outer harbour, always open, which will have 10 ft. of water at the lowest spring tides, and the entrance to which will be protected with two arms or piers. The works will not interfere with the drainage of the marshes, and the waters of the Stoc will be so seldom required for flushing the basin that the river above and below Sandwich will not be injuriously affected.

AN ENORMOUS PAIR OF SHEARS.—Messrs. Tangye, Brothers, and Price, of the Cromwell Works, Parade, Birmingham, have completed, for the Russian Government, an immense pair of shears, weighing 24 tons, having a power of pressure equal to 1,000 tons, and able to nip to pieces a cold bar of iron half a foot square. The contrivance is technically described as a "horizontal hydraulic shearing machine, with open mouth;" and it is said to be, if not the largest, at least the most powerful article of the kind ever made.

THE MERSEY DOCK BOARD.—EXTENSION OF DOCK ACCOMMODATION.—After a long and animated discussion at a recent meeting, the Board decided to adopt the recommendations presented by a special committee appointed to consider the new plans for dock works, and to apply to Parliament in the next session for power to borrow a sum of £850,000, to be applied in the making of the purchases, and in the construction of the new dock works on the Liverpool side of the river, included in the plans agreed to by the committee. It was afterwards resolved to increase the amount to £875,000, in order to include the purchase of some additional lands.

PROPOSED TUNNEL UNDER THE MERSEY.—A plan has been suggested by Mr. T. J. Edwards, Tranmere, to make a tunnel under this river. It would commence on the Cheshire side in the low land at the corner of Camden and Conway-streets, which is only about 26ft. above the level of the Old Dock sill, proceeding thence to the north of the Woodside Landing-stage under the river, and emerging on the Liverpool side at the corner of Whitechapel and Preston-street. The length of the tunnel would be 3400 yards, with descending gradients from the termini to the centre of the tunnel under the river of one in forty. It is also part of the plan to construct a branch tunnel for connecting the goods line with the London and North-Western Railway, passing under Byron-street at one end, and a connection with the Birkenhead Railway for the goods traffic, and a through passenger traffic from Whitechapel to Chester at the other end. Mr. Edwards estimates that the works may be executed for £400,000.

MINES, METALLURGY, &c.

MINERAL WEALTH OF THE COUNTRY.—The "Mineral Statistics of the United Kingdom of Great Britain and Ireland for 1862, by Robert Hunt, F.R.S., Keeper of Mining Records," has just been issued in a printed form at the Stationery Office. From this it appears that the total results are as follows for the year 1862:—

Metals produced from British Minerals and Coals.

Gold	5,209 oz.	£20,390 value
Tin	8,476 tons	983,216 "
Copper	14,843 "	1,493,341 "
Lead	99,031 "	1,436,345 "
Silver	686,123 oz.	189,041 "
Zinc	2,151 tons	50,548 "
Iron, pig	3,943,469 "	9,358,672 "
Other metals, estimated		250,000 "
Total value of British metals		£14,281,453
Coals	81,638,338 tons	20,409,584 value.
		£34,691,037

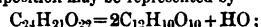
Earthy minerals, such as barytes and lime, salt, and the more valuable clays, are estimated at £1,750,000, and we find by a return compiled by Mr. Hunt in 1859, that the value of building stones, slates, &c., amounted to £7,954,075. The actual wealth added to the national store, therefore, as obtained from our native rocks, amounts to nearly £46,000,000 sterling.

COAL-CUTTING MACHINE.—Mr. Delahaye, of Rouen, proposes an apparatus, which consists of a frame, or frames, adjustable to height or length, with the two ends capable of being caused by the pressure of a screw to hold firmly against the top and bottom or partition walls of a mine, or other cavity to be excavated. The frames form guides for slides worked by means of a lever and ratchet, and a pulley with a cord round it, such slides having connected to them, by means of suitable cross-framing, the carriage for the travelling tool, which carriage is supplied with holes for the insertion of a forked bar, or bars, by means of which the carriage may be worked as required along the cross-framing, friction rollers being applied to the carriage in order to facilitate its motion thereon. By means of the foregoing arrangement of apparatus, the operations of the workman will be made to consist in guiding the travelling tool, which will work after the manner of a plane, whereby he will be relieved from the more trying operation of working as usual with a pick.

APPLIED CHEMISTRY.

