

HYDRAULIC

PROPELLER.

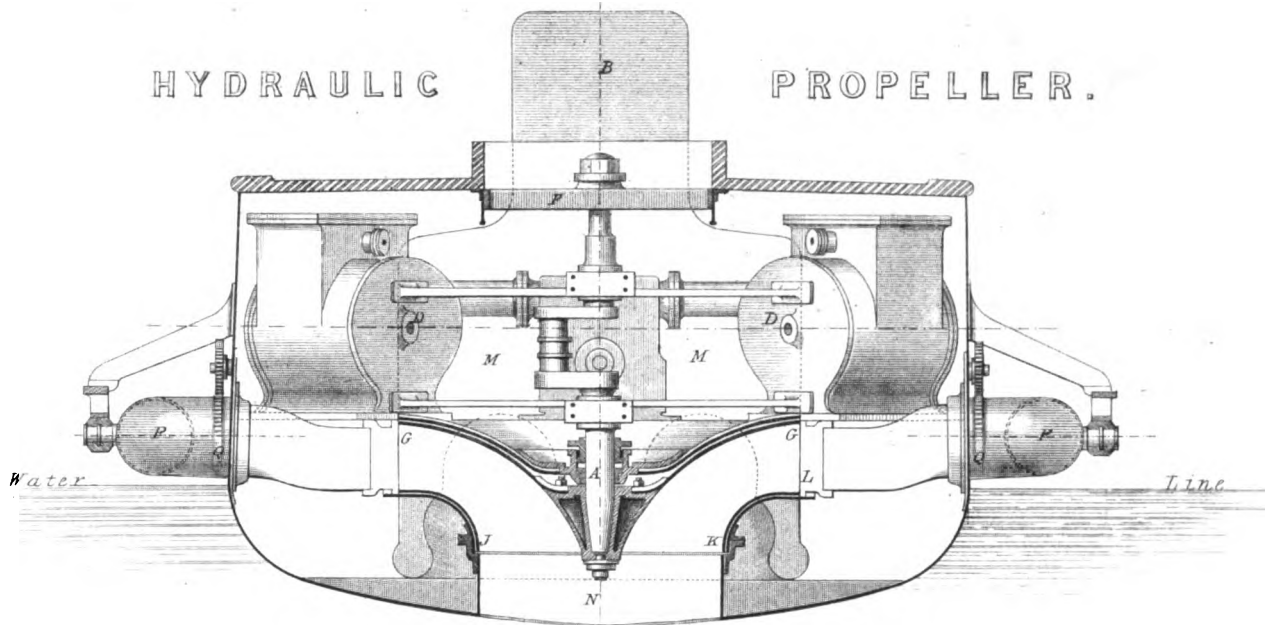


FIG. 1.

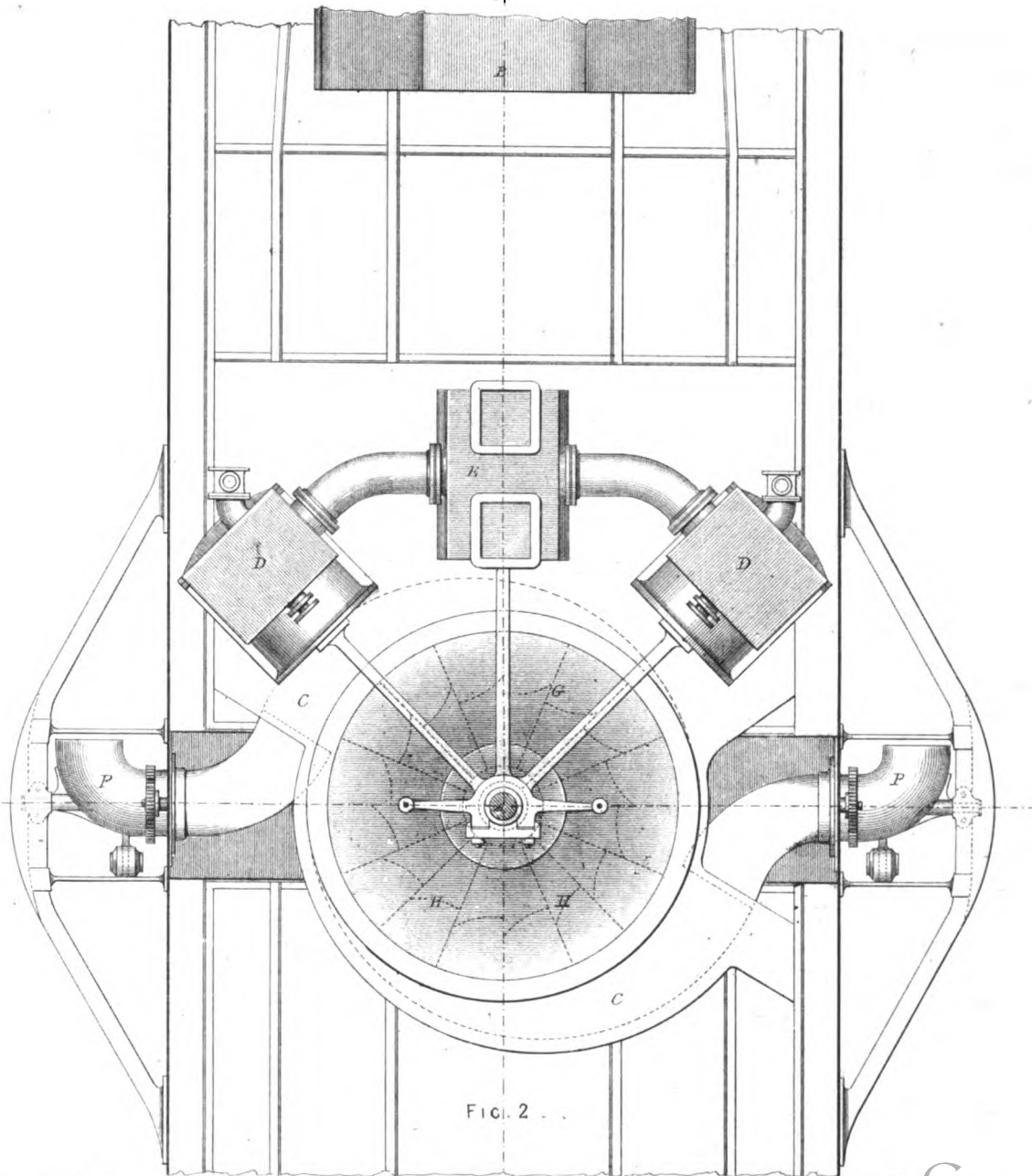


FIG. 2.

THE ARTIZAN.

No. 10.—VOL. 1.—THIRD SERIES.

OCTOBER 1ST, 1863.

WATER-JET PROPELLED SHIPS.

(Illustrated by Plates 249 and 250.)

Considerable attention has recently been given to the necessity which exists for the employment of some efficient arrangement of submerged propellers. The Admiralty, impressed with the importance of having a means of propelling and manœuvring vessels by a propeller so placed as to be nearly, if not entirely, free from the liability of being shot away or otherwise damaged when in action, have given this subject their serious attention, and, we understand, it has been decided that one of her Majesty's ships is to be propelled by means of water projected through nozzle-pipes, placed one on either side of the vessel. We may add that we believe it is mainly owing to a sense of the importance of this principle, and the intention on the part of the Admiralty to adopt it, that Mr. Ruthven recently obtained from the Privy Council a prolongation of his patent.

Some time since, Messrs. Cockerill, of Seraing, near Liège, built a steamer intended for passenger traffic on the river Meuse, and fitted to her a hydraulic or water-jet propeller, being a modification of Ruthven's patent.

The accompanying plate, 249, shows the general arrangement of the vessel, and Figs. 1 and 2, Plate 250, show respectively a cross-section and plan of the propelling apparatus, which may be described as consisting of three distinct parts; viz., the motor or engine for working the apparatus, the pump, and the propeller tubes and nozzles.

The same letters of reference are used in both plates to denote the like parts of the apparatus. The motor, M, is a horizontal condensing engine, of 40 H.P. nominal; B, the boiler; DD, the cylinders, placed diagonally, and working upon the same crank pin; E, the condenser, air pump, &c. The crank shaft, A, is placed vertically, and is worked direct from the cylinders; the upper portion of the shaft, A, works in the bearing F; and the lower portion forms the driving axis of the centrifugal pump, G, open at the bottom, JK, and its exterior circumference L. A water conduit or chamber, N, with a number of holes in the bottom thereof, forms the channel of communication between the pumps and the external water; C is the spiral channel or passage around the pump case connected with the propeller tubes. The motion of the pump G, when rotated, being transmitted to the water enclosed, a centrifugal force is generated, by means of which the water, driven off from the axis, ascends into the passage surrounding the pump, and is projected through the nozzles PP, which are capable of being turned in a stuffing-box or gland, Q, so that the vessel may be propelled in either direction; or, if the two nozzles are each placed in opposite directions, the vessel may be turned on the centre, and manœuvred by this means similarly to a vessel provided with twin screws. Moreover, this propelling apparatus is of considerable value where canals, narrow rivers, or tortuous channels have to be navigated—and which is the character of the route upon which this vessel plies—as the extreme breadth of the ship is reduced by 25 to 30 per cent.

The nozzles of the tubes are worked from the deck, and the movements of the vessel may thus be governed directly and independently of the working of the engines; and also independently of the rudder, as, though this might become damaged, and even rendered useless, the vessel could be steered as usual by the proper management and working of the movable nozzles of the propeller tubes.

Although, in the case of the *Seraing*, the vessel which we have illustrated—she being a vessel of very light draught—the nozzles are not submerged (being entirely above the water line);—in war vessels, or in vessels of deep draught, the nozzles would be submerged; and, indeed, the whole of the machinery and apparatus would be placed so far below the water line as to be out of reach of shot.

Thus the hydraulic propeller, whilst it requires no greater draught of water than paddle-wheels, has the great advantage over a screw propelled ship of having the propelling tubes submerged and freed from the contingencies to which a screw is liable, or, in the case of war vessels, of being shot away or damaged by the enemy; and, as an additional security, the propeller-tubes might be placed within the body of the vessel, instead of externally.

Although we have briefly referred to some of the advantages peculiar to the hydraulic propeller, it cannot, on the other hand, be argued for it—nor is it, we believe, intended to do so—that in point of economy of fuel there is anything to be gained by its adoption. We look forward, how-

ever, with considerable interest to the purposed adoption of the principle by the Admiralty for the propulsion and manœuvring of ships of war, and hope to be able at some future day to give the results obtained from its application.

We may add that the vessel which we have illustrated and referred to has been running regularly between Seraing and Liège since July of last year, making seven double journeys each day. The distance between the two places is about five miles, and the single journey is accomplished in about thirty minutes, inclusive of four stoppages. We purpose giving, upon another occasion, some formulæ relative to, and results obtained from, experiments recently made with this propeller.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

BY J. J. BIRCKELL.

(Continued from page 193.)

As we are unavoidably compelled to defer giving until next month the second of our series of plates of types of locomotives, and accompanying text devoted to that portion of our subject, we will now, in order to make our task as complete as possible, proceed to supply such omissions as may have occurred in the course of our labours from want of sufficient data on points which are yet matter of disagreement among engineers, and to correct one or two statements as to facts about which we had been misinformed.

Prominently among the former items stands the question of the density or of the relative volume of steam, which of late years has received all the attention due to its importance, and of which we have barely made mention in its proper place in our paper on the Boiler, in *THE ARTIZAN* of January last; with this question we are now enabled to deal in a satisfactory manner, through the courtesy of Drs. Rankine and Fairbairn, to whose researches the scientific world are indebted for the better knowledge they now possess of the subject of the density of steam.

Until the comparatively recent period of 1855, it was universally admitted, with scarcely a dissentient voice, that the law of expansion of steam under constant pressure was the same as that of a perfect gas, as defined by Gay-Lussac; namely, that for equal increments of temperature there are equal increments of volume at the rate of $\frac{1}{273}$ of the volume of the gas at the temperature of melting ice, for every degree centigrade; and that, under constant temperature, the changes of volume and pressure were in accordance with Mariotte's (or Boyle's) law, namely, that for a given weight of gas, the product of pressure by volume remains constant for all degrees of expansion. From a combination of these two laws, and with the data furnished by Dumas, respecting the density of steam at the temperature of boiling water, the general formula reproduced below has been constructed, by means of which all the tables of relative volume of steam had hitherto been calculated, viz. :—

$$\mu = 1669 \times 14.7 \frac{459 + T}{671 \times P} \dots\dots\dots (1)$$

where μ is the relative volume (or the volume produced by one cubic foot of water) of steam at the temperature T and of pressure P, and 1669 is the volume of steam at the pressure of 14.7 lb. being that of the atmosphere.

The correctness of the tables thus computed, assuming the perfect gas theory to be valid, was dependent upon the accuracy of the observations on the correlation of temperature and pressure, and of the formulæ embodying the same; and to ascertain and define this relation, a series of experiments, on a large scale, were undertaken, in 1830, by Arago and Dulong, which were extended to pressures of 24 atmospheres; and such great care was bestowed upon them, that Pambour, in his work on the locomotive engine, says that "*their results are entitled to the highest degree of confidence.*" The original formula, constructed by them to express that relation, reads as follows, in its most convenient shape :—

$$T^{\circ} = 140.7 \sqrt[5]{P - 39.8} \dots\dots\dots (2)$$

where T° expresses the temperature in degrees centigrade, measured from

the zero of melting ice, and P the pressure in kilogrammes upon the square centimetre. Previous to their labours, however, Tredgold had constructed a formula for temperatures below that of 212° , which till now held the reputation of being more accurate than any other, for pressures not exceeding four atmospheres. It reads as follows:—

$$T^{\circ} = 85\sqrt{p} - 75 \quad (3)$$

where T° is again the temperature in degrees centigrade, and P the pressure in centimetres of mercury; and the more carefully constructed tables were computed from the data furnished by Tredgold's formula for the pressures below four atmospheres, and from those furnished by Arago and Dulong's formula for the pressures above that named.

As early as 1836, however, Pambour showed, by plausible reasoning, and proved by direct experiment, that the expansion of steam in a cylinder does not take place exactly in accordance with Boyle's law, which supposes the gas to maintain its temperature unchanged; but that, at any point of the expansion, the volume, temperature, and pressure are those of steam at its maximum density, or otherwise of saturated steam; and he accordingly constructed an empirical formula to define the relative volume of steam in terms of the pressure only, the results of which, especially for the higher pressures, agree in a remarkable manner with those obtained by later investigations, which must now be held to be the nearest embodiment of truth that may be expected of human skill. His formula reads as follows:—

$$\mu = \frac{10'000}{1'421 + 0'3312 p} \quad (4)$$

where μ again represents the relative volume, and p the pressure in lbs. per square inch. Pambour's suggestions, however, do not appear to have received the amount of consideration which they deserved, and the perfect gas theory remained the basis of all calculations on the phenomenon of expansion of steam, although it is recorded that at a later date other circumstances had strengthened the suspicion that the results of this theory showed too low densities, and consequently too large volumes, at a ratio of error increasing with the increase of pressure, until the labours of Mayer, Joule, and others placed the science of dynamics into a new phase of its history, by proving experimentally that *heat and mechanical energy* are mutually convertible, or otherwise; that heat requires for its production, and produces by its disappearance, a certain amount of mechanical work, ascertained by Dr. Joule to be equal to 772 foot-pounds for every British unit of heat.

It is then that Dr. Rankine conceived the idea that the heat which disappears, in the shape of latent heat, during the conversion of water into steam, represents so much mechanical work performed upon the change of molecular arrangement which has taken place; and from this assumption (to us very natural indeed when the law above enunciated is accepted as a truth), coupled with this other law, that the total heat contained in a fluid, its pressure and its volume, are three quantities of which, when two are known, the third is known also, he has constructed his formula expressing the relation between heat and mechanical work, as represented by the changes of volume and pressure during a given change in the quantity of heat contained in a gas, which formula, when applied to the determination of the density of steam, reads as follows:—

$$V = v + \frac{J h}{\tau \frac{dP}{d\tau}} \quad (5)$$

where V is the volume of 1 lb. (in weight) of steam, v the volume of 1 lb. of water at the same temperature, J Joule's mechanical equivalent of a unit of heat (*i.e.* 772 foot-pounds), h the latent heat of evaporation in British units, and $\tau \frac{dP}{d\tau}$ the mechanical equivalent of so much water as fills one cubic foot more in the vaporous than in the liquid state. In order to find by means of this formula the relative volume of steam at various temperatures, it is necessary, therefore, to have the numerical values of h and of the quantity $\tau \frac{dP}{d\tau}$, the best known values for which are those deduced from the experiments of Regnault, on the specific heat of water, the total heat of steam, and the relation of temperature and pressure; which latter were instituted to correct the formula of Arago and Dulong, slightly deficient for very high temperatures and pressures. When these are introduced into the above formula, it assumes the following shape:—

$$\mu = 62'425 \left(v + \frac{772 h}{2306 P \left(\frac{B}{461'2 + T} + \frac{2c}{(461'2 + T)^2} \right)} \right) \quad (6)$$

where μ stands again for the relative volume; P for pounds pressure per square foot; T for temperature in degrees Fahrenheit; h the latent heat

of evaporation at the given temperature which will be found in the table on next page, and B and C are two constants, the values of which are:—

$$\log. B = 3'43642, \log. C = 5'59873.$$

It would undoubtedly be matter for satisfaction to our readers, were we to detail before them the considerations which have, step by step, led Dr. Rankine to the relation expressed by formula (5), and it would no doubt incline them to receive the results obtained by the same with a greater amount of faith than the mere statement of a fact can command; but as that formula is an absolute embodiment of the laws of thermo-dynamics, such an attempt would necessitate a complete exposition of those laws, an exposition which it would here be impossible to enter upon, owing to the magnitude of the subject, but for the study of which we refer the reader to Dr. Rankine's treatise "On Prime Movers," where it is dealt with in such manner as to enable every earnest student possessed of a moderate amount of mathematical knowledge to become familiar with the same.

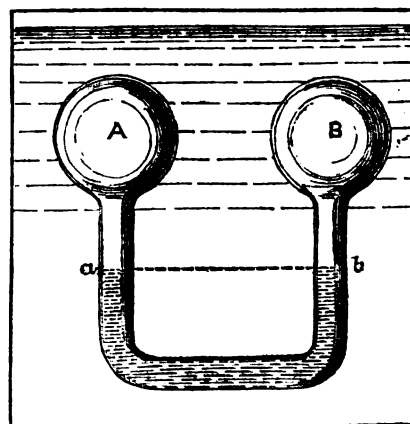
It is very natural in man—and we feel inclined to say also quite competent—to look with an indifferent eye upon the deductions of any new theory not yet verified by direct experiment or by the practice of a majority; and such has been the case in the instance under consideration. Dr. Rankine's first tables were published in 1855, but until now they have not been received by the engineering world generally as representing a nearer embodiment of truth than the old ones; and volumes even have been written by careless observers, and still more careless students, to prove that the dynamical theory of heat, and the deductions drawn therefrom, are utter fallacies.

Meanwhile, however, Dr. Fairbairn, conjointly with Mr. Tate, undertook a series of experiments, the object of which was to measure directly the specific volume of saturated steam; and in order to satisfy the minds of our readers that those experiments were conducted with every possible care, and with such unmixed desire to ascertain the true state of facts as entitle the results arrived at to our entire confidence, we give below a short account of the mode of conducting them, together with a sketch of the apparatus which was used.

The method followed consisted in vaporising a known weight of water in a large glass globe with a stem, of given capacity and devoid of air, and observing the exact temperature at which the whole of the water was just vaporised; then, knowing the weight, volume, and temperature of the steam, its density was easily calculated. The difficulty hitherto had been to ascertain with sufficient accuracy the temperature at that point when the whole of the water was vaporised, and when the steam was still at its maximum temperature of saturation; but in these experiments it has been overcome with great ingenuity by the use of what has been termed a *saturation gauge*, which may be illustrated as follows:—

In the adjoining cut (Fig. 1), suppose A and B to be two globes devoid of air, connected by means of a bent tube containing mercury, and immersed in a liquid bath to ensure uniformity of temperature; let A contain a certain quantity of water, and B double that quantity; and let heat be applied to the liquid bath until the water gradually passes into steam. The elastic force of the steam in each globe will increase with the

FIG. 1.

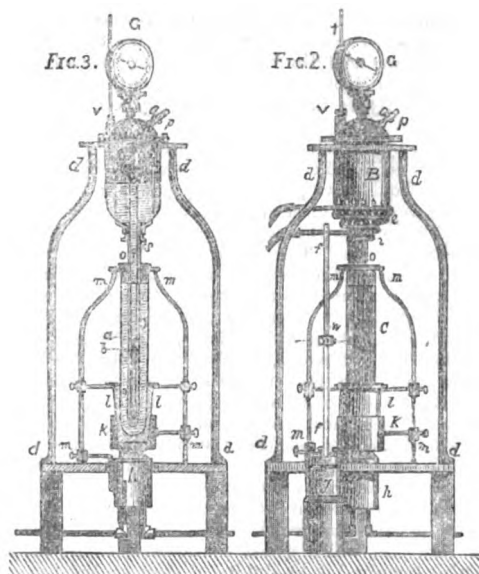


temperature without in the least affecting the uniformity of level of the mercury columns a and b , until the whole of the water in the globe A has been vaporised; but when this has taken place, the pressure in the globe B will increase in the ratio of saturated steam, whilst that in the globe A

increases only in the much smaller ratio of superheated steam, and the mercury column *a* will rise, whilst *b* will fall. The instant at which the difference of level begins to take place, is the point at which the whole of the water in *A* is converted into steam, and the temperature then noted is the maximum temperature of saturation. The density or relative volume of steam may now be easily found as follows:—Let *w* be the weight of the water vaporised in the globe *A*; *W* the weight of the water (at its temperature of maximum density) which would occupy the same space in the globe *A* as the steam of weight *w*; let μ be the specific volume of that steam, then—

$$\mu = \frac{W}{w}$$

|| In the adjoining wood cuts, Fig. 2 is an elevation, and Fig. 3 a section of the apparatus used for pressures above that of the atmosphere. *A* is the glass globe, about 5 in. diameter, for the reception of the weighed portion of water drawn out into a stem about 32 in. long and $\frac{1}{2}$ in. diameter; *B* is the copper boiler forming the steam bath in which the globe was heated uniformly; the copper boiler is prolonged by a strong glass tube *c*, $\frac{1}{4}$ in. diameter, hermetically sealed at the bottom and securely fixed to the boiler by means of the stuffing box, *s*; this outer tube was steeped in an oil bath *C*, made of blown glass, 20 in. long, resting in a sand bath *I*, which was supported on a tripod *m m*. The copper boiler was heated by a spiral coil of jets of gas *e e*, and the oil bath by means of a large wire gauze lamp *h*, protected from draughts by a ring of sheet-iron *k*; and the temperature thus obtained and distributed uniformly through the glass tube and steam bath was measured by a thermometer placed in each; a stop cock *p* was provided, through which the steam could be blown off, and on the top of the boiler was placed a Schaeffer's gauge for roughly indicating the pressure. The two mercury columns, the outer in the tube *c*, and the inner in the globe stem *i*, separating the water in the steam bath from that in the globe, form the saturation gauge.



A series of file marks were made upon the globe stem to denote various capacities of the globe and stem, and the column levels were read off to a hundredth of an inch by means of a cathetometer *f*, consisting of a small telescope with sight wires sliding upon an iron stem divided into inches and tenths, the sliding block carrying, at the same time, a vernier.

In order to make sure that the whole of the water introduced into the globe stem be converted into steam, it was at once superheated and then allowed to cool until the maximum temperature of saturation was reached, a precautionary measure rendered necessary by the fact that a vapour near the point of liquefaction has the power of retaining suspended, in it a portion of the liquid in the shape of mist; and that the attraction between water and glass is such as to cause the latter to retain in contact with it a film of water, at a temperature at which it would be vaporised but for this power of attraction.

The results of the experiments thus conducted, and in which Regnault's tables were used for the exact determination of the pressures, invariably

showed greater densities and smaller volumes than are obtained by the combination of the laws of Boyle and of Gay-Lussac; but we do not reproduce the empirical formula constructed by Messrs. Fairbairn and Tate, for the tabulation of their results, because it can be made use of only in conjunction with a summary of the observations that had to be taken during each individual experiment, which our space will not permit to detail here. In order, however, to enable the reader to compare the results of the various theories and experiments to which we have briefly alluded, and in order, at the same time, to supply the practical want of a correct series of relative volumes of steam, at various temperatures and pressures, we have embodied an abstract of these results in the accompanying table. After a careful comparison of the results contained therein, it must be conceded that Dr. Fairbairn's experiments, so far as they have been carried, verify the conclusions arrived at by Dr. Rankine through the thermo-dynamic theory; and the slight differences of volume shown in the two columns under consideration must be accounted for by the difficulty of manipulation in experiments of so delicate a nature, and may, perhaps, be looked for as much in Regnault's experiments on the total and sensible heat of steam, as in Fairbairn's direct measurement of the relative volume of steam. It is to be hoped that this latter series of experiments will soon be extended to the higher pressures, as was originally intended.

TABLE OF RELATIVE VOLUMES WITH TEMPERATURES, PRESSURES, AND LATENT HEAT OF EVAPORATION.

Pressures in lbs. per sq. in.	Temperatures.		Relative Volumes as given by				Latent Heat of Evaporation.
	Fahren-heit.	Centi-grade.	Perfect Gas Theory.	Pambour.	Rankine.	Fairbairn.	
lb.	Deg.	Deg.					Units.
10.18	194	90	2387		2325.9	2320	978.3
12.26	203	95	2006		1951.4	1950	972.0
14.70	212	100	1698	1669	1645.5	1635	965.7
17.53	221	105	1457	1403	1394.6	1380	959.3
20.80	230	110	1210	1211	1187.9	1170	952.9
24.54	239	115	1079	1047	1016.3	995	946.5
28.83	248	120	937.2	911	873.9	855	940.1
33.71	257	125	817.2	794	754.7	736	935.6
39.25	266	130	710.8	692	654.2	640	927.2
45.40	275	135	619	606	559.6	560	920.8
52.52	284	140	543	531	501.7	485	914.4
60.40	293	145	474.6	466	436.5	428	907.8
69.21	302	150	419	410	384.1	378	901.2
79.03	311	155	392	382	339.1	332	894.9
89.86	320	160	328	320	300.6		888.5
101.90	329	165	295	284	267.2		881.8
115.10	338	170	265.6	252	238.1		875.2
129.80	347	175	238.9	225	212.9		868.7
145.80	356	180	211.6	201	190.8		862.2
163.30	365	185	194.6	180	171.5		855.5
182.40	374	190	176		154.6		848.8
203.3	383	195	159.9		140.2		842.3
225.9	392	200	145.3		126.4		835.7

On the other hand, it cannot escape the reader's eye how closely the volumes obtained by Pambour's formula keep to those given by Rankine; and, when we remember that the experiments upon which this formula was based were made 25 years ago, probably with comparatively imperfect means of observation, we cannot but pay a passing tribute of respect to the penetrating mind from which it has proceeded; yet has it been almost totally ignored, and especially so in France.

As for the importance of the subject, that cannot fail to force itself upon the reader's mind when, upon comparing Rankine's volumes with those commonly in use, it is found that the difference, which amounts to $\frac{1}{5}$ of the whole volume at the temperature of 212°, goes steadily increasing until it reaches the almost incredible amount of $\frac{1}{3}$ th of the whole volume at the temperature of 400°.

(To be continued.)

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN."—TENTH VOYAGE FROM NEW YORK TO LIVERPOOL, SEPTEMBER, 1863.

Date each day, ending at Noon.	PADDLE ENGINES.				SCREW ENGINES.				Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship.		GENERAL REMARKS.
	Revolutions of En- gines each day.	Average Pressure of Steam in Engine-room.	Average Pressure of Steam in Engine-room.	Tons of Coal used each day.	Revolutions of En- gines each day.	Average Pressure of Steam in Engine-room.	Average Pressure of Steam in Engine-room.	Tons of Coal used each day.									Inclination to windw.	Inclination to leeward.	
Sept. 8	12,222	9.0	11.7	42,380	840	291	291	270	40° 37' N.	69° 14' W.	N. 8° E.	30.00	Sept. 8, at 11.30 a.m., started screw engines ahead slow.						
Sept. 9	12,627	9.0	12.7	41,680	837	307	303	265	41° 45' N.	63° 33' W.	N. 77° W.	30.02	Sept. 9, at 1.10 p.m., started paddle engines ahead slow; at 2 p.m., full speed paddle and screw engines; at 9.50 p.m., stopped paddle and screw engines, to discharge pilot, off Montauk Point; at 10.5 p.m., full speed; light S.W. breeze; sea smooth.						
Sept. 10	11,490	8.13	12.1	41,980	827	290	290	265	43° 31' N.	59° 43' W.	N. 76° 30' E.	30.04	Sept. 10, strong N.E. breeze and heavy sea running.						
Sept. 11	12,407	9.65	12.1	41,780	827	325	325	285	44° 12' N.	52° 58' W.	N. 63° 34' E.	30.01	Sept. 11, fresh N.E. breeze and heavy sea running.						
Sept. 12	13,639	10.26	12.6	46,630	927	303	303	285	45° 57' N.	46° 45' W.	N. 67° 23' E.	30.04	Sept. 12, light variable breeze and heavy swell; passed a large iceberg.						
Sept. 13	14,406	10.23	12.1	48,350	945	349	349	299	47° 43' N.	40° 28' W.	N. 67° 23' E.	30.01	Sept. 13, light S.W. breeze and heavy sea running.						
Sept. 14	14,006	10.16	12.1	48,580	945	349	349	299	49° 5' N.	33° 18' W.	N. 74° E.	29.07	Sept. 14, light S.W. breeze and heavy sea running.						
Sept. 15	14,763	10.16	12.6	49,640	945	351	351	299	50° 30' N.	25° 41' W.	N. 74° E.	29.08	Sept. 15, fresh S.E. breeze and heavy sea running.						
Sept. 16	14,175	10.13	12.6	48,580	945	351	351	299	51° 35' N.	18° 47' W.	N. 86° 58' E.	29.08	Sept. 16, strong S. breeze and heavy sea running; fore and aft and square sails set.						
Sept. 17	14,088	10.13	12.6	48,580	945	351	351	299	51° 35' N.	11° 34' W.	N. 81° 24' E.	29.08	Sept. 17, light S.W. breeze and heavy sea running; square sails set.						
Sept. 18	14,088	10.13	12.6	48,580	945	351	351	299	51° 35' N.	11° 34' W.	N. 81° 24' E.	29.08	Sept. 18, fresh S.W. breeze and heavy sea running; square sails set; at 2.15 a.m., stopped paddle and screw engines; at 2.16 a.m., reversed screw engines, full speed; came in collision with the ship <i>Jane</i> , of Liverpool.						
Sept. 19	14,082	10.5	12.6	48,580	945	351	351	299	51° 35' N.	11° 34' W.	N. 81° 24' E.	29.04	Sept. 19, strong S. to S.W. breeze and heavy sea running; square sails set.						
Sept. 20	2,177	10.7	20	6,740	337	17	85	82	Steering by the land	...	...	...	Sept. 20, at 3.20 p.m., stopped engines off Point Lyness, to take pilot on board; all particulars of engines taken up to this time.						
Total	140,419	9.33	204	511,270	3267	3815	3727	3065	...	...	...	...							
Actual time of steaming from New York to Bell Buoy, 11 days 3 hours. Distance run (by account), 3204 knots. Indicated horse-power of paddle engines, 3215 91; ditto screw engines, 4252.4 horse-power. Density of water in boilers, $\frac{11}{16}$; 30 lbs. of coals per indicated horse-power per hour; vacuum in paddle engines, 25.5; ditto in screw engines, 26.0; extreme diameter of paddle wheel, 50.5 ft.; effective diameter, 46.8 ft. = 135.5 ft. line revolution; screw, 4.4 ft. pitch; average distance run per hour, 11.76 knots; immersion on leaving New York, 27 ft. 3 in forward; 23 ft. lin. aft; immersion on arriving at Liverpool, 23 ft. forward; 26 ft. 6 in. aft; slip of paddle wheel, 1.29 per cent.; ditto screw, 16.28 per cent.; average daily consumption of coals by paddle engines, 126.41 tons; ditto screw engines, 167.12 tons; total daily consumption, 293.53 tons.																			

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

NEWCASTLE AND GATESHEAD WATER SUPPLY.

By D. D. MAIN.

Newcastle has had its supply of water from various sources. Up to the year 1693 the inhabitants appear to have been chiefly supplied from wells and public fountains, communicating by means of conduits with the springs in the neighbourhood. Leland, the antiquarian, who visited the town in 1538, mentions three of these conduits for conveying fresh water to the fountains.

In 1647, it was discovered that the water which supplied one of the fountains was "hurtfull and dangerous to be used for food and dressings of meat," and was ordered by the Common Council to be cut off. Then the sinking of collieries drained several of the springs, and in 1671 the scarcity was so great that an order of Common Council was issued for stopping the supply to all private taps. In 1693, one Cuthbert Dykes erected an engine and works, at a cost of £3500, for supplying the town from the River Tyne at Sandgate. But although these works continued in operation many years, the water obtained there was never acceptable to the inhabitants, who, in derision of the project, bestowed upon it the name of the "Folly." In 1697, a scheme of a much more comprehensive and satisfactory character was suggested by William Yarnold, an enterprising attorney from New Woodstock, in Oxfordshire, who came before the Mayor and made a proposal for supplying the town with good and wholesome water, which he proposed to convey from springs at a distance. The Corporation readily granted him a lease for 300 years of all the waste ground without the walls, but within the liberties of the town, empowered him to erect cisterns for holding the water, which were to be set on columns, and to construct any mill, waterhouse, wheel, or engine for forcing the water into the cisterns; to break up the pavement of the streets, and lay down pipes of lead or timber for the supply of water to the inhabitants. For this privilege Yarnold was to pay the Corporation 13s. 4d. per annum, convey good and wholesome water to all parts of the town where required, and allow the Mayor and Burgesses to cut and break his pipes to obtain water in case of fire; he was not to dig trenches in the streets to catch the water of the "River of Tyne," nor any of the springs or streams of the Town Moor and Castle Leazes, or that supplied the waterhouse of Cuthbert Dykes in Sandgate, or any other public pants, or fountains, of the town.

The site selected by Yarnold was about three miles north of Newcastle, adjoining what is still called the "Waterworks Farm," and it was necessary that he should have parliamentary power to enable him to enter upon the land between that place and Newcastle. He accordingly applied for and obtained an act in the tenth year of King William the Third (1698-9) for that purpose. The supply was obtained from a spring of remarkably fine water, and conveyed to the town by means of elmwood pipes. But it was soon found that the spring, though abundant in winter, yielded but a scanty supply in summer, and Yarnold, after contending with the difficulties of leakage and air locks, was at length obliged, in aid of the supply from his own works, to rent the Folly Works of Cuthbert Dykes at £40 a year. But the enterprise of Yarnold was not successful, and he ultimately disposed of it and left the town. In 1739 occurred a severe frost, which lasted many weeks, and entirely stopped the supply from Yarnold's works, and so damaged the pipes and cisterns that it was a considerable time before they could be again brought into working order. The "Folly" works suffered even more severely, and the proprietors, rather than repair it, abandoned the concern in disgust. After this period the proprietors of the waterworks obtained a lease of some valuable springs near Heworth, which added considerably to the supply, and in 1805 still further improved it by sinking a shaft on the Town Moor, and erecting a windmill to raise the water.

From these various sources the town continued to be supplied until the year 1831. The service was limited to three days per week, and the total quantity required was between 70,000 and 80,000 gallons per day for a population of 54,991 in Newcastle, and 15,860 in Gateshead, being about a gallon per head. But even that small quantity could not always be obtained.

The summer and autumn of 1831 had been remarkably dry, and had been succeeded by a mild, open winter, during which the Asiatic cholera for the first time made its appearance, and the Water Company's reservoirs were completely exhausted. In this emergency the company erected an engine, and pumped water from the River Tyne, conveying it in carts to their tenants. About 120 carts were employed in this way for six weeks.