CARBONATE OF SODA.—METHODS USED FOR MAKING, TRYING &c.—In 1789 or 1790, Lord Dundonald, Mr. Losh, and Mr. Doubleday, tried, by decomposing common salt by oxide of lead, making the insoluble chloride of lead into a pigment, while the caustic soda formed in the operation was made into carbonate. Another process was by decomposing common salt by sulphate of iron. Sulphate of soda was formed; this, then, heated in a furnace with small coal—sulphide of sodium being formed—they (that is Messrs. Losh) then tried to make the sulphide into carbonate, by burning with sawdust; this was without success. Another process, again, was to form the sulphate by decomposing a mixture of common salt, and sulphate of potash. About this time, the first soda works were erected at Walker, a small village a few miles down the River Tyne, from Newcastle. The partners were Lords Dundonald and Dundas, and J. and W. Losh. Mr. Losh, about this time, got brine from a spring near Walker, and evaporated it down, and then decomposed it by oxide of lead; this was then crystallised. In 1816, Mr. Losh, when in Paris, learnt Leblanc's process for decomposing sulphate of soda, by heating with coal and carbonate of lime; and he was the first to commence the same in England. The greatest disadvantage of this process is that all the sulphur is wasted. Crystals of soda cost then about £60 a ton, now £4 15s. a ton. In 1841, Mr. J. Shanks, of St. Helens, Lancashire, obtained a patent for a process of converting the caustic and silicate of soda in black ash into carbonate, by means of carbonic acid. In 1840, Mr. J. Wilson took a patent for improvements in the manufacture of soda. He applied as much bicarbonate of soda to black ash as would convert the caustic into carbonate of soda. A plan has also been tried for making caustic from the sulphate of soda, by means of caustic baryta. M. Blanc and Bazille patented a soda process, founded on the decomposition of salt by silica at a high temperature, and in the presence of steam. Mr. Wm. Hunt boiled sulphide of sodium with oxide of zinc or copper and caustic soda was formed.

NOTE ON VEGETABLE IVORY, BY DR. PHIPSON, F.C.S., &c.—Vegetable ivory is the fruit of the *Phytelphas macrocarpa*, a plant allied to the palm-trees, common in South America. At the period of maturity the grain forms a hard mass resembling ivory or bone, and which is manufactured into various kinds of ornaments. According to an analysis by Muller, its composition may be represented by—



Baumhauer obtained a precise similar result some years later. I have found that vegetable ivory takes, in contact with concentrated sulphuric acid, a splendid red colour, almost equal to magenta. This colour, at first pink, then bright red, becomes much deeper and more purple when the acid has been allowed to act for about twelve hours. This reaction may sometimes be found useful in order to distinguish small pieces of vegetable ivory from the ivory of the elephant's tusk, or from bone, neither of which take this beautiful red colour in contact with sulphuric acid. The analysis quoted above shows that the greater portion of vegetable ivory is pure cellulose, but the reaction produced by sulphuric acid proves that other substances are present, for cellulose does not become red with sulphuric acid. Mr. Connel found in 1815 that vegetable ivory contained

81.34 per cent. of cellulose, and that the other substances were gum 6.73, legumine 3.80, albumine 0.42 (that is 4.22 of albuminous substances), oil 0.73, water 9.37, and ash 0.61 = 100. Filings of vegetable ivory dried at 140° to 150°C. give 1 per cent. of ash. Payen found that these filings when boiled with caustic soda took a yellow colour, a fact confirmed by Baumhauer, who asserts that potash does not produce any colour. The reaction of sulphuric acid on vegetable ivory has enabled me more than once to distinguish immediately between filings of this substance, and bone or ivory filings. It is owing to the well-known action of this acid upon albuminous substances in presence of sugar, and which has been utilised by Raspail in his microscopic researches. But whether the sugar is formed by the action of the acid in the cellulose, or pre-exists already formed in the substance is of little import. I incline, however, to the first opinion, as the colour takes a little time to show itself (five or ten minutes), and as Mr. Connel did not find any sugar readily formed. I have since observed that the white portion of the cocoa-nut presents a similar reaction with sulphuric acid; the colour produced is first pink, then red, reddish purple, and finally, in about sixteen hours, a fine violet. The colours thus produced with vegetable ivory and cocoa-nut disappear gradually in contact with water, like the fine reddish-brown colour produced with essence of turpentine and sulphuric acid.

ON THE EXTRACTION OF IRON AND STEEL FROM THE CINDERS OF PUDDLING AND REHEATING FURNACES, BY A. L. FLEURY.—The thought to give a more practical use to the many thousand tons of cinder that are drawn from the puddling and reheating furnaces, and which are by most of the rolling mills thrown away as useless, or, in the best case, used up as admixture to iron ores in blast furnaces, in order to increase the yield (but certainly not to improve the quality) of the iron, has occupied my attention for several years past. I have made numerous experiments on a practical working scale, and I come now to detail the same in my present communication. Chemical analysis gave me the full assurance that these cinders contain invariably from 25 to 50 per cent. of metallic iron, combined and mixed with sulphur, silica, lime, and alumina, forming a brittle compound of a very peculiar constitution, defying the most ingenious devices of our ironmasters. Near Troy, New York, for instance, near the Troy and Albany Iron Works, are many thousand tons of these puddling cinder spread over the streets, every hundred pounds of which contain from thirty to fifty-five pounds of good iron. After many unsuccessful attempts, I have finally succeeded in extracting good casts, as well as wrought iron, and have even been so fortunate as to produce from this refuse material a good quality of cast steel. Two great difficulties had to be overcome. First, the oxides and metallic iron are in these cinders combined with silica and other substances in such a peculiar way, that, by remelting the same in the puddling, cupola, or other furnace, very little of the metallic iron can be extracted, the combination withstands even to the high heat in a steel crucible—no sufficient per centage of iron can be extracted to make it alloy. Second, I have found further, that by re-working the cinder with lime alone, or with lime mixed with charcoal and clay, the product was invariably red-short, and many times red and cold-short (brittle at a bright red heat, as well as when hammered cold.) The sulphur remained still combined with the iron, equally so the silicon and phosphorus—the three devils or evil spirits of iron; all my attempts to extract good neutral iron from the puddling cinder by dry admixture of lime were unsuccessful; there was no other way open but to destroy, or loosen the tenacious chemical combination of these substances before they were placed into the furnace. Unslacked burnt lime has the peculiar property to decompose silicates during the act of hydration or slacking, as it is commonly called. This can easily be demonstrated by pouring water slowly into an intimate mixture of sand and fresh burnt lime—the outside of the sand grains will yield to the lime gelatinous silica, and when fused form with it a strong chemical combination, silicate of lime—the base of a good mortar. Taking advantage of this chemical fact, I mixed a proper per centage of powdered burnt lime with the fine ground cinder, and after wetting the whole with water, exposed the mixture to the drying influence of the atmosphere. The dry compound was then heated in a common puddling furnace, and treated like pig-iron. I obtained 50 per cent. of wrought iron, which, however, retained still some traces of sulphur, leaving the iron somewhat red-short. To extract these last traces of sulphur, I dissolved in the water, which I used for slacking the lime, a small per centage of a chlorine salt, and my expectations were thoroughly realised. The process is also applicable to the working of silicious ores, and can be performed in the puddling, cupola, or blast furnace; it can also be worked to advantage in Bessemer's, Nystrom's, Swett's, and other similar furnaces. The preparation of the cinder, cost of lime, salt, &c., does not exceed two dollars per ton, and the result is, if properly worked, invariably a good quality of iron.

DETECTION OF SUGAR IN GLYCERINE.—The suspected glycerine is to be dried as far as possible in a water bath. The glycerine is dissolved out with chloroform, in which sugar is insoluble. The residue, if any, may then be thrown on a filter, washed once or twice with chloroform, and then weighed.—Solubility of Paraffin.—Aug. Vogel has determined the solubility of paraffin in benzol, chloroform, and sulphide of carbon. The paraffin experimented with melted at 46° C., and congealed at 45°. The benzol had the specific gravity 0.887.

The part of benzol at 46° C. dissolved 7.7 parts paraffin.

"	"	43°	"	5.0	"
"	"	30°	"	4.0	"
"	"	23°	"	0.7	"
"	"	20°	"	0.3	"

Solubility in Chloroform.—One part of chloroform at 23° dissolved 0.22 parts paraffin. One part of chloroform at 20° dissolved 0.16 parts paraffin.—Solubility in Sulphide of Carbon.—One part of sulphide of carbon at 23° dissolved an equal weight of paraffin. Comparative experiments with stearic acid showed that one part of benzol at 23° C. dissolved 0.22 parts of stearic acid; and one part of sulphide of carbon at 23° dissolved 0.3 of stearic acid. This acid is consequently less soluble in the above menstrua than paraffin. A mixture of stearic acid and paraffin fused together did not separate from these solutions in a homogeneous mass, but in two layers, the stearic acid appearing in distinct crystals. This may suggest a method of recognising the presence of stearic acid in a mixture with paraffin.