In 1834, a new company obtained an Act of Parliament for supplying the town entirely from the River Tyne. They erected a powerful pumping engine, and laid down filter beds at Elswick, and, after purchasing the old works, continued to supply the town chiefly with Tyne water until the year 1845. By this latter company the consumption of water was greatly extended, and in 1845 had reached 700,000 gallons per day for a population of about 100,000, being about 7 gallons per head.

In 1845, the present company was established, and having in their turn purchased the existing works, continued to supply from them until their own were completed in October, 1848.

The works of the present company were designed to supersede the necessity of taking water from the River Tyne for the domestic use of the inhabitants. With this object, large reservoirs were formed near Harlow Hill, about 12 miles north-west of Newcastle, in which the water of the Whittle Burn was to be impounded. The drainage area was about 4340 acres, the capacity of the reservoirs 215,000,000 gallons, and the pipe to convey the water to Newcastle was 2ft. in diameter, and capable of conveying from $4\frac{1}{2}$ to 5 million gallons per day. The amount of rainfall in the district was ascertained to be 24in. per annum, and it was assumed that, as in a district of ordinary character, one-third of the rainfall finds its way into the rivers; in a peculiar locality like Whittle Dean, where the declivities were rapid, the ground impervious, and vegetation scanty, the proportion of water which would be carried off by the natural channels of the country could not be taken at less than one-half.

Twelve inches of rain from an area of 4340 acres would have produced $3\frac{1}{4}$ million gallons per day; and as the consumption was then only 700,000 gallons per day, and the reservoirs were laid out to contain ten months' supply, it appeared to the promoters that the works were of sufficient magnitude for many years to come, and that ample provision had been made against the longest drought ever likely to happen. The works were finished and brought into operation in October, 1848, and were found sufficient until the year 1850. The consumption had, in the mean time, increased to $1\frac{1}{2}$ million gallons per day, and the number of persons supplied with water from 10,275 in 1845 to 62,740 at the end of 1849. The reservoirs could then, of course, hold only a supply for five months.

In the middle of February, 1850, a drought commenced which lasted till the end of October, during which the reservoir went continually down, and the company were obliged, before the end of the summer, to have recourse to the old works, and pump down from the Tyne in aid of the supply from the reservoirs. It was found that instead of the rain fall being 24in., that year it was only 17·68in., and instead of the available quantity being 12in., the water actually impounded only amounted to 6in. But it was also discovered that the rain available for water works falls almost entirely in the winter months, and that to take full advantage of the collecting ground the reservoirs should be of such magnitude as to impound all that falls, it being unsafe to depend on summer rains, which, unless they are heavy and continued, are quickly absorbed by the land. After very dry weather, it is not unusual for rain to fall to the depth of an inch, and none find its way to the reservoirs. If the reservoirs are not filled between November and February there is not much certainty afterward. But in a district like this, where the rainfall is so limited, and droughts extending to six and eight months are of frequent occurrence, even great reservoir storage is not altogether to be relied upon. In the experience of the Company there have been seasons in which the reservoirs have not been filled in the winter—one in particular deserves to be mentioned, that of 1857. From the 1st of December, 1857, to 1st May, 1858, only 3·08 inches of rain fell, and the reservoirs being pretty well run down at the end of the summer and not filled in the succeeding winter, the Company had to meet the spring and summer of 1858 with an almost empty exchequer.

The river Tyne has necessarily been the great resource in such seasons of drought. The present Company, although their works were constructed with a view to be independent of obtaining any portion of the supply from the Tyne, have preserved the power of resorting to it in case of necessity, a clause being inserted in their Acts of Parliament to enable them to do so with the concurrence of the Town Council. But the prejudice against the use of Tyne water is very great, nor is it difficult to account for it. It has either been resorted to in cases of great emergency, when little care could be taken to render it pure, or it has been taken at an objectionable place within the tidal influence. In 1831, when cholera was raging in the town, the Tyne water was lifted into carts, and, without any attempt at filtration, conveyed to the inhabitants. In 1850, and also in 1853, when cholera was once more amongst us, it was pumped at Elswick, beyond which the tide flows four or five miles.

The Tyne water is the softest in the district, and the chief objection to it arises from the stain of peat which it contracts from the moors in times of heavy rains. Whether this stain could be effectually removed by filtration, or by storing the water in large reservoirs, where it would bleach by exposure, has not been ascertained.

The present Company, several years ago, removed their pumping station on the Tyne, Newburn, beyond the flow of the tide; but they have also gone to great expense to supply the town independently of Tyne water. The original capital of £200,000 has been more than doubled, the reservoir storage has been increased from 215 to 530 million gallons, and the drainage area from 4340 to 17,300 acres, and in the last Session power was obtained to construct a large impounding reservoir, which will contain 500 or 600 millions more, gaugings having been previously taken, which show

that in ordinary years a much larger quantity even than that can be obtained from the Company's present streams, if sufficient reservoir storage were provided. But it has been found in this town, as in others, that a great quantity of water is needlessly wasted, and, in order to prevent a state of things which, while it brings no benefit to the public, inflicts grievous loss on the Company, very stringent powers for preventing waste, and regulating tenants' fittings, have been obtained by their recent Act.

In some towns the consumption has, by the adoption of such measures, been reduced as low as 15 gallons per head.

If this Company could limit the supply to even 20 gallons per head, or about 100 gallons per house per day, which is certainly ample for all legitimate consumption, the quantity of water at present brought to the town would be sufficient for 250,000 people, and the present works would require no addition for many years to come.

When the Company commenced operations in 1845, the quantity consumed was 700,000 gallons per day, and the system of supply intermittent and irregular; but in their first Act of Parliament they voluntarily bound themselves to give constant service and unlimited supply. At that time the lowest rate for water was 10s. per annum, a scale of charge which prohibited the poor from having it in their houses at all; and the custom was to carry it from the street pumps, or fountains, where it was retailed at a farthing per skel of 3 gallons. By the present Company these pumps were gradually abolished, the charge to a poor person, occupying a single room, was fixed at 5s. per annum; and where houses were let in several tenements, which is the case to a very great extent in this town, and the tenants could be supplied at one common tap, the Company was at the entire expense of the exterior and interior pipes and fittings. By these measures the supply became greatly extended, and the Company may now be said to supply the whole population where their pipes are laid.

The united population of Newcastle and Gateshead, and of the adjacent villages, supplied by the Company, is about 165,000, and the gross daily supply is about 4,700,000 gallons.

The total daily consumption is, therefore, about 28 gallons per head, one-fourth of which is consumed by railways and manufactories, and for trade purposes generally, leaving 21 gallons per head for domestic consumption.

In 1854 the water of the different streams diverted into the Company's reservoirs, and used for the supply of the town, was tested for hardness by Dr. Smith, of Manchester, with the following results:—Whittle Burn, 11·7 degrees; River Pont, 15·7; ditto in flood, 4·6; Fair Spring, 17·0; Moot Law Burn, 16·2; Hallowell Spring, 18·0; Hallington East Burn, 14·5; Hallington North Burn, 15·5; Small Burn, 12·5; River Tyne at Newburn, 8·7; in the reservoirs, 13·2; in Newcastle, 12·9 degrees.

Dr. Smith says, "These waters are all remarkably clear and free from any impurity, with the exception of the lime and magnesia constituting hardness."

The water has also been analysed by different analytical chemists, and found to be composed of the following ingredients:—

	Dr. Smith, March, 1854.	Dr. Letheby, February, 1863.
Carbonate of lime and magnesia.....	6·54	13·01
Sulphate of lime	6·13	4·65
Alkaline chloride	4·23	1·63
Oxide of iron and silica	·81	·83
Organic matter	2·38	1·21
Total solid contents in grains per imperial gallon	20·09	21·33

Dr. Letheby says, "The water is clear, colourless, and sparkling, of good flavour. Its hardness is rather great, amounting to 20 degrees of Clark's scale; and of these 6 were permanent. It has no action whatever on lead, and excepting that it is rather hard, it is a good water for domestic use."

The Tyne water has also been analysed, and shows the following ingredients:—

	Dr. Letheby, February, 1863.	Dr. Richard- son, May, 1863.	Mr. Pattinson, January, 1863.
Carbonate of lime and magnesia.....	4·09	3·06	4·50
Sulphate of lime.....	2·49	1·22	·82
Alkaline chloride.....	1·22	·87	1·65
Oxide of iron and silica.....	0·41	·50	·58
Organic matter	1·39	2·63	2·05
Total solid contents in grains } per imperial gallon	9·60	8·28	9·60

Of the Tyne water Dr. Letheby says, "It is a remarkably soft water, with a slightly brownish tint from humus or peat. It contains only 9·6 grains of solid matter in the gallon, and its hardness is only 7 degrees of Clark's scale. This is only half the degree of hardness of the London supply, and of this 4 degrees were removed by boiling for a quarter of an hour. I ascertained that the water was entirely without action on lead. It is a good water for manufacturing and domestic use."

Dr. Richardson says, "Our examination of the water from the River Tyne proves that, when taken from such a locality as Newburn, it is perfectly suited to the requirements of this district."

It only remains to mention the system of supply.

The Reservoirs at Whittle Dean are 360ft. above high water mark of the Tyne at Newcastle, but, on account of the friction along the 12 miles of main pipe, the water does not reach by gravitation the houses in the higher parts of the town.

About one-fifth of the whole supply has to be pumped to these high districts, and for that purpose the company have a 50-horse engine at Benwell Reservoir, whence the water is forced to a reservoir at Benwell Bank top, 400ft. above high water mark, which commands the most elevated houses in the town and suburbs.

THE RAILWAYS AND LOCOMOTIVES OF THE DISTRICTS ADJOINING THE RIVERS TYNE, WEAR, AND TEES.

By JOHN F. TONE.

The Author stated in his Paper that the early tramroads seldom exceeded two or three miles in length. They were in use about 260 years ago, and were constructed mostly of oak and beech timber; and of this last extensive woods are in existence in the upper portions of the county of Northumberland, planted apparently about 120 years ago, up to which period the demand for timber for these tramroads had not entirely ceased.

Wooden tramroads were in general use till about 1780, although cast iron rails were first used about 1770; but up to this time the use of cast iron rails still continues in some of the older private railways. These, however, are now almost always replaced with wrought iron as they are worn out, and may soon become matters of history.

The conversion of the wooden tramroads into iron ones was the first great step in the improvement of railways which (after the introduction of wrought iron rails, in 1820) assumed their present shape, so far as the general principles of construction were concerned.

The railway system has been carried to a great extent in these districts; and so completely has the country been intersected with railways, public and private, that, on an area of about 666 square miles, comprised in the northern coal-field, there are only 122 square miles, or about one-fifth of the whole, at a greater distance than one mile, and only 221 square miles, or one-third of the whole, at a greater distance than half a mile from a railway, public or private.

The total length of the private railways in the entire district is 287 miles, and of the public railways constructed for the more immediate service of the district, exclusive of main lines, 387 miles—making together 674 miles.

The complete reticulation of the district, by means of these railways, will be understood from the circumstance that within the actual limits of the coal-field itself, comprising about 666 square miles, there are (including all lines general and local) 609 miles of railway, being nearly 1 mile of railway for each square mile of surface of the northern coal-field, in addition to the 1300 miles of underground railway, as estimated by Messrs. Wood and Taylor.

Previous to the introduction of tramroads, the old pack horse conveyed 3 cwt. at 3 miles per hour, and travelled on an average about 8 miles with his load.

The cost of this mode of conveyance was about 1½d. per cwt. per mile, or 2s. 6d. per ton per mile.

The introduction of macadamised roads increased the horse load from 3 cwt. to 18 cwt., and with the same mileage performed, the 2s. 6d. was reduced to 8½d. per ton per mile.

On the early wooden tramroads a horse averaged a load of 2 tons, further reducing the cost of haulage to 3½d. per ton per mile.

The immediate cost of actual haulage on private railways, exclusive of interest on capital and waggons, as before, in cases wherein horses, inclines, and fixed engines are intermixed, as circumstances require, and with quantities varying from 80,000 to 160,000 tons per annum, is found to amount to about 7d. per ton per mile.

The cost by leading with a locomotive engine, costing 38s. per day, and with a load of 126 tons net on the ordinary local railways of the North of England, and in gradients reaching up to 1 in 100, travelling with a load about 35 miles per day, exclusive also of interest of engine and railway, and of waggons, as before, amounts to about 11d. per ton per mile.

And on first-class gradients, and under most favourable circumstances, with loads of 350 tons, a mileage of 60 payable miles, at a cost of 48s. per day, this haulage may possibly be reduced to 03d. per ton per mile; but this can but rarely be maintained in actual working.

Taking even 1 of a penny as being the cost of the mechanical effect required to lead a ton of coals on a railway by locomotives we have reduced the cost to 30th part of that by pack horses, and to 17th part of the cost of wooden tramroads.

In order, however, more fully to estimate the relative commercial value

of the different mode of haulage, as practised in these northern coal-fields, it will be necessary to include the other elements of expense, such as interest of capital, maintenance, and the cost of different descriptions of railway required in each case, and to compare the entire cost of the locomotive system with that of the fixed engines and inclines, as practised extensively in these districts.

1st. By horses, fixed engines, and inclines, intermixed with traffics, varying from 80,000 to 160,000 tons per annum, including waggons, maintenance, and renewals (and with interest on cost of line at £1500 per mile). The total expense of leading coals is found to amount to an average of 1½d. per ton per mile. This is exclusive of cost of land, or of the way leaves paid in lieu thereof.

2nd. By fixed engines and inclines, without horse-power, this expense including, as before, with a yearly traffic up to 400,000 tons, and a distance up to 7 miles, the total cost amounts to 54d. per ton per mile.

The particulars of this mode of leading are as follows, viz.:—Engines, inclines, and maintenance of way, in all 43d. per ton per mile; interest on cost of railways and plant, 5 per cent per annum, waggon rates and contingencies, exclusive of land, 11d. per ton per mile—making, as above, 54d. per ton per mile.

By locomotives, and on railways of improved construction, including, as before, this cost with loads of about 126 tons, and with gradients up to 1 in 100, amounts, on an average of railways, to 44d. per ton per mile; viz., the cost of maintaining and working a heavy locomotive engine, including repair, coke, water, stores, wages, &c., amounts in one year, on an average, to £600. To this must be added interest on capital, viz., £2300 at 5 per cent., £115; making the gross cost of an engine per annum £715, or say £720 per annum.

But to maintain three engines in working order on a railway, four must be kept; and this reduces the available number of working days to 234 throughout the year, costing 61s. for every day an engine works on the line, and travelling 35 payable miles with a load of about 120 to 130 tons, gives the locomotive power in conveyance of minerals, at the rate of about 12 to 13 miles per hour, the sum of 17d. per ton per mile.

To this must be added the cost of waggons, and interest thereon, amounting to 125d. per ton per mile; add interest, maintenance, and renewals of way, rates, &c., amounting in all to 222d. per ton per mile, on a lead of 800,000 tons, making the cost of leading by locomotive power with full employment, 517d. per ton per mile.

Thus it will be seen that the locomotive system, although capable of carrying a much greater mineral traffic, is not, on the whole, more economical than fixed engines and inclines, as now used in this district, unless in large traffic; indeed, where the traffic does not exceed 400,000 tons, and unless the gradients are better than 1 in 100, the fixed engine has the advantage; with gradients of 1 in 70 the two systems would be about on a par as regards expense. As the gradients improve or deteriorate, the locomotive gains or loses respectively, and at a million tons has a superiority.

The history of the rise and progress of the manufacture of locomotive engines especially connects itself with Newcastle-on-Tyne. The large manufactories of Messrs. Stephenson and Hawthorn have for many years been, and continue to be, of the highest repute.

In 1825, Messrs. Stephenson turned out the first locomotive on the Stockton and Darlington Railway, and, in 1829, completed the Rocket.

It is a remarkable circumstance that, notwithstanding the lapse of 34 years, during which the manufacture of locomotives has increased at a rate almost without precedent in similar matters, yet, in the general principles of mechanical construction, the present most improved locomotive remains very closely analogous to the Rocket.

The leading features of the Rocket were as follows:—Cylinder, diameter 8in.; stroke, 14in.; driving wheels, 4ft. 8in.; trailing wheels, 2ft. 10in.; heating surface, 144 square feet; weight of engine, 4½ tons; weight of tender, 3½ tons; horse-power, 40; evaporating power, 18·24 cubic feet water per hour; coke per cubic foot water evaporated, 11·7lbs.; maximum speed, 29 miles an hour; average speed, 13·8.

In the largest narrow gauge engines, now constructed, the heating surface has been increased from 144 to 1620 square feet; the weight of an engine from 4½ to 38 tons; the horse-power from 40 to 1300.

Since the commencement of the manufacture of locomotives, about 2400 have been turned out by the manufacturers of Newcastle, and upwards of 900 of these have been sent abroad. Taking an average cost of £2000 from the commencement to this time, the gross value of the exported locomotives from Newcastle amounts to £1,800,000; adding those manufactured for use in Great Britain and Ireland at £1500 would give a further sum of £2,700,000; making the gross value of the locomotives from Newcastle to amount in all, since the commencement of the manufacture, to £4,500,000. Of the £4,500,000 nearly one-half is represented by material purchased by the manufacturers in various stages of completion; thus, work to the value of upwards of £2,000,000 has been furnished, by the manufacturers of Newcastle, to the other branches of industry connected with their trade.

EXTRACTS FROM PAPERS READ ON RIFLE ORDNANCE.

Mr. George Richards read a paper on this subject, which was illustrated by diagrams, representing the square-bored rifle gun and the round bored rail gun, of which the paper treated.

Various modifications of the bores were shown, such as substituting portions of circles for the angles or corners for preventing the risk of initial fracture, &c. (a quality inherent in the rifle principle generally). He adduced the authority of many eminent experimentalists as to the force exerted by the gases generated by gunpowder with its supposed "absolute velocity" of expansion, and to the fact of its pressure in all directions in an equal degree; and that, as a natural consequence, the greater the surface presented to it on any side the more in that direction would be felt (or obtained) an increased momentum. Hence the necessity of presenting a greater surface to the propelling gases to gain more velocity for projectiles, as well as to cause less bursting strain to be inflicted upon the bore of the gun, of all of which he gave illustrations by figures, and showed important considerations why this principle should be followed out in the construction of guns.

He stated that the purpose of the square bored gun was to give greater initial velocity to the projectiles than was attainable by any plan yet proposed, inasmuch as the area of the square bore was at least twenty per cent. more than that of the circular bore containing a shot of the same diameter, thereby exposing (by using a wad or sabot) a greater surface to the impact of the ignited powder.

The invention embraced two principles:—In the first place, the square-bore gun gave at least twenty per cent. more initial velocity than the round bore of the same diameter; and secondly, the method of obtaining increased velocity to any extent was by means of projections or *rails* on the interior of the surface of the round-bore gun, on which the projectile runs or slides, there being in them the necessary amount of twist to give the shot the rifle motion.

In both cases the sabots would be used to act as air-tight pistons, but might be dispensed with by using wedge-like shoulders on the periphery of the shot to fill up the angular spaces of the bore, and also to give the projectile the piston-like qualities sought to be obtained. This principle of presenting an increased surface to the propelling force of the gas, was considered to admit of an extra power, in aid of velocity, of about 15 tons for every additional square inch so obtained. Those forms of bore would admit of shot whose transverse section, might be square, hexagonal, octagonal, cylindrical, spherical, or other polygonal, or geometrical forms of areas.

In addition, Mr. Richards showed a method of loading heavy ordnance (applicable to sea service) by means of a loading rod. The method of loading the gun was by means of the rod passing through a perforation in the breech of the gun, and thence to the muzzle. The cartridge used was also made with a perforation, through which the loading rod passes. The loading rod was quickly attached to the base of the projectile at the muzzle of the gun. The charge was quickly drawn into the chamber of the piece and disconnected in readiness for firing, and the breech was then closed by a simple apparatus. The object of this method of loading, is to acquire the advantages of the breech-loader, and to retain the strength of the muzzle loader. The ports, or embrasures, could be closed during the operation of loading, and the men at quarters thereby protected from the enemy's fire.

ABSTRACT HISTORY AND DEVELOPMENT OF THE ENGINEERING MANUFACTURES OF THE TYNE AND NEIGHBOURING DISTRICTS.

By PERCY WESTMACOTT, M. INST. C.E., AND J. F. SPENCER, M. INST. M.E.

The north-eastern districts of the United Kingdom, long pre-eminent for mining operations in coal, and more lately ironstone, have also been gradually rising into importance as the seat of most extensive engineering manufactures.

The unlimited supply of coal, an intelligent, hard-working, and enterprising population, together with the engineering necessities of such a large mining district, and the advantage convenient seaports have combined to create a large and increasing demand for all classes of engineering manufactures.

As early as the year 1747 the Gateshead Iron Works were commenced, and the present proprietors, Messrs. Hawks, Crawshaw, and Co., have now one of the largest engineering establishments on the Tyne.

In 1703, millwright work was undertaken at Chester-le-street, paper, lead, corn, and other mills being constructed and supplied to all parts of England, Scotland, Ireland, and abroad; in 1826, a large foundry business was added.

In 1800, the Walker Iron Works, owned by Messrs. Losh, Wilson, and Bell, were commenced, and, as in the two establishments previously mentioned, the variety and extent of engineering work rapidly increased, as the demand arose for an improved class of machinery and motive power.

Mr. Losh, the late senior partner of the firm, is well known in connection with the introduction of wrought iron railway wheels, an improvement that has materially tended to perfect the efficiency of the rolling stock. The manufacture of Losh's patent wheels was at one time a very large and important branch of the Walker Iron Works.

It may be interesting to notice, at the early date of 1784, the erection on the Tyne of one of Watt's steam engines, for the owners of Walker Colliery, by Boulton and Watt. Mr. Losh purchased this engine in 1805 for the Walker Alkali Company, and it may yet be seen working daily at Walker, with its wooden beam and bed plate, and sun and planet crank motion.

In 1817, Mr. Robert Hawthorn, the present senior partner of Messrs. R. and W. Hawthorn, established the Forth Bank Engine Works, receiving as a partner his brother William, in 1820. The increase from 8 men in 1817, to nearly 1000 in 1862, indicates very forcibly the progression of this well known establishment. (See Table A appendix.)

In 1830, Mr. T. D. Marshall, of South Shields, commenced the building of steam tugs and fitting them with machinery.

In 1838, the Hartlepool Iron Works were established by Messrs. Thomas Richardson and Sons; these works are now of considerable magnitude.

In 1844, the Tees Engine Works, now owned by Gilkes, Wilson, and Co., were established for the manufacture of large iron bridges and similar constructions, locomotives, marine and stationary steam engines, and foundry work.

In 1847, the Elswick Engine Works were commenced, with about 200 men, and, although then only engaged in the manufacture of hydraulic and general machinery, there has been a later period when, with the manufacture of the Armstrong guns (1858), the number of hands employed has amounted to upwards of 4000.

In 1847, Mr. Renoldson, of South Shields, established shops for the construction of engines and boilers for tug steamboats.

As the increasing commercial interests of this country, and the improvements matured in steam power, gave a fresh impetus to engineering manufacturers, the undoubted advantages and facilities of this district were appreciated and availed of by Messrs. Palmer Brothers in 1852, Messrs. Morrison and Co. in 1853, Messrs. Thompson in 1856, and Mr. David Joy, of Middlesboro', in 1862.

In referring briefly to the progress and present condition of the engineering manufacturers of the Tyne and neighbouring districts, it will be necessary to classify them under the following heads:—

1. General machine and mill work.
2. Stationary and steam engineering.
3. Locomotives.
4. Marine engineering.
5. Hydraulic machinery.
6. Iron bridges, viaducts, lighthouses, &c.

1. GENERAL MACHINE AND MILL WORK.

During the past 116 years, the following firms have contributed largely to the supply of first-class machine and mill work of all descriptions:—Messrs. Hawks, Crawshaw, and Co., of Gateshead Iron Works; Thomas Murray and Co., Chester-le-street; Losh, Wilson, and Bell, Walker Iron Works; R. and W. Hawthorn, Forth Bank Engine Works; R. Stephenson and Co., South-street Engine Works; Thomas Richardson and Co., Hartlepool Iron Works; Gilkes, Wilson, and Co., Tees Engine Works; W. G. Armstrong and Co., Elswick Engine Works; Morrison and Co., Ouseburn Engine Works; Thompson and Co., Spring Gardens Engine Works. With reference to the magnitude of the work undertaken by some of the above firms, it may be stated that Messrs. Crawshaw and Co., Losh, Wilson, and Bell, Thomas Murray and Co., W. G. Armstrong and Co., and Morrison and Co., that single castings have been supplied from 45 tons downwards, and there are capabilities for turning out single castings of even 60 tons.

As every description of paper, corn, lead, and other mills have been extensively constructed, it is impossible to refer to them in detail; but the erection of a self-acting crane for delivering ballast at St. Anthony's Quay, by Messrs. R. and W. Hawthorn, at the early date of 1820, is worthy of notice.

2. STATIONARY STEAM ENGINEERING.

Steam power was first practically utilised in mining operations, and its application was early introduced in the North-Eastern mining districts by several of the engineering firms before referred to; and the fact that the wants of a large mining district were almost exclusively supplied with steam power by local talent, and capital, is a satisfactory proof that there were the right men, at the right time, to aid by their engineering experience the resources and trade of the district.

Among the engineering specialties of this district may be mentioned many large winding and blowing engines. Messrs. Hawks, Crawshaw, and Co. have cast and bored cylinders of 108in. diameter for this class of engines.

In 1822, Messrs. R. and W. Hawthorn first applied steam to drive their lathes, and in 1824 they constructed a 50 horse-power engine for the Plate Glass Works of Messrs. Cookson and Cuthbert; and this engine is still doing efficient duty. At this period the same firm also fitted a self-acting steam crane, for delivering ballast at Hebburn Quay, on the Tyne.

Several of the firms previously mentioned have extensively supplied steam cranes of various powers; Messrs. Thompson and Co. alone having made upwards of 200.

Messrs. Morrison and Co. are noted for their large steam hammers, several of which they have supplied to the Government, the Elswick Engine Works, and other large establishments; and they have them in their own works of 15 to 20 tons weight, together with 2 steam cranes capable of lifting 50 tons each.

Although not quite finished, yet, on account of its excessive magnitude, it is of some interest to note here that Messrs. Morrison and Co. are now engaged in completing a monster steam hammer for the Russian Government. The forging for the hammer piston is 40 tons, and the enlarged part of the same is 6ft. 6in. diameter, finished size. The total weight of this hammer, when completed, will be about 550 tons, the bed alone being 240 tons, and will be cast in three pieces in its final resting place; it is believed this will be by far the largest steam hammer in the world.

The application of steam power to underground haulage has been successfully introduced by Messrs. Thomas Murray and Co., of Chester-le-street, the steam being conveyed to engines underground from boilers placed above the surface.

A model of this application of steam power in Hetton Colliery was exhibited at the meeting; in this case there are a pair of 18in. cylinders, and 3ft. stroke, working four drums, all on separate shafts, for drawing on a plane and incline.

Messrs. Murray and Co. have lately erected two 200 horse-power condensing engines for winding at Ryhope New Winning; the cylinders are 68in. diameter and 7ft. stroke; these engines can deliver 2000 tons per day from a depth of 300 fathoms. The same firm also erected at North Seaton a winding and pumping engine cylinder, 60in. diameter, and 7ft. stroke, fitted with the first hollow plate iron beam.

Messrs. Loeh, Wilson, and Bell were early in the field in the construction of steam engines for mills, collieries, and iron works. This firm have erected a large pumping engine, about 30 years ago, for Friar's Goose; also, at later dates, a large pumping engine for the North Seaton Colliery—diameter of cylinder, 76in., and 8ft. stroke; 60in. double cylinder high pressure engines for the Burradon Colliery, and many engines for blast furnaces and winding, having steam cylinders of 38, 40, and 42in. diameter.

At the present time this firm is largely engaged in the manufacture of surface condensers for mill and other steam engines, in connection with Mr. J. F. Spencer, the patentee of certain improvements in their application to existing and new engines.

This short and limited notice of such an important subject as the development of stationary steam engineering, can only serve to indicate in a very limited degree the engineering capabilities of the district.

3. LOCOMOTIVE ENGINEERING.

To this district belongs the undoubted honour of being the birthplace of the locomotive, and this fact must ever be recorded, when the names of Trevethick and Stephenson appear on the page of history.

In a paper written expressly to record the contribution of the north-east of England to the engineering talent of the country, it would be simply unjust to forget, in the now almost world-wide extension of locomotive manufacture, the Stephenson "Rocket" of 1829, or the Hawthorn "Comet" of 1835. The latter engine, which was used at the opening of the Newcastle and Carlisle Railway, can still be seen in daily work at the saw mills of the Forth Bank Engine Works.

In Table C, in the appendix, will be seen the number of locomotives and tenders manufactured by the several local firms; and it will be sufficient here to state, generally, that during the past 34 years upwards of 2400 locomotives have been constructed by R. Stephenson and Co., R. and W. Hawthorn, Gilkes, Wilson, and Co., and Sir W. G. Armstrong and Co.

In the above number are included all the known varieties of the locomotive, from the comparatively small tank engine to those magnificent specimens, constructed by Messrs. R. Stephenson and Co., for the late Viceroy of Egypt (photographs of these engines were exhibited).

4. MARINE ENGINEERING.

It would display an unwarrantable indifference to the birth and progress of great improvements, if reference was not made to the first practical application of steam power on the Tyne for towing purposes, more especially as the date of such application was almost coeval with Henry Bell's "Comet," on the Clyde, in 1812.

It is also of interest, in an engineering point of view, to place on record the names of those local firms who were the earliest in the field in making and fitting the first steam engines for Tyne tugs.

In 1814, the first steam tug, the "Perseverance," was fitted and started on the Tyne, there being at that time only 17 steamboats in existence; and Table B, in the appendix, gives the particulars of the introduction of steam for towing purposes on the Tyne, from 1814 to June, 1822; in this table it will be seen that the now existing firms of R. and W. Hawthorn firstly, and Hawks and Co. secondly, made and fitted steam engines for tugs as early as the years 1820 and 1821.

This reference to the beginning of steam navigation, and manufacture of marine engines on the Tyne, is the more important from the well known fact that almost all the ports of the United Kingdom, as well as those of foreign countries, have to the present day come to the Tyne for their steam tugs. From this fact it may be fairly assumed that the Tyne engineers have from the first supplied a most important want in a manner that has defied competition; and even now it is difficult to suggest any important improvement in the class of engine that has been working in these tugs during the past 40 years.

Some additional force is given to the last statements by the fact that, at the present time, there are upwards of 250 of what may be aptly termed "native steam tugs" employed on the Tyne, besides nearly 100 more in the ports of Sunderland, Stockton, Middlesborough, and Hartlepool; and the engines in all these are almost identical in type with those fitted in 1820.

Among the evident causes for the rapid extension of marine engine construction in the ports of this district are the early introduction of steam power for towing purposes, and, more lately, the increasing substitution of steam for sails, in the coal carrying trade, leading to the introduction of screw colliers; these may be fairly considered, with respect to this district, as native productions, and, further, they have proved stepping stones to the construction of the higher classes, and larger powers, of marine engines.

As before stated, Messrs. R. and W. Hawthorn were the first of the now existing firms to make engines for steamboats; and during the past 10 years especially they have been extensively engaged in fitting marine engines, both paddle and screw, up to 250 horse-power. In 1859 they applied most successfully to the *Frankfort*, 100 horse-power, of Liverpool, Mr. J. F. Spencer's system of surface condensation, and they have, more lately, applied the same arrangement with equal success to a pair of 140 horse-power screw engines they made and fitted into the *London*, for the Cadiz trade; the economy of fuel being considerable.

The same firm have also supplied Her Majesty's Government with 150 horse-power horizontal screw engines for H.M.S. *Shearwater*; these engines are fitted with separate expansion valves, worked by a second link.

Messrs. Hawks, Crawshaw, and Co. have constructed several pairs of marine engines, paddle and screw, for river and sea service, and they date the commencement of this class of work as early as 1821.

In 1830, Mr. T. D. Marshall, of South Shields, commenced building and fitting

steam tugs, and out of the 600 engines this firm have made since that date, upwards of 300 have been fitted in steam tugs, Marshall's steam tugs being well known in every port. The present firm of Marshall Brothers are still largely engaged in the construction of paddle and screw engines.

The names of Renoldson, Almond, and Kepple are also well known as producers of steam tug engines on a large scale; and it may be safely stated that upwards of 1000 tug engines have been made and fitted on the Tyne.

Messrs. Thomas Richardson and Co., of Hartlepool, have paid much attention to marine engineering, and are now engaged in perfecting several improvements therein. The extent of their establishment can be seen by reference to Table C, in the appendix.

Messrs. R. Stephenson and Co. have employed a large portion of their extensive establishment in the construction of marine engines; and, in addition to a long list of engines fitted, of various sizes, they put on board a Sardinian frigate a pair of 250 horse-power horizontal screw engines for the Sardinian Government.

In 1852, Messrs. Palmer Brothers established the Jarrow Engine Works, where have been manufactured, and fitted on board, a considerable number of marine engines, paddle and screw, and some of them of large power, having 90 and 80in. cylinders.

During the past 18 months this firm has introduced surface condensation into several pairs of engines, adopting an American plan for jointing the tubes. These engines are reported satisfactory for duty and economy of fuel, and there are several pairs in hand on the same plan, having 63 and 60in. cylinders.

Of the latest and most successful of this firm's engines may be mentioned those of the *Georgia*, having 60in. cylinders, giving a high speed and small consumption of fuel.

Messrs. Morrison and Co., of the Ouseburn Engine Works, have given much attention to the construction of marine engines, up to 250 horse-power, and have applied Hall's surface condensers, separate expansion gear, and steam jackets with much success. The mail steamship *Auckland*, with the improved engines referred to of 150 horse-power, has proved on her trial and economical and successful ship.

Messrs. Thompson and Co., of the Spring Gardens' Engine Works, have, especially since 1856, been largely engaged in the construction of marine engines up to 200 horse-power, and they have also paid some attention to economy of fuel.

Messrs. Gilkes, Wilson, and Co., of Middlesboro', and Mr. G. Clark, of Sunderland, are also engaged in marine engine construction, but have not furnished any information as to extent or speciality.

In this limited notice of what is now a most important branch of engineering industry in this district, it is important to state that the North Country engineer has to provide a larger and more powerful marine engine at a less cost per horse-power than the engineer on the Thames; and this unjust difference has tended materially to check in this district the manufacture of the higher class of marine engines.

Finally, it may be confidently stated there is a general desire among the North Country engineers, that the system of quality of workmanship following price should be superseded by price following quality of workmanship.

Several of the large firms just referred to have every capability, in extent and convenience of shops and tools, for supplying the largest engines that may be required for her Majesty's navy or mail steamships.

5. HYDRAULIC ENGINEERING.

It will be necessary under this head to refer separately—first, to the application of machinery to pumping, either for removing or supplying water; and secondly, to the application of machinery in using water as a motive power.

Extensive mining necessities require the constant attention of the mechanical engineer, especially to provide large and capable machinery for discharging water from great depths; and it is matter of much satisfaction when such machinery can be designed and applied on the spot.

The following brief reference to the productions of local firms, in addition to the supply of machinery for waterworks, &c., will clearly show that this district has reaped the full benefit of such local designs and applications.

Messrs. Thomas Murray and Co., of Chester-le-street, have applied steam power extensively to pumping for colliery purposes, and completed some of the largest colliery pumping engines in the district, some of them being 200 horse-power, with 60in. and 68in. steam cylinders.

Messrs. R. and W. Hawthorn were very early in the field in the construction of large engines for pumping, and in 1834 they erected a single-acting pumping engine, with 55in. cylinder and 8ft. stroke, for the Newcastle Subscription Water Company. This engine was the first erected in the neighbourhood with steam jackets and valves on the Cornish principle; it was at a later date (1854) converted into a double-acting engine, and is now doing duty at Newburn.

In 1845 several large pumping and winding engines were erected by the same firm at the various collieries in the North of England, among which was a powerful pumping engine of 250 nominal horse-power, at Walbottle Colliery, on the Tyne, with steam cylinders 77in. diameter and 10ft. stroke; it was erected to drain a large coal-field area, where it is now working.

In 1847-8 several first-class waterworks' engines were manufactured and erected by the same firm in the towns of Newcastle, Derby, Nottingham, Wolverhampton, Southampton, and Brighton; and in 1858-9 they erected powerful double-acting, combined, high and low pressure, and rotative beam engines, at the works of the Nottingham Waterworks Company, the Coventry Waterworks Company, and at Altona, near Hamburg, for the supply of that city with water, under the direction of Thomas Hawksley, Esq., C.E. Those last-named engines performed a duty of 110 millions, with 112lbs. of coals, the consumption being 2½lbs. per indicated horse-power. An arrangement for causing the governor

to act directly upon the steam valves was introduced in these engines with perfect success, giving them great steadiness in working, and effecting a considerable saving in the quantity of steam used.

Messrs. Hawks, Crawshaw, and Co., of Gateshead, have constructed and erected at the Hull Waterworks the largest pumping engine that has been made in this district.

The steam cylinder is 85in. diameter, and stroke 10ft. 6in.; the plunger pump being 34½in. diameter, and the same stroke as the steam cylinders.

This beam engine is single acting, and capable of lifting nearly 2 tons of water 174ft. high each stroke.

The same firm has also erected a large pumping engine for the waterworks at Scarborough. The steam cylinder is 46in. diameter, and stroke 8ft.; this is a single acting beam engine, worked expansively.

Messrs. Morrison and Co., of the Onseburn Engine Works, have made several large pumping engines. One pair was erected at Cleadon-lane, for the Sunderland and South Shields Water Company. There are two steam cylinders, each 60in. diameter, and stroke 8ft., worked expansively.

Messrs. Losh, Wilson, and Bell have also erected several large colliery pumping engines.

Messrs. Sir W. G. Armstrong and Co., in addition to their extensive application of machinery for applying water as a motive power, have constructed the engines for the Durham Water Works, together with other pumping engines for collieries; and they have been successful in introducing a self-acting valve to waterworks' supply pipes that effectually shuts off the supply in case of a pipe bursting.

Of the second division, or the use of water as a motive power, there is a distinct speciality of manufacture pertaining to this district in the machinery produced by Sir W. G. Armstrong and Co., at the Elswick Engine Works; and the following somewhat full reference to this subject may be justified by the fact, that the manufacture of this class of machinery has been exclusively confined to this district.

At the meeting of the British Association for the Advancement of Science, held in the year 1864, Sir William (then Mr.) Armstrong read a paper on the "Application of Water Pressure Machinery," wherein he described the origin and principles of his invention in the system of hydraulic machinery now referred to.

In the further extension, since that period, of this class of machinery, many improvements have arisen, the principles as then expounded, however, remaining the same.

The application of water power is classed under two heads, viz., the one where the pressure is obtained from natural sources; the other, where it is generated by artificial means. The employment of the former has remained limited, owing to its being confined to districts less accessible for the erection of works; and, therefore, the important and extended application of hydraulic machinery which has taken place, in nearly all the principal docks, railways, and Government establishments in this country, is due to the invention of the "Accumulator," for producing artificial pressure which is usually made equal in effect to a head of water of about 1600ft.

This high pressure system has been adopted with economy to a great variety of purposes, such as to crane, waggon-lifts, coal-drops, hoists, and tipping machines; to the working of turntables, traversing machines, hauling machines, capstans, &c.; but in no one branch of labour, perhaps, has this economy been more exemplified than in the loading and discharge of vessels, particularly those employed in the coal trade.

Nearly 1800 hydraulic cranes, hoists, and other machines of this description, have been applied, and 174 steam engines, having a collective power of more than 5200 horse power, are employed in supplying the pressure required for working them. In addition to these, 177 hydraulic engines of various forms and powers have been produced, and 23 movable bridges are worked by hydraulic machines.

The most novel and noticeable arrangement for the discharge of coal from vessels, by means of hydraulic machinery, is to be seen on board a vessel belonging to Mr. Cory, moored in the River Thames. This vessel, originally built for other purposes, has been converted into a floating wharf, and is supplied with a steam pumping engine, accumulator, 6 hydraulic cranes (which weigh the coal at the same time), 2 hydraulic capstans, and a variety of appurtenances for facilitating the work by day and by night. Rapidity of discharge is the great feature of this scheme—steam colliers carrying 1200 tons of coal are delivered in 10 hours. Such vessels, plying between the Tyne and the Thames, have accomplished the voyage there and back in 90 hours; having loaded and discharged each cargo in one tide, and made the passage in three tides each way. Two such vessels can be delivered at the same time alongside Mr. Cory's floating wharf, thus rendering the power equal to the discharge of about 5000 tons of coal in the 24 hours.

The application of hydraulic hoists for shipping coal has met the difficulty formerly felt in loading from low levels, at a comparatively moderate cost, may be seen from the following figures:—

At the Newport Docks, Monmouthshire, in the year 1862, 219,485 tons of coal were shipped from three hydraulic hoists worked by six men. The sum paid in wages, stores, and repairs, amounted to £501 6s. 2d. The cost of supplying the pressure amounted to about £250, which gives a charge of about 0.276 of a penny per ton for the pressure, and 0.562 of a penny per ton for wages, stores, and repairs. These figures are exclusive of the interest upon the outlay of capital. Before the introduction of hydraulic machinery at these docks, the cost of loading coals by hand amounted to between 5d. and 7d. per ton.

In point of dispatch the hydraulic is equal with the gravitation system, both being limited by the labour of trimming the coal in the hold of the vessel.

The most remarkable application of a hydraulic machine for loading coals is the one now constructing at Goole Docks, in connection with the system adopted by Mr. Bartholemew for the coal traffic upon the Aire and Calder Canal. The barges, carrying 33 tons of coal each, will be lifted by this machine out of the water, and their contents tilted directly into the hold of the vessel to be laden.

Recent improvements in the construction of rotatory engines have so simplified and reduced their size, that the application of this class of engines is rapidly extending. A 7 horse-power hydraulic engine, worked from the ordinary high (accumulator) pressure, occupies a space of 2½ft. square by 9in. deep. Such engines are now being applied directly to new, as well as to the existing dock gate crabs at the Liverpool Docks, without at all disturbing the present arrangement of the hand power gear of these crabs, which can thus still be used by hand in cases of emergency. Other engines are similarly applied directly to the crabs of handpower cranes, swing bridges, and other hauling appliances, to capstans, machines for planing armour plates, &c.

The latest improvement in hydraulic engines consists in making them with variable power, so that their consumption of water may be the better proportioned to meet any fluctuations in the amount of work to be done. An engine of this description, capable of being worked up to 17 horse-power, under an ordinary accumulator pressure of 700lbs. per square inch, was exhibited in the collection of models brought together in this town during the meeting of the Association.

The advantage of the system of storing up pressure in accumulators, so that a great force can be quickly brought to bear upon heavy masses to be rapidly moved for a limited distance, is well exemplified in its application to movable bridges; and the importance is the more felt in situations where traffic would be seriously impeded by slow action, as, for instance, at the part of the Swansea and Neath Railway, where the line crosses the mouth of the river, and the entrance to the dock in Swansea. The communication of the line is kept up over these two points by hydraulic draw bridges. The time occupied in lifting and drawing back the largest bridge—which has a space of 75ft. and weighs 260 tons—is under 1½ minutes.

At Wisbeach, where the plan of storing up pressure in an accumulator by hand pumps is resorted to, a bridge weighing 450 tons can be opened or closed in less than two minutes.

In noticing the application of water pressure, derived from natural sources, to the working of machines upon the system introduced by Sir William Armstrong, no better reference can be made than to the complete and extensive works erected upon the lead mines at Allenheads. Hydraulic machinery is therein employed in raising materials from mines; in giving motion to machines for washing, separating, and crushing ore; in pumping water, and driving saw mills and the machinery of a workshop.

The most recent application of water power at these mines deserves especial notice.

The district upon which the several new works are opened is void of falls of sufficient altitude for working the engines and machines directly, but a river runs through the district which is suitable for overshoot wheels; and through such mediums the stream is made to force water into accumulators, thus generating an intensified power, which is utilized by compact machines distributed in situations most convenient for their several duties. The principal object sought in thus intensifying the pressure is to lessen the size of the pipes, cylinders, and valves of the machines, and to gain more rapid action, and also by so reducing the size of parts to effect a saving in outlay upon the work generally.

6. IRON BRIDGES, VIADUCTS, LIGHTHOUSES, &c.

The art and manufacture of iron bridge building, and of other similar iron structures, which form such an important feature in railway construction and harbour improvements, are followed to a considerable extent by several engineering firms in this district.

The following brief notice of some of the most important of these works can only be taken as an index of the resources of the district in this direction.

That noble structure which spans the River Tyne, and forms a communication of road and rail, at a high level, between the towns of Newcastle and Gateshead, emanated, as is well known, from the same practical mind and genius that with dauntless courage and rare skill threw railway bridges across the Menai Straits and the St. Lawrence River.

The superstructure of the high level bridge was executed by Messrs. Hawks, Crawshaw, and Sons, of Gateshead. This firm has recently erected the cast iron bridge at York, from the designs of Mr. Page; it spans the river Ouse in one arch of 172ft. in width. Also, the new bridge at Sunderland, which consists of a single arch of about 237ft. span, at a level of 90ft. above high water mark. A melancholy interest is attached to this bridge, it being one of the very last works designed and undertaken by the late Robert Stephenson.

Messrs. Hawks, Crawshaw, and Co. likewise constructed the wrought iron gates for the Northumberland Docks, and the iron lighthouses at Gunfleet, Calais, and Harwich; and supplied the materials for the iron pier at Madras, a work of considerable magnitude.

Messrs. Robert Stephenson and Co. have been engaged upon the construction of wrought iron gates for docks, and have made 38 wrought iron bridges, among which, as most noteworthy, may be mentioned the Kaffie Azzayat Bridge, over the River Nile. The total length of this bridge is 1807ft. It is composed of four fixed openings, each 114ft. wide, and two swing openings each 80ft. wide. The girders are box shaped, and are carried upon wrought iron cylinders, 10ft. diameter, and about 80ft. long. The gross weight of this bridge, with the supporting cylinders, amounts to 2634 tons.

The firm of Gilkes, Wilson, and Co., of Middlesboro', have recently executed, from the designs of Mr. T. Bouch, some lattice bridges for the South Durham

and Lancashire Union Railway, of a peculiar light and cheap construction. Of these the Beelah Viaduct may be looked upon as the most interesting specimens of construction and workmanship. (Several models of this bridge were exhibited at the meeting.) It is constructed upon a somewhat similar plan to the celebrated Crumlin Viaduct, from which, however, it differs in many essential points.

This Beelah Viaduct consists of 15 pieces, composed of hollow columns. The span of the lattice girders forming the roadway is 80ft. in width. The total length is 1000ft., and the greatest depth from the rail to the ground is 195ft. The quantity of materials used in construction consists of:—

776 tons of cast iron.
398 tons of wrought iron.
12,343 cubic feet of Memel timber for roadway.

Messrs. Sir W. G. Armstrong and Co. have been engaged extensively in designing and manufacturing iron bridges. They have constructed 25 movable, and 44 fixed bridges. With one or two exceptions the whole of the former are worked upon the hydraulic system introduced by them.

The swing and draw bridges at the Birkenhead, Liverpool, and London Docks, and upon the Swansea and Neath, and Great Western Railways, are among the most noteworthy of this class. The largest fixed bridge constructed by this firm is the one which crosses the River Somme in India, made after the plans of Mr. G. Rendel, now one of the partners of this firm. Being about one mile in length, it boasts of being the longest bridge but one in the world. It is formed with 28 spans. The girders, carrying a railway platform above, and a common roadway beneath, are of the lattice construction, the top section being composed of wrought iron boxes, and the lower section of tension bars. The girders are carried upon brick piers.

The total weight of the bridge, including the pier superstructures, which are of iron, is about 4000 tons.

Sir W. G. Armstrong and Co. have also turned out from their works, caissons, dock gates, pontoons, coffer dams, saddle-back barges, wrought iron dredges, and a variety of works of this description.

There are many other firms in the district engaged in constructing similar classes of work to those before referred to. Enough, however, has been said to show the important position which this district holds in this branch of industry, the history and development of which have been shortly traced in this paper.

APPENDIX.—TABLE A.

Showing the average number of Men employed by Messrs. R. and W. Hawthorn from the commencement of their Works, in 1817, to the year 1862.			
Years.	Average Men.	Years.	Average Men.
1817	8 to 10	1838 to 1842	511
1818 to 1822	42	1843 to 1847	726
1823 to 1827	108	1848 to 1853	907
1828 to 1832	216	1853 to 1857	890
1833 to 1837	318	1858 to 1862	984

TABLE B.

Statistics having reference to the introduction of Steam Power for towing purposes on the Tyne.				
Date.	Name of Steamer.	H.P.	Engine Builder.	Total number employed in the United Kingdom.
1814	Perseverance	3	Crowther	17
1815	Swift	3		21
1816	Eagle	20	Watt	31
1817	Enterprise	5	Robson ...	40
1818	Speedwell	10	Robson ...	52
1819	Hope	6	Robson ...	64
1819	Swift	3	Robson ...	65
1820	Tyne	10	Robson ...	78
1820	Two Brothers.....	9	Robson ...	79
1820	Indefatigable	8	Hawthorn	80
1820	Duchess of Northumberland	10	Hawthorn	81
1821	Navigator	18	Hawthorn	117
1821	Safety	14	Hawks ...	118
1821	Union	4	Gibson ...	119
June, 1822	Lemington Packet	7	Hawthorn	148

NOTES HAVING REFERENCE TO TABLE C.

4. Present works comprise 28 shops (including 2 extensive erecting shops with powerful travelling cranes), the tools and machinery in which consist of 19 planing machines, 55 lathes, 4 boring mills, 5 shaping machines, 28 drilling machines, 7 punching machines, 3 shearing machines, 1 rivetting machine, 3 plate-bending machines, 3 steam hammers, 22 cranes, 2 hydraulic presses, 1 lifting apparatus for loading boilers, &c., with winches to lift 40 tons, and other tools in proportion, 2 large steam hammers in the forge, 30 cwt. and 60 cwt. each.

5. Extent of works, about four acres.

7. The whole works cover an area of 4½ acres, and consist of erecting shop, fitting and turning shops, iron and brass foundries, pattern shop, coppersmith shop, boilersmith shop, smith shop and 2 forges, with 3 steam hammers, 10, 15, and 50 cwt. each.

9. Extent of works, 9 acres.

11. The works consist of the usual machine, fitting, erecting, smith, and pattern shops, together with forge, boiler yard, and an extensive foundry for engineering and general castings.

12. Extent of works, about 10,000 square yards, and consist of forge, foundry, engine, and steam hammer shops. In the forge are 3 steam hammers, one of which is 15 tons, and can be increased to 20 tons, if necessary; also 2 steam cranes capable of lifting 50 tons each. The foundry has 2 travelling cranes, capable of lifting 30 tons each.

13. Extent of works, about 1½ acres.

TABLE C.—APPROXIMATE STATISTICS OF ENGINEERING MANUFACTURE IN THE NORTH EASTERN DISTRICT.

Number.	Manufacturers.		Date of establishment of works.	Description of Work executed.	Total number of hands employed.	Total number of Engines, Boilers, Machines, or Mills completed since the commencement of their works.	Horse-power of said Engines and boilers.	Quantity of raw materials used in the construction of the said Engines and Machinery.	Approximate value of raw materials.
	Name.	Address.							
1	Hawks, Crawshaw, & Co.	Gateshead	1747	Millwork and general machinery, Waterworks, Mill, Colliery, and Marine Steam Engines, Bridges, &c.	1500	{ 92 Marine Engines 58 Land Engines }	5000 in 30 years	Tons.	£ —
2	Murray & Co.	Chester-le-Street	1793	1793 to 1826, Paper, Lead, & Corn Mills, Agricultural Machines and Water Wheels. 1826, engine building and cast iron Foundry. 1841, Boiler Making, underground hauling engines	200	{ 350 Stationary Engines, 500 Boilers, 400 Corn, Clay, Tread, and Lead Mills, Brickmaking Machines, and Waterwheels	15,000 Engines 10,000 Boilers.	15,000	300,000

Number.	Manufacturers.		Date of establishment of works.	Description of Work executed.	Total number of hands employed.	Total number of Engines, Boilers, Machines, or Mills completed since the commencement of their works.	Horse-power of said Engines and Boilers.	Quantity of raw materials used in the construction of the said Engines and Machinery.	Approximate value of raw materials.
	Name.	Address.							
3	Losh, Wilson, & Bell ...	Walker	1807	{ Millwork, Steam Engines for Mills, Blast Furnaces, and Colliery purposes	200	{ 250 Stationary Engines & extensive foundry work	2000		—
4	R. and W. Hawthorn ...	Newcastle	1817	{ Millwork and general Machinery, Waterworks, Mill, Colliery, Marine, and Locomotive Engines	984	{ 797 Locomotive Engines, 121 Mining do., 9 pairs & 2 single Water-work do., 171 general do., and 80 pairs and 20 single Marine Engines...	15,000, exclusive of Locomotives.		—
5	R. Stephenson & Co.* ...	Newcastle	1823	{ Locomotive, Marine, and Mill Engines, Bridges, &c. }	1500	{ 1510 Locomotive Engines, 115 Marine Engines, 206 Marine Boilers, 263 Stationary Engines & Boilers ... }	35,000 Engines and Boilers, exclusive of Locomotives.	80,000	2,000,000
6	Marshall & Co.	Willington Quay	1830	{ Side-lever Paddle Engines for Tug Steamers, and inverted direct acting Engines for Screw Engines ... }	300 in Engine Shops, 700 in Boiler Shipyard	{ 600 Engines, with a large proportion of Boilers for the same, chiefly for steamers	3000		—
7	Richardson & Sons	Hartlepool	1838	{ Marine Engines & Machinery connected therewith... }	600	{ 340 Steam Engines and Boilers	12,318	20,000	300,000
8	Gilkes, Wilson, & Co. ...	Middlesboro'	1844	{ Millwork and general Machinery, Mill, Colliery, Marine, and Locomotive Engines, Bridges, &c. }	1000	{ 100 Locomotive Engines, and a large number of Blowing Engines, Steam Cranes, Marine and Stationary Engines			—
9	W. G. Armstrong & Co.	Elswick	1847	{ Millwork and general Machinery, Mill, Waterworks, Locomotive, and Hydraulic Engines, Bridges, &c. }	800	{ 202 Locomotive, Stationary, Pumping, and Dredging Engines, 255 Boilers, 173 Hydraulic Engines, 150 Accumulators	15,000 Steam Engines, 1400 Hydraulic Engines.		1,300,000
10	J. Renoldson	South Shields.....	1847	{ Marine Engines for towing purposes... }	40	{ 4 Stationary Engines, 66 Marine Engines for towing purposes	2230	Cast Iron 634, Forged Iron 255, Copper 21, Brass 43, Boiler Plates 726, Bar Iron 396.	—
11	Palmer, Bros., & Co.....	Jarrow	1852	{ Marine Engines, & Machinery connected therewith }	600	{ 71 pairs marine engines, 130 boilers }	11,842	Cast Iron 6000, Forged Iron 2500, Boiler Plates 2000, Copper and Brass 350.	450,000
12	Morrison & Co.	Onseburn	1853	{ Millwork and general Machinery, Mill, Waterwork, Colliery, & Marine Engines, Steam Hammers, &c. ... }	600	{ 80 pairs marine engines, 170 Boilers, 90 Steam Hammers, 30 Land engines, 88 Steam Cranes	5321	3460, used in the construction of Marine Engines & Boilers.	159,790
13	Thomson & Co.	Newcastle	1856	{ Millwork and general Machinery, Mill and Marine Engines, &c. }	400	{ 26 Land Engines, 7 Dredging Machines, 12 Sugar Mills, 55 pairs Marine Engines, 200 Steam Cranes, 16 Cotton Presses ... }	4645		180,000
14	Joy & Co.	Middlesboro'	1862	{ Steam Engines & Patent Steam Hammers	50	{ 1 Engine, 4 Boilers, 13 Patent Steam Hammers }	45 Steam Engines.		—

* 38 Wrought Iron Bridges, of various sizes and descriptions.

THE ROYAL SOCIETY.

PRELIMINARY NOTICE OF AN EXAMINATION OF RUBIA MUNJISTA, THE EAST-INDIAN MADDER, OR MUNJEET OF COMMERCE.

BY JOHN STENHOUSE, LL.D., F.R.S.

It is rather remarkable that while few vegetable substances have been so frequently and carefully examined by some of the most eminent chemists than the root of the *Rubia tinctorum*, or ordinary madder, the *Rubia munjista*, or munjeet, which is so extensively cultivated in India and employed as a dye-stuff, has been, comparatively speaking, very much overlooked, never having been subjected, apparently, to anything but a very cursory examination. Professor Runge, at the close of his very elaborate memoir upon madder, published in 1835, details a few experiments which he made upon the tinctorial power of munjeet, the constituents of which he regarded as very similar to those of ordinary madder. Professor Runge stated that munjeet contains twice as much available colouring matter as the best Avignon madder. This result was so unexpected that the Prussian Society for the Encouragement of Manufactures, to whom Professor Runge's memoir was originally addressed, referred the matter to three eminent German dyers, Messrs. Dannenberger, Böhm, and Nobiling. These gentlemen reported, as the result of numerous carefully conducted experiments, that, so far from munjeet being richer in colouring matter than ordinary madder, it contained only half the quantity. This conclusion has been abundantly confirmed by the experience of my friend Mr. John Thom, of Birckacre, near Chorley, one of the most skilful of the Lancashire printers. From some incidental notices of munjeet in Peroz and similar writers, and a few experiments which I made some years ago, I was led to suspect that the colouring matters in munjeet, though similar, are by no means identical with those of ordinary madder, and that probably the alizarine or purpurine of madder would be found to be replaced by some corresponding colouring principle. This hypothesis I have found to be essentially correct; for the colouring matter of munjeet, instead of consisting of a mixture of alizarine and purpurine, contains no alizarine at all, but purpurine and a beautiful orange colouring matter crystallising in golden scales, to which I purpose giving the name of "munjistine." Munjistine exists in munjeet in considerable quantity, and can therefore be easily obtained.

The colouring matter of munjeet may be extracted in various ways; that which I have found most suitable is as follows:—Each pound of munjeet in fine powder is boiled for four or five hours with two pounds of sulphate of alumina and about sixteen of water. The whole of the colouring matter is not extracted by a single treatment with sulphate of alumina; the operation must be repeated therefore two or three times. The red liquid thus obtained is strained through cloth filters while still very hot, and the clear liquor acidulated with hydrochloric acid. It soon begins to deposit a bright red precipitate, the quantity of which increases on standing, which it should be allowed to do for about twelve hours. This precipitate is collected on cloth filters and washed with cold water till the greater portion of the acid is removed. It is then dried, reduced to fine powder, and digested in a suitable extracting apparatus with boiling bisulphide of carbon, which dissolves out the crystallisable colouring principles of the munjeet, and leaves a considerable quantity of dark-coloured resinous matter. The excess of the bisulphide of carbon having been removed by distillation, the bright red extract, consisting chiefly of a mixture of munjistine and purpurine, is treated repeatedly with moderate quantities of boiling water and filtered. The munjistine dissolves, forming a clear yellow liquid, while almost the whole of the purpurine remains on the filter. When this solution is acidulated with hydrochloric or sulphuric acid, the munjistine precipitates in large yellow flocks. These are collected on a filter and washed slightly with cold water. The precipitate is then dried by pressure, and dissolved in boiling spirit of wine slightly acidulated with hydrochloric acid to remove any adhering alumina. As the munjistine does not subside from cold alcoholic solutions, even when they are largely diluted with water, about three-fourths of the spirit are drawn off by distillation, when the munjistine is deposited in large yellow scales. By two or three crystallisations out of spirit in the way just described the munjistine is rendered perfectly pure.

I have likewise succeeded in extracting munjistine directly from munjeet by boiling it with water, filtering the solution, which has a dark brownish-red colour, and then acidulating with hydrochloric acid. The precipitate which falls is collected on a filter, washed, dried, and treated with boiling spirit of wine, which leaves a large quantity of pectine undissolved. The munjistine which dissolves in the alcohol is obtained in a pure state by repeated crystallisations in the way already indicated. The first process which I have described is, however, by far the best. The colouring matter of munjeet can likewise be extracted with boiling solutions of alum; but I find sulphate of alumina greatly preferable, as the alum, by its tendency to crystallise, very much impedes the filtration of the liquids. I likewise

attempted to employ Professor E. Kopp's process with sulphurous acid, which gives such excellent results with ordinary madder, but I found it wholly inapplicable to munjeet.

Munjistine, prepared by the processes described, when crystallised out of alcohol, forms golden-yellow plates of great brilliancy. It is but moderately soluble in cold, but dissolves pretty readily in boiling water, forming a bright yellow solution, from which it is deposited in flocks when the liquid cools. Saturated solutions almost gelatinise. It dissolves to some extent in cold, but more readily in boiling spirit of wine, and is not precipitated by the addition of water. It dissolves in carbonate of soda with a bright red colour. In ammonia it forms a red solution with a slight tinge of brown; caustic soda produces with it a rich crimson colour. Both its aqueous and alcoholic solutions, when boiled with alumina, form beautiful flakes of a bright orange colour, almost the whole of the munjistine being withdrawn from solution. These flakes are soluble in a large excess of caustic soda, with a fine crimson colour. Munjistine dyes cloth mordanted with alumina a bright orange. With iron mordant it yields a brownish-purple colour, and with Turkey-red mordant a pleasing deep orange. These colours are moderately permanent, and bear the application of bran and soap tolerably well. The munjistine sensibly modifies the colours produced by munjeet, giving the reds a shade of scarlet, as has been long observed.

Commercial nitric acid dissolves munjistine with a yellow colour, but does not appear to decompose it even on boiling. Fuming nitric acid (1.5) dissolves munjistine in the cold, and on application of heat decomposes it, no oxalic acid being produced. It readily dissolves in cold sulphuric acid with a bright orange colour; and the solution may be heated nearly to boiling without blackening or giving off sulphurous acid; it is reprecipitated by water in yellow flocks apparently unaltered. When bromine water is added to a strong aqueous solution of munjistine, a pale coloured flocculent precipitate is immediately produced; this when collected on a filter, washed and dissolved in hot spirit, furnishes minute tufts of crystals, evidently a substitution product. I may remark, in passing, that when alizarine is treated with bromine water in a similar way, it also forms a substitution product crystallising in needles. I am at present engaged in the examination of both these compounds.

When munjistine is strongly heated on platinum foil, it readily inflames and leaves no residue; when it is carefully heated in a tube, it fuses, and crystallises again on cooling. It sublimates more readily than either purpurine or alizarine, forming golden scales which consist apparently of unaltered munjistine, as they give the characteristic rich crimson colouration with caustic alkalis. Baryta water produces a yellow precipitate with munjistine. Acetate of lead throws down a bright crimson precipitate, both in its aqueous and alcoholic solutions. I expect, from this and the bromine substitution compound, very shortly to ascertain the atomic weight of this body; in the mean time I submit the results of its ultimate analysis.

I. .314 grm. of munjistine yielded .732 grm. of carbonic acid and .106 grm. of water.

II. .228 grm. munjistine yielded .535 grm. carbonic acid and .0765 grm. water.

	I.	II.
C per cent.	63.6	64.0
H "	3.77	3.73
O "	32.63	32.27
	100.00	100.00

The munjistine operated upon in each case was prepared at different times; moreover, No. 1 was burnt with oxide of copper, No. 2 with chromate of lead.

Munjistine in some of its properties bears considerable resemblance to Runge's madder-orange, the "rubiaceine" of Dr. Schunck; it is, however, essentially different from rubiacine, both in several of its properties, such as its solubility in water and alcohol, &c., and in the amount of its carbon—rubiaceine, according to Dr. Schunck's analysis, containing 67.01 per cent. of that element, while munjistine contains only 64. The spectra afforded by solutions of the two substances, as may be seen from the following extract from a letter received from Professor Stokes, are decidedly different:—

"The two substances are perfectly distinguished by the very different colour of their solution in carbonate of soda, when a small quantity only of substance is used. The solution of munjistine is red inclining to pinkish orange, that of rubiacine a claret-red. The tints are totally different, and indicate a different mode of absorption. Both present a single minimum in the spectrum; but while that of rubiacine extends from about D to F, that of munjistine extends from a good way beyond D to some way beyond F. The beginning and end of the band in each case is not very definite, and varies of course with the strength of the solution; but by comparing the substances with different strengths of solution, there can be no doubt of the radical difference in the position of

the band of absorption. In this way it is easy to convince oneself that the difference of colour is not to be explained by the possible admixture of some small impurity present in one or other specimen. With caustic potash munjistine gives as nearly as possible the same colour as rubiacine, agreeing with the colour of rubiacine in carbonate of soda. There appears to be a slight difference in the spectrum of the munjistine and rubiacine solutions, but not enough to rely on; so that the substances are not to be distinguished by their solutions in caustic alkalis.

"A second perfectly valid distinction is, however, afforded by the different colour of the fluorescent light of the ethereal solutions. The solid substances themselves and their ethereal solutions are fluorescent to a considerable degree; but the tint of the fluorescent light of the ethereal solution of rubiacine is orange-yellow, while that of the ethereal solution of munjistine is yellow inclining to green. The examination in a pure spectrum shows that the difference is not due to the admixture of a small impurity, itself yielding a fluorescent solution; but the tints may be readily contrasted by daylight, almost without apparatus, by the method I have described in a paper 'On the existence of a second crystallisable fluorescent substance in the bark of the horse-chesnut.' (*Quarterly Journal of the Chemical Society*, vol. ii. p. 20). I consider either of the two points of difference I have mentioned sufficient by itself to establish the non-identity of munjistine and rubiacine."

The purpurine which I succeeded in extracting from munjeet, and in purifying from munjistine in the way already described, formed beautiful dark crimson needles, having all the usual properties of that substance. When examined by Professor Stokes, they gave the very characteristic spectra of purpurine.

·3285 grm. of purpurine gave ·8005 grm. carbonic acid and ·1050 grm. water.

	Analysis.		Debus (mean).
	Theory.	Found.	
C.....	66·67	66·46	66·40
H.....	3·70	3·55	3·86
O.....	29·63	29·99	29·74
	100·00	100·00	100·00

From the results abovedetailed there can therefore be no doubt that the colouring matter of munjeet, as already stated, consists of purpurine and munjistine.

I cannot conclude this preliminary notice without acknowledging the essential services I have received from Professor Stokes, who kindly submitted the different products obtained by me to optical examination. Though it is plain that a substance optically pure, that is, containing no impurities affecting the spectrum, may still be far from being chemically so, yet the spectroscope is extremely useful in indicating admixtures of kindred substances of very similar properties, having a great affinity for each other, and therefore not readily separable. I feel certain, therefore, that if Professor Stokes would draw up a short treatise, embodying his extensive and accurate observations on the spectra of the colouring matters and similar substances, he would confer a great boon on the cultivators of organic chemistry.

Since the preceding paper was communicated to the Royal Society, I have been enabled to examine the action of nitric acid on munjistine much more fully. When munjistine is digested with moderately strong nitric acid, as already stated, copious fumes are given off, the munjistine gradually dissolving and forming a colourless solution. When this is evaporated to dryness on the water-bath, a white crystalline mass is obtained, consisting almost entirely of phthalic acid contaminated with a small quantity only of oxalic acid. The oxalic acid may be easily removed by washing the mass with a little cold water and then pressing between folds of bibulous paper, or by neutralising the mixture of the two acids with lime and then treating with boiling water, which dissolve the phthalate of lime. The acid freed from oxalic acid by either of these methods presents all the usual reactions of phthalic acid. One of the most convenient ways of purifying it consists in subliming it repeatedly in a Mohr's apparatus, when the anhydrous acid is obtained in beautifully white iridescent four-sided prisms, frequently several inches in length. ·3745 grm. of the crystals of the anhydride, burnt with chromate of lead, gave ·891 grm. carbonic acid and ·096 grm. of water.

	Theory.	Expt.	Marignac.	Laurent.
C ₁₆	96	64·86	64·89	64·88
H ₄	4	2·70	2·81	2·71
O ₆	48	32·44	32·30	32·41

From this result it is evident that the acid chiefly produced by the

* I may mention that the rubiacine which Professor Stokes examined was prepared by Dr. Schunck himself.

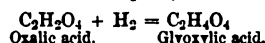
actions of nitric acid upon munjistine is phthalic acid, which, as is well known, may also be procured from alizarine and purpurine. This reaction, therefore, indicates a very close relationship between these three substances, the only true colouring principles of madder with which we are at present acquainted.

THE CHEMICAL SOCIETY.

NOTE ON SOME METAMORPHOSES OF OXALIC ACID.

By ARTHUR H. CHURCH, B.A.

When oxalate of sodium is submitted to the action of sodium-amalgam in presence of water, some interesting effects ensue. If the action be not accelerated by elevation of temperature, and the amount of salt employed be large, a partial reduction only of the oxalic acid takes place, in accordance with the equation—



A more ready method of attaining the same result is found in the reaction of zinc, oxalate of zinc, and sulphuric acid. A large quantity of oxalate of zinc is placed, together with a few pieces of pure zinc, in a beaker, the mixture covered with water, and dilute sulphuric acid added very slowly, drop by drop. Milk of lime, in very slight excess, having been added, together with much water, and the mixture warmed, the whole was filtered, saturated with carbonic acid, again warmed, and filtered. The filtrate deposited, on cooling, some quantity of fine needle-shaped crystals of glyoxylic acid of calcium. This salt required about 160 parts of cold water for solution. Calcium and water determinations suggested for this salt the formula—

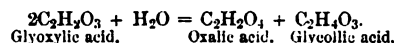


while a series of careful qualitative experiments proved the identity of the acid of which it was the calcium compound with Debus's glyoxylic acid. A larger yield of this product is obtained if, in the process just given, the use of lime be altogether omitted, the glyoxylic acid being extracted directly by means of ether from the concentrated and acidified solution of the mixed zinc-salts first formed. The syrupy ethereal solution is treated with carbonate of calcium, and the various calcium-salts thus made are separated by the method of Debus.

When lime-water was added to the solution of the glyoxylic acid, a white powder fell, agreeing in its amount of calcium with the formula—



and suffering, when boiled for some time with water, the following change—



This transformation of oxalic acid into glycollic acid has, however, been previously accomplished. Under the name of *ozonic acid*, F. Schulze has described one of the products obtained by acting upon oxalic acid with zinc in presence of sulphuric acid. Schulze, indeed, in all probability, thus obtained glyoxylic acid; but his method of eliminating the new product of the reaction, by ebullition of the zinc salts with excess of milk of lime, necessarily destroyed the glyoxylic acid first formed, producing oxalate and glycolate, as stated above. But if we adopt Schulze's plan, and instead of moderating in every way the reducing action in the experiment under review, we exalt its energy in every way, then glycollic acid is the chief product. The method of procedure in this case may be thus modified:—Into a retort containing a large quantity of zinc and dilute sulphuric acid, and heated by a lamp, small quantities of oxalic acid are introduced from time to time. When the desired quantity of acid has been added, a brisk evolution of hydrogen is maintained for some hours, and the liquid boiled with excess of zinc till the acids present are saturated. Excess of slaked lime having been added to the mixed salts, the whole is to be saturated with carbonic acid, boiled, and filtered. This filtrate, on concentration, deposits abundance of glycolate of calcium, in concentric tufts of fine crystals. Analysis and qualitative experiments confirmed the identity of the formula of this salt—



But in the mother liquor from which the glycolate had been deposited, another calcium-salt was contained. This salt was excessively soluble in water, thus differing from the oxalate, the glyoxylic acid, and the glycolate of calcium. When to its warm syrupy solution an exactly equivalent quantity of sulphuric acid was added, and the sulphate of calcium separated, star-shaped clusters of crystals filled the filtrate. Further examination proved these crystals to be an acid. As far as the small quantity of this substance at my disposal permitted, I have determined some of its properties and its probable composition.