FINELY DIVIDED IRON AND ITS APPLICATION FOR THE PRECIPITATION OF COPPER FROM SOLUTIONS AND OTHER PURPOSES.—Mr. Gustav Bischof, of Skelly, near Swansea, has built a reverberatory furnace of his construction at the works of Messrs. Roberts, Dale, and Co., Warrington, for the production of finely divided iron, by heating a mixture of pulverised oxide of iron and carbonaceous matter, avoiding fusion. The powdered iron thus obtained is used for the precipitation of copper from its solutions in the manufacture of aniline instead of iron filings, and for other purposes. In the manufacture of aniline, iron filings may be used as usual, which, having been oxidised, are re-converted into the metallic state as described, thus being employed over and over again. For the precipitation of copper, Spanish or Irish burnt ores, containing a few per cent. of copper are reduced in the above furnace. Both iron and copper in these ores are converted into the metallic state, and being employed for the process of precipitation, the latter mixes with the copper precipitated from solutions. As by these means the whole copper contained in the burnt ores is extracted, the greater value of such copper to the price paid for the ores fully covers the costs of purchase and reduction, even leaving in most cases a considerable surplus. Trials made with the precipitation of copper from artificial solutions and mine waters by Mr. Bischof have amply proved the powerful action of such iron powder. This process therefore combines the saving of all costs for iron with a greatly facilitated and accelerated precipitation.

LIST OF APPLICATIONS FOR LETTERS
PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT BRITAIN PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUESTING INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED OCTOBER 23rd, 1883.

- 2617 J. Ronald—Spinning hemp, flax, manilla, and wool.
2618 V. J. Casanellas—Prisms, lenses, and glasses of stereoscopes, and ornamenting glass.
2619 F. Tolhausen—Regulating the working of springs.
2620 J. Parker—Application of steam combined with air as a motive power.
2621 A. V. Newton—Railway wheels.
2622 A. Wardle & J. Bindley—Improvements in smoking pipes.

DATED OCTOBER 24th, 1883.

- 2623 W. Bates—Metallic capsules for bottles and similar vessels.
2624 E. S. Cressie—Drilling, boring, or excavating rock or other earthy substances.
2625 J. Davidson—Doubling yarns or threads of silk.
2626 J. Thomas—Improvements in gas meter indicators.
2627 G. Haselme—Attachment to coverings for the head and to other articles of dress for lighting matches.
2628 F. B. Baker—Dressing lace and other textile fabrics.
2629 J. Brown, J. T. Way, & T. M. Evans—Preparing cements and varnishes.
2630 W. Locke, J. Warrington, W. E. Carrett, W. E. Marshall, & J. Telford—Working and mining coal, minerals, and earthy matters.
2631 L. J. Mannart—Fastening for gloves and other wearing apparel.
2632 A. & W. P. Potter—Improvements in railway waggons.
2633 A. Sellar—Improved instrument for lubricating rifles.
2634 B. Brown—Sewing machines.
2635 A. Allison—Atmospheric railways, and carriages for the same.

DATED OCTOBER 26th, 1883.

- 2636 R. Littleboy—Improvements in the manufacture of nosebags.
2637 B. Beziunets—Improvements in locks for bags.
2638 F. B. Parker—Carriages.
2639 T. Marsh—Projectiles.
2640 S. J. Healey—Water gauges applicable to steam boilers and other purposes.
2641 M. Vian—Composition for preserving iron ships.
2642 J. Nicholas—Treating Canadian petroleum and other mineral oils.
2643 W. E. Gedge—Improved pillow.
2644 L. Baggs—Capturing or killing fish, birds, and other animals.
2645 J. Wilcox—Sewing machines.
2646 A. Blake—Refrigerator for cooling worts for brewing.
2647 E. Clifton & B. Greenwood—Manufacture of brushes.

DATED OCTOBER 27th, 1883.

- 2648 J. Marshall—Expression of oil from oil-yielding substances.
2649 T. H. Holderness—Improvements in propelling navigable vessels.
2650 J. C. Wilson—Mounting, firing, cleaning, and loading ordnance.
2651 T. Graon—Boots, shoes, elgs, and such like coverings for the feet.
2652 E. G. Athley—Obtaining motive power by certain arrangements of machinery and water.
2653 W. Livingston—Punching, shearing, and rivetting metals.
2654 J. Hutchinson & J. Hellingworth—Weaving.
2655 P. B. O'Neil—Salinometer.
2656 E. Smith—Doubling and winding machines.
2657 E. R. Hollands—Punching, cutting, and pressing metals and other materials.
2658 M. W. Carr—Manufacture of wooden sleepers for railways.
2659 W. & S. Pith & J. Sturgeon—Cutting and boring coal, stone, or other materials.