This acid is soluble in water, and readily crystallisable. From its boiling aqueous solution, it evaporates slowly, with a peculiar faint odour. It melts above 100° C. Its lime salt (the only one yet made) is very soluble in cold water, and confusedly crystalline. A combustion of this acid dried over sulphuric acid indicated the formula—



while a calcium determination in the salt of that metal gave numbers nearly agreeing with the formula



If the preliminary examination of these substances has conducted me to a correct conclusion, and I am right in supposing the last-mentioned acid to have the formula assigned to it, we have a new isomer of acetic acid, differing remark-

ably from that body in several particulars. The series of reduction-products of oxalic acid will stand thus:—

Oxalic acid	= $C_2H_2O_4$, which - O gives
Glyoxylic acid	= $C_2H_2O_3$, which + H_2 gives
Glycollic acid	= $C_2H_4O_3$, which - O gives
New acid	$C_2H_4O_2$.

By addition of H_2 to the last term, glycol, $C_2H_6O_2$, might perhaps be formed.

The existence of a body $C_2H_4O_2$ has, I find, been predicted by Professor Kekulé. He gives the following table (*Lehrbuch der Organischen Chemie*, Bd. ii, s. 18)—

Monatomic series:—

C_2H_6O Alcohol.	$C_2H_4O_2$ Acetic acid.	C_2H_2O Aldehyde.
-----------------------	-----------------------------	------------------------

Biatomic series:—

$C_2H_6O_2$ Glycol.	$C_2H_4O_3$ Glycollic acid.	$C_2H_2O_4$ Oxalic acid.
$C_2H_4O_2$ (Unknown.)	$C_2H_2O_3$ Glyoxylic acid.	$C_2H_2O_2$ Glyoxal.

It is thus clearly shown how a monatomic alcohol, losing H_2 , yields one aldehyde, and this, gaining O, yields one acid; while, on the other hand, a triatomic alcohol, by losing H_2 or $2H_2$ yields two aldehydes, and each of these, by gaining O, yields another acid. The new acid may thus be the missing first aldehyde of glycol, of which glyoxylic acid may be regarded as the second.

It will not be unreasonable to expect corresponding results from the action of nascent hydrogen on the homologues and analogues of oxalic acid, and the acid and neutral ethers* of these acids.

I have commenced a few experiments in this direction also.

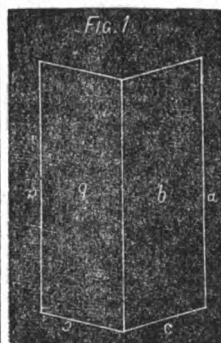
Succinic acid, after the prolonged and energetic action of nascent hydrogen, as above described in the case of oxalic acid, suffers a similar change. I have not endeavoured to moderate the action so as to form the intermediate or butyloxylic acid, but have pushed it to the extreme, so that butylactic acid might be obtained.

The operation was performed in a retort; towards its conclusion a powerful odour, resembling that of butyric acid, was noticed in the aqueous distillate. The mixture of zinc-salts in the retort was evaporated, sulphuric acid added in excess, and the liquid shaken up with ether. From this ethereal solution (besides some unchanged succinic acid) a deliquescent acid was obtained, the properties and salts of which agreed completely with those of the butylactic acid of Wurtz. I have likewise submitted suberic and phthalic acids to the above-described treatment, and the reactions promise interesting results. But the products of these reactions, obtained only very recently await further purification and analysis; and it would be altogether premature to express any opinion as to their composition.

DR. JOHN STENHOUSE, F.R.S., ON LARIXINIC ACID, A CRYSTALLISABLE PRINCIPLE FOUND IN THE BARK OF THE LARCH TREE (*Pinus Larix*, Linn.)†

The most convenient way of preparing this somewhat singular substance consists in cutting the bark of the larch into small pieces, and then digesting it in water for twenty-four hours at a temperature of about $80^\circ C$. The solution, which has a deep reddish-brown colour, is then poured off on to a second portion of larch bark and digested as before. The concentrated infusion is then cautiously heated in an open porcelain dish, at the temperature of about $80^\circ C$, till it is converted into a syrup. A portion of this syrup is then distilled, either in glass or porcelain retorts, or, what is better than either, in a silver alembic. Iron retorts cannot be employed for this purpose, as the acetic acid which is always produced during distillation, by forming acetate of iron, instantly destroys the larixinic acid, changing it into a deep purple-coloured liquid. When a silver alembic cannot be procured, a very convenient way of distilling the extract of the larch is to pour it into a large Florence flask, the neck of which is passed obliquely through a cork or bung, inserted into a glass condenser. When the flask is cautiously heated on a sand-bath, the larixinic acid comes over with the first portions of the liquid, but becomes more abundant as the distillation proceeds, and usually forms large flat crystals which condense on the sides and neck of the receiver. The liquid which is distilled over, and which contains the greater portion of the larixinic acid, should be poured into small flat basins, and cautiously concentrated at about $60^\circ C$. When the greater portion of the water has been dissipated, it is advisable, especially in warm weather, to complete the operation by spontaneous evaporation; for unless the concentration of the aqueous solution of larixinic acid is conducted cautiously, the larixinic acid volatilises along with the vapour of water, and is thereby lost. The highly concentrated solution of larixinic acid obtained in the way just described, deposits, on standing, brownish-yellow crystals, which are impure larixinic acid. This is to be pressed between folds of blotting-paper, and re-crystallised from a small quantity of water. The larixinic acid may be rendered perfectly pure by subliming it once or twice. This is easily effected by placing the larixinic acid between two watch-glasses, or in any other suitable apparatus, and heating it cautiously on a sand-bath, or even on a water-bath, as it sublimes at the very low temperature of $93^\circ C$. The larixinic acid is a proximate principle, which exists ready formed in the larch. This is easily proved by distilling even a dilute infusion of the bark, when the liquid which passes over will be found to strike a deep purple colour with a persalt of iron, which is very persistent. The bark of old larch trees contains very little larixinic acid; but the bark of the small

branches, and that of the stems of the larch, when not more than from twenty to thirty years of age, contains very considerable quantities of this substance. The concentrated syrup from the portions of bark yielding more larixinic acid than an equal weight of catechu does of oxyphenic acid. Larixinic acid, after it has been purified by sublimation, forms beautifully white crystals, often more than an inch in length, of a brilliant silvery lustre, very much resembling benzoic acid in appearance. They sublime at $93^\circ C$, and melt at $153^\circ C$, but the aqueous solutions volatilise at ordinary temperatures. I am indebted to the kindness of Professor W. H. Miller, of Cambridge, for the subjoined measurements of the crystals of larixinic acid.



between the normals to two faces is taken as the measure of the angle between the faces.

"Oblique:—

$$100, 101 = 26^\circ 22'$$

$$010, 111 = 74^\circ 36'; 001, 101 = 44^\circ 20'.$$

"Forms observed:—

$$010, 001, 110, 011, 023.$$

Angles.

$$110, 001 = 71^\circ 58'$$

$$101, 110 = 69^\circ 35'$$

$$010, 011 = 59^\circ 37'$$

$$010, 023 = 68^\circ 39'$$

$$010, 001 = 90^\circ 0'$$

"Cleavage 001 distinct, and very easily obtained."

The smell of the aqueous solution of larixinic acid is sweetish, like that of a syrup, but the smell of the sublimed acid is very peculiar and slightly empyreumatic. As larixinic acid emits a sensible odour at ordinary temperatures, it bears in this respect a considerable resemblance to naphthalene and ordinary camphor. The taste of larixinic acid is slightly bitter and astringent. It reddens litmus paper very slightly, but a single drop of potash or ammonia, when added to a solution of a large quantity of larixinic acid, renders it alkaline. Larixinic acid is very soluble in boiling water, but by no means very soluble in cold water, 87.88 parts of water at $15^\circ C$ dissolving 1 part of the acid only; but the solubility of larixinic acid in cold aqueous solutions is greatly increased by the addition of either acids or alkalis. Larixinic acid is deposited from its aqueous solutions in crystals which are very brittle, and often an inch or two in length. It likewise dissolves in cold alcohol, but to a much greater extent in hot alcohol. The crystals deposited from its alcoholic solutions are thicker and more distinctly formed than those from water. It also dissolves but sparingly in ether, and is deposited in crystals of very considerable lustre.* The following are the results of the analysis of the larixinic acid:—

	Calculated numbers.	Found.		
		I.	II.	III.
C_{20}	= 57.14	57.13	57.06	57.09
H_{10}	= 4.77	5.04	5.09	5.04
O_{10}	= 38.09	37.83	37.85	37.87

From these results it is evident that the carbon, hydrogen, and oxygen in larixinic acid are in the proportion of $C_{20}H_{10}O_{10}$, or some multiple of these numbers, $C_{20}H_{10}O_{10}$ being the numbers we have adopted as the more probable.

When a quantity of larixinic acid was dissolved in a great excess of liquid ammonia, a yellow-coloured solution was produced; when this was evaporated to dryness, over sulphuric acid *in vacuo*, the larixinic acid was deposited in crystals which were nearly unaltered. It gave its characteristic reactions with salts of iron, and when boiled with milk of lime gave off no trace of ammonia. The combination which larixinic acid forms with ammonia is, therefore, so feeble that it is decomposed by the volatility of the ammonia. In this respect, therefore, and in its forming no hydrate, larixinic acid closely resembles both pyrogallol and oxyphenic acids.

When larixinic acid was treated with an excess of aqua potassae it very readily dissolved, forming a yellowish solution. When dried over sulphuric acid *in vacuo*, the potash combination formed long flatish crystals having considerable lustre, but of a reddish-brown colour. These crystals, when pressed between

* From oxalate of ethyl, M. Löwig has already obtained in this way paratartrac acid.
† From the Philosophical Transactions, 1863.

* The crystals of larixinic acid catch fire readily, and burn with a bright flame, leaving no residue.

folds of blotting-paper to free them from excess of potash, and re-crystallized *in vacuo*, yielded crystals which were more deeply coloured than the first. This potash combination is so very feeble that it is decomposed by carbonic acid. It contained a considerable quantity of potash; but I have not been able to obtain it of a constant composition.

A solution of larixinic acid gives no precipitate, either with lime-water or with saccharate of lime. The behaviour of larixinic acid with baryta is extremely singular and characteristic. When a solution of caustic baryta is added to a concentrated aqueous solution of larixinic acid, the latter being in excess, a bulky semi-transparent, gelatinous precipitate immediately falls, and if the solutions are concentrated, fills the whole vessel. This precipitate, which considerably resembles hydrated alumina, is but slightly soluble in cold water; but it dissolves very readily in boiling water, from which it is again deposited on the cooling of the liquid. This baryta-compound is readily decomposed by carbonic acid. When thrown on a filter and washed, the air being carefully excluded, it was dried *in vacuo* over sulphuric acid, and was then found to contain, as the mean of two experiments, 34.92 per cent. of baryta.

A solution of larixinic acid yields no precipitate with either basic or neutral acetate of lead, neither is it precipitated by nitrate or ammonio-nitrate of silver; but when its solution in the latter salt is boiled, the silver is reduced in a pulverulent state. Larixinic acid forms no precipitate with perchloride of platinum, even on the application of heat. It does not contain any nitrogen. It does not reduce oxide of copper when tried by Trommer's test. It dissolves in concentrated sulphuric acid, but no conjugate combination is produced, as was ascertained by neutralising with carbonate of baryta, larixinic acid being obtained unchanged. When larixinic acid is boiled with a mixture of hydrochloric acid and chlorate of potassa, it is decomposed, but without the formation of chloranil. When it is boiled with a solution of hypochlorite of lime, no colouration is produced. It is readily attacked by nitric acid, especially when assisted by heat; nitrous fumes are given off, and oxalic acid is the only fixed product, and is also readily attacked by bromine, especially when assisted by heat. Abundant vapours of hydrobromic acid are given off, the larixinic acid being entirely destroyed and converted into an uncrystallisable resin. The salts of copper produce an emerald green colour in solutions of larixinic acid, but no precipitate. Chloride of manganese produces neither colouration nor precipitation. Protosulphate of iron strikes a brownish-red colour with solutions of larixinic acid, which acquire a brighter red colour on standing, resembling meconate of iron. Perchloride and persulphate of iron produce a beautiful purple dahlia colour, which is very persistent, and stands dilution well. Its reactions with salts of iron are very characteristic of larixinic acid, which forms an excellent reagent for the detection of salts of iron, even in very minute quantities. In this way the presence of iron in tolerably pure sulphate of copper can readily be detected by the purple colouration produced. Larixinic acid does not affect neutral protosulphate of mercury in the cold; and on the application of heat no mercury is reduced.

Larixinic acid appears to be peculiar to the larch tree; at least I have not been able to find a trace of it in the bark of the spruce fir (*Abies excelsa*), or in that of the Scotch fir (*Pinus sylvestris*). Larixinic acid evidently belongs to that small group of substances of which pyrogallol and pyrocatechin, the oxyphenic acid of Gerhardt, are the only other members yet known. Larixinic acid is much less easily oxidisable than oxyphenic acid, which again is less easily oxidated than pyrogallol. Larixinic acid volatilises at a much lower temperature than either of these two substances, from which it also differs in being a ready-formed proximate principle, and not an educt.

Addendum.—In consequence of the extremely feeble, if not somewhat doubtful, acid properties of the so-called larixinic acid, perhaps the name *Larixin* would be more appropriate; but in that case the name of pyrogallol acid should be altered to *pyrogallin*, and that of oxyphenic acid to *pyrocatechin*, the name originally given to it by Zwenger.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

At a monthly meeting of this society, held on the 5th ult., Mr. Joseph Newton, President, in the chair, the auditors for the half-year just expired presented their report, which showed that, in a numerical and financial sense, the association was in a prosperous condition.

Mr. Gettliffe then read his promised Paper on "An Apparatus for the Prevention of Steam Boiler Explosions and Railway Accidents," and, after some preliminary observations, proceeded to say that the apparatus was the invention of M. Auguste Acharde, C.E., of Paris, and that it was known in France under the title of the "Embrayage Electrique." It was calculated to maintain a constant level feed in steam boilers by automatic means, and without the assistance or supervision of the engineman. This regulator, as it might be termed, consisted of a ratchet wheel of peculiar construction, and which was keyed upon a spindle turning freely in its bearings. Right and left of the wheel were mounted loosely on the spindle two wrought iron levers of about 20in. each in length, and connected together by cross-pieces. A two-armed "click," supported by the levers, turned freely round an axis. The double click acted upon the ratchet wheel, which was furnished with two sets of teeth turned in opposite directions to each other and separated by a blank space. The click was fitted with a tail-piece in the form of a fork, the two prongs of which were braced together by a cross-rod. In the fork was mounted an "armature," which was provided with an opening through which passed the cross-piece. The armature was made of brass, and to it was attached a piece of soft iron fitted in so as to be flush with the surface of the armature. Opposite to this latter was placed a horizontal electro-magnet, the poles of which abutted against the armature in such a way as that it (the armature) could only slide against the poles without coming into immediate contact therewith. The part played by the armature was merely

to act as a weight on the levers supporting the fork; for it would be understood that when the electric current was in circulation, the armature would be suspended by its adherence to the electro-magnet, and thus relieve the fork of its weight. The suspension of the current, on the contrary, would cause it to drop on the cross-piece connecting the levers, and thus alter the gravity of the fork. It was these alterations of the weight on the tail-piece of the levers which caused the fork to act upon the upper or lower set of teeth on the ratchet wheel; or, in other words, to open or shut the feed-cock of the boiler. It was necessary that the fork should have continual motion—a kind of pump-handle movement, indeed—which could be effected by a simple contrivance (a small eccentric, for instance, attached to a running shaft on the general machinery). The effect would be that the compound ratchet wheel would be acted upon and moved in one direction when the boiler required feeding, and in the other when fed sufficiently. If all were going on well, the click would simply move over the blank portion of the wheel, and communicate no motion whatever to it. Advancing now to the general action of the contrivance, the reader proceeded to state that when the current was broken off from the electro-magnet, the weight of the armature operating upon the cross-piece would press down the tail-piece of the levers carrying the click, which latter would rise and act with its lower arm upon the ratchet wheel. The consequence would be, that the wheel would turn from left to right to the extent of one tooth, or about half an inch at each oscillation of the levers, until the blank space presented itself and stopped further movement. This would be at a point when the wheel had made one-fourth of a revolution. On the other hand, when the current was in circulation, the armature, in sliding against the poles of the electro-magnet, would bring the plate of soft iron into contact with the poles, which would then hold it firmly, and prevent the armature descending with the click during the downward oscillation of the levers. The tail-piece would thus be relieved, and not have to support any weight while the latter rocked in the opposite direction. It would follow that the upper arm would then act upon the wheel, and cause it to turn the reverse way, *i.e.*, from right to left: It would thus become evident that the two-armed click would act on the ratchet wheel, and cause it to move in opposite directions, whether the electric current were traversing the electro-magnet or not. The rising and falling of the float in the boilers of stationary or land engines controls the electric current, and causes it to circulate or be interrupted at the proper times. This result is obtained directly by the wires which proceed from the pile or battery being made to pass first to the float instead of being connected immediately to the electro-magnet. The float itself was connected by a rod with an index, on the lever of which was mounted a piece of wood faced on one side with a brass plate. On another piece of wood, in the form of a rocking lever, and moving on an axis, was a second plate of brass. The electric wire from one of the poles of the battery was fixed to the first-named plate, and the other end of the wire, after traversing the electro-magnet, was attached to the other pole of the battery. In order that the current might circulate, it was indispensable that both plates should meet, and from the peculiar arrangement of the two metallic plates, they would always be in contact when the index was at zero (the normal feeding point) or above it, but the contact ceased as soon as the index fell below zero. Let it be supposed that the feed-cock of the force-pump, or other appliances for supplying water to the boiler, was connected to the spindle of the ratchet-wheel: it would follow that the cock must partake of the movement of the wheel, and that it will make a quarter of a turn in one direction when the electric current circulated, and a quarter of a turn in the other when the current was interrupted: thus the automaton regulator, which was sensitive to the smallest alteration in the water level of the boiler, was perpetually and inevitably maintaining it at a constant height, and thus one great source of danger was obviated. As an extra security, however, against accident by explosion, a minor contrivance was affixed to the same apparatus, and which owed its action to similar principles. On the side of one of the levers was fastened a cap with a gudgeon in its centre. An armature resembling that already described was carried by this cap and rested on the gudgeon. In connection with this second armature was placed an electro-magnet, against which it was made to slide and press constantly upon the poles. It was still the index of the water gauge, which induced the circulation or effected the interruption of the electric current; and the same electric pile or battery, composed of a single element, or Daniel's pair, sufficed to put in motion the two electro-magnets. The electric wire which proceeded from one of the poles of the battery, and was affixed to the brass plate on the lever at the index, served for the two electro-magnets also. The returning wire corresponding with that about to be described, however, was fixed to a third brass plate, and, after traversing the electro-magnet was attached to the second pole of the battery. The last-mentioned plate was arranged in such a manner as to establish a metallic contact which permitted the electric current to pass, notwithstanding the variation in the level of the water to the extent of an inch above or below its proper line. If the variation exceeded these limits, the current would be forcibly broken. When the electric current was in circulation—that is to say, when the lever was between the limits of variation named—the armature would be suspended by the adhesion of the second electro-magnet; but if the level rose or fell beyond those points, the armature, from the current being broken, must fall. In either case, a small tappet fixed to the armature below the gudgeon touches an alarm lever and thus rings a bell. This arrangement is also serviceable in other respects. The alarm bell rings when the feed-pump is out of order; when the electric pile ceases to act; if the stoker neglects the fire; or if steam is generated too rapidly. The reader proceeded to point out the application of the "Embrayage Electrique" to the prevention of railway accidents by connecting it with brakes upon the wheels of the engines and carriages, and certainly gave some very practical illustrations of its value and efficacy in this respect. In France it is extensively used, and testimonials in its favour from many eminent scientific men were, together with the apparatus, submitted to the meeting. It was also stated that the apparatus might be seen daily in action at the works of Mr. Cater, engineer, &c., Grove, Southwark; also at Messrs. Simpson's, Little Britain, City.

VISIT OF THE INSTITUTION OF MECHANICAL ENGINEERS
TO CREWE.

In connection with the annual meeting of the Institution of Mechanical Engineers, held this year at Liverpool, a series of visits have been paid to several engineering establishments, or other places of interest in the neighbourhood; amongst others, the large engine works belonging to the London and North-Western Railway Company, at Crewe, were, on the invitation of Mr. John Ramsbottom, the locomotive superintendent of the line, visited by about one hundred and fifty of the members, on Friday, the 7th of August last. They were conveyed by a special train, kindly placed at their disposal by the directors of the line, from the Lime-street Station in the first place, to Parkside, about seventeen miles from Liverpool, to examine Mr. Ramsbottom's patent apparatus, which has been laid down near that station, for supplying with water the tenders of locomotive engines whilst in motion. It will be remembered that a working model of this apparatus was exhibited in the International Exhibition of last year, where it attracted considerable attention. A Plate Illustration and detailed description of the apparatus having already appeared in *THE ARTIZAN* (July, 1863), it will only be necessary here to remind our readers that it consists of a dip pipe or scoop attached to the bottom of the tender, with its lower end curved forward, and dipping into the water, contained in an open trough lying longitudinally between the lines of rails, at about the rail level, so as to scoop the water, and deliver it into the tender tank while running. On the arrival of the train at Parkside, the engine, which was fitted with the dip pipe and gearing, was run several times over the trough, in order that the members might, either on the tender or on the line, witness the apparatus in action.

From Parkside the train proceeded to Crewe, arriving there about noon. These works consist principally of a rolling mill for the manufacture of permanent way rails, and engine works for the manufacture and repair of the locomotive stock of the line. The latter, first opened in the year 1843, in connection with the then Grand Junction Line, have been extended from time to time, to meet the requirements of the traffic, until, with the rolling mill, they now cover upwards of 17 acres of ground, not less than 30,000 square yards of this being taken up by covered or workshop area alone.

The visitors were first conducted by Mr. Ramsbottom and Mr. Webb, his assistant, to the rolling mill, where the operation of rail making was seen in all its stages, from the crude pig iron to the finished rail, a number of rails being also rolled in 2 ft. lengths from solid ingots of Bessemer steel. The visitors were also shown a collection of specimens of steel rails made at these works, which had been rolled, in some cases, from the solid ingot, and in others from the ordinary pile, the body being composed of iron and the top and bottom slabs of steel, the slabs being rolled down, either from the ingot or from the crop ends of steel rails. These specimens, from the fineness of the grain and the excellence of the weld between the steel and iron, were much admired. It may be noticed here, as a proof of the superiority of the steel rail, that near the Crewe station several lengths of iron rails were replaced about two years ago by others of steel, which are, at present, but slightly worn, whereas the original iron ones had to be renewed about every twelve months, both webs being worn out.

The tilt hammer forge and mill rolls are driven by a pair of Boulton and Watt's horizontal engines of 150 nominal horse-power.

There are, altogether, twenty-three furnaces, the yield of finished rails being nearly 15,000 tons per annum.

Leaving the rolling mills, the engine works were next visited, commencing with the forge, where the engine tyres, axles, and heavier forgings, such as wheel spokes, rim pieces, coupling and connecting rods, together with fire-box roof stays and portions of the motion are forged ready for the smith to finish.

Adjoining the forge is the scrapyard, where a couple of shearing machines cut the scrap into convenient lengths for "piling," which is done by a number of boys in the forge, the scrap having previously passed through the cleaning machine, consisting of a revolving cylinder, into which the scrap is thrown. The pile is afterwards drawn down, faggoted, and worked up in the usual manner.

We here notice the method of welding the wheel-spokes—required for the solid wrought iron wheels—to the rim pieces. The spoke already hammered to shape, and the outer end heated to a welding heat, is dropped between a pair of dies placed under the hammer in lieu of the usual anvil block, and held in a vertical position, with the heated end projecting about an inch past the face of the dies. On this, the rim piece, also heated, is laid, the two being welded firmly together, and dressed on the edges and rim in a few blows. Of the grate bars used in the locomotive fire-boxes about 800 tons are used per annum; and for rolling this and the smaller sections of bar-iron there is a 10 in. train rolling mill, driven by a double cylinder horizontal engine, built locomotive fashion, with longitudinal

frames of cast iron carrying the crank shaft, and between which the cylinders are bolted, the whole resting on a stone foundation.

There are twelve furnaces in the forge arranged in pairs, the waste heat being economised by vertical boilers fixed between them. These boilers, which are fitted for smoke burning, are very simple in arrangement, consisting merely of a cylindrical shell with round ends, surrounded with a casing of brickwork, between which and the boiler the flame passes, the chimney being carried at the top of the brickwork shell.

Passing on to the smithy, the attention of the visitors was especially directed to the method of forging the solid wrought iron wheels. The spokes, with their attached portion of the rim, the forging of which we have already noticed, are here welded together at the butt ends to form the boss, in such a manner as will form a segment of the intended wheels. These segments are then laid together, a hoop passed round the rim, the whole tightened up, and the welding of the boss centre completed, thus forming one solid mass, independent of any further operation. The boss which, from the ridge shape of the butt end of the spokes, is dished on each side, is then heated and laid on the anvil of a steam hammer. A disc, or boss-plate, also heated, being laid on the boss, is first struck by the hammer (the head of which is of small diameter), on the centre, so as to curl up the edges, and allow the scoria to be driven out, and then hammered round the edge by a number of rapid blows, the wheel being turned round on the anvil for that purpose, the operation being repeated for the other face of the boss; the whole is then dressed ready for the lathe.

The arrangement of the hammer, specially adapted for the purpose of "bossing," consists of a pair of cast iron girders, between which the steam cylinder is bolted. These girders are carried by cast iron columns at the ends, and are of sufficient span to allow of space round the anvil block for manipulating the wheel. The hammer weighs about 10 cwt., and is double acting.

A similar arrangement is used for welding the plates required for the locomotive frames. The circular hearths, used for bossing and heating the frame plates, are placed under the girder so that the wheel or plate can be lifted direct from the fire to the anvil. To the framing fire has been fitted a deflector, which can be raised or lowered at pleasure, consisting of a plate bent down the middle of its length to about a right angle, and lined with fire bricks. The ends of the plate to be welded are laid about 4 in. apart in the fire, and the deflector lowered; the flame rising from the fire strikes the inclined sides of the deflector, and is thrown back on the top surface of the framing plate, which is free from fuel, producing a welding heat in a very short time.

The forge and smithy have an area of about 5000 square yards. There are, altogether, 15 steam hammers, varying from 6 to 50 cwt., and over 100 smiths' hearths, about 20 of which are employed in wheel making alone. Some idea of the amount of work done may be gathered from the fact, that at present over 4000 tons of scrap iron, in addition to the ordinary merchant bars, are worked up annually.

The boiler shop, contiguous to the smithy and forge, was next visited. It consists of a main building, down the sides of which the boilers in course of erection, and the bending rolls, punching, shearing, and other machines, are arranged, the whole being traversed from end to end overhead by a travelling crane. The smiths' hearths, steam rivetting machine, and the tender tank shop occupy wings at each end, while in the adjoining yard are placed the plate heating furnace and bending blocks and in addition to the manufacture of tender tanks, ordinary repairs, and other work, over 120 locomotive boilers are turned out per annum from this department.

The travelling crane already referred to was the chief point of attraction, and was minutely examined by the visitors. It consists of transverse hollow or box girders of plate iron, at the ends of which are fixed the carrying wheels. The longitudinal roadway is made of the ordinary permanent way rail, carried by cast iron brackets bolted to the side walls, the crab running on rails rivetted on the top web of the transverse girders. The method of driving is an arrangement of Mr. Ramsbottom's, first adopted in this crane, but which he has since carried out to a greater extent in other parts of the works. It consists of an endless cotton cord of small diameter, and very light, driven at a high velocity, and running down the ship on grooved slippers or guides, pulleys being dispensed with. From this cord, which in its course is carried across the traverser, all the motions are taken. Attached to the crab, and under the control of the attendant, is a sliding bar carrying two pulleys, between which the cord runs; by this means he is enabled to deflect the cord, and press it into grooves cut in the edge of a horizontal wheel, the motion thus communicated being afterwards reduced through a train of worm and spur wheels to the chain barrel. The reverse movement is obtained when the cord is applied on the opposite side of the wheel, and a second, or quick speed, by means of another groove of less diameter cut in the same wheel. The cross and longitudinal motions are worked in a similar manner. This crane lifts a weight of 6 tons at the rate of 4 ft. 6 in., while moving across and down the shop, at the rate of 50 ft. per minute.

Passing on to the fitting and turning shop, the various details of locomotive work were seen in process of manufacture, from the forged to the finished state, there being nearly 200 machines of all descriptions, from the small bolt lathe or nut-cutting engine to the cylinder boring mill. The engine cylinders are here bored in pairs, the different machines being so arranged as to be within the range of a wrought iron jib crane placed near them. After planing, the cylinders are removed to a template, consisting of a base plate carrying cast iron standards, between which the cylinders are dropped, the bolt holes in the cylinder flanges being marked off corresponding holes in the standards, such accuracy of work being thus obtained as to allow of damaged cylinders being replaced by others in a finished state, without any additional fitting, and which has been done in several instances. After the bolt holes have been marked and drilled, the cylinders are fitted with steam chest covers, glands, &c., and bolted together. The lifting and moving about of the cylinders in this stage of the work is effected by means of a long shaft overhead, from which chains are suspended at the different points required, the cylinder or other object being raised or lowered by the revolution of the shaft, which can be started or stopped at pleasure. We notice this as a good example of a cheap and serviceable crane, where power is applied at different points.

This shop is also fitted with a number of auxiliary tools, specially designed by Mr. Ramsbottom for these works; amongst others we remarked a machine for squaring bolt holes in cylinder covers, pipe flanges, glands, &c. This machine, which is simple in arrangement, consists merely of an upright girder, to which is bolted a long socket. In this socket slides a vertical forcing ram, with the end recessed to receive the point of a taper-toothed drift, the entering end of which fits the hole to be squared. The cover flange, or other object, is carried by a table bolted to the upright. The machine is driven in the usual way, and forces the drift through at one stroke of the ram.

The short copper bolts used to stay together the inner and outer shells of locomotive fire-boxes, after being cut to length in the boiler shop, are here straightened and centred at each end. The tool used for this purpose consists of three rollers, one of which is movable on an eccentric spindle, so as to allow of the bolt being dropped in between them, when the movable roller forces it into contact with the other two, while a pair of square centres are simultaneously brought to bear on the ends. The stay thus straightened and centred is dropped out underneath, and is found sufficiently true to allow of its being chased in the lathe without further preparation.

Several other tools, which our space does not admit us to describe, also attracted the attention of the visitors, who minutely examined them, and other features of interest in this department.

Leaving the fitting shop, and passing in the adjoining yard the tyre furnace and bending mill, the spring smithy, which is fitted with furnace and machinery for the manufacture of the locomotive engine and other springs used by this department, was next visited.

The steel from which the engine springs are made is received in long bars, which are first cut by a small shearing machine into plates of the required length. The centre of the plate being then heated, is indented by a conically pointed punch fitted to the same machine, a nipple or projection being thus formed on the under side; the ends are then heated and passed between eccentric rolls, which, at each revolution, strike the plate and taper it down. The ragged ends are afterwards cut off. The nipple referred to, dropping into an adjustable stop attached to the machine, serves as a guide for the length. The plates are then bent to shape, hardened, and tempered down in the usual manner, built up into the complete spring, and the buckle shrunk on, the plates being prevented from moving endways by the nipple of one plate fitting into the corresponding recess of the one below it, which thus dispenses with a centre bolt and the consequent weakening of the plates. It appears that during the past twelve months, in order to supply the new engines and keep up the repairs, upwards of 10,000 springs of all kinds have been manufactured.

The erecting shop, next visited, is about 240ft. long by 80ft. wide, and is capable of accommodating 24 of the largest class of engines. It is divided into two bays by a row of cast iron columns down the centre, the engines in course of erection standing on four lines running the length of the shop. Four excellent travelling cranes, made by Moore, of Liverpool, are here fitted; they run on cast iron girders carried by the side walls of the building and the columns in the centre, and are driven by an endless rope moving at a low velocity, and carried along the walls by guide pulleys, the motion being transmitted through friction wheels and cross shafts to the traverser and crab. Each crane lifts a weight of 20 tons 1ft. 6in., and moves it along and across the shop at the rate of 30ft. per minute.

This shop has been fitted with several portable tools designed by Mr. Ramsbottom, for the purpose of boring cylinders, dressing the steam port faces, and axle-box girders, when worn. These machines are driven by cords off the line of shafting moving down the centre of the shop, and are so arranged that all the operations may be performed without moving the engine from its berth, or in any way disturbing the parts to be acted on.

The steam port facing machine consists of a bed plate carrying a pair of disc wheels, to which the scraping tool is bolted, and driven by a centre screw acting simultaneously on both wheels; the feed motion being self-acting, and the whole so arranged that it can be introduced into the narrowest steam chest.

The hornblock dressing machine is similar in construction and in the method of driving, but is made long enough to reach across the engine, so that each block can be dressed at the same time.

The cylinder boring machine consists of the ordinary boring bar, to which the boring head is keyed fast and driven by worm wheels. The driving pulleys are made in two halves, so as to be applied at any point in the length of the line of shafting.

Adjoining the erecting shop, and running its full length, is a building about 40ft. wide, where the frame plates are slotted and drilled, six plates being cramped together and laid on the machine at the same time. The splashers and handrail are likewise finished in the same way, ready for the erector.

The locomotive boilers are tried in a yard lying between the erecting and wheel-turning shops, one end of the yard being used in connection with the foundry, and the other as a store yard for spare wheels and axles.

The wheel-turning shop is fitted throughout with the heaviest class of lathes, slotting and drilling machines, required in the finishing of wheels, axles, and tyres, to which work this shop is exclusively devoted.

The machines are arranged along each side of the shop, the centre space being reserved for the stowage of the wheels, axles, &c., in progress; and a pair of travelling jib cranes running on single rails, bolted to the floor, supply the necessary lifting power. These cranes consist simply of box girders of plate-iron forming the base, and carrying a strong cast-iron pillar, round which the jib, with its attached lifting gear, revolves. Mr. Ramsbottom has carried out the system previously noticed, when speaking of the boiler shop crane, of driving by means of a light cotton cord running at a high velocity; the constructive details, however, present different characteristics. The crane pillar is guided at the top by rolled iron girders of a double T or trough section, carried on edge from the roof, the motion of the cord being transmitted by a vertical spindle passing down the centre of the crane pillar. From this spindle the lifting, lowering, and transverse motions are taken by means of friction cones, worm, and spur gearing, the whole running on a pair of wheels, carried at the ends of the hollow girder forming the base. Each crane is capable of lifting a weight of four tons at the rate of 6ft. per minute, and traversing 40ft. in the same time.

The repairing shops which adjoin the wheel shop have a total area of 5800 square yards, and afford standing room for upwards of 70 large engines. The smaller of the two shops is fitted with four 15-ton travelling cranes, made by Moore, of Liverpool, and worked by hand from the floor by means of chains working in grooved wheels. The larger shop is at present being fitted with four travelling cranes, each capable of lifting 20 tons. Two of these cranes have been finished, and were seen in operation; the others were in progress, and it was expected would soon be in their places. These cranes run on longitudinal girders, in a similar manner to those in the erecting shop; and Mr. Ramsbottom has carried out in them the cord system. The details of the arrangements are, however, different; the cord being guided across the traverser, and returning in nearly the same vertical plane, the motion of the pulley, which is double grooved, being reversed when either the upper or under cord, as the case may require, is pressed into the corresponding groove.

The erecting and preparing shops turn out per annum about 100 new engines, and keep in repair the greater part of the stock, which at present exceeds 11,000 engines.

Our limited space does not allow us to describe, the tender, joiner, and pattern shops, situated in another part of the works.

The town and works are supplied with gas, made at the Company's Gas Works.