DATED OCTOBER 28th, 1883.

- 2660 W. Wanklyn—Opening and conditioning cotton.
2661 J. Marshall—Applying adhesive substances to spindles.
2662 A. S. Correll—Preparation of tobacco for fumigating purposes.
2663 W. E. Gedge—System of permanent advertisement.
2664 S. Procter—Instrument for extracting corks from bottles.
2665 E. Oldfield—Self-acting mules for spinning and doubling cotton.
2666 H. A. B. Henville—Clasps for portemonnaies, pocket books, and bags.
2667 K. Needham & J. Pollitt—Equilibrium valves for steam engines.
2668 J. J. Carruth—Making bricks and tiles.
2669 M. Henry—Military knapsacks and travelling bags.

- 2670 W. Hall—Ornamenting glass and sheet gelatine.
2671 G. E. Donisthorpe—Getting coal and other minerals.
2672 R. B. Jones—Portable cooking apparatus.
2673 J. Kennedy—Ships of war and other vessels, and masting and rigging the same.
2674 R. A. Brooman—Taking astronomical and other observations.
2675 R. A. Brooman—Clocks, watches, and other timekeepers.

DATED OCTOBER 29th, 1883.

- 2676 O. C. Evans—Digging machinery.
2677 J. R. Johnson—Manufacture of lubricating compounds.
2678 J. Rawlings—Attaching cords to window sashes.

DATED OCTOBER 30th, 1883.

- 2679 A. R. Le Mire Normandy—Playing cards.
2680 F. N. Osborne—Coating ships bottoms.
2681 J. Nash—Mottos.
2682 J. Haworth—Conveying electric signals.
2683 H. Cochrane—Surface condenser.
2684 W. M. Neilson—Taps.
2685 W. Gaid—Bonnet and cap fronts.
2686 W. Durand—Cotton cloths.
2687 M. J. Roberts—Oiling wool.
2688 G. Roserlet—Sustaining and raising ships.
2689 A. Turner & W. E. Newton—Looms.
2690 B. Russ—Iron and other ships.
2691 A. Turner—Looms.
2692 W. Verran—Obtaining motive power.
2693 H. Clow—Ovens.
2694 G. F. Budge—Feeding sheets of paper to a drying machine.
2695 J. Brigham & R. Bickerton—Reaping and mowing.
2696 J. H. Johnson—Soap.

DATED OCTOBER 31st, 1883.

- 2697 H. B. Barlow—Wool and hair felting.
2698 A. A. Wassenaar & T. Lessinger—Snow cards and window tickets.
2699 S. H. Parker—Opera glasses, telescopes, microscopes, spectacles, and other optical instruments.
2700 W. Traker—Making safety paper.
2701 J. Reuter—Candelabra and lamps.
2702 W. Law—Furniture.
2703 J. Getty—Building ships and vessels.
2704 J. H. Brown—Securing envelopes and other packages.
2705 W. Power—Crushing stone.
2706 J. Wilson—Threshing machines.
2707 S. Holman—Raising and f. ricing fluids.
2708 E. Jones—Bricks, drain pipes, traps, sewage tanks, and water closet pans and valves.

DATED NOVEMBER 2nd, 1883.

- 2709 T. Adams & J. Scott—Transmission of patterns or samples of merchandise by post.
2710 P. J. Yoderne—Excavating land.
2711 W. E. Newton—Clock-work movements.
2712 T. F. Winton—Ventilators and fire-guards.
2713 T. W. Alderton—Sewing machines.
2714 F. J. Pastorelli—Surrey instruments.
2715 D. Jay—Six-arm hammers.
2716 J. Macintosh—Taps or cocks.
2717 K. Enayou—Rubbing or making leather.
2718 S. Bateman—Gun wool and other fibrous substances.
2719 J. P. Booth—Beds and bedding.
2720 J. J. Key—Explosive compounds.
2721 M. Henry—Zinc white.

DATED NOVEMBER 4th, 1883.