In order more effectively to knit together these works, which spread over a great surface, a tramway has been laid down at 1' 6" gauge since May, 1862, for the purpose of carrying stores and material of all kinds from one part of the works to another, together with the various parts of the engines being built or under repair.

The tramway is now about $\frac{3}{4}$ ths of a mile long, and is worked by a small locomotive engine, named "Tiney." In its course it traverses curves of 15ft. radius each, no difficulty being found in going round these curves, with loads of 12 to 15 tons, or in taking 7' 6" wheel forgings or tyres on edge, by means of trucks specially adapted for the purpose. This engine has four wheels coupled, inside cylinders $4\frac{1}{2}$ diameter, and 6' in stroke; the wheels are 15in. in diameter on a base of 3ft. The total heating surface is about 42 square feet; the boiler is fitted with a No. 2 Giffard's injector, and carries a saddle tank capable of holding 28 gallons. The total weight, in working order, is $2\frac{1}{2}$ tons. The line is in most cases parallel to the ordinary rails in the works, and the engine is used to fly-shunt the large waggons in all cases where it can be brought to bear.

REVIEWS AND NOTICES OF NEW BOOKS.

L'Art Naval a l'Exposition Universelle de Londres de 1862; Description et Discussion de tout ce que l'Exposition présentait de plus remarquable dans la Marine. Par le Contre Amiral PARIS, C.B., &c. Large 8vo., 350 pp., with 20 engraved Plates, in separate cover. Paris: Arthus Bertrand, 21, Rue Hantefeuille.

Although it is now more than a year since the International Exhibition was closed, the memoirs devoted to some of the more special features in its contents are only now appearing. The work—the subject of this notice—treating upon the contents of Class XII., written by Admiral Paris, of the Imperial French Navy, has just been published, as above.

When so able a man as Admiral Paris addresses himself to any subject, the natural expectation is that the result of his labours will be highly useful to the class to which his work is dedicated. In the works previously published by the same author, a vast amount of not only novel, but useful and thoroughly practical and exact information was comprised within reasonable limits; and on the present occasion he has succeeded in the highest degree in rendering both complete and interesting subjects of the greatest importance to maritime nations. How successfully Admiral Paris has accomplished the task which he undertook can only be ascertained by a perusal of the book itself.

The first part treats of the different constructions of ships of war, and the various types employed, giving a short historical sketch of various periods of transition, and the changes effected; and he devotes a large portion of the first division of his book to iron-plated ships and iron constructions. He has treated the latter part of the subject admirably—indeed, in such a manner as only a highly scientific naval officer, of great experience in steam, combined with practical seamanship, could do; and we doubt if any officer in our service could have treated the subject equally well.

The second part of the book is devoted to a description of the various engines, machines, and works in connection with naval architecture, which were exhibited in the International Exhibition of last year. The various articles contained in Class XII. are critically described, and the several interesting chapters devoted thereto are worthy of being translated into English and re-published; and this, we trust, will be done. Accompanying the text are 20 large plates, executed in an admirable manner, and illustrating with fidelity the several subjects.

We recommend Admiral Paris's highly valuable work to the officers of the Royal Navy, as well as to engineers and others; and to every one who felt an interest in Class XII. of the Exhibition of 1862, Admiral Paris's book will supply the only really useful record which is available for scientific and technical reference.

We regret that, from the late period at which we received the book, it is impossible for us to render it ample justice by now reviewing it at length; but we hope next month to be able to give a more extended notice of its contents.

A Treatise on Parabolic Construction of Ships, and other Marine Engineering Subjects. By J. W. NYSTROM, C.E. Philadelphia: J. B. Lippincott and Co. London: Trübner. 1863.

We have, in previous numbers, given Mr. Nystrom's views somewhat at length (see pp. 102–105, ARTIZAN); and we cannot do better than refer our readers to the book itself for further information.

A Manual on Earthwork. By ALEX. J. S. GRAHAM, C.E. London: Lockwood and Co. 1863.

An excellent book, appropriately dedicated to Mr. R. P. Brereton, the successor to the business of the late Mr. Brunel.

As a really handy book for reference we know of no work equal to it; and the railway engineers and others employed in the measurement and calculation of earthwork will find a great amount of practical information very admirably arranged, and available for general or rough estimates, as well as for the more exact calculations required in the engineers' contractor's offices. The *Manual* could not have appeared more opportunely than at this time.

Pocket-book of Mechanics and Engineering; containing a Memorandum of Facts and Practice and Theory. By JOHN W. NYSTROM, C.E. Philadelphia: J. B. Lippincott and Co.; London: Trübner and Co. 1864.

We have just received the eighth edition of this excellent Pocket-book. On previous occasions we have expressed so high an opinion of the book that we can but repeat the praise so deservedly bestowed.

In this edition, Mr. Nystrom has added several pages of new matter, and much that is original. Many of the errors which were unnoticed in previous editions have been corrected, and, on the whole, it may be said Mr. Nystrom's Pocket-book contains a great deal that cannot be found elsewhere. The high estimation in which it is held amongst practical men is an evidence of its usefulness.

Treatise on Mills and Millwork. Part II. "On Machinery of Transmission and the Construction and Arrangement of Mills." By W. FAIRBAIRN, Esq., C.E., LL.D., F.R.S., F.G.S. London: Longmans. 1863.

As a further instalment of the promised series, Dr. Fairbairn has given us a useful collection of treatises on wheels, shafts, and couplings, engaging and disengaging gear, and on mill architecture. In the portion of the work devoted to corn, cotton, flax, silk, and woollen mills, will be found some useful examples of modern constructions. Added to these, there are descriptions of oil, paper, and powder mills, and a short account of the manufacture of iron—all useful in their way.

[We regret that other books received have come to hand too late to enable them to be noticed in the present number.]

NOTICES TO CORRESPONDENTS.

G. S. (Cardiff).—The following is a formula for ascertaining the speed of a screw ship in knots per hour, calculated from the velocity of the screw, and compiled from formulae given in Nystrom's *Pocket Book of Mechanics*, &c. :—

$$M = \sqrt[3]{\frac{81 D^3 n^3}{480,000 \Sigma}} (L \sin W + 0.110)$$

in which—

M = number of knots run by the vessel per hour.

D = diameter of screw.

n = number of revolutions of screw per minute.

L = length of blade parallel with centre line of propeller.

S = slip of screw.

W = angle of the blades at the periphery.

Σ = area of resistance (to vessel) in square feet.

We would also refer you to a "Table of Speeds of Screw Propellers in Knots and Statute Miles per Hour," given in THE ARTIZAN volume for 1856.

W. J. C.—We await the receipt of the promised particulars.

E. R. W.—The subject is in hand.

J. G. (Edinburgh).—We are glad to hear you have succeeded, and that we had hit upon the cause of your previous non-success.

G. B.—We have referred your inquiry to Professor Rankine, the author of the Paper to which you refer, and which was read at the late meeting of the British Association at Newcastle-on-Tyne. We will send you his reply.

VACUUM.—You will be able to obtain a fair vacuum from your air-pump by assuming a speed of not less than 90 and not exceeding 100 ft. per minute. A greater speed would, in our opinion, materially injure the vacuum. In general, a speed of the air-pump bucket half that of the steam piston will give a very good result. As regards the india rubber valve alluded to in your letter, the following proportions will be the best :—

Height of aperture = $\frac{2}{3}$ ths of diameter of air-pump.

Width of aperture = $\frac{1}{3}$ ths " "

Or else—

Area aperture : area of air-pump :: 54 : 229.

T. J., and other correspondents whose letters we have received since going to press, will, where possible, be answered through the post, or in our next issue.

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.

RAILWAY COMPENSATION CASE.—In the Lord Mayor's Court, on the 10th ult., before Mr. Russell Gurney, Q.C., the Recorder, and a special jury, Mr. Daffield, of Long-lane, Smithfield, and Aldersgate-street, whose repository is about to be removed to make way for the Smithfield extension of the Metropolitan Railway, claimed the sum of £13,000 as compensation for the leases, removal, depreciation of stock, loss of trade, and the consequent injury that would accrue to his business. The evidence was of a very conflicting character. Ultimately the jury gave their award as follows:—£2250 in respect of the leases, £200 for the fixtures, £100 for removal, £900 for depreciation of stock, and £1200 for loss of trade, making a total compensation of £4950, or £3100 less than the amount claimed.

THE METROPOLITAN RAILWAY.—COMPENSATION CASE.—This case—Samuel v. the Metropolitan Railway—has been recently tried at the Sheriff's Court, Red Lion-square. The claim, as originally proposed, exceeded £18,000, and the company had offered £2000. The claim, as now submitted, was £7700. It appeared that Messrs. Samuel held an unexpired lease of their premises for 20 years, at £37 per year. It was further proved that property in the neighbourhood had increased in value in consequence of the many undertakings in progress. The Under-Sheriff stated that the question in this, as in other similar cases, was a fair compensation, and not to allow the parties to make a profit out of the company. The jury, after some deliberation, assessed the compensation at £2250.

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.

DRAINAGE OF AN IRISH LAKE.—A gentleman has performed a great drainage feat in the county of Roscommon. About five years ago he purchased an estate on which was a lake called Keoghville, covering 137 acres, with a depth of water varying from 5ft. to 16ft. Mr. Wallace made an arterial cut two and a half miles long connecting the lake with the river at Milltown Pass. This cut is 4ft. wide at bottom and 13ft. wide at top, and in some places 18 feet deep. For a mile it passes through solid rock, which had to be blasted. The result is that the lake has disappeared, and in its place is a large tract of rich alluvial soil, giving every promise of luxuriant vegetation.

A MAGNETIC MOUNTAIN has been discovered in Swedish Lapland, and the vein, which is several feet thick, promises to be one of the richest sources of natural magnets at present known. A natural magnet weighing 400lbs. has already been obtained, and larger ones may be expected. The extraordinary magnetism of this mountain suggests the question whether the magnetic pole of the earth must not be sought in Lapland rather than in Siberia.

THE CONTRACT FOR THE NEW INDIA AND FOREIGN OFFICES, to be erected by Mr. Scott, the architect, has been let to Messrs. Smith and Taylor, whose tender, £185,573, being the lowest, was accepted.

TRACTION ENGINES.—A public trial has been made at the Chatham Dockyard, of a new description of traction engine invented by Messrs. Aveling and Porter, of Rochester, which has been brought into use at the Dockyard for conveying the machinery and other heavy materials used in the improvements now in progress at the establishment to and from the Dockyard Works. Three of the engines, each having a heavy load attached, started from Messrs. Aveling and Porter's works, on the Strood side of Rochester-bridge. The first engine weighed 12 tons, and was one of several on the eve of being shipped to Kingston, Jamaica. Attached to the engine were two lorries, each containing three cast-iron girders, to be used in the works now in progress at the Dockyard. The united weight of the girders was 18 tons, and of the two trucks 5 tons. To the second engine were attached five empty lorries, each weighing 2½ tons, and constructed to carry 7 tons each. The last engine had attached a large steam thrashing-machine, and some other agricultural machinery. The three engines with their loads started away over Rochester Bridge, and through the streets of the town towards the Dockyard, the speed varying from two to four miles an hour. The ascent of Star Hill, which has an incline of 1 in 12, was made by all three engines, with their respective loads, without the least apparent difficulty, and without any stoppage, the rate being two miles and a half per hour. In the passage through the crowded streets of Chatham to the Dockyard no inconvenience whatever was experienced, the engines adapting themselves to every variety of road, and travelling with a uniform rate of speed. Attached to one of the engines is an appliance for loading and unloading heavy weights, and on the train of trucks being stopped the engine was detached and brought round to the trucks conveying the girders, when, by means of the lifting apparatus, the latter were lifted from the lorries and deposited in the spot selected for them. Each of the engines started from the factory with a stock of 10cwt. of coals, which is sufficient for eight hours' consumption. The trials were pronounced in all respects satisfactory.

THE POPULATION OF THE GLOBE.—A professor of the University of Berlin has recently published the result of his researches as to the population of the earth, according to which Europe contains 272 millions; Asia, 730 millions; Africa, 89 millions; America, 200 millions; and Polynesia, 2 millions—making a grand total of 1283 millions of inhabitants. As in places where deaths are accurately registered the annual mortality is at least 1 in 40, the number of deaths must be about 33 millions every year, which gives 87,761 per day, 3653 per hour, and 61 per minute, so that every second witnesses the extinction of one human life. Another calculator states that the number of persons who have lived on the earth since the creation is 36,627,843,275,075,365!

IRON STREETS.—A project has been broached in New York for paving the streets with iron, and conducting the traffic by steam carriages moving on these iron floors. It is urged that the saving to clothing, furniture, and goods, from damage by dust and mud would be enormous; that the resistance on clean iron floors would be small, the wear on carriages slight, and the noise but trifling in comparison with what it is at present. Shoes, it is represented, would wear much longer on iron-side walks than on stone.

ASSESSMENT OF RAILWAYS, GAS, AND WATER COMPANIES.—The recent decision in the Court of Queen's Bench upon the subject of rating railway and other companies, who either destroy rateable property, or occupy land and premises beneficially, have induced many of the metropolitan parishes entirely to revise their assessments in this particular. The assessment-rate and appeal committee of the parish of St. Pancras have, therefore, taken into consideration the subject in relation to the assessment of the London and North-Western, the Great Northern, the North London, the Midland, the Metropolitan and the Hampstead Junction Railways, now existing, or in course of progress in that parish; as also the Imperial and Chertsey Gas Company, the New River and West Middlesex Water Companies, the Electric Telegraph, and London Cemetery Companies; and they find that the assessment on the rate made on the 11th April of the present year was £63,936, a sum totally disproportionate to the amount of land and premises occupied beneficially, or of property destroyed, and they have therefore recommended to the representative vestry to increase the assessment upon these properties by a sum of

£30,542, or, in the aggregate, to the sum of £94,478. The recommendations of the report have all been adopted.

LIGHTNING CONDUCTORS.—The Bishops Waltham Clay Company have made a brick with a hole through a moulded portion of it, for the purpose of securing lightning conductors.

NEW MODE OF USING NAPHTHALINE.—Mr. Serbat has taken out a patent in Belgium, for using naphthaline pure or mixed, or in combination with other substances, for lubricating machinery. It is caused to enter either into substances prepared for lubricating purposes, or into natural oils, or greases, or artificial oils, by dissolving it in, or merely mixing it with them. 100 parts of naphthaline are mixed with from 10 to 25 parts of oil or greases and stirred; when the paste produced in this manner has become cold, it may be used for lubricating axles, shafts, bearings, or other mechanical organs. For lubricating spindles and other articles on which oil is usually applied, add from 5 to 20 parts of naphthaline to 100 parts of oil; heat the mixture in warm water until the naphthaline is dissolved, and then shake it until the mixture is cooled down. Such oils, mixed with naphthaline, are more unctuous, they last longer, and are consequently more economical than common oils.

INJURIOUS ACTION OF LEAD PIPES ON WATER.—A discovery has recently been made through which the water supplied by leaden pipes may be obtained by the consumer as pure as from the original source. Dr. H. Schwartz, of Breslau, has discovered a means by which the portion of the lead forming the interior surface of the pipe may be converted into an insoluble sulphide, the consequence being that the water passing through will be as free from impurity as if passed through glass. Dr. Schwartz effects this conversion by simply passing a strong solution of the sulphide of an alkali through the pipe to be acted upon, and the process is completed. This solution, which is either a sulphide of potassium or of sodium, is used at a temperature of about 212 degrees Fahrenheit, and is allowed to act on the metal from 10 to 15 minutes. It is stated that in practice the boiling solution of caustic soda and sulphur is found to answer every purpose.

THE "JANE," PATENT IRON-TANK SHIP, has arrived in the Mersey from Philadelphia, with a cargo of crude petroleum oil in bulk, belonging to the Liverpool and Romsey Oil Refining and Chemical Works Company (Limited). This is the first iron-tanked vessel with petroleum that has arrived in this country. The *Jane* was specially constructed for carrying oil from America to the company's works at Romsey, where it is discharged into hermetically sealed floating tanks, which are moored in the river. The vessel made the passage in twenty days.

NAVAL ENGINEERING.

THE "SCYLIA," screw corvette, 1467 tons, 400 horse-power, underwent her trial trip at the measured mile off Maplin Sands on the 25th ult. The vessel made six runs at the measured mile with full boiler power, and attained an average speed of 10·837 knots, with a draft of water 17ft. forward, and 19ft. aft. The revolutions of the engines were 57, pressure of steam, 20lb., and vacuum, 24. Two runs were also made with half boiler power, giving a result of 9·092 knots per hour, revolutions, 45, pressure of steam, 20lb., vacuum, 24. There was a slight force of wind from S.S.W., and water smooth. The circle was turned at full boiler power, with helm port, 21 degrees, in 4 min. 55 sec., the diameter of circle being 405ft.; at half boiler power, with helm starboard, 38 degrees, in 5 min. 30 sec., diameter, 419ft. Messrs. John Penn and Son are the builders of the engines, which are fitted with Smith's screw propeller, diameter, 18ft., pitch, 3ft. 6in., length, 3ft. The trial was considered very satisfactory.

THE "PRINCE CONSORT" was laid down at Pembroke as a line-of-battle ship on the same lines as the *Gibraltar*; but was afterwards cut in two, lengthened 23ft., and, like the *Ocean*, reduced to a two-decker. She was first called the *Triumph*, but this name was altered to the *Prince Consort*. Her launch took place in June, 1862. The dimensions are:—Length over all, 277ft.; length between perpendiculars, 273ft.; keel for tonnage, 232ft. 3½in.; breadth extreme, 53ft. 6in.; ditto for tonnage, 57ft. 2in.; ditto moulded, 56ft. 4in.; depth of hold, 19ft. 10in.; tonnage, 4045 28-94 tons; ditto Board of Trade, 3621·34 tons; tonnage of engine room, 1913·73 tons; ditto register, 1607·6 tons; displacement when light, 2924 tons; ditto estimated when loaded, 6328 tons; estimated draught when loaded, 23ft. 7in. forward, 25ft. 2in. aft. Her draught, when launched, was 12ft. 11in. forward, 16ft. 10in. aft.; mean draught, 14ft. 10½in. The engines collectively of 1000 horse-power (nominal) are from the manufactory of Messrs. Maudslays, Sons, and Field, and are seated 15ft. before the mainmast; they are termed "horizontal double piston rod." The horizontal double action air-pump is worked direct from the engine. Each of the engines fitted with box slides; they are worked by double eccentric and link motion, and are provided with metallic slide valves. The air-pump valves are of india-rubber, with metallic valves to discharge through the sides of the ship. The air-pumps are 29in. in diameter, and have a 4ft. stroke. The inside diameter of the steam cylinders is 92in.; they are steam jacketed. The diameter of the main steam pipes is 23in. The pistons are fitted with metallic packing, and not with hemp as heretofore. There are also in the engine-room two small auxiliary engines of 12in. diameter. Each of these is fitted with a pump for filling boilers from the sea; together they are capable of supplying the requisite amount of water when the main engines are working full boiler power. She has in addition a double 7in. pump, which can be worked by hand or steam, capable of supplying a sufficient quantity of water for working half-boiler power, and arranged so as to pump on deck or overboard, and to draw water from the bilges or the sea. The eight boilers contain 3840 tubes, each of which is 6ft. long by 2½in. outer diameter, and 2½in. inner diameter. By the fore boilers the power of 600 horses (nominal) can be obtained, and by the other 4000 horses, calculated at 7½lbs. effective pressure per square inch. The gun metal screw propeller is four bladed; it weighs about 15½ tons, and overhangs, or rather, has no outer bearings. The diameter is 21ft., and the pitch, on Maudslay's principle, can be altered from 20ft. to 25ft. mean pitch. The stern bracket is surfaced up, and the boss of the screw is surfaced also; the machinery is arranged so that the screw-shaft can be carried forward to close the opening entirely where the two surfaces meet. The *Prince Consort's* screw shaft is fitted with a disconnecting clutch and friction brake, by which, when the ship is under canvas only, the screw will be allowed to revolve freely in the water. The brake can be used when it is necessary to stop the screw, and reconnect it with the engines for the purpose of resorting to steam. In the fore stroke-hole there is a spare blade for use in case of accident; like the others its flange is perforated with slotted holes for the reception of the screws which fasten it to the boss. The blades are twisted slightly, and become much thinned towards the outer ends. The engines and machinery weigh 750 tons; the cost is about £50,500, and the manufacturer obtains in addition £1 per horse power (£1000) for placing them on board. The contractors' trial of the engines of this iron-plated screw steamship took place on the 24th ult., outside Plymouth breakwater, and proved completely successful. The mean speed of the six runs at the measured mile was 13·132 knots an hour; the revolutions of the engines were 56½ per minute. On the 14th ult. the *Prince Consort* completed the last of the series of trial trips. The result of four runs at the measured mile gave a mean speed of 12·093 knots; mean revolutions 50½. With two large boilers forward, estimated at 300 horse-power, the mean speed was 9·427; revolutions 40. With four small boilers aft, estimated at 400 horse-power, the speed was 10·33 knots; revolutions 43½; and with two small boilers aft (200 horse-power), the speed attained was 7·94; revolutions 33.

A NEW FRIGATE, CALLED THE "BELLEROPHON," is to be built at Chatham, from the plans of Mr. Reed, which will eclipse anything that has preceded her in the shape of iron

ships. The trial target, which is now under construction, is formed of 10in. iron frames, about 2ft. apart, covered first with iron nearly 2in. thick, then with teak 12in. in thickness, and finally with 6in. armour plating; and should they be found to succeed on the occasion of the trial, the *Bellerophon* will be covered in exactly the same manner from stern to stern. Her engines will be of the most powerful description, to steam at least 14 knots per hour, and this, coupled with her enormous strength, and her shot-resisting power, will render her by far the most formidable of the iron vessels yet constructed.

THE FRENCH STEAM RAM "MAGENTA."—The *Opinion Nationale* gives the following description of this new steam ram. She is higher out of the water at the bows than the stern; her masts are short and thick, and the bows culminate in a gigantic spar or ploughshare. The upper deck is flush, and with the exception of two bow chasers, there are no guns upon it; close to the smoke pipe is a shot proof turret, whence orders can be communicated to every part of the ship. In action the crew are all below, and the captain, his signal officers, and a few picked marksmen occupy the turret. The *Magenta* has two gun decks, each armed with 24 breech-loading guns, throwing a 60lb. shot. All the guns are protected by iron plates, but the iron casing stops short at the bows and stern. The engines (1000 horse-power nominal), can be worked up to 2700. Her speed on an even keel is from 13 to 14 knots, and her consumption of coal 130 tons per day. Her length over all is about 285ft.; extreme breadth about 57ft.; her displacement 6000 to 7000 tons.

NAVAL APPOINTMENTS.—The following appointments have been made since our last:—W. Anderson, Chief Engineer, to the *Asia*, for the *Odin*; T. H. Dawkins, Acting Engineer, to the *Asia*, as supernumerary; W. F. Innes, Engineer, to the *Dawntless*, for the *Tender*; R. Harris, Engineer, and F. Pugh, W. McNaught, and G. T. Stronach, Assist. Engineers, to the *Medusa*; W. H. Brimfield, of the *Wye*, confirmed as First-class Assist. Engineer; W. H. Harker, of the *Topaze*, promoted to Acting First-class Assist. Engineer; F. Stow, Chief Engineer, to the *Indus*, for special service; H. Brown, Chief Engineer, to the *Challenger*; J. Davis, Chief Engineer, to the *Lily*; S. H. Dawkins, Acting Engineer, A. J. Tront, J. D. Lamont, M. Baird, R. Young, and G. R. Beer, Assist. Engineers, to the *Nile*, as supernumeraries; T. F. Hill, Chief Engineer, to the *Flagard*, for the *Wolcerine*; J. Copplesstone, Assist. Engineer, to the *Indus*, for the *Constance*; G. Park, Chief Engineer, to the *Indus*, for the *London*; E. Barrett and J. Brand, Assist. Engineers, to the *Cumberland*, as supernumeraries; J. M'Lauren, in the *Cumberland*; E. Carling, in the *Indus*; M. M'Intyre, in the *Adventure*; A. B. Luckie, in the *Victoria*; and A. T. Pringle, in the *Wye*; W. Gentles, of the *Cumberland*, for the *Wildfire*; D. M'Vean, of the *Flagard*, for the *Bann*, and T. Spence, in the *Supply*, promoted to First-class Assist. Engineers; J. Bannatyne, in the *Centaur*, D. Storrar, in the *Cygnat*, D. M'Intyre, in the *Argus*, and R. Findlay, in the *Cormorant*, promoted to Acting First-class Assist. Engineers; T. T. Murray, Chief Engineer, to the *Gibraltar*; W. Stell, Chief Engineer, to the *Pelorus*; J. Gillies, Chief Engineer, to the *Scylla*; R. Anderson (a), Engineer, to the *Supply*; J. Snell, Engineer, to the *Scylla*; W. Skene, Engineer, to the *Gibraltar*; W. Maxwell, Engineer, to the *Asia*, for the *Earnest*; J. L. Davies, Engineer, to the *Indus*, for the *Delight*; F. W. Sutton (b), Engineer, to the *Indus*, for the *Royalist*; E. Taylor, Engineer, to the *Pelorus*; J. Annable, First-class Assist. Engineer, to the *Pelorus*; W. N. Sennett, Assist. Engineer, to the *Indus*, for the *Donegal*; J. Hopwood, Assist. Engineer, to the *Flagard*, as supernumerary; W. Bowen, Assist. Engineer, to the *Scylla*; R. J. Morman, Assist. Engineer, to the *Pelorus*; G. O. Wilson, Assist. Engineer, to the *Russell*; W. Pilcher, G. W. Robins, and W. F. Cole, Assist. Engineers, to the *Gibraltar*; B. F. Pine, promoted to be Chief Engineer. G. Glasson, Chief Engineer, to the *Liverpool*; J. A. H. Marcus, Assist. Engineer, to the *Asia*, as supernumerary; J. A. Lodge, Engineer, and J. King (a), and W. Hawksley, Assist. Engineers, to the *Flagard*, for the *Hydra*; A. Ritchie, in the *Dasher*, for the *Speedy*, and W. Landells, in the *Asia*, supernumeraries, promoted to First-class Assist. Engineers; B. G. Little, Assist. Engineer, to the *Flagard*, as supernumerary; R. H. East, Assist. Engineer, to the *Indus*, as supernumerary; T. Lumley, Chief Engineer, to the *Indus*, for the *Research*; J. D. Lamont, in the *Nile*, promoted to Engineer; A. Lowton, in the *Orlando*, promoted to First-class Assist. Engineer; H. W. Wilkins, W. E. Blackburn, and E. Bolton, Assist. Engineers, to the *Asia*, as supernumeraries; J. T. Stockington, Assist. Engineer, to the *Dawntless*, for the charge of the engines of the *Argus*; R. E. Chiswell, Assist. Engineer, to the *Dawntless*, for the *Argus*; J. W. Hawes, Assist. Engineer, to the *Colossus*; J. T. S. Flynn, Assist. Engineer, to the *Cumberland*, as supernumerary; G. Tyril, C. J. Cock, and W. G. M'Burney, Assist. Engineers, to the *Indus*, as supernumeraries.

THE "OSBORNE" paddlewheel steam yacht, went out of Portsmouth harbour, on the 17th ult., to Stokes Bay for a trial of her machinery and her new paddlewheels, under the superintendence of Commander Brett and other officials of the Steam Reserve. The trial was considered satisfactory.

THE STEAM FRIGATE "ARCTHUSA," 39 guns, 3141 tons, 500 horse-power, having undergone several important alterations in her machinery to enable her to work either by surface or injection condensation, or the two conjointly, was taken out of Sheerness Dockyard on an experimental trip of five hours on the 11th ult. During the trip the average revolutions of engines were 68 per minute; vacuum, 28lb.; and pressure of steam, 25lb. The trial was of a most satisfactory character.

THE "SNIPE," 5-screw steam gun vessel, 431 tons, 80 horse-power, recently underwent her final trial of machinery at the measured mile off Maplin Sands. The trial was pronounced highly satisfactory, the vessel's speed being 8.440 knots an hour, about a quarter of a knot greater than that of her sister ship the *Jaseur*.

THE "FREEDY," screw gun vessel, in commission for service at the Channel Islands, having undergone repairs to hull and machinery at Portsmouth, and received new boilers, was tested at the measured mile in Stokes' Bay on the 18th ult. She realised a mean speed of eight knots, and under high pressure slightly exceeded that rate. The machinery worked satisfactorily.

MILITARY ENGINEERING.

ENGLISH AND FRENCH METAL.—A third trial of French and English armour-plates took place at Portsmouth on the 2nd ult. The plates comprised four from the French firm of Petin, Gaudet, and Co., two of 4in. and the remaining two of 5in.; one from Messrs. John Brown and Co., of Sheffield, of 5in.; and one from the Millwall Company, of 5in., the average length of the whole being 15ft., and their breadth 3ft. 4in. Petin and Gaudet's two 4in. plates received six and seven shots respectively, and both proved to be of inferior quality. They had both very extensive cracks and separations of the metal, and showed cracks of a greater extent than has been done by the French made plates on any former trial. Messrs. Brown's plate and that of the Millwall may be considered about equal, and as the best by far of the six tested. The French plates proved to be far below the average of "A I" plates, and very inferior indeed to the two first plates which were tried at Portsmouth from the same firm. M. Gaudet, who was present during the trials, expressed his astonishment at the results as regarded his plates, and said that no such result had ever attended any trial of them in France.

THE ARMSTRONG.—At Fort Cumberland the Royal Marine Artillery, at Lumps Fort the Royal Artillery of the 6th Brigade; and on board her Majesty's ship *Excellent* the trained gunners, have been engaged in making a series of experimental rapid firing courses with shot and shell from the new "wedge" Armstrong 40 and 70 pounders. Similar experimental firing is taking place at other out-stations under competent officers, and each officer engaged in conducting the experiments will, at their close, forward his own report,

independently of all others, to headquarters. The guns now under trial are the most perfect form of the Armstrong breech-loader extant. The whole of the experimental firing has not yet been concluded with all the guns under trial, but it has proceeded sufficiently far to enable a correct judgment to be formed of the gun's power and its suitability for service on board ship. The 70-pounder wedge gun under trial concluded its course after firing 200 shot and 50 common shell (Armstrong, but not built in segments). The target was placed at 2000 yards' distance out on the Horse Shoal, seaward. The charge of powder used for the shot was 10lb. and for the shell 9lb.; the latter containing 8lb. of powder as a bursting charge. Two different targets were used for shot and shell, that for the latter being built up of nine inch oak plank, as the shells were fired with a pillar fuse, and therefore required a resisting object of some solidity to strike against to cause them to burst. The practice made throughout with this gun was very fine; 65 shots were fired in 47½ minutes, and the target was struck 36 times. This was the longest period of firing at one time to which the gun was subjected, for the "keybolt" gave out on several occasions, and the gun became disabled until the armourer had removed the pin, and repaired the damage. The Armstrong armourer stationed at Portsmouth being present, examined the bolt by Colonel Longdon's directions, and gave it as his opinion that it was made from a similar metal to the gun. He suggested that he should be allowed to make a new steel bolt. To this the colonel at once assented, and the new bolt was tried, and 64 shots were fired from the gun consecutively without any bursting up of the metal on the wedges, or any serious damage to the bolt beyond the indentations which might be expected on the side of so small a piece of metal. The firing from the 40-pounder, also under trial, is not yet concluded. One of the 70-pounder shells burst at the mouth of the gun, but that was the only instance of the kind throughout its firing, and no cause could be assigned for it. With all the accuracy exhibited by both the guns, there was a great eccentricity of movement observed in the after course of the shots, and the general opinion which has been formed thus far of the wedge gun is that it is not in its present state at all fit for sea service.

IMPROVED ORDNANCE.—A course of experiments is now in progress in the Royal Arsenal at Woolwich which promises important results. A 32-pounder cast iron service gun, strengthened on Capt. Palliser's plan, has been tested by firing a double-proof service charge of 38lb. of powder, and a cylinder gradually increased in size. The gun was fired upwards of 100 rounds without manifesting the slightest signs of giving way, and burst at the 107th round. The result is considered exceedingly favourable, and has been reported accordingly to the War Department. A number of cast iron service guns have been consequently placed at Capt. Palliser's disposal, to be bored and altered in accordance with his principle, and to be similarly tested at the Arsenal proof butt at Woolwich. Capt. Palliser, it appears, has for many years applied himself to the study of cast iron ordnance. His plan consists in removing a portion of the existing metal from the interior of the gun and inserting a combination of steel and iron tubes in such a manner as to relieve the outer cast iron case from all strain, whereby the gun acquires all the advantages of the present wrought iron ordnance. Capt. Palliser, it is understood, maintains the principle that steel and wrought iron tubes of limited thickness can be so inserted into cast iron skins or outer portions of the existing service guns as to relieve the structure from all strain, and that only a small portion of the gun is required to resist explosion, and the remaining portion being useful merely to prevent recoil. Several guns are being prepared on Capt. Palliser's plan.

STEAM SHIPPING.

TESTING OF A STEERING SCREW PROPELLER.—On the 8th and 9th ult. a series of interesting experiments was carried on at Sheerness by order of the Admiralty to test the value of a steering screw propeller applied to the *Charger* gunboat, the invention of Mr. W. J. Curtis, C.E. The peculiarity of this screw is that a ring forming an universal, or ball and socket joint, is placed within the hollow boss of the screw, which is thereby connected with the main shaft, the centre of gravity of the screw and the centre line of the rudder intersecting the centre line of the main shaft, so that the entire weight of the screw is borne by the shaft, and by means of the tail or spindle of the screw projecting from the boss working in the rudder, whatever may be the movement of the rudder, it communicates an equal movement to the screw, which therefore becomes not only the propelling but also the guiding power of the ship. Furthermore, by this invention the retarding action of the rudder and likewise the vibration are removed, while the speed of the vessel is increased. The *Charger* gunboat, having been handed over to Mr. Curtis for the purpose of making experiments, was taken for trial at the measured mile off Maplin Sands, the result being that the mean of the runs to and fro was 8.998 knots an hour, as contrasted with 7.751 knots obtained at Portsmouth previous to the vessel being placed in Mr. Curtis's hands; showing a gain of .531, or about half a mile, in favour of the steering screw, while the indicated horse power showed 113.30, against 145.25 obtained at Portsmouth. It was felt by those who witnessed the experiments that had the engines been in a more efficient working state the gain would have been still more considerable. On the following day a competitive trial of speed took place between the *Charger* and the *Spanker*, twin boats, having been built upon the same model and lines by the same builders, and each containing engines of 60 horse-power. The distance run was from a buoy off the *Formidable*, round the Nore Light and back, a total distance of about eight miles. In this distance the *Charger* beat the *Spanker* by 17 minutes, being 25 per cent. gain, or equivalent to about a mile and a half per hour, the whole run being made by the *Charger* in one hour and one minute. This gain is evidently obtained by avoiding the retarding effect of the rudder, as it was found that to keep the vessel in her course the helm never varied more than from 3 to 5 degrees. The full circle was made in 2 min. 40 sec., helm starboard 40 degrees, the diameter of the circle being 120ft., measured by a line paid out from the stern of the ship. The circle to port, helm 40 degrees, was made in 2 min. 30 sec., diameter the same, the length of the vessel being 115ft. By working the screw astern and putting the helm over 40 degrees, the vessel can be turned in about half the time above stated, and in a radius of only one-third its length, measuring from the screw itself. The screw can be applied in the dead wood of the ship, and lifted as in the ordinary way, so that the vessel may be governed either by the rudder or screw, or by both, at the option of the commander; also if found necessary or desirable, the rudder may control the movement of the vessel by the momentum after the engines are stopped.

THE ANTWERP STEAMER, THE "BARON OBY," whilst coming up Limehouse Reach, at low tide, on the 3rd ult., with 100 passengers on board, struck her bottom against the remains of an old anchor, and sustained such a serious rent, that she sunk almost immediately, leaving barely time to get out the passengers and luggage.

STEAM SHIPBUILDING ON THE CLYDE.—Messrs. Steele and Co., of Greenock, have launched a fine screw of 2000 tons, named the *Peruvian*, for Messrs. Allan's ocean line of steamers. Messrs. Blackwood and Gordon, of Port Glasgow, have launched a screw named the *Tuskar*. She is the second vessel of the same name, and has been built—to supply the place of the last *Tuskar*, which was sold some months back to a Spanish firm—for the Clyde Shipping Company, by whom she will be employed as a consort to the *Pladda* in the Cork, Waterford, and Glasgow trade. The dimensions of the new steamer are as follows:—Length of keel, 175ft.; breadth, 24ft. 6in.; depth (moulded), 14ft. Her burden is 525 tons, builders' measurement, and she is to be propelled by a pair of direct acting trunk engines of 100 horse-power, manufactured by the builders. Mr. J. G. Lawrie, of Whiteinch, has launched the *Otago*, a screw of 850 tons, built for the Intercolonial Royal Mail Steampacket Company. The *Otago*, which is intended to carry

the mails between Sydney and New Zealand, will be propelled by direct acting engines of 750 horse-power, supplied by Messrs. Blackwood and Gordon. Her length of keel and fore-rake is 234ft. 6in.; breadth of beam, 28ft. 9in.; depth of hold, 18ft. 6in. Among trial trips may be mentioned that of the *Fergus*, lately launched by Messrs. A. Stephen and Sons, of Kelvinhaugh, which in running down the river attained a speed of nearly 20½ miles per hour. This vessel was launched in 56 days from her keel being laid; her engines are by Messrs. Aitken and Co. The *Mariani*, a screw built by the Société Accélére d'Haiti, has also made a trial trip, at which she steamed at the rate of 12 miles per hour. She was built by Mr. T. B. Seath, of Rutherglen, and is 140ft. in length, 18ft. breadth of beam, and 10ft. deep. Her engines, which are of 50 horse-power nominal, have been supplied by Messrs. Campbell and Sons, of Glasgow.

THE "NORMANDY," new paddle-wheel steamer, built by Messrs. Ash, of Millwall, for the South-Western Railway Company, tested her machinery, which were manufactured by Mr. J. Stewart, Poplar, on the 3rd ult. During her trip to the Nore, her engines, which are of 225 nominal horse-power, were worked up to eight times that amount, or 1800 horse-power, and a speed of 17 knots per hour was obtained. Her draught of water was 8ft. 9in. forward, and 8ft. aft.

TRIAL OF THE "WO-KEE."—This fine screw steamer, built by Mr. Laing, of Sunderland, for the China and Japan trade, had her trial trip on the 9th ult., when she steamed on an average about 11 miles an hour. She was engine by Mr. John Key, Kirkcaldy; the engines of 80 horse-power, being those that were exhibited by him in the Exhibition of last year, and illustrated and described in THE ARTIZAN Exhibition Series, No. 6. Her engines averaged 86 revolutions a minute. The *Wo-Kee* is a vessel of 600 tons, builders' measurement. Her dimensions are:—Length over all, 185ft.; breadth, 26ft.; and depth, 15ft.

LAUNCHES.

LAUNCH OF AN AUSTRALIAN RIVER STEAMER.—On the 3rd ult. an iron screw steamer, named the *Nutfield*, was launched from the premises of the builders, Messrs. James Ash and Co., Poplar. After the launch the vessel was removed into dock to be fitted with her machinery and boilers, previous to being forwarded to her owners in Australia, where she will be used for river passenger traffic. The *Nutfield* is 1770 tons burden, length 215ft., and breadth 25ft. 6in.

THE "WOLVERENE," to carry an armament of 21 guns, has been launched from the shipbuilding yard at Woolwich. Her keel was laid down in the spring of 1859. Her principal dimensions are—length over all, 253ft. 1in.; length between perpendiculars, 235ft.; length of keel for tonnage, 196ft.; breadth extreme, 40ft. 9in.; ditto for tonnage, 40ft. 5in.; ditto moulded, 39ft. 9in.; depth in hold, 24ft. 5in.; burthen in tons, 1703 5-8; horse-power, 400. Her draught of water (when she had about 30 tons on board) was found to be 16ft. aft., and 9ft. forward. She will be brought forward for the first-class steam reserve.

LAUNCH OF THE "EL MOUNASSIR," IRON RAM.—We noticed in THE ARTIZAN of August the launching of an iron-plated steam ram, from Messrs. Laird Bros., Birkenhead; another of these vessels, named the *El Mounassir*, which may be translated as the *Victory*, was launched by this firm on the 29th August. The length of the vessel over all is about 230ft.; beam extreme, 42ft.; depth, 19ft. 6in.; tonnage, about 1850 tons, O.R.; power of engines, 350 horse power. The model of the vessel will combine speed with good seagoing qualities. The stem is formed so that the vessel may be used as a ram, and the stern is arranged so as to afford protection to the screw and the rudder from shot or collision. The rig will be that of a barque with long lower masts of iron; the lower yards are also of iron. The cylindrical cupola towers, on Captain Cowper Cole's patent, are to be fitted, one before and the other abaft the engine-room, cased with thick armour plates. The arm or plating of the sides of the vessel is 4½in. thick amidships, and rather less at the extreme ends. The plates are fitted on to a teak backing of great thickness. The deck of the vessel is also covered with iron plates.

THE "LAUREL" SCREW STEAMER, for the Glasgow and Londonderry Steam Packet Company, and intended to fill up the place of the well known *Thistle*, has been recently launched from the yard of Messrs. A. and J. Inglis, on the Clyde. Her dimensions are:—Length in keel and fore-rake, 185ft.; breadth moulded, 25ft.; depth moulded, 13ft.; and tonnage, 565 B.M. She will be propelled by a pair of piston-rod geared engines, the nominal horse-power being 140.

THE PADDLE STEAMER "ALEXANDRIA" was launched from the dockyard of Messrs. Laird Bros., Birkenhead, on the 15th ult. The following are her dimensions:—Length between perpendiculars, 222ft. 6in.; beam, 29ft.; depth, 16ft.; tonnage, 680 tons; engines (oscillating), 320 H.P.; her paddle-wheels are on the feathering principle. The vessel has been built for the London and North-Western Railway Company, for the cattle trade between Holyhead and Dublin. She has a hurricane deck extending from the fore-castle nearly as far aft as the forward sponson houses, and a deck house aft for passenger accommodation; so that the whole of the 'tween decks and lower holds are available for cattle, being fitted up with sloping stages leading down from the hatchways, for the cattle to walk into and out of the holds. The machinery, as well as the vessel, has been constructed by Messrs. Laird Brothers, and will be fitted on board in one of the docks at their works.

AT CORK A LARGE SCREW STEAMER was launched from the yard of Messrs. G. Robinson and Co., on the 14th ult. She has been built for Messrs. Malcolmson, Portlao, and Co., and is intended to trade between London and Oporto. Her proportions are 275ft. long; breadth of beam, 31ft.; depth of hold, 18ft.; and her burthen, 1200 tons, being the largest iron steamship ever built at Cork.

THE "SNACFELL," a steamer built by Messrs. Caird and Co. of Greenock, recently arrived at Douglas, Isle of Man, for service between that place and Liverpool. She is 225ft. in length, 26ft. beam, and draws 8ft. of water. The engines, constructed by the same firm, are of 250 horse-power. In a trial trip on the Clyde the *Snacfell* realised a speed of 17 miles per hour.

THE "HELEN SINCLAIR," a fine screw steamer, was launched on the 12th ult. from the yard of Messrs. J. Wigham and Co., Low Walker. The *Helen Sinclair* is the property of the London Chartered Gas Company, and is intended to form one of the line of screw colliers between the Tyne and London. Her dimensions are 190ft. long by 28ft. beam, and 17ft. depth of hold. Her engines will be supplied by Messrs. R. and W. Hawthorn, and will be of 90 nominal horse-power.

THE "NOLA," paddle steamer, was launched from the yard of Messrs. Caird and Co., on the Clyde, on the 12th ult. The *Nola* is of 750 tons, and measures 225ft. long, 25ft. broad, and 13½ft. deep. She will be fitted, by Messrs. Caird, with oscillating engines of 260 horse-power, with tubular boiler fitted before and abaft the engines.

THE "MARIA PIA" screw steamer of 513 tons, built by Messrs. J. Reid and Co., Port Glasgow, and belonging to the Lusitania Steam Packet Company, of Lisbon, was launched on the 12th ult. Her direct acting engines are of 120 horse-power, fitted with condensers, and will be supplied by Messrs. Macnab and Co., Shaw's Water Foundry.

TELEGRAPHIC ENGINEERING.

THE TELEGRAPH ACT.—The Act passed on the day of the prorogation to regulate the exercise of powers under special Acts for the construction and maintenance of telegraphs has been printed. It contains as many as 53 sections. Before a company proceeds to

place a telegraph over, along, or across a street, not being a street in the metropolis or in a city, or a public road, or to place posts, they are to publish a notice that they have got the consent of the body having the control of the street, and leave notice at the dwelling houses, and are not to place the telegraph until after 21 days' notice, during which time objections can be made to the Board of Trade. If any person in the employ of a company willfully or negligently omits or delays the transmission or delivery of any message, or improperly divulges to any person the purport of any message, he may for every such offence be liable to a penalty not exceeding £20. All messages on her Majesty's service are to have priority, and on the request of the Board of Trade a telegraph is by a company to be placed for the exclusive use of her Majesty. The Act further provides that in case of an emergency telegraphs may be taken possession of for her Majesty's service by a warrant from the Secretary of State. The warrant is only to be in force one week, but successive warrants may be issued. The Treasury in such case is to pay the company for the loss sustained. A company may be proceeded against by the law officers of the Crown on a certificate from the Board of Trade that any provision of the Act has not been complied with, or that compliance would be for the public advantage.

THE INDIAN TELEGRAPH CABLE.—The *Kirkham*, 1081 tons registry, with about 187 miles of this cable on board, left Gravesend, on the 11th ult., for the Persian Gulf, her precise destination being Bagdad. This is the second portion that has gone out, and the remaining lengths will be conveyed in three sailing vessels and a steamer. The entire length is upwards of 1200 miles, and the weight about 6000 tons.

THE MALTA AND ALEXANDRIA CABLE.—The *Hawthorne* arrived at the supposed place of the fault of this cable, about 61 miles from Alexandria, on the 10th of August, and, after creeping for five days across the line in which the cable was laid, a fragment of the cable, about half a mile in length, was picked up in 27 fathoms. The creeping was then repeated, and an end raised, which, on testing, was found to be in communication with Benghazi. Four more detached pieces of the cable were picked up, of about half a mile each in length, and on the 17th an end was found that was in perfect communication with Alexandria. A new piece of cable, about seven miles and a half long, was spliced in, and perfect communication restored throughout the whole line. In the short length of three miles that was actually picked up there was no less than ten faults, where the cable had been completely severed, evidently for some time. There are still about four miles of unconnected cable left at the bottom, but in what condition it is impossible to tell. Some 160 sponge-boats were found by the *Hawthorne* at work on the spot, and the inference is that their anchors cut up the cable, which at this part is a deep-sea cable of small diameter, two of the boats having been found with their anchors foul of it. The navigation and direction of the ship were entirely confided to Lieutenant Drew, who was present at the laying of the cable.

THE ATLANTIC TELEGRAPH COMPANY have raised the capital they required, and the directors have selected the tender of Messrs. Glass, Elliot, and Co., who undertake to lay the cable across the Atlantic before the end of the year 1864.

THE BAGDAD TELEGRAPH of the Ottoman Government is being continued by the English Government as a line to India, and there is every probability that next year the telegraph will be in operation through Constantinople and Bagdad from London to Persia, Calcutta, Bombay, Madras, Ceylon, and the frontiers of China. This will be the prelude of the through line of railway from London to India. The Imperial Government, finding that the telegraphic administration had fallen into a deplorable state, has removed the director general, appointed a new one, and restored order in the management.

RAILWAYS.

CONNECTING ALDERSHOT CAMP WITH LONDON.—The project for connecting Aldershot camp with London by a railway junction is now assuming a more definite form. According to the "preliminary prospectus" issued, the proposed line will be about 7½ miles in extent, commencing from the South-Western Railway between the Woking and Farnborough stations, proceeding by a direct route to Aldershot and thence to a point near to the Farnham station of the London and South-Western Railway Company. It can be connected also with the South-Eastern Railway at or near North Camp or Ash Church stations, whereby the whole of the military material and commissariat stores from Chatham, Woolwich, and the Tower will be conveyed direct to the Government stores by rail. The capital calculated as sufficient to complete the undertaking is £75,000, which it is proposed to raise in 7500 shares of £10 each.

TURKISH RAILWAYS.—The Smyrna and Aden Company has received the new firm for its extension to Aden, and is taking measures for its Bojiah branch. The Varna Railway is successfully launched, its capital obtained, and its arrangements are steadily proceeding.

A NEW RAILWAY.—A survey, it is understood, is now proceeding for the purpose of enabling the promoters to obtain parliamentary powers in the next session for the construction of a railway from the Brighton and South-Western on Wandsworth Common to Wimbledon Common, Kingston Vale, Norbiton, Petersham, Richmond Kew, and to join the North and South-Western at Brentford. The project, it is said, is earnestly supported by the National Rifle Association.

RAILWAY ROLLING STOCK.—The gradual increase in the rolling stock of the various railway companies is very striking. Thus the Bristol and Exeter, which had, at the close of 1861, 60 locomotives and 1173 carriages of various kinds, had advanced at the close of 1862 to 64 locomotives and 1229 carriages and trucks; the Great Eastern progressed from 329 engines, and 8604 and other carriages and trucks in 1861, to 330 engines and 8650 other carriages and trucks in 1862; the Great Northern from 338 engines and 10,122 carriages and trucks in 1861, to 338 engines and 10,167 carriages and trucks in 1862; the Great Western, from 443 engines and 10,424 carriages and trucks in 1861, to 504 engines and 11,591 carriages and trucks in 1862; the Lancashire and Yorkshire, from 363 engines and 11,897 carriages and trucks in 1861, to 370 engines and 11,954 carriages and trucks in 1862; the London and North-Western, from 972 engines and 21,233 carriages and trucks in 1861, to 1031 engines and 21,390 carriages and trucks in 1862; the London and South-Western, from 177 engines and 4616 carriages and trucks in 1861, to 177 engines 4921 carriages and trucks in 1862; the London, Brighton, and South Coast, from 145 engines and 3862 carriages and trucks in 1861, to 155 engines and 3899 carriages and trucks in 1862; the London, Chatham, and Dover, from 49 engines and 576 carriages and trucks in 1861, to 76 engines and 933 carriages and trucks in 1862; the Manchester, Sheffield, and Lincolnshire, from 133 engines and 4687 carriages and trucks in 1861, to 133 engines and 4703 carriages and trucks in 1862; the Midland, from 473 engines and 11,740 carriages and trucks in 1861, to 479 engines and 11,951 carriages and trucks in 1862; the North-Eastern, from 446 engines and 24,996 carriages and trucks in 1861 to 457 engines and 29,125 carriages and trucks in 1862; the North-London, from 66 engines and 2460 carriages and trucks in 1861, to 68 engines and 2592 carriages and trucks in 1862; the South-Eastern, from 189 engines and 3900 carriages and trucks in 1861, to 201 engines and 4179 carriages and trucks in 1862; the Stockton and Darlington, from 161 engines and 17,552 carriages and trucks in 1861, to 155 engines and 17,698 carriages and trucks in 1862; and the West Midland, from 105 engines and 3743 carriages and trucks in 1861, to 115 engines and 4232 carriages and trucks in 1862. The Scotch and Irish lines have, of course, developed their rolling stock to a corresponding extent.

RAILWAY REVENUE.—In the year ending December 31st, 1860, the railways of the United Kingdom acquired £26,743,602, 10,002 miles being in operation; in 1860 the receipts rose to £27,796,622, the number of miles at work being advanced to 10,433; in

1881 the earnings further increased to £23,565,355, the extent of effective lines being 10,865 miles; and in 1882 there was a further expansion to £29,123,558, produced by 11,551 miles. The progress effected in the last three years is £3,385,056, so that this is not a very improbable assertion. The working expenses of British railways do not appear to be proportionately reduced, the ratio to the rough receipts last year having been 49 per cent., as compared with 43 per cent. in 1881. Thus, while the profits of 1881 are returned at £14,691,286, in 1882 they only increased to £14,820,691.

THE LUDGATE-HILL VIADUCT.—The City Commission of Sewers have held a meeting, at which a design of the proposed railway viaduct across Ludgate-hill was submitted for approval by the solicitors to the London, Chatham, and Dover Railway Company, who had engaged to make the structure after a design to be sanctioned by the Commissioners. The Company propose to widen Ludgate-hill to the extent of 16ft., by setting back the houses that are on the south side of the hill, from about the Old Bailey to Bridge-street. The present width of the hill is 44ft. The alterations make it 60ft., with a carriage way 30ft. broad. The proposed viaduct would allow a clear headway of 18ft. for the carriage traffic, and have sides 8ft. high. It would be an iron structure, with a span of 60ft., and with ornamental brackets at each end, placed against the sides of the abutments, and leaving a head way for foot passengers of about 9ft. A great deal of surface ornamentation was shown on the sides, giving the appearance, at first sight, of an open perforated bridge; but it would have an interior lining to prevent the fall of burning cinders from the passing trains. Mr. Haywood, the engineer, took occasion to warn them that the structure, when erected, might fall short of the expectations formed from its appearance on paper.

RAILWAY ACCIDENTS

ACCIDENT ON THE WEST CORNWALL RAILWAY.—On August 31st, the train leaving Truro at a quarter past 7 o'clock, on arriving at Penwithers-bridge, about half a mile from the station, came in contact with a "trolley." The engine was thrown off the rails, and overturned in the centre of the bridge, which gave way. The engine tender and third-class carriage were then precipitated to the road beneath, a depth of from 16ft. to 20ft. Another third-class carriage rested upon those which had fallen, and thus checked the other carriages of the train, which at once came to a stand-still. The engine-driver was killed on the spot. The two third-class carriages were empty, and the passengers in the other carriages escaped injury.

COLLISION ON THE NORTH-EASTERN RAILWAY.—On the evening of the 7th ult. the Parliamentary train from York to Newcastle, which is due at 10.5, ran completely through a mineral train, consisting of 25 ironstone waggons, heavily laden, which, at the moment, happened to be passing over the very dangerous point where the Stockton and Darlington and North-Eastern—two of the busiest lines for mineral traffic in the kingdom—cross each other at right angles. Behind the engine and tender of the passenger train were three or four third-class carriages, all occupied. These were thrown off the line by the force of the concussion, and although greatly crushed, fortunately preserved their perpendicular. One of the waggons was carried on the buffers of the engine a distance of several yards, and acted as a powerful break. Another was pitched end over into a ditch close by; and a third fought, as it were, in the front rank of the mineral train with the passenger train for the right of way, and so caused the injury to the carriages. Fortunately no lives were lost.

ACCIDENT ON THE NORTH LONDON RAILWAY.—On the morning of the 12th ult. an accident occurred to a North London Railway train within a few yards of the Fenchurch-street station. The train in question was the 10.20 from Camden-road, and consisted of some ten or eleven carriages, three of which were first-class and the remainder second-class carriages of the North London line. It was due at Fenchurch-street shortly before eleven o'clock, and the pace of the train had been slackened to run into the North London compartment. Suddenly a very severe shock was felt by the passengers, and many in the foremost carriages were thrown from their seats, when it was discovered that the engine No. 2, of the composite class—that is, with the boiler and tender, &c., attached, and ordinarily in use on the North London line, had left the metals and had dashed against the walls of the viaduct, carrying a great portion of it away. The escape of both train and passengers was most fortunate, for had the engine proceeded a foot or two further it must have been precipitated over the viaduct, and in all probability have dragged one or two carriages over with it.

COLLISION ON THE GLASGOW AND SOUTH-WESTERN RAILWAY.—On the night of the 10th ult. a collision occurred between two heavily-laden luggage trains at Mauchline station. The railway between Kilmarlock and Auchinleck station is at intervals on a slight incline, and between these two stations two engines are generally employed for trains which on other parts of the line require but one. On the night mentioned a train, consisting of above 30 trucks, passed along, and on coming to Auchinleck stopped to take on more trucks. There were two guards with this train, one of whom was on one of the engines and the other in the van at the end of the train. The former uncoupled some of the waggons to admit these to be taken on, and it was the duty of the latter to put on the break at his end of the train. There is reason to believe, however, that he was asleep, and on the couplings being loosened the latter part of the train commenced to run down the incline. It ran, gathering velocity as it went, for about four miles, and was nearing Mauchline station, when it was met by another train drawn by two engines. A collision occurred, and the van of the runaway being smashed, the guard was crushed to death. The first engine of the second train was thrown on its side, the nearest waggons of the other train being thrown over it.

ACCIDENT ON THE GREAT EASTERN RAILWAY.—On the 21st ult. at the 4.5 p.m. down train from Norwich to Great Yarmouth was running between Reedham and Yarmouth, the tender of one of two engines by which it was propelled left the rails. Both the engines and the other tender and all the carriages remained on the metals, and no injury was sustained by any of the passengers, as the train was promptly brought to a stand-still. The accident occurred near the Berney Arms station.

RAILWAY COLLISION BETWEEN ASTON AND STALYBRIDGE.—A collision occurred about two o'clock on the afternoon of the 19th ult., between Ashton and Stalybridge, on the Manchester, Sheffield, and Lincolnshire line, by the passenger train due at Ashton at 1.55 running into a luggage train shortly after leaving Stalybridge. The luggage train was standing on the line at the time. The train was proceeding at a rapid space, and, by the force of the collision, many of the passengers received injuries more or less severe. The carriages were thrown off the line, and many of them were damaged to a considerable extent.

ACCIDENTS TO MINES, MACHINERY, &c.

COLLIERY ACCIDENT NEAR NEWCASTLE.—An accident has happened since our last, at Burradon Colliery, about six miles from Newcastle, in which pit, about three years ago, ninety men lost their lives by an explosion of fire-damp. The present accident represents in its general features that of the Hartley calamity, but without the loss of life that there occurred. About one o'clock, while the engine was working, the winding machine balanced weight became detached, came crashing down through the engine-house, smashed the machinery, and broke the two winding ropes. The two cages having thus nothing to hold them fell to the bottom, completely cutting off all communication with the men below. There were between one and two hundred men and boys down the pit at the time. Under the guidance of some who knew the workings thoroughly, they sought a passage

to the shaft of Seghill Colliery, which is about three miles distant; and though constantly exposed to danger from disturbing stoppings, &c., they steadily made their way out.

QUARRY ACCIDENT AT CARDIFF.—On the 14th ult. an accident occurred at Llandaff Stone Quarry, about two miles from Cardiff, which resulted in the death of two men and serious injuries to seven others. The quarry in question is of rather an extensive description, and supplies material for the construction of the Penarth Harbour Dock. The depth being somewhat considerable, an engine is employed to raise the blocks of stone. This engine overhangs the pit of the quarry, and is supported upon two large beams of wood. As the work was proceeding on the evening in question a more than usually large piece of stone had to be raised. The engine had raised the stone some slight distance when the beams upon which the engine rested were discovered to be giving way, but before anything could be possibly done the whole structure—beams, engine, stone work, and ruins—fell down the pit.

ACCIDENT AT AUCKLAND PARK COLLIERY.—The scene of this accident is about one mile and a half from Bishop Auckland, and lies in close proximity to the Stockton and Darlington Railway. The colliery is the property of the Black Boy Coal Company. It appears that, in consequence of government requirements, the Messrs. Wood were engaged in sinking a new shaft about fifty yards distant from the old one, so that, in case of a similar fatality to the recent one at Hartley, or any accident to the regular mode of egress, the men would still have ample means for their release in a very short time. Although this was the principal reason for the sinking of the new shaft, it was not the only one, as it was intended to sink to the bottom or working seam; but a rich seam considerably nearer the surface was the one from which the coal had to be obtained. Four seams had already been passed, when it was found necessary to fix a tap in the tubing for the purpose of relieving it from the pressure of water to which it was subject. This tap was proposed to be fixed about 5½ fathoms from the top of the shaft, and with that object a half-cradle was lowered on the 13th ult., on which were six men. They proceeded with their work until ten o'clock, when they were joined by Mr. Coulson, of Durham, the contractor, and the work then proceeded under his superintendence, when shortly afterwards, while four of the men were engaged in raising the tap to the "nozzle" or branch pipe, the cradle "canted," and they were precipitated to the bottom—a distance of 51 fathoms. The cradle righted almost instantly, and it was discovered that four of its occupants had been at once killed.

BOILER EXPLOSIONS.

BOILER EXPLOSION AT DUKINFIELD.—An accident took place on the 19th ult. at the boiler works of Messrs. Fernihough, Newton Moor, by which two men lost their lives. It appears that about half-past ten a number of boiler-makers were engaged in testing what is termed a balloon boiler, or wrought iron still, used at chemical works for the purpose of boiling tar. Before these boilers are sent out it is usual to see whether there are any leakages in the joints. The workmen were engaged in this duty when the over-pressure of steam suddenly blew out the bottom of the boiler.

WATER SUPPLY.

THE ABERDEEN NEW WATER WORKS about to be constructed, will, it is calculated, supply the city with 5,000,000 gallons per day. The maximum quantity at present available is 1,200,000 gallons.

WATER WORKS FOR BRECON.—At a recent meeting of the Brecon Local Board of Health, it was agreed that it was necessary to have a sufficient supply of wholesome water for the inhabitants of the town, and such supply of water be confined, preferably, if not absolutely, to the source at Rhydgoch, on or near the spot indicated by the town surveyor. It appears that the estimated cost of the works does not exceed £4800.

THE WATER SUPPLY OF LONDON.—The analyses of Dr. R. Dundas Thompson of the metropolitan waters, in August, offer some points of interest and importance. There was a slight increase upon the organic and total impurity of the preceding month. Moreover, the Thames water at London-bridge, at high water, was highly charged with impurities and sea water, three experiments having yielded a mean of 232.67 degrees of total, and 28.39 degrees per gallon of organic impurity, while the amount of ammonia from the sewage was 7.43 grains per gallon. One of the wells in St. Marylebone contained as much as 2.72 grains of ammonia per gallon. The following is the analysis as in the Registrar-General's returns:—

	Total impurity per Gallon.	Organic impurity per Gallon.
	Grs. or degra.	Grs. or degra.
Distilled Water	0.0	0.0
Loch Katrine Water, new Supply to Glasgow	2.35	.605
Manchester Water Supply	3.33	.630
Upper Marylebone-street Well	106.40	7.60
Thames at London-bridge	232.67	28.38
THAMES' COMPANIES.		
Chelsea	17.09	1.40
Southwark	16.40	1.44
West Middlesex	16.72	1.36
Grand Junction	16.74	1.90
Lambeth	17.20	1.72
OTHER COMPANIES.		
East London	17.52	1.66
New River	16.00	1.20
Kent	26.16	3.68

The following is the reading of the table:—Loch Katrine water contains in the gallon 2.35 degrees or grains of foreign matter in solution, of which .605 degrees or grains are of vegetable or animal origin.

GAS SUPPLY.

THE CARDIFF GAS LIGHT AND COKE COMPANY have further reduced their price of gas 3d. per 1000 cubic feet, and have declared their usual dividend. The price is now 3s. 3d. to small consumers.

THE LIVERPOOL UNITED GAS-LIGHT COMPANY have declared a dividend of 5 per cent. for the past half-year on the consolidated stock of the company. After complying with the demands of their Act of Parliament, and having a large net surplus, the directors have recommended a further reduction in the price of their gas, namely, to all consumers within the borough 2d. per 1000 cubic feet; and to all consumers in the out-townships 3d. per 1000 cubic feet; making the actual charge for gas in the borough 3s. 5d., and in the out-townships 3s. 9d. per 1000 cubic feet.

CITY GAS.—At a recent meeting of the City Commission of Sewers, Dr. Letheby submitted a quarterly report of the illuminating power and chemical quality of the gas supplied to the city of London. The report referred to the testing of the gas in the city laboratory at Jewry Chambers, Aldgate, and it is stated that 735 examinations had been made of the illuminating power of the gas during the quarter, the result of which was as follows:—

Illuminating Power in Standard Candles.

	Maximum.	Minimum.	Average.
Great Central Company	18.05	12.14	14.15
Chartered Company	14.65	10.79	13.03
City Company	16.26	8.50	13.78

From this it appears that the illuminating power of each company's gas had been generally very good. In the case of the City Company's gas, when the illuminating power fell to 8.50, it was caused by the unavoidable access of air to the gas, while the main was being laid in the neighbourhood. The chemical quality of the gas as regards the proportion of sulphur present had not been satisfactory, for in a large majority of cases the amount of sulphur was largely in excess of the quantity authorised by Parliament. This is evident from the following sulphur in 100ft. of gas:—

	Maximum.	Minimum.	Average.
Great Central Company	23.2	12.9	18.8
Chartered Company	28.9	16.9	23.1
City Company	30.9	17.7	23.4

In 26 examinations of the Great Central 16 were above the Parliamentary proportion; in 20 of the Chartered 25 were above it, and in 27 of the City Company 23 were above it. The pressure of the gas had in each case been good, exceeding that of one inch of water. A question was then asked whether or not sulphur in coal gas was injurious to health? Dr. Letheby replied that unless the proportion was so large as to be offensive to the smell, and actually to interfere with breathing, he could not say it would be injurious to health; but as the products of the combustions of sulphur were exceedingly injurious to all textile fabrics, Parliament had considered it right to prohibit the existence of more than 20 grains of sulphur in 100 cubic feet of gas.

THE CALNE GAS COMPANY have reduced the price of gas from 5s. 10d. to 5s. per 1000 feet, from and after the 31st December, 1863; with 5 per cent. off to consumers of 10,000 feet and upward in a quarter.

THE WITHAM GAS COMPANY have declared a dividend of 7½ per cent., and have reduced the price of their gas to 5s. per 1000 feet.

AT THE WALLASEY LOCAL BOARD MEETING the gas proceedings comprised a statement of the actual cost of the manufacture of gas by the board, showing the aggregate cost of making and supplying during the past year to be 2s. 8d. per 1000 cubic feet.

AT GREAT BARDFIELD it is proposed to erect gasworks at a cost of £1000, and a limited company is being formed for that purpose.

THE PORTSEA ISLAND GAS COMPANY have declared a dividend of 8 per cent., per annum.

AT MACHYNLLETH a meeting has been held, at which it was resolved to erect gasworks for the town. A company with a capital of about £2000 is being formed.

THE BURY ST. EDMUNDS GAS COMPANY, at the 28th half-yearly meeting, declared a dividend of 10 per cent. on the old capital, and 7½ per cent. on the new.

THE EASTBOURNE GAS COMPANY have declared a dividend of 10 per cent., and are increasing their capital £2000, to enable them to lay down new mains when required, and to substitute larger mains in the principal thoroughfares.

THE NEWPORT GAS COMPANY have declared a dividend of 10 per cent. per annum on the class A shares, and 7½ per cent. on the class B shares.

REDUCTION IN THE PRICE OF GAS AT BRISTOL.—From the first of January next, the cost of gas at Bristol is to be reduced from 3s. 9d. to 3s. 6d. per thousand feet.

DOCKS, HARBOURS, BRIDGES, &c.

LIVERPOOL DOCK AND HARBOUR WORKS.—The magnitude of the dock and harbour works at Liverpool may be estimated, from a report given recently at a meeting of the dock board. In the year ending June 1863, it appears that upwards of £600,000 have been spent on both sides of the Mersey, in harbour and dock works.

NEW FLOATING BRIDGE BETWEEN PORTSMOUTH AND GOSPORT.—A contract has been entered into by Messrs. Lewis and Stockwell, of Blackwall, with the directors of the Portsmouth and Gosport Floating Bridge Company for the construction of a new floating-bridge for the conveyance of passengers and vehicles to and from Portsmouth and Gosport. The new bridge will be 100ft. in length by 60ft. in breadth, with two balanced piers at either end 30ft. by 18ft., for receiving and discharging freights from the shore. Along the centre of the bridge will be erected the usual deck and engine-houses, over which will be the promenade deck. On either side of the houses will be the carriage ways of equal breadth with the piers. The engines are to be 50 horse-power, nominal, and will drive two chain wheels in the centre of the engine house, over which are passed chains nearly 2000ft. each in length, the ends of which are moored in wells with ballast weights on the beach just above high water mark at Portsmouth and Gosport; the links of the chain being each 10in. in length, 5in. wide, and of 1½ths iron. By crossing Portsmouth harbour by this bridge vehicles will save a *detour* between Portsmouth and Gosport of about 14 miles.

CLIFTON SUSPENSION BRIDGE.—The half-yearly meeting of proprietors has been held. The Chairman, in moving the adoption of the report, congratulated the proprietors on the progress now being made with the works. They had received 1040 tons of chains and ironwork from Hungerford; but in order to complete the work they had had to obtain 200 tons more chains, and 300 tons more of girders and ironwork, so that what was brought from London was not more than two-thirds of the material required for the work. At the next annual meeting the bridge would be nearly completed. In reply to questions, it was stated that the bridge would be considerably stronger than the one originally designed by Mr. Brunel. It would be 30ft. in width, having a clear space of 20ft. in the centre for the carriage-way, and two footpaths of 5ft. each railed from the carriage-way on either side.

THE PARIS AND DIEPPE CANAL.—A French paper states that all the surveys and soundings for this undertaking have been completed, and that the important question of feeding the canal has been solved. The line proposed by M. Sabatier stops at Gennevilliers, near Courbevoie, in the department of the Seine, where, according to the project, the great mercantile port of Paris is to be established. From Gennevilliers it takes the direction of Ile Adam, skirting the foot of St. Gratien, and, reaching Beaumont, cuts the Oise at Taverny, passes under Mont Aitair, in the valley of Thérain, and, following the right side of that valley, arrives at Beauvais, where a large basin is to be formed. From Beauvais, it enters the valley of the Avelon, by which it enters Gournay; it then follows the valley of Bray until it arrives opposite the mineral springs of Forges. There it turns to the right into the small valley which receives the waters of those springs, and finds a passage through the not very elevated table-land which blocks up that valley after the rivulet has found an issue below the old Abbey of Beaubec. It then meets the Ithune, near St. Saire, and successively arrives at Neufchâtel, Arques, and Dieppe. At the latter place it sweeps away the slaughterhouse, the demolition of which has already been or-

dered by the city; it skirts the parsonage and infant-school of Le Pollet, suppresses the old houses of the Rue de la Lombarderie, cuts off a small corner from the cliffs, and penetrates into the port. Hence it is seen that the point of division of the canal is the plateau lying between Forges and the Abbey of Beaubec. Here, it appears, the ground is 80 metres (240ft.) above the level of Paris; instead of tunnelling the plateau, a system of locks is proposed, which are to be fed by hydraulic machines; but from what source or reservoir these are to receive their supply has not yet been decided on. The State, it appears, has not been applied to for any subvention or guarantee of interest to the company which undertakes the work.

APPLIED CHEMISTRY.