- 2722 J. Livesey & J. Edwards—Permanent way of railways.
2723 P. A. Santreuil—Lubrication of bearings.
2724 G. V. A. Treating natural phosphates of lime.
2725 J. Thomas—Preparing ores and earths containing copper for smelting.
2726 E. Hughes—Fans for forcing and exhausting air or other gases.
2727 E. How—Sewing machines.
2728 J. Tange—Portable hydraulic clearing and rivetting machines.
2729 R. Brooks & C. Inwards—Facilitating the teaching and playing of stringed instruments.
2730 A. Gille—Cutting chaff.
2731 J. A. Barral & L. A. Coehery—Mauure.
2732 J. H. Maw—Application of preservative coatings to the bottoms of ships.
2733 W. Audinwood—Threshing machines.
2734 M. Lunera—Hat or cap frames.

DATED NOVEMBER 5th, 1883.

- 2735 G. W. & J. Craven—Cutting and placing iron and other metals.
2736 J. Northrop—Pringles.
2737 E. K. Dutton—Covering the surfaces of rollers or cylinders.
2738 T. Farrar—Skirtings employed as wearing apparel.
2739 R. Smith—Colouring matters.
2740 B. Blackburn—Coupling or buckle.
2741 W. French—Looms.
2742 H. Hancock & W. H. Vickers—Fastenings.
2743 J. Whitworth—Treatment and application of steel and homogeneous iron metal.
2744 H. Besmer—Railway bars.
2745 S. Selig—Harrows.
2746 H. Besmer—Iron and steel.
2747 R. T. Tate—Woolen garments.
2748 G. Speight—Collars and cuffs.
2749 P. E. Sickle—Steering vessels.

DATED NOVEMBER 6th, 1883.

- 2750 C. D. Abel—Flood meters.
2751 G. Coates—Printing cotton.
2752 R. Selig—Harrows.
2753 J. Muckart—Unweaving vegetable substances.
2754 W. Davies & G. Cate—Cutting corks.

- 2755 C. H. Southall & R. Heap—Cutting and shaping the soles and heels of boots and shoes, and screwing them on to the uppers.
2756 R. Saunders—Fastening together the parts of ships and vessels.
2757 J. S. Gurette—Inhaling apparatus.
2758 J. Townsend—Nirate of potash.
2759 W. M. Neilson—Axle boxes.
2760 W. D. Allen—Casting steel.
2761 C. M. Campbell—Drying earthenware.
2762 W. H. Perkin—Colouring matters.
2763 R. Johnson—Testing the strength of wire.
2764 W. E. Newton—Sewing machines.

DATED NOVEMBER 7th, 1883.

- 2765 H. L. Emery—Ginning and cleaning cotton.
2766 T. C. Burmelough—Looms.
2767 R. B. Jones—Paper-making machinery.
2768 J. K. Hoyt—Revolving fire-arms.
2769 J. Johnson—Laborators.
2770 J. J. & G. W. Dyson—Forming metal plates, bars, and rods taper.
2771 L. Esham—Spectacles and hand frames.
2772 W. Clark—Sewing machines.
2773 G. S. Mel and—Fire-arms and ordnance.
2774 A. Priester—Sewing machines.
2775 A. Barclay & A. Merton—Injecting and ejecting fluids.
2776 C. D. Abel—Raising and lowering bodies.
2777 H. Wickens—Lamps.
2778 M. Mellor—Loomed or knitted fabrics.
2779 G. Haselme—Bending metallic pipes.

DATED NOVEMBER 9th, 1883.

- 2780 A. A. L. P. Cochrane—Propelling and steering ships.
2781 H. Migs—Soap.
2782 W. J. Cunningham & H. Connop—Sawing machines.
2783 G. T. Bousfield—Ships and vessels.
2784 N. Thompson—Stepping bottles.
2785 G. Ryder & M. Gutteridge—Hay making machines.
2786 R. H. Philipson & J. Dees—Cutting coal.

DATED NOVEMBER 10th, 1883.

- 2787 T. Weston—Printing presses.
2788 J. C. Habicht—Keyless watches.
2789 G. Yates—Heel and toe tips.
2790 J. Ramsbottom—Measuring and registering fluids, and obtaining motive power from the same.
2791 S. J. Bartlett—Taps.
2792 H. A. Bonnevill—Chimney pot.
2793 F. Castellan—Two-wheeled vehicles.
2794 J. Mash—Safety valves.
2795 S. Faulkner, J. B. Berry, & G. Harrison—Grinding corrie.
2796 S. Faulkner—Carding engines.
2797 J. Catter—Fountains.

DATED NOVEMBER 11th, 1883.