ON THE POISONOUS EFFECTS OF THALLIUM, BY M. LAMY.—In my memoir on thallium, I remarked that the compounds of the new metal appeared to produce poisonous effects. I attributed in fact to these effects the pains principally in the lower extremities, and accompanied with extreme lassitude, from which I suffered in the course of my labours. The facts I communicate to the Academy leave no doubt of the poisonous nature of the compounds of thallium, and I hasten to publish them, in order to call the attention of toxicologists and therapeutists to the subject. I dissolved five grammes of pure sulphate of thallium in some milk in order to administer it to two puppies; but after having tasted the liquid the animals refused to touch it again. The next day, in the afternoon, the door of the kennel was left open by a servant without my knowledge, and all the milk disappeared, having no doubt been eaten, as the sequel will show, by two hens, six ducks, and a middle-sized bitch. Some hours after the milk had disappeared the bitch became dull, uneasy, and refused to take her usual meal. In the night she was seized with acute gripping pains, which caused her to howl incessantly. In the morning the pains had subsided neither in intensity nor frequency. The poor animal refused all drink and nourishment; the expression of her face was changed; her body was drawn up; her flanks were flattened; her breathing was oppressed, and there was abundant salivation. The hind limbs were at first convulsed, and afterwards, by degrees, became paralysed. The seat of pain was evidently the intestines, for she was calmed momentarily by pressure and friction on the belly. Under the preconceived idea that thallium is so small a dose could not produce such poisonous effects, I did not dream of having iodine of potassium administered as an antidote. The pains did not appear to lessen in the course of the day. The next day the paralysis had made progress; the animal was in a state of complete prostration; she was sensible, however, and seemed pleased when I went near her. The following day she died, sixty-four hours after taking the poison. During the illness she was not observed to vomit or be purged. In the evening we found one hen and six ducks dead or dying. In the birds which were still living we remarked more or less complete paralysis of the lower extremities. Lastly, the two puppies, who had only tasted a very small quantity of the poisoned milk, became dull, and seemed very fatigued; soon after they were seized with convulsive tremblings, and could with difficulty keep on their hind legs; then acute pains came on, and they died four days after taking the poison, notwithstanding the efforts made to save them. On making a post-mortem examination of these different animals, we were surprised to find neither lesion nor sign of serious inflammation. The gall-bladder of the bitch alone was distended, and in some of the ducks various serous membranes, particularly that of the liver, had a whitish granulated appearance. Spectrum analysis promptly revealed the nature of the poison. On examining small pieces of different organs with the spectroscopic, I immediately recognised thallium by its characteristic, sharply-defined green line. The intestines and their contents contained the metal in greater abundance than the muscular flesh and the bones; the serous membrane of the liver more than the substance of that organ. A tooth gave no evidence of the presence of thallium. Eight days after this accident, which had deprived me of a beautiful sporting dog, and most of my poultry, I remarked that a second hen was dull; her wings drooped, and it was with difficulty she kept herself on her feet; and, curious to see, when she attempted to eat her neck did not seem long enough; when she pecked her beak could not reach the food. She languished in this state three days, when I had her killed. I was able to prove the presence of thallium in her intestines, although in very minute quantity; in other organs I did not remark a trace. Thus eleven animals—two hens, six ducks, two puppies, and a middle-sized bitch—had died from the effects of five grammes of sulphate of thallium. To be still more convinced of the energy of the poison, I gave one deci-gramme only to a third puppy, and this animal also died forty hours after having taken the poison. From the preceding facts it results that sulphate of thallium is an energetic poison, and that the two principal symptoms it produces are, in the first place, pain in the intestines, manifested by violent gripping, and, in the second place, trembling, succeeded by more or less paralysis of the lower extremities. Perhaps I may add constipation, retraction and depression of the belly, and an absolute want of appetite to the above-mentioned symptoms, but I confine myself to those which most struck me. I shall remark besides the analogy of these symptoms to those produced by lead. The foregoing facts deserve the attention of physicians and physiologists. The salts of thallium, the sulphate, and particularly the nitrate, are remarkably soluble; they have but little taste, and may consequently be easily administered. But, at the same time, no poison can so easily be discovered; and, by means of the spectroscopic, scientific men can with certainty tell the organs by which it is absorbed, and the channels by which it is expelled from the system. I cannot terminate this note, without remarking that spectrum analysis may render important services to physiology and particularly to toxicology.

NEW PROCESS FOR SILVERING GLASS, BY M. A. MARTIN.—Among the large number of processes for silvering, Drayton's process is the best adapted for telescope glasses; but, as this process requires great skill on the part of the operator, I have endeavoured to find some method, which, by its simplicity and sureness, might become general. After carefully studying and experimenting on all the known processes (aldehyde, sugar of milk, glucosate of lime, &c.), I have arrived at one, which, from its simplicity and the firm adherence of the layer of silver deposited, seems to fulfil all the necessary conditions. I begin by preparing:—1. A solution of 10 grammes of nitrate of silver in 100 grammes of distilled water. 2. An aqueous solution of pure ammonia, marking 13 degrees on Carter's areometer. 3. A solution of 20 grammes of pure caustic soda in 500 grammes of distilled water. 4. A solution of 25 grammes of ordinary white sugar in 200 grammes of distilled water. Into this pour 1 centimetre cube of nitric acid at 36 degrees, boil for twenty minutes, to produce the interversion of the sugar, and then make up the volume of 500 centimetres cube with distilled water, and 50 centimetres of alcohol at 36 degrees. This done, I prepare an argentiferous liquid by pouring into a flask 12 cubic centimetres of the solution of nitrate of silver (1), then 8 cubic centimetres of ammonia at 13 degrees (2), then 20 centimetres of the solution of soda (3); and lastly, make up a volume of 100 centimetres by 60 centimetres of distilled water. If the proportions have been properly observed the liquid will remain limpid, and a drop of solution of nitrate of silver will produce a permanent precipitate; then after being left quiet for twenty-four hours the solution is ready for use. Clean the surface to be silvered with a cotton plug impregnated with a few drops of nitric acid, then wash it with distilled water, drain and place it on supports on the surface of a bath, composed of the argentiferous liquid, to which has been added one-tenth or one-twelfth of the solution of sugar (4). Under the influence of diffused light the liquid becomes yellow, then brown, and after from two to five minutes the whole of the surface of the glass will be silvered; after ten or fifteen minutes it will have attained the required thickness; it must be washed first with ordinary water, then with distilled water, and stood upon its edge to dry in the air. The surface will then be covered with a light, whitish veil, easily removed by a little polishing rouge on chamois leather, leaving a brilliant surface, perfectly adapted by its physical constitution for the purposes for which it is intended.

LIST OF APPLICATIONS FOR LETTERS
PATENT.

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

DATED JULY 27th, 1863.

- 2115 T. Bourne—Storing and holding petroleum and other oils, naphtha, and other products of distillation containing essential oils.
2116 F. Praxer—Steam engines and the mode of utilizing steam.
2117 J. Clark—Break blocks for railway and other carriages.
2118 J. Ward—Diving apparatus.
2119 C. Richard—Lighting and cutting the end of cigars.
2120 W. E. Newton—Breech-loading fire arms.
2121 G. Richards—Ordnance and fire arms, and the projectiles to be used therewith.

DATED AUGUST 29th, 1863.

- 2122 G. Davies—Iron and steel.
2123 M. Bell—Measuring apparatus for looms.
2124 J. Shaw—Cutting or reducing turnips or other roots as food for animals.
2125 R. Vickers—Steel.
2126 E. Amoureux—Separating solid from fluid fecal matters.
2127 L. A. Mulet—Shoring of hardwood (indiarubber, gutta-percha, and other improved similar materials, applicable to all domestic animals.
2128 J. Allison—Tilling land.
2129 G. Harratt—Tilling land.
2130 J. Walls—Steam boilers.

DATED AUGUST 29th, 1863.

- 2121 H. C. Penwell—Skates.
2122 M. W. Putnam—Winding clothes.
2123 G. Lewis—Cotton glass.
2124 T. Williams—Crushing and flattening the stalks of tobacco and other substances.
2125 W. Tinney—Printing carpets, piled fabrics, druggets, and other similar articles.
2126 T. Williams—Swimming and opening cotton and other fibrous materials.
2127 W. Whitworth & J. Wrigley—Furnaces of steam boiler.
2128 D. Speira, A. Boyd, & J. Kirkwood—Looms for weaving.
2129 A. Agnew—Breech-loading fire arms.
2130 P. C. Hoffman—Shears for cutting metal and other substances.
2131 W. Weldon—Aerial navigation.
2132 A. Rowand—Evaporating fluid solutions.
2133 J. Dodge—Grinding and polishing metallic articles.
2134 I. E. C. Martin—Generating steam and gases for heating steam boilers.

DATED AUGUST 31st, 1863.

- 2145 G. Attock—Assistant bearing springs for locomotive engines, railway carriages, waggon, and trucks.
2146 H. E. Kremer—Printing in colours pictures or devices to be used in ornamenting porcelain, stoneware, earthenware, or any other substances where the colours can be annealed or melted or burned.
2147 F. A. Brandlin—Breech-loading fire arms.
2148 G. Bebbington & J. R. Hampson—Securing the ends of bands in packing bale goods.
2149 E. L. Burnett—Removing the fuel from stores or grates, and facilitating the extinguishing of fires used therein.
2150 W. E. Gedge—Watch.
2151 A. V. Newton—Sewing by machinery.
2152 A. V. Newton—Sawing irregular forms of wood.
2153 J. Miles—Traps for catching rats and mice, rabbits, and other animals and birds.
2154 G. B. Pettit—Preparing mice and rats in order to render them applicable to articles of wearing apparel and ornamental purposes.
2155 M. J. Roberts—Fitting axles for railway and other carriages.

DATED SEPTEMBER 1st, 1863.

- 2156 J. Smith—Breech-loading and other ordnance.
2157 C. & W. Shorrocks—Looms for weaving.
2158 G. Russell—Apparatus for cooking, and obtaining fresh water.
2159 W. Clark—Hydraulic apparatus.
2160 P. Joyot—Fabric, and looms for manufacturing the same.
2161 J. H. Banks—Benches or desks for schools, churches, and other similar purposes.
2162 G. T. Bousfield—Illuminating gas.
2163 T. Erich—Pressing, past.
2164 W. W. Kewenau—Wedding paper and felted fabrics.
2165 M. Pinner—Flexible translucent material or fabric to be used as a partial substitute for glass.

DATED SEPTEMBER 2nd, 1863.

- 2166 J. Lewis—Preparing and drying clay, and bricks and tiles.
2167 R. Young—Separating and elevating apparatus for grain or granular matter.
2168 K. Collier—Grindstones and crisoline fastenings.
2169 R. Sims—Reaping and mowing machines.
2170 C. H. Corlett—Valves, taps, or cocks.

- 2171 E. Allen—Feeding wool and other textile and fibrous substances into carding, combing, and other machines for treating such substances.
2172 F. C. P. Hoffmann—Crushing hard substances, washing ores and minerals, and separating earth and earthy matter from solid substances.

DATED SEPTEMBER 3rd, 1863.

- 2173 C. Jackson—Bolts for fastening doors, windows, and shutters.
2174 A. L. Durand—Nails.
2175 A. A. Beaumont—Engine for raising liquids.
2176 W. Boulton & J. Wothington—Mixing and insulating encaustic tiles or other plastic articles and substances.
2177 N. Bailey—Application of rolling friction to the axle boxes and journals of running shafts and axles of machines and vehicles for lessening the resistance to the motion.
2178 W. & T. Joliffe, W. Graham, & H. Taylor—Paddle and other propelling wheels for navigable vessels.
2179 H. A. Bonneville—Attaching horses to carriages or other vehicles.
2180 H. A. Bonneville—Glossing and glazing all kinds of threads.
2181 A. V. Newton—Cleaning and decorating grain and seeds.
2182 J. Loebel & I. Pick—Fastening gloves.

DATED SEPTEMBER 4th, 1863.

- 2183 C. Thornhill—Sewing boots, shoes, saddlery, and leather work generally.
2184 C. G. Kelvey & W. Holland—Chronometers and other time keepers.
2185 J. Hendry & W. Coutts—Furnaces.
2186 T. Fisher—Spring balances where spiral springs are used.

DATED SEPTEMBER 5th, 1863.

- 2187 W. Lorberg—Gas and other substances.
2188 G. Hargreaves—Steam boilers.
2189 S. M. Bourne—Preparation of materials for the manufacture of paper.
2190 W. Norton—Laying and supporting submarine telegraph cables.
2191 T. & E. T. Meedy—Generation and production of motive power.
2192 J. Rowell—Pencils.
2193 T. Smith—Wagon brake.
2194 R. Smith—Paper making machinery.
2195 C. H. Anames—Lids or covers for certain articles of hollow ware.
2196 G. B. Reunie—Floating docks and pontoons, and cleaning, painting, or repairing them.

DATED SEPTEMBER 7th, 1863.

- 2197 F. Mills, T. Booth, & T. Clegg—Preparing and spinning cotton.
2198 J. B. York—Closets.
2199 N. Singleton—Cutting hay, straw, or other similar products.
2200 H. Twelvetrees—Portable mangling and wringing apparatus.
2201 A. Smith—Apparatus for directing motion in right lines.
2202 S. Gerish & J. Weston—Mortising, drilling, dovetailing, and cutting wood.

DATED SEPTEMBER 8th, 1863.

- 2203 L. Mend—Obtaining sulphur and sulphurous acid from alkali waste.
2204 J. H. Cutler—Dress fastening.
2205 J. C. Lotz—Turning over the leaves of music.
2206 W. A. Wilson & J. Smith—Furnace flues.
2207 J. Burch—Printing on certain and other tery and velvet pile fabrics, felted cloths, and other fabrics and materials.
2208 T. H. Baker & G. Friedl—Treating excrementitious and sewage matters.
2209 R. A. Brooman—Working and preparing skins.
2210 W. Hewitt—Rudder.
2211 J. D. Jack—Slitting metals.
2212 L. Adam—Machine for mowing grass or reaping grain.

DATED SEPTEMBER 9th, 1863.

- 2213 W. H. Tucker—Propelling and steering vessels.
2214 J. Lillie & J. H. White—Coating for surfaces of iron, wood, and other materials.
2215 W. H. Hawksorth—Preparing cotton and other fibrous materials for spinning.
2216 T. Naden—Raising the covers of hot water jugs, tea pots, coffee pots, and other vessels.
2217 W. Glydon—Metallic tubes and hollow cylinders.
2218 J. B. York—Closets.
2219 W. E. Gedge—Paving ways or roads.
2220 K. T. Hughes—Chenille.
2221 J. Robinson—Steam boiler and other furnaces.
2222 N. Thompson—Stopping bottles, jars, and other vessels.
2223 G. T. Bousfield—Spinning and manufacturing wool, cotton, and other fibrous materials.
2224 W. Hutchinson—Steam engines.
2225 A. V. Newton—Steam engines.
2226 J. Morgan—Fountain pens.
2227 E. Oliver & G. Myers—Lowering and disengaging boats from vessels.

DATED SEPTEMBER 10th, 1863.

- 2229 J. H. Wilson—Side lights for ships and other vessels.
2230 T. B. Gordon—Granulating and drying gunpowder.
2231 W. W. Greener—Fire arms.
2232 H. & J. W. Wright & W. Clough—Glazing and rolling press papers, pasteboard, and other paper.
2233 M. H. Muir & J. M. Ilwham—Winding yarns.
2234 W. Clark—Furification and distillation of hydro-carburets and oils produced by the distillation of coal and oil and boghead.
2235 J. H. Whitehead—Manufacture of felted fabrics.

DATED SEPTEMBER 11th, 1863.

- 2236 J. Hartshorn & W. Redgate—Lace.
2237 W. Taylor—Iron rods.
2238 L. Dracens—Bath or bathing machine adapted for deep water.
2239 T. J. Sloun—Braiding machines.
2240 J. Rhodes—Piecing machines.
2241 L. Meyer—Employing vapours, gases, and the heat derived from combustible matters.
2242 J. Dobbin—Railway and other carriages.
2243 J. D. Lee & J. Crabtree—Looms.
2244 H. Chrchley—Stove grates and kitchen ranges.
2245 M. Gerstenhofer—Roasting pyrites.

DATED SEPTEMBER 12th, 1863.

- 2246 J. Crellin—Governing and stopping the flow or passage of liquids.
2247 J. King—Assisting and regulating the process of fermentation.
2248 C. E. Wallis—Revolving fire-arms.
2249 E. N. Gregory—Uniting belts and lengths of wire gauze and other metal cloth.
2250 W. C. Sutherland—Revolving fire-arms.
2251 D. J. Sutherland—Blasting rocks and other materials.
2252 J. A. Whipple—Supporting photographic cameras.

DATED SEPTEMBER 14th, 1863.

- 2253 H. Riviere—Heating, cooling, and evaporation.
2254 W. R. Hutton—Lubricating compound.
2255 T. Bell—Distilling shale or other bituminous materials.
2256 W. E. Gedge—Safety lamps for mines.
2257 G. F. Millin—Facilitating the detachment of horses from carriages or vehicles, and the application of brake power.
2258 G. W. Billings—Preparing hemp, flax, and other vegetable materials.
2259 W. Gassange—Drying or curing certain vegetable productions.

DATED SEPTEMBER 15th, 1863.

- 2260 C. Hattcock—Cigar lighters and fusee matches.
2261 G. Howell—Stamping or obliterating and printing.
2262 W. Thompson—Electric telegraph apparatus.
2263 A. Barclay—Locomotives or other steam engines.

DATED SEPTEMBER 16th, 1863.

- 2264 J. Fox—Planing or cutting off the sides of timber.
2265 A. Fernug—Cutting or finishing matting and similar fabrics.
2266 G. Lewis—Heating and warming buildings and for drying purposes generally.
2267 J. C. Swings.
2268 J. Rehill—Liquid compasses.
2269 A. Watson—Hinges.
2270 J. Dunsatt—Cooling liquids.
2271 B. Latchford—Spur.
2272 R. H. Webster—Thrashing machines.
2273 R. Thomson—Mixed fabric, and the application thereof to covering umbrellas and parasols.
2274 E. Scott & J. Starkey—Looms.
2275 R. Harrington—Umbrellas and parasols.
2276 J. M. Tate—Hanging the lower topsail yards of ships and other sailing vessels.

DATED SEPTEMBER 17th, 1863.

- 2277 J. McKewen—Combined coke and hot blast system.
2278 Z. J. Mercier—Gas cock of elastic and continuous pressure.
2279 W. E. Gedge—Instruments for ascertaining level.
2280 J. Edwards & J. Livesey—Permanent way of railways.
2281 A. Chaplain—Propelling ships or vessels.
2282 P. Cowen—Refining sugar.
2283 F. de Wyde—Hydrated silica.
2284 R. A. H. Tappin—Taps.
2285 J. G. Ulrich—Apparatus for railway carriages and trains in order to obtain greater safety to passengers.
2286 J. H. Johnson—Life and swimming belts.
2287 J. H. Johnson—Drying paper, pasteboard, and similar fabrics.
2288 C. M. Chaddburn & W. J. Tristram—Ships and other vessels.
2289 J. Whitehead—Pneumatic motive power machinery.

DATED SEPTEMBER 18th, 1863.

- 2290 J. Allen—Valves and cocks for steam, water, gas, and other fluids.
2291 J. Roberts & K. Naylor—Increasing, diminishing, or otherwise regulating the power and tone of organs, harmoniums, pianofortes, or other instruments with similar keys or key boards.
2292 R. D. Dwyer—Cleaning and painting or coating the bottoms of ships and other structures.
2293 G. Davies—Improvements in the manufacture of iron and steel.
2294 W. Lorberg—Treatment of rags, and obtaining valuable chemical products from the animal fibre therein.
2295 I. Baggs—Protecting and preserving the hulls and bottoms of ships and vessels from fouling and corrosion.
2296 A. Nolrot—New tiles.
2297 J. H. Cook—Railway carriages and other sprung vehicles.
2298 R. A. Brooman—Improved threads for fishing nets.
2299 H. W. Hart—T fastenings.
2300 H. C. Hudson—Improvements in the manufacture of buttons.
2301 A. V. Newton—Improvement in propelling vessels.
2302 W. Smith—Constructing breech-loading ordnance.
2303 W. Smith—Construction and mode of working ordnance for ships and forts, and in the means of protecting those engaged in working guns employed for such purposes.

- 2304 T. Small—Improvements in motive-power machinery.
2305 V. Houghton—Improvements in lamps and lamp wicks.

DATED SEPTEMBER 19th, 1863.

- 2306 L. F. Chémand & H. F. Christen—Printing postage stamps, banker's bills, shares, and other similar documents.
2307 J. Buckley—Mules for spinning cotton and other fibrous substances.
2308 J. Fraser—Machinery for the safe and more economical storing of volatile oils in localities where the ground and labour are expensive.
2309 R. Cocheman—Improvements in instruments for supporting, holding, or carrying parasols, bags, watches, ornaments, or other articles or appendages.
2310 C. L. Frieschmann—Ginning cotton, and cleaning, opening, and preparing cotton, wool, or other fibrous substances.
2311 B. Davis & W. Bowler—Strengthening tilt masts.
2312 J. C. Pockley—Improvements in brewing or preparing leavages from malt and hops.
2313 J. P. B. le Patourel—Improvements in breech-loading fire arms.
2314 I. de Angeli—Apparatus for obtaining motive power.
2315 T. Richardson, J. J. Landy, & R. Irvine—Improvements in the extraction of oils from vegetable substances.
2316 H. Bateman—Improved construction of rotary engines.
2317 T. R. Vickers—Manufacture of cast steel tyres.
2318 J. Farmer & C. Haddield—Machinery for making bricks, tiles or slabs, and other such articles.

DATED SEPTEMBER 21st, 1863.

- 2319 E. F. Batten—Crisolines.
2320 W. Kieron—Rail and road carriages, wheel tyres, and railway crossings, adapting them to such carriages.
2321 W. B. Robins—Improvements in portable fire and garden engines.
2322 A. A. Downes—Improvements in artificial teeth.
2323 E. Alcan—Improvements in shears for cutting metal threads, wires, and rods, applicable also to gauging wires.
2324 E. Alcan—Improvements in condensers applicable to wool carding engines.
2325 P. A. Chateau—Burners for burning all mineral oils.
2326 R. Wallis—Loading and unloading vessels, and raising, lowering, and otherwise conveying sacks, cases, agricultural produce, and other objects from one locality to another.
2327 R. Ridley & J. G. Jones—Giving a reciprocating motion to picks and cutting tools used in getting coal and other minerals and stone.
2328 G. T. Bousfield—Improvements in power looms for weaving hair cloth and fibres in which the warp is inserted in separate lengths of material.
2329 C. T. Burgess—Improvements in reaping machines.
2330 W. Hutchinson—Manufacturing moulded articles of India rubber.
2331 T. B. Duff—Iron ships and vessels, and sheathing the same.
2332 W. A. V. Kaul—Improvements in railway telegraphs and signals, and also the permanent way and carriages, for preventing railway accidents.

DATED SEPTEMBER 22nd, 1863.

- 2333 J. Reushaw & J. Haworth—Stretching woven fabrics.
2334 G. M. de Bayet & J. E. Pigoulet—Agglomerating fuel.
2335 P. Efferts—Making bricks, tiles, pipes, and other similar articles.
2336 C. Mainland—Improvements in mashing apparatus.
2337 J. & J. Bond—Improvements in brick and tile making machinery.
2338 R. A. Brooman—Compositions for preserving cheese.
2339 J. Brigham & R. Bickerton—Reaping or mowing machines.

DATED SEPTEMBER 23rd, 1863.

- 2340 W. Cleminson—Improvements in the construction of pipe wrenches.
2341 J. H. H. H. Machinery applicable to steam and water engines.
2342 P. A. L. de Fontainebleau—Centrifugal machines.
2343 W. & J. Galloway—Lubricating journals of revolving shafts and axles.
2344 R. T. Hughes—Pickers of looms.
2345 W. Gibb & J. Holland—Looms.
2346 W. T. Riry—Ball carriages.
2347 A. Collingridge—Receptacles for oil and petroleum.
2348 J. Phillips—L vals.

DATED SEPTEMBER 24th, 1863.

- 2349 W. Whit—Coating wood and other surfaces.
2350 A. R. Kugon—Machinery for mixing various ingredients to a pasty consistence.
2351 W. Woolf—Implements for tilling the soil.
2352 T. & W. Marshall—Metallic instruments for sewing, stitching, and closing boots.
2353 R. Drouke—Gunpowder.
2354 W. G. Helaby—Mounting transparent photographic pictures.
2355 A. Firth—Furnaces for heating wheel hoops.
2356 J. Welser—Utilizing the waste fuel from galvanizing works.
2357 J. Sturges—Cutting and boring coal and rocks.
2358 W. Oxlley—Pickers of looms.
2359 A. V. Newton—Gunpowder.
2360 H. A. Bonneville—Horse collars.
2361 H. A. Bonneville—Joining leather.

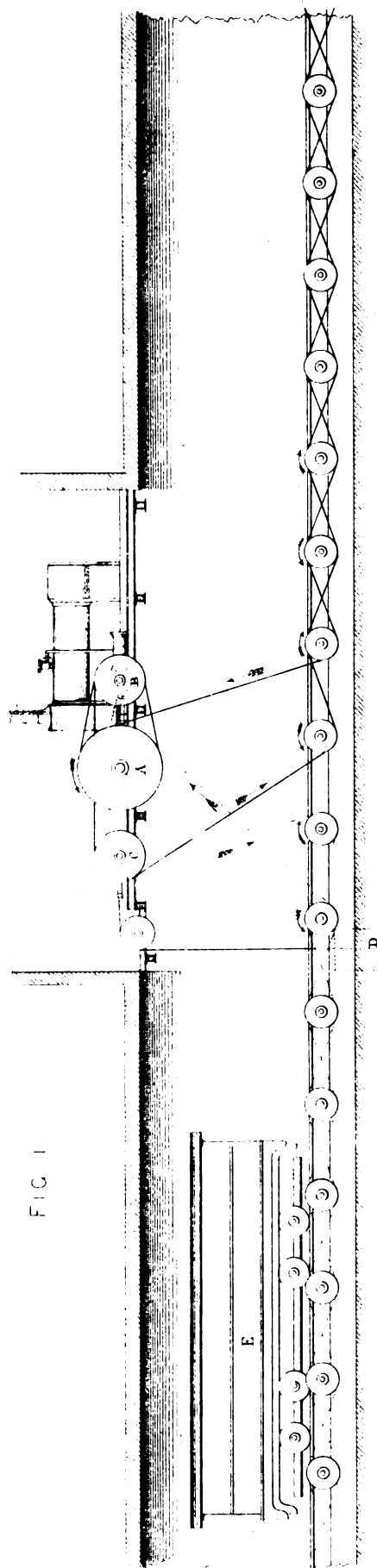
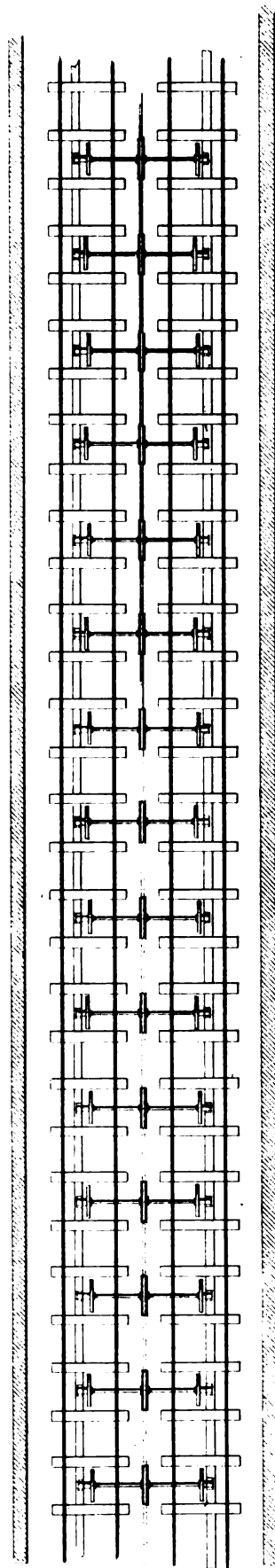


FIG. 1

FIG. 2.



PROPOSED METHOD OF
WORKING RAILWAYS BY STATIONARY ENGINES

BY

R & W. HAWTHORN NEWCASTLE-TYNE
1863.

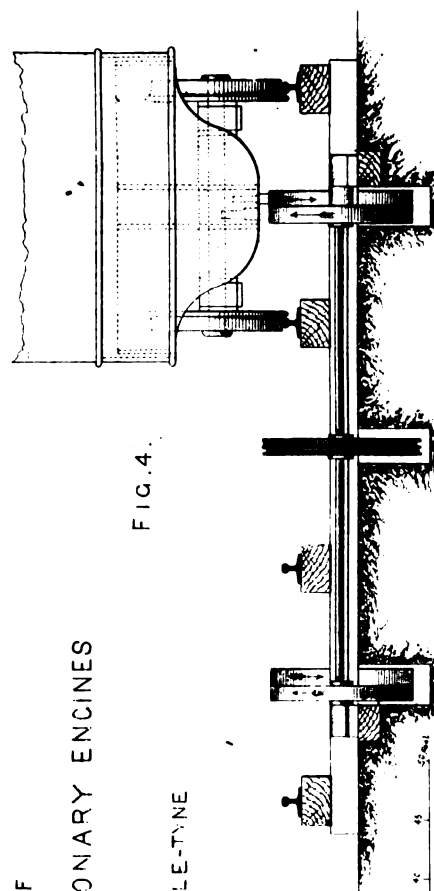
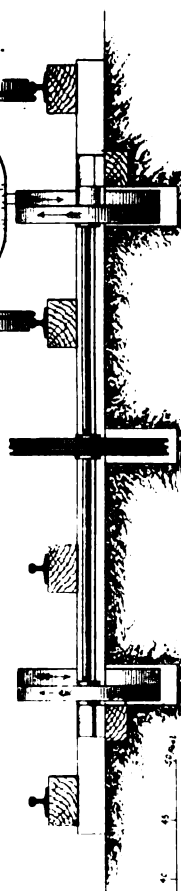


FIG. 3.

FIG. 4.

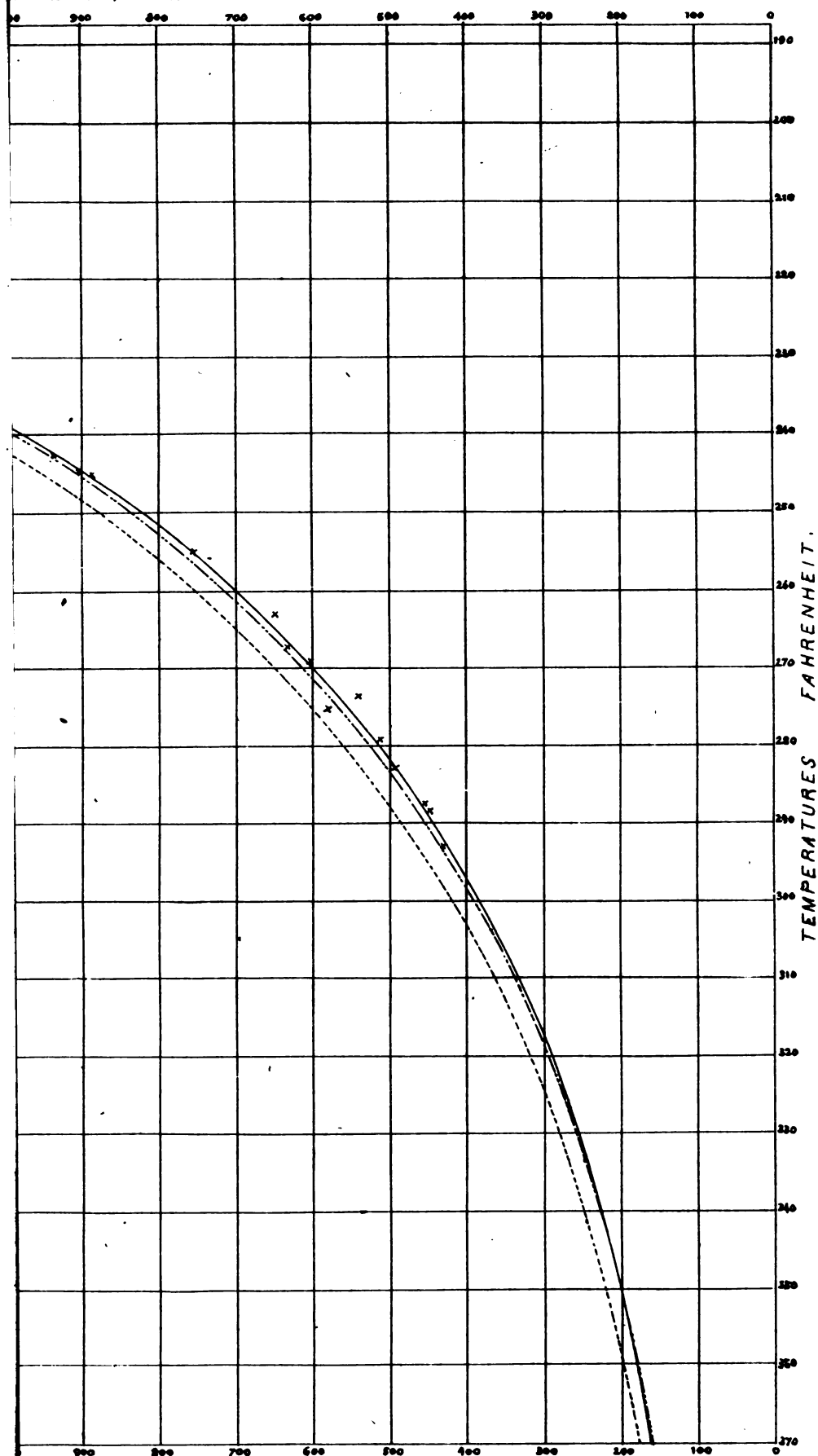


SCALE 1/4 INCH = 1 FOOT

Scale in Feet 1/2 3

ERING.

OF THE WATER WHICH PRODUCED IT.



Curve from M. Rankine's formula.
The Experiments are marked x

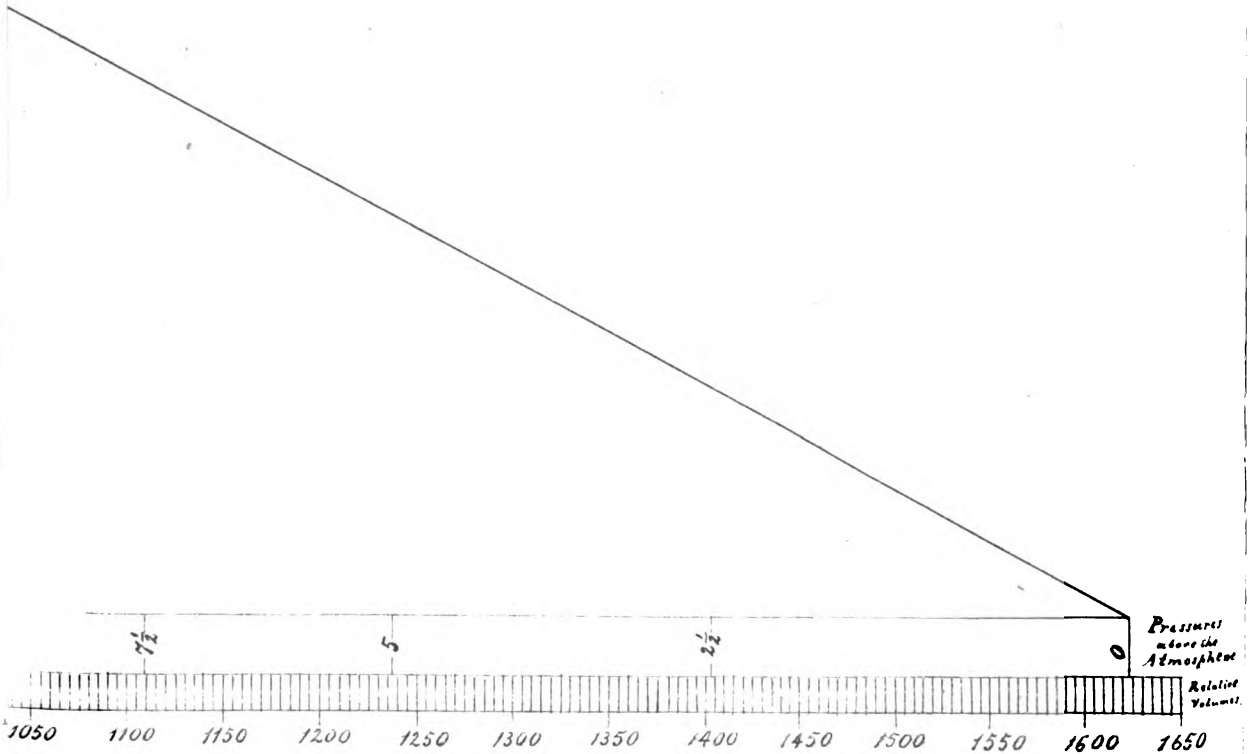
Percentages

10 20 30 40

LOCOMOTIVE ENGINEERING.