- 2798 F. Testut—Railway brakes.
2799 J. Smith—Finishing woven fabrics.
2800 W. R. Bowditch—Gas-lighting.
2801 T. H. Edwards & J. Hewitt—Regulating the supply of water to water-closets.
2802 J. Pottrill—Deodorising petroleum.
2803 D. Dawson—Colours for dyeing.
2804 Anne Catherine, widow Durat Wild—Hats and bonnets.
2805 H. Melton—Shakes, military and other hats and caps.
2806 W. D. Richards—Engines.
2807 M. Stinson & D. Lawson—Sewing ships.
2808 W. Clissold—Opening, cleaning, preparing, and carding wool.
2809 G. Haselme—Endless chain horse powers.

DATED NOVEMBER 12th, 1883.

- 2810 B. A. Murray—Doubling, bolting, and winding silk.
2811 H. J. Simlich—Fascers.
2812 J. B. Smith—Distilling hydro-carbons.
2813 B. Peske—Neckties, cravats, and waistbands.
2814 J. J. & J. Booth—Cranes.
2815 A. Illingworth—Twisting cotton and wool.
2816 H. Holden—Shuttlings for weaving.
2817 G. Davies—Spring for rail-road cars.
2818 K. Rowland—Weighing solid bodies.
2819 W. E. Gedge—Amalgamating precious metals.
2820 D. Ford—Propelling boats and barges.
2821 G. H. Breckbank—Piano-fortes.
2822 L. E. K. Martin—Generating steam.
2823 W. E. Newton—Gas burners.
2824 P. Bettle—Pins, brooches, and buckles.
2825 D. M. Fyfe—Carriages.

DATED NOVEMBER 13th, 1883.

- 2826 C. W. Siemens—Submerging telegraph cables.
2827 B. Marrott & C. Radcliff—Watches.
2828 W. Robertson—Spinning and doubling.
2829 W. Chambers—Finishing cloth.
2830 G. Remington—Railways and engines.
2831 H. F. Hudson—Cigars.
2832 W. F. Dearlove—Separation of animal and vegetable substances.
2833 E. Spencer & J. Dodd—Mules.
2834 J. W. Drummond—Looms.
2835 G. K. Geyrin—Water closets.
2836 G. T. Bousfield—Apparatus used when rolling blinds.
2837 T. Harrison—Excavating coal.

DATED NOVEMBER 14th, 1883.

- 2838 M. A. Muir & J. McIlwham—Looms.
2839 J. Medway & S. Joyce—Colouring matter.
2840 H. Gladstone—Skin cartridges.
2841 De B. Hughes—Producing dramatic effects.
2842 J. P. Burns—Sewing machines.
2843 J. Kilson—Silk reels.
2844 J. C. Wilson—Cotton gins.
2845 E. T. Hughes—Sewing machines.
2846 E. Hargrave—Preventing the escape of heat from steam boilers.
2847 A. Kilham—Preventing the fouling of ships.
2848 T. Selig—Harrows.
2849 G. Barker—Bylons.
2850 W. A. Lytle—Covers for umbrellas.

- 2851 G. H. Courtney—Tills.
2852 W. E. Newton—Iron and steel.
2853 G. Lindemann—Singing fabrics.
2854 J. Lewis—Cottons.
2855 L. Mackrill—Cleaning charcoal.
2856 R. A. Brooman—Printing.
2857 J. Harrison—Cleaning cotton seed.
2858 R. A. Brooman—Engines and boilers.
2859 J. Harrison—Portmonnaies.
2860 T. Williams & J. Naylor—Fur spoils.
2861 J. Walsley—Cleaning the soil.
2862 J. Hulze & J. Lawrence—Attaching door knobs.

DATED NOVEMBER 16th, 1883.

- 2863 E. & F. A. Leigh—Driving cotton gins.
2864 C. Pengilly—Pulverising ores.
2865 S. Cameron and W. Johnson—Taps.
2866 G. Thonger—Preventing accidents arising from the sale of poisons.
2867 E. W. Emslie—Cottages.
2868 R. Griffiths—Propelling ships.
2869 A. F. Henry and K. T. Power—Affixing labels.
2870 G. T. Bousfield—Carriages.
2871 L. Pomes—Hydraulic motor.
2872 J. J. Maurer—Towing boats.
2873 L. L. Sovereign—Cultivating land.
2874 C. W. Harrison—Filters.
2875 R. A. Brooman—Salt.

DATED NOVEMBER 17th, 1883.

- 2876 M. Parsons—Ordnance.
2877 F. W. Baiton—Music stools.
2878 W. Cowan—Gas meters.
2879 J. V. Baker—Ordnance.
2880 J. Beteley—Sheathing ships.

DATED NOVEMBER 18th, 1883.

- 2881 W. Pratchitt, J. Blylock, and J. Pratchitt—Movable platforms.
2882 T. C. Kimpton—Time, fare, and distance apparatus.
2883 R. Mayer—Fire arms.
2884 J. H. Johnson—Rotatory engines.
2885 R. W. Berry—Jacquard machines.
2886 W. M. Williams—Installation of coal and peat.
2887 J. R. Cooper—Barrels for gun-powder.
2888 W. Wrigall and G. Jolly—Explosive compound.
2889 J. Elder—Docks.
2890 J. Stewart—Steam boilers.
2891 J. Mackew—Looped fabrics.
2892 E. C. Nicholson—Colouring matters.
2893 J. G. Jennings and M. J. Lavater—India-rubber tubes, rings, and cords.
2894 H. Hirtzel—Colouring matters.
2895 P. Saint G. Greme—Vases of war boxes.

DATED NOVEMBER 19th, 1883.

- 2896 W. B. Adams—Wheels, tires, axles, and axle boxes.
2897 J. Eglin—Drifts.
2898 J. Elder—8-am engines.
2899 A. G. Southby—Distillation of petroleum.
2900 A. Bally—Stopping horses instantly.
2901 T. Francis—Cleaning coal and coke.
2902 W. H. Gray—Blast cylinders.
2903 J. Kirkham—Treatment of ores.
2904 E. Walker—Windlasses.
2905 J. Culler—Closing orifices in casks.
2906 R. and J. S. Walker and B. Brown—Preparing cotton to be spun.
2907 E. Christmas—Carriages.
2908 W. Symons—Working of railways.
2909 R. Gooch—Shearing piles.
2910 J. Colling—Carriage—Finkney—Reeding and finishing ship's square sails for holding oils.
2911 W. B. Hodson—Cans for holding oils.

DATED NOVEMBER 20th, 1883.

- 2912 G. Rait & J. Winsthorpe—Gas meters.
2913 J. Seward and H. Smith—Preventing incrustation in steam boilers.
2914 E. Marwood—Covering rollers used in spinning and preparing wool.
2915 B. Dobson, E. Barlow, and P. Knowles—Ginning cotton.
2916 K. Poid—Pile stick.
2917 C. Stevens—Hoisting and lowering apparatus.
2918 A. H. Perry—Hammer and hammers.
2919 J. H. Hare—Hot-air stoves.
2920 G. S. Kirkham—Connecting railway carriages.
2921 T. Brinsford—Thrashing wheat.
2922 A. McLean—Gun boats, gun vessels, and rams.
2923 G. Fawcus—Connecting scaling, firing, and other like ladets.
2924 W. E. Newton—Fan blowers.
2925 W. E. Newton—Attaching labels to bales.
2926 H. A. Bonnevill—Preserving grain and flour.
2927 J. H. Johnson—Steam engines.
2928 G. C. Wright—Binding together letters and music.

DATED NOVEMBER 21st, 1883.

- 2929 T. Turner—Fire-proof floor or roof for buildings, bridges, and other structures.
2930 H. Ayckbourn—Cultivation of oyster spire and brood.
2931 P. Fenton—Treatment of vegetable fibres.
2932 W. Williams—Biscuits.
2933 D. Cope—Metallic drums, kegs, casks, and cylindrical packages.
2934 L. D. Etienne de Saint Jean—Shutting gates.
2935 E. Finch—Flood, oil bridge and houses.
2936 F. Walsley—Bolts, nuts, spikes, and rivets.
2937 A. Simonson—Linen cloth.
2938 T. Humphreys—Strings for tying up fire wood.
2939 D. W. Hamper—Mashing malt.
2940 M. B. Westcott—Tapes and threads.
2941 J. Stuart—Extracting fibres from marine marina.

DATED NOVEMBER 23rd, 1883.

- 2942 W. Beatwick—Braiding machines.
2943 C. Howard—Watch case pendant.
2944 P. Bowden—Bricks.
2945 J. Smith—Covering the bottoms of ships.
2946 E. B. Wilson and J. Lamy—Frees.
2947 T. Carr—Intermixing dry, semi-dried, or aqueous materials.
2948 J. Platt—Cultivating land.

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