DIAGRAM FOR DEFINING THE PRESSURE & RELATIVE VOLUMES

OF STEAM EXPANDING IN A CYLINDER.



THE ARTIZAN.

No. 11.—VOL. 1.—THIRD SERIES.

NOVEMBER 1st, 1863.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. BIRCKEL.

(Illustrated by Plates 252 and 253.—Continued from page 219.)

In order to render more easy, at a single glance, the comparison between the relative volumes of steam, as we have given them in our paper in the ARTIZAN of October last, we have prepared a diagram plate, in which the relation of temperature and specific volume is expressed by a curve, the abscissæ of which stand for increments of temperature, and the ordinates for increments of volume. The three curves shown embody respectively the results of the perfect gas theory, those obtained by Dr. Rankine's formulæ, and those obtained by Dr. Fairbairn's direct experiments; and the reader cannot but observe that the first of these curves keeps steadily aloof from the two others, while there is a strong tendency in these latter to identify themselves with each other.

Referring to Dr. Rankine's formula, it should be stated that the same was arrived at by a different process of investigation, independently and contemporaneously, by Dr. Clausius, in Germany, and that it was published almost simultaneously in the two countries in February, 1850. Dr. Rankine, however, is the first who published a complete set of tables computed from that formula; and, we think that his results have a claim to preference until further experimental evidence be obtained to show cause to the contrary, because the chances of error which may accrue from Regnault's experimental data are common both to them and to Fairbairn's, while, with these, there are the additional chances arising from the difficulties of manipulation already pointed out, such as the perfect evaporation of the whole weighed portion of water, and the simultaneous reading of the thermometer and of the column levels at the exact point of maximum temperature of saturation. As affecting, however, all practical questions relating to the steam engine, the differences between the latter named results are too small to be of any consequence.

In the application of those volumes to the calculation of the heating surface according to formula (6) of our paper of January last, it is but necessary to remember that the pressures corresponding to the volumes given in the table are absolute pressures; 15lbs., therefore, must be added to the mean actual pressure at which the steam is to work in the cylinder (which pressure, it will be remembered, is easily defined by the aid of the table given in our paper of February last), and the sum thus obtained will correspond to the value of μ required for formula (6). In plate 253 we have given a diagram, the principle of which was suggested to us by Mr. Ramsbottom, affording a ready means of finding the effective pressure, and the corresponding relative volume of steam expanding in a cylinder, at any period of the expansion. The base line represents relative volumes and actual pressures, here modified to suit Rankine's tables; the vertical lines correspond to per centages of any arbitrary stroke. The use of the diagram will be best explained and illustrated by an example; thus, let it be proposed to find the final pressure and corresponding relative volume of steam having an original pressure of 140lbs., when it is cut off at 30 per cent. of the stroke; from the point marked 140 in the base line draw a radial line to point *o* of the stroke; through the point at which it intersects the vertical corresponding to 30 per cent. of the stroke, draw a horizontal until it intersects the vertical corresponding to the end of the

stroke; through this point, from point *o*, draw now a radial until it intersects the base line, and the point thus determined indicates the pressure we are in search of, namely, 23½lbs., with a relative volume of 598. In a similar manner it is found that with the same initial pressure and the same cut off, the pressure of the steam at 75 per cent. of the stroke is equal to 44½lbs. with a relative volume of 448. By a similar mode of procedure it will be found also that steam of a 100lbs. initial pressure, cut off at 35 per cent. of the stroke, has a pressure of 37lbs. with a relative volume of 507 at 75 per cent. of the stroke, and a final pressure of 23lbs. with a relative volume of 675. This diagram may be found very useful also for defining the mean actual pressures required in formula (6), provided always, that due allowance be made in the assumption of the initial pressures, for loss due to wire drawing and condensation in the passage of the steam from the boiler to the cylinder; this loss has been assumed to amount to 23 per cent. of the pressure in the boiler in the computation of the table previously referred to.

In our paper on the boiler*, when speaking of the relative evaporating capabilities of coal and coke, we have stated that the result of actual practice on the London and North-Western Railway confirms Mr. Clark's experience, that coal is capable of rendering a duty of ⅓rds of that of coke only, and in making this statement we had trusted to the information of one of the assistants at Crewe; but as soon as Mr. Ramsbottom saw the paragraph quoted, he desired us to contradict the same. In his letter to us on this subject he says that *he has long been of opinion that coal should yield a duty equal to that of coke, and that it might even yield a higher duty*. It appears also that the result of actual practice in the year 1862 upon that line, shows a ratio of 100 to 91·3, which ranges close upon equality, instead of 100 to 66, as we had stated it to be. This result becomes particularly cheering, and grows much in importance, when it is taken into consideration simultaneously with the subject of the limited duration of our coal fields,† for the calculations of geological science are almost as exact and reliable now as those of the positive sciences; and it becomes, therefore, a duty to all consumers, and especially to manufacturers and engineers in this country, independently of any considerations of present gain, not to deal wastefully with a material which is the very foundation of our industrial and commercial supremacy, and to the comforts of which, after generations have an equal claim with us.

For the conversion of coal into coke the greater part of the hydrocarbons, representing 25 per cent. of the total weight of coal, are partly required for the process of conversion, or are partly lost altogether as fuel. Considered therefore from the point of view upon which we have endeavoured to place this question, the conversion of coal into coke for the sole purpose of obtaining a fuel free from smoke is a double loss. It is an immediate loss to the consumer, who pays nearly double price for an article from which, in the production of steam, he need not necessarily obtain any better results. It is a national loss, because the period of duration of this portion of our mineral wealth is reduced in the very proportion of the waste inherent to that process. For the same reasons, also, every step made towards the perfect combustion of coal is a double gain, and every attempt towards the improvement of the steam-engine generally should be in this direction.

(To be continued.)

* ARTIZAN, number for January last.

† Estimated by Sir W. G. Armstrong, in his address to the late meeting of the British Association, at 200 years, at the present rate of consumption.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF
SCIENCE, NEWCASTLE, 1863.ON THE CONSTRUCTION OF IRON SHIPS AND THE PRO-
GRESS OF IRON SHIPBUILDING ON THE TYNE, WEAR,
AND TEES.

BY MR. C. M. PALMER.

The first portion of Mr. Palmer's paper consisted of an account of the general principles on which iron ships are constructed; and he concluded his observations upon this part of the subject by stating that he believed that the compasses are difficult of adjustment, and that the bottoms get foul; but he hoped that in a short time science, in the promotion of which the British Association is so powerful an agent, may show us how both these difficulties may be overcome.

Mr. Palmer then proceeded to give a sketch of the progress of iron shipbuilding on the Tyne, Wear, and Tees, which formed the second, and perhaps more interesting, division of his paper.

For a very long period the district of the Tyne, Wear, and Tees has been famous for its shipping. A Committee of the House of Commons, that sat so far back as the year 1642, designated Newcastle as "the nursery for shipping;" and Defoe, writing of the Tyne in 1727, states that "they build ships here to perfection—I mean as to strength and firmness, and to bear the sea."

The history of iron shipbuilding in this district does not commence, however, until the year 1840. In March of that year, the *John Garrow*, of Liverpool, a vessel of 800 tons burthen, and the first iron ship seen in these rivers, arrived at Shields, and caused considerable excitement. A shipbuilding firm at Walker commenced to use the new material almost immediately; and, on the 23rd of September, 1842, the iron steamer *Prince Albert* glided from Walker slipway into the placid waters of the Tyne.

During the next eight or ten years very little progress was made. The vessels mostly in demand were colliers, and no one thought of applying iron in their construction; but, about the year 1850, the carriage of coals by railway began seriously to affect the sale of north country coal in the London market, and it became essential in the interest of the coal owners and others to devise some means of conveying the staple produce of this district to London in an expeditious, regular, and, at the same time, economical manner. To accomplish this object, Mr. Palmer caused an iron screw steamer to be designed in such a manner as to secure the greatest possible capacity with engines only sufficiently powerful to insure her making her voyages with regularity. This vessel (the *John Bowes*), the first screw collier, was built to carry 650 tons, and to steam about 9 miles an hour. To the success of this experiment may be attributable in a great measure the present important development of iron shipbuilding in this district, and the fact that we continue to supply so largely the London market with coal. On her first voyage, the *John Bowes* was laden with 650 tons of coals. In 48 hours she arrived in London; in 24 hours she discharged her cargo; and in 48 hours more she was again in the Tyne; so that in five days she performed successfully an amount of work that would have taken two average-sized sailing colliers upwards of a month to accomplish.

The amount of prejudice with which nautical men and persons engaged in the shipping and coal trades opposed the introduction of screw colliers was great. They argued that it would be impossible for steamers carrying 650 tons of coals, and costing about £10,000, to compete with vessels that consumed no fuel, and which, though carrying only half the quantity, cost little more than £1000, or only one-tenth the amount. Mr. Palmer was, however, confident of the result, and persisted in the development of the system. How far his views have proved correct will be borne out by the following table, which shows the number of cargoes and tons of coals imported into London by screw steamers in each year, from July 31st, 1852 (the date of entry of the first screw steamer, *John Bowes*) to June 30th, 1863:—

Year.	Cargoes.	Tons.
1852	17 making	9,483
1853	123 "	69,934
1854	345 "	199,974
1855 (Crimean war).....	174 "	85,584
1856	413 "	238,597
1857	977 "	547,099
1858	1,127 "	599,527
1859 (Italian war)	899 "	544,614
1860	1,069 "	672,476
1861	1,299 "	851,991
1862	1,427 "	929,825
1863 (Half year ending June)...	714 "	463,609

5,212,713

By this table it is seen that a total quantity of 5,212,713 tons of coals have been imported into London by screw colliers; and, in addition to this, large and increasing quantities have been taken to other ports both in this country and abroad. Since its first introduction, the screw collier has been greatly improved, and the facilities for loading and discharging very largely augmented. The screw collier *James Dixon* frequently receives 1200 tons of coals in four hours, makes her passage to London in 32 hours, there—by means of the hydraulic machinery invented by the President (Sir W. Armstrong)—discharges her cargo in ten hours, returns in 32 hours, and thus completes her voyage in 76 hours. The *James Dixon* made 57 voyages to London in one year, and in that year delivered 62,842 tons of coals, and this with a crew of only 21 persons. To accomplish this work on the old system, with sailing colliers, would have required 16 ships, and 144 hands to man them.

One of the great difficulties encountered in perfecting these vessels was in the ballasting. To dispense with the necessity of shipping shingle or chalk as ballast, many costly experiments were tried, and at length, by a system of double bottoms, the construction of which adds to the strength of the ships, the ballasting of the vessels with water was brought to a highly satisfactory result. The water is allowed to run into the spaces between the two shells as the vessels pass down the Thames; when the spaces are full, the cocks are closed, and so remain until the arrival in the Tyne, when the water is pumped out by means of an apparatus provided for the purpose. This system allows the vessel to be ballasted without loss of time at either end of her voyage, and does not impair in the slightest degree her power of carrying coals.

The introduction of the screw collier has revolutionised the coal carrying trade, and has had a most beneficial effect upon commerce generally. Besides accomplishing the purpose for which it was designed, this class of vessel has been proved capable of rendering very important services to the Royal Navy. When, in the latter part of the year 1854, information reached this country that the commissariat department of our army in the Crimea had broken down, and that the salvation of our troops depended upon a rapid despatch of supplies, it was found that screw colliers were admirably adapted for the work, and the majority of them were temporarily taken out of the coal trade and employed in the transport service. The Government admitted, on that occasion, that screw colliers had proved to be more useful and economical than any other class of vessels they had employed.

In the year following the launch of the *John Bowes*, namely, in 1853, the first iron vessel built on the Wear was loosed from its blocks. The Tees followed with great energy and considerable success, and on both those rivers, as we shall see presently, a very considerable trade in iron shipbuilding is carried on.

The first iron vessel for war purposes constructed in this district was the *Terror*, one of the large iron-cased floating batteries designed during the Russian war to operate against Cronstadt. This vessel, of 2000 tons, and 250 horse-power, carrying twenty-six 68-pounder guns, was built in three and a half months; and she would have been completed in three months had not the declaration of peace slackened the energies of the men, which up to that time had been maintained so nobly by their patriotic feelings.

It was in the building of this vessel that rolled armour-plates were first used. The demand for forged armour-plates was so great that the forges of the kingdom could not supply it, and recourse to rolling was unavoidable. At that time the largest plate mill was at Parkgate, and Messrs. Palmer accordingly employed Messrs. Beale and Co., the owners of Parkgate Works, to roll the plates required for the *Terror*. To the use of these rolled plates, however, the Admiralty opposed itself. Messrs. Palmer, feeling convinced by experiments made by them that the rolled armour plates were at least equal to the forged, invited the Admiralty to a trial of their efficiency, and built a target 9ft. square on the cellular principle, on a plan which they thought might be advantageously adopted for large vessels of war. The cells were filled with compressed cotton, which had been found by experiment to be very effectual in stopping shot. On this target was a thin teak backing, and on the teak were bolted one hammered and two rolled plates. The target was bolted on to the side of an old wooden frigate at Portsmouth, under the direction of Capt. Hewlett. The first shot fired at it missed the target, went through both sides of the frigate, and skimmed over the surface of the water for nearly a mile. The firing showed that, whilst the hammered plate split and cracked to pieces, the rolled plates were not broken, only indented, and were superior to the hammered plate in every respect. Unfortunately the target was not firmly bolted to the vessel, and it sprang at each shot, so that the bolts which held the armour plates were broken, and they fell into the sea.

A shot was then tried to test the resisting power of the compressed cotton, and it appeared to answer so well that Captain Hewlett advised a series of experiments to be tried. The Admiralty were willing, but required the targets to be provided by Messrs. Palmer at their own expense. Having already spent upwards of £1000 on experiments for the

good of the country, they declined this proposal, although Messrs. Palmer considered they had proved to the Admiralty this important fact, that the rolled plates were superior to the forged. It is, therefore, claimed for this district the honour of being the first to prove the strength and utility of rolled armour plates, since known and spoken of in Parliament as "Palmer's rolled plates."

Mr. Palmer (as the builder of the iron plated frigate *Defence*) then made a slight digression in order to express an opinion upon the class of marine architecture to which that vessel belongs, and stated that the *Defence*, although in every respect a strong ship, does not combine all the strength which, with the same weight of material, might have been obtained, and, with respect to her model, gave it as his opinion that, if she had had less rise, and more floor, and so had drawn less water, she would have steamed faster, answered the helm quicker, and have proved in all respects more manageable and convenient. The Admiralty authorities, he knew, did not agree in this view, and they are at the present moment spending a large amount of money in the national dockyards for the express purpose of building a class of vessels similar in construction. In his opinion, it was, to say the least, very questionable policy for the Admiralty to speculate in this kind of shipbuilding. Private builders exerted themselves greatly in the production of armour-plated frigates for the Government; those vessels were built in much less time than would have been consumed in the Naval dockyard, and in the matter of cost the difference must be greatly in favour of vessels built by contract. It is surprising to see the tenacity with which the Admiralty cling to wooden ships, notwithstanding the most overwhelming proofs that it is time to adopt iron exclusively.

Mr. Palmer stated that it was his desire to furnish the Association with accurate statistical details of the iron shipbuilding trade of these northern rivers, showing the quantity of iron consumed, the number of men directly employed, and the amount of tonnage launched per annum. But, unfortunately, his neighbours on the Tyne, Wear, and Tees, with a few exceptions, were too much engaged to supply him with the statistics of their respective establishments; he had, therefore, estimated the several totals from such materials, aided by personal knowledge and experience as he had been able to obtain, and the following statement is a pretty close approximation to accuracy.

Estimated amount of tonnage of iron ships launched during the year 1862:—

	Tons.
On the Tyne.....	32,175
On the Wear	15,608
On the Tees	9,660

The number of men annually employed in producing this quantity of tonnage, exclusive of those engaged in the manufacture of engines, was—

On the Tyne.....	4,060
On the Wear	2,500
On the Tees	1,550

The quantity of iron consumed during the same period in the construction of iron ships was—

	Tons.
On the Tyne.....	22,540
On the Wear	9,360
On the Tees	6,760

The amount of iron tonnage at present on the stocks in this district is as follows:—

	Tons.
On the Tyne.....	33,000
On the Wear	19,000
On the Tees	10,630

But these statistics show us only the labour that is directly employed in the production of iron ships, and that, as we all know, is but a small proportion of the whole. It would, indeed, be difficult accurately to estimate the amount of labour that is indirectly concerned in this trade; as for instance in the manufacture of iron, the production of coals, the importation of timber, the construction of engines, and the supply of anchors, chains, sails, &c. Enough has been said, however, to prove that iron shipbuilding is one of the most important branches of industry in this great commercial and manufacturing district.

Mr. Palmer added,—I may, perhaps, be allowed to describe very briefly the operations of my own firm, which I trust will prove of some interest, as showing the extent to which one establishment may be developed. In the first place, we obtain the greater portion of our ironstone from our own mines. At a point on the coast ten miles north of Whitby, the ironstone seams crop out in the sides of the cliffs, and here we have formed the small harbour of Port Mulgrave, where vessels can ride in safety, and ship their cargoes with ease and expedition. Between the Tyne and Port Mulgrave, some of our steamers run direct, making on the average four voyages per week, whilst others of a larger class call to load stone on their return voyage from London. At Jarrow the ore is delivered to the furnaces, by means

of the Armstrong hydraulic cranes, and mixed with ores from Cumberland, Devonshire, and Lincolnshire; thence it is passed to the mills, and from the mills to the shipyards. The number of men employed in these operations is upwards of 3500. The number of tons of iron consumed per annum in our yards and engine works is about 18,000 tons. The amount of tonnage launched during the year ending the 1st August was 22,000 tons. We have 15,000 tons in course of construction, and orders, spread over a period, for 40,000 tons more. Amongst these latter are steamers of upwards of 3400 tons burthen, pronounced by their owners to be "the finest and most complete merchant steamers ever built." They are intended to bring cotton from the Southern States of America, so soon as the unhappy war in that country shall cease; and they will, no doubt, be but the pioneers of others of a similar class. One of these steamers is of sufficient capacity to carry 7000 bales of cotton, and it is estimated that during one year she will bring from New Orleans to Liverpool 38,500 bales. The crew of such a vessel consists of 60 hands, and it would require five sailing vessels of 1200 tons each, employing 130 seamen, to do the same work.

A consideration of the future of the iron shipbuilding trade opens out a vast field for speculation, but the ultimate result is not difficult to anticipate. We have seen with what success sailing vessels have been superseded by steamers in the coasting and coal trades; and we know that magnificent fleets of steamers, engaged in the postal and other services, are ploughing almost every known sea. As commerce increases there will be few trades in which the employment of iron steamers will not be found of advantage. Most of the carrying trade to the Baltic and Mediterranean is already conducted in vessels of that class, and the sailing ships that cross the North Atlantic are being rapidly displaced by iron steamers. Their advantages in strength, speed, and capacity are so marked that sailing vessels of timber must give way before them. Even the Admiralty, cautious and unyielding though it be, will have to abandon its "wooden walls" in favour of the stronger and more useful material—a material, too, that lies in rich profusion beneath our feet, and has not, like timber, to be purchased of other nations. The commercial men of this country have set the Admiralty a signal example of industry and enterprise. It is they who have made the experiments and adopted the inventions that have established the maritime supremacy of this country, and it is owing to their energy that we find on every sea, in the shallow rivers of the East, and the deep broad waters of the West, English built ships of commerce, diffusing the benefits of free trade, and linking nations and tribes together in bonds of amity and peace. The true source of our national greatness is to be sought in this wonderful development of our merchant navy. Other nations are entering into friendly rivalry with us, but the larger share of the carrying trade of the world will ever be secured to that country that can produce vessels combining the largest capacity with the utmost amount of economy and expedition in construction, and that can, at the same time, navigate those vessels with the greatest degree of skill and rapidity.

In conclusion, permit me to express the proud conviction I entertain, that the mineral wealth of this district, and the skill and endurance of its workmen, whether on land or sea, will enable the locality that gave birth to an Armstrong and a Stephenson to maintain its character for maritime industry and enterprise, and to bear its full share in promoting the commercial greatness of the country.

SHORT ACCOUNT OF THE IMPROVEMENT OF THE RIVER TYNE UNDER THE PLANS NOW BEING CARRIED OUT.

When the writer was appointed engineer to the Tyne Improvement Commissioners, in 1859, certain works had been constructed and others were in progress. Of these the most important were the river walls, which had been partially constructed between Bill Point and Jarrow Slake, very much according to a plan laid down by the late Mr. Rennie, in 1813; the Northumberland Dock, made by the River Commissioners, having an area of about 50 acres, opened in 1837; the Tyne Dock, of a similar area, by the North Eastern Railway Company, opened in 1859; and the piers works at the entrance to the river, now about half completed, and then about half their present extent. The river, at that period, 1859, was much as in 1855 when its state was examined and, after a long and careful inquiry, reported on by a Royal Commission, of whom the late Mr. Brunel, Admirals Bowles and Fitzroy, Lieut. Generals Sir John Bell and Robert Armstrong, Q.C., were the members. They state in their report, in relation to the past history of the river, as follows:—

"During the last two or three centuries all the evidence would lead to the conclusion, that a very general similarity has been maintained in the state of the Tyne, notwithstanding local and partial changes. In the present century much more exact surveys have shown a similar result, namely, that notwithstanding encroachments on both banks, and many artificial works executed with various objects, the navigable state of the river has not been much altered. Whether it has been improved, and whether the works in progress are likely to improve it, or otherwise, are matters of opinion rather than fact, on which parties differ materially;

but the preponderating evidence of good authorities encourage a belief in some improvement. That this should still be only matter of opinion, needs explanation. Formerly ships sailed up and down this river, and required greater width of channel than is now wanted for steam navigation. At present the channel is less winding and deeper, but it is not so wide as it was; and although the passage for steam propelled vessels appears to be improved, the navigable condition for ships under sail, except with a fair wind, is probably to a certain extent deteriorated."

When the writer came to consider the state of the river, with the view of recommending a plan for its improvement, he found the accommodation for vessels resorting to it to be very deficient; the expenses for lighterage from the manufactories, which are principally situated in the upper part of the river, to the larger class of vessels which did not ascend above Shields' Harbour, to be large; the shifting character of the sands rendered uncertain the depth at the coal shipping places and factories on the banks; it was not unusual for vessels to be detained two months, and even longer, with their crews on board, waiting for moderate weather, with a tide sufficiently high to be able to cross the bar; deeply laden inward bound ships had a corresponding difficulty in arriving, which operated to prevent the Tyne becoming an import port; its entrance was dangerous with on-shore gales; the insand and middle ground stretched nearly across the entrance to the harbour, and in rounding it vessels, particularly if long and deep-laden, had to come nearly broadside on to the tide, when much damage was done, especially when vessels left in fleets, which was frequently the case after stormy weather, to the extent of 200 and 300 vessels in one tide, in addition to those entering. This danger became of increasing magnitude with the increasing size of vessels; the passage through Shields Harbour was very shoal, so that deep-laden vessels could not leave the docks and take the bar at high water of the same tide, which involved their staying in the harbour, after leaving the docks, till high water of the following tide, thereby incurring considerably increased expense.

Between the Northumberland dock and Newcastle, the small river steamers grounded on some of the shoals for two and three hours at low water of spring tides, and vessels of but small draft, about 13ft. to 15ft., could ascend the river to Newcastle, and these only at spring tides.

Above Newcastle the navigation was only used by keels, which were interrupted in their passage by not being able to pass over the Scotswood Shoal at high water of neap tides.

The deficiencies in the navigation were comparatively little felt in the olden time, when the Tyne was the only outlet for the comparatively small produce of the coalfields of Durham and Northumberland, in the class of vessels of about 16ft. draught, then most employed in carrying on the trade, which was principally coasting and short foreign; but when a larger and deeper draughted class of vessels came to trade to the port, to carry the greatly increased quantities of coal required to supply the steam marine of a large portion of the world, the detentions and risks became serious.

These inconveniences, and their consequent expenses, were the cause of much serious complaint, and were diverting the trade and commerce natural to the river, which the railway system made easy to do, to be developed at other places where improved provision had been made for its accommodation.

Having explained some of the commercial features of the time, when the writer had the plan for the improvement of the river under consideration, he will now give a few of its principal physical features, from observations then taken.

The rise of an average spring tide at

	Ft.	In.
Tynemouth was about	14	8
Hebburn	12	3
Below Newcastle Bridge	11	9
Above Newcastle Bridge	11	5
Scotswood	7	9
Newburn	3	11

Ryton was the limit of the tidal flow and the conservancy.

The high water of average spring tides was level between the sea and Newcastle, and rose about 12 inches higher at Newburn, but very high spring tides scarcely filled the tidal receptacle at Newcastle.

The high water of an average neap tide rises 4 to 5 inches higher at Newcastle, and about 11 inches higher at Scotswood, than at sea; it does not reach Newburn.

The rise of an average neap tide was, at

	Ft.	In.
Tynemouth	6	6
Hebburn	6	6
Below Newcastle Bridge	6	7
Above Newcastle Bridge	6	7
Scotswood	3	5

The high water of average spring tides rose higher than the high water of average neap tides, about 4 feet at Tynemouth, 3½ feet at Newcastle, and 3½ feet at Scotswood.

The average travel of the tidal wave between Tynemouth and Newcastle varied, but with average tides it was 8 to 12 miles per hour, and the spring tide wave between Newcastle and Newburn was about 12 to 18 miles per hour.

At that time, during average spring tides, there was 20½ feet of water at high tide on the bar; within the bar, near to the Narrows, on the north side of the channel, a dangerous hard projection called the "stones" existed, but which had been partially removed; and immediately above, on the opposite side of the river, projected the insand and middle ground; a little further up from the north shore projected the Dortwich sand, with about 6 feet on it at low water; higher up was the Jarrow shoal, above which there were several shoals having not more than 3, 4, and 5 feet on them at low tide. Above Newcastle, at low water, the bed of the river was a great sandbank, through which the land waters drained, a great portion of the channel being not more than a few inches, and most of the remainder not more than 2 to 3 feet deep.

The places where trade was conducted and vessels lay, were mostly at the bends on the concave side of the river, where the current had scoured deep water—as between the Low Lighthouse and New Quay, North Shields, where the depth at low water was 15ft. to 21ft.; opposite South Shields, between Panash Point and Tyne Docks, 12ft. to 18ft.; the Killingworth Staiths, 10ft.; the Pelaw Staiths, 10ft. to 12ft.; the Tyne Main Staiths, 7ft. to 8ft.; Blaydon, 3ft. to 5ft., and several other such places; and Newcastle, where the deepening of the channel was due to the contraction of its width, the depth at the Quays was 5ft. to 6ft., with two short berths about 13ft.

A general comparison of the observations taken by me in 1859, with those left on record by Mr. Rennie, taken in 1813, show the high water to be about the same at both periods; but that the low water level at Newcastle had been depressed during that period about 14in. to 18in., lessening towards the sea.

In the year 1859, the number of vessels that arrived in the river was 18,878, having 3,143,857 register tonnage; and they carried altogether, including imports, exports, ballast, &c., about 5,500,000 tons; there was, in addition, carried on the river, in keels, nearly 2,000,000 tons, and about 1,000,000 tons of dredging material and factory rubbish, carried along the river to be deposited at sea.

With these data, the writer prepared a plan, by which he intended to take a comprehensive view of river improvement, and which could not fail, if successfully carried out, to benefit materially all the interests situated on the banks of the Tyne. This plan, in 1860, was submitted to the River Commissioners and approved by them, and received the sanction of Parliament in the session of 1861.

A portion of the plan sanctioned by Parliament was a dock of about 40 acres area, known by the name of the Low Lights Dock, designed with the view of affording better accommodation to the larger class of vessels, effecting a saving in towage and pilotage, and enabling that portion of the steam coal-field which is situated on the seaboard to ship the coals from it with a somewhat shorter railway lead; but, as the dock does not necessarily form a portion of the river improvement, which it is the intention of this paper to draw attention to, it will not be further alluded to.

The plan of river improvement contemplated deepening, widening, and straightening the river from the sea to the limits of the Commissioners' jurisdiction near Ryton, a distance of nearly twenty miles inland, so as to make a channel easily navigable for the largest vessels between the sea and Shields Harbour, the Docks there, and Newcastle; and for such a class of vessels in the upper part of the river as can be passed under the High Level Bridge at Newcastle; a sufficient depth of water to be carried up to the river walls, for the purposes of traders having establishments on the banks.

To give effect to these views, the plan provided for a depth at high water average spring tides of 29ft. from the sea to the docks, thence to Newcastle, 26ft., and thence to Ryton (the boundary of the Commissioners' jurisdiction), 23ft.; at average neap tides the high water depth would be about 3 to 4ft. less.

This would give a low water depth, at spring tides, of about 15ft. up to the docks, 12 to 13ft. thence to Newcastle, and above Newcastle 10 to 11ft.; at average neap tides the depth would be 3 to 4ft. more.

And to give a safe and easy navigation, at the abrupt bends, for the larger class of vessels, expected to use the river in its improved condition, it was intended to remove all projecting points that would be difficult to navigate; as, for instance, the stones, the unsand and middle ground, Whitehill Point, Bill Point, Bill Quay Point, Felling Copperas Point, Friar's Goose Point, and other smaller points; and above bridge, to cut a straight channel between Scotswood and Semington, and to remove other projections, and form a uniform navigable channel, leaving the existing channel at Blaydon to be deepened and used as a tidal basin for the accommodation of the trade located there.

The width of the river would then be, in Shield's Harbour, from 1000 to 1400ft., gradually diminishing to 850ft. at Howden, 700ft. at Hebburn, 500ft. at Newcastle, except at the narrowest part, where the quay walls are

already constructed to the limited width of 350 to 400ft., 500ft. above Newcastle Bridge, 450ft. at Scotswood, and 400ft. at the boundary at Ryton.

To admit of masted ships into the upper river, a bridge, in lieu of the existing town bridge, at Newcastle, was provided, the two centre spans, each 100ft. wide, to swing open, when it was expected that sailing vessels up to 400 tons, screw steamers up to 1000 or 1200 tons, would use the upper river, and receive their cargoes without transshipment or lighterage; and that vessels of any size, the *Great Eastern* not excepted, could be built and engined there.

The estimated capital expenditure to complete these works, with the purchase of land, &c., was £950,000.

The improvements just indicated would, when executed, give to the river a channel greatly exceeding its natural capacity, the formation of which the writer intended to accomplish and maintain by dredging; and remove the projecting points by blasting, excavation, diving, and the other usual means. The cost of maintenance of this channel he estimated to be moderate.

The piers at the entrance to the river, which were being carried out under the direction of the late Mr. Walker, he relied on for shelter when dredging in the open sea; but, from the slow progress which these works have made, he has not yet received the full benefit from this source that he expected, though, no doubt, it will be so. These works have already considerably protected the entrance to the port, and will increase in value as they approach completion by giving increased shelter to vessels entering the harbour, by dispersing and dissipating the waves after they have passed their heads, thus enabling vessels to bring up in comparatively quiet water; and the shelter so afforded will permit of the dredging machinery being applied effectually to deepen any requisite area inside of them that may be found requisite either for refuge or the ordinary operations of commerce.

The estimated expenditure to complete the piers into a depth of 30ft. at low water, as made by Mr. Walker, was £660,000; that being the depth into which the commissioners have at present resolved to carry them.

When the improvements in the river are carried out, the writer anticipates that the high water will rise about 1ft. higher at Newcastle, and 2ft. higher at Ryton, than at the sea; that the tidal column of the sea will be carried inland to the limits of the improvements; that the tidal wave will be accelerated to an average speed of 16 to 20 miles per hour; and that the great additional momentum due to the increased column of tide and greater area of receptacle, situated chiefly in the upper part of the river, and the increased sectional area of channel by allowing a more rapid discharge of the freshes, will greatly add to the scouring power of the tidal and flood waters on the river, but more especially on its sea channels.

Towards carrying out these works some progress has been made.

The stones, the insand and middle ground, the Dortwich sand, a large portion of the Whitehill Point have been removed; the general river has been deepened to such an extent, that there will be shortly, probably during the present year, the depth of water between the sea and the docks contemplated by the original plan; the river up to Newcastle has been so far improved, about 2 to 3 feet, that the small passenger steamboats are never interrupted in their passage at low water, and the passenger steamboat traffic has thus been enabled to be established. The increased depth at the same time benefited the general trade, and the upper river can be navigated by keels during all tides.

There has been already provided, or is under contract for delivery during the next three months, dredging plant, consisting of 6 dredging machines, 7 tug steamboats, 40 hoppers, 10 screw hoppers, 10 craft, repairing shops, &c., of the value of about £250,000, which is capable of raising out of the bed of the river about 2½ to 3 millions of cubic yards per annum.

Plans are in progress, and nearly completed, for the removal of Bill Point and Friar's Goose Point, and the reconstruction of Newcastle Town Bridge as an opening bridge.

The writer has hitherto every reason to be satisfied with the results attending the prosecution of these works, and does not entertain any doubt of their ultimate success. He fully expects that in about four years hence the improvements will be completed up to Newcastle, and in about four years afterwards up to the boundary at Ryton.

The only modification of the plans just described is the endeavour now being made to bring 20ft. of water at low tide from the sea into Shields Harbour, in place of 15ft., as originally intended; and the only further deviation at present contemplated is to make a portion of Shields Harbour and adjoining river 26ft. to 28ft. deep at low tide, in place of 15ft., as originally intended, in order that the very largest vessels may then be able to float there—a result which it is hoped may be accomplished during the next or following year.

Already with the improvements made there is little detention to shipping, and large vessels are frequenting the port in increasing numbers. The ease

of entrance, as well as exit, combined with providing proper accommodation for cargo will, the writer anticipates, at no distant date be the means of establishing an import trade, as ships chiefly now arrive light in ballast; and he would expect that the general facilities afforded by an improved river, which in fact will become a deep and spacious harbour, nearly 20 miles long, and from 400 to 1400ft. wide, will be so valuable as to add vastly to the industrial pursuits and commerce carried on on its banks; and by no means the least expectation he ventures to indulge in, the hope that the vessels of her Majesty's navy—the Channel Fleet, if wished—may freely enter and leave our port, and be well accommodated when in it.

ON REGENERATIVE GAS FURNACES AS APPLIED TO IRON WORKS.

By C. W. SIEMENS, F.R.S., &c.

The principle of the regenerative gas furnace has already been explained to the scientific public by Professor Faraday, in a lecture delivered by him at the Royal Institution in June, 1862. Its general construction, and the history of its invention and gradual development, form, moreover, the subject of a paper which was read by me in January, 1862, before the Institution of Mechanical Engineers.

Since that period this principle of heating has been extensively applied in England, France, Germany, and other countries to glass houses, for heating gas retorts and muffles for metallurgical purposes, for melting steel, and for puddling and welding iron.

The ostensible object of this invention being to save fuel, it could hardly be expected that it would be favourably looked upon in this, the greatest coal producing district of the whole world; but experience has proved that there are other advantages resulting from its application which, in the case of puddling and working iron, are even superior in value to mere saving of fuel. The accompanying illustrations (see next page) represent a furnace for welding and working iron, and the gas generator connected with it.

The heated chamber K, is of the usual form, but, instead of a fire-place, there are four passages MN (two at each end of the chamber), leading downwards into four regenerators, or chambers LL, filled with loosely piled fire-bricks. The lower extremities of these four regenerator chambers communicate with two cast iron reversing valves.

The gas arriving from the producer through a pipe J, is directed into one or more regenerators, according to the position of the valve S, then ascends upwards, and becomes charged with heat previously deposited in the brickwork, and issues into the furnace at a certain point where it meets with a current of heated air, rising from the second regenerator to effect its combustion. The products of combustion pass away through the opposite regenerators and the reversing valves into the chimney flue.

The last named regenerators receive at this time the waste heat of the furnace, becoming heated at their upper extremity to the temperature nearly of the furnace itself, but remaining comparatively cool towards the bottom.

Every hour or half-hour the direction of the currents is reversed by a change of the valve levers; the heat, before deposited in the one pair of regenerators, is now communicated to the air and gas coming in, while the waste heat replenishes the second pair of regenerators.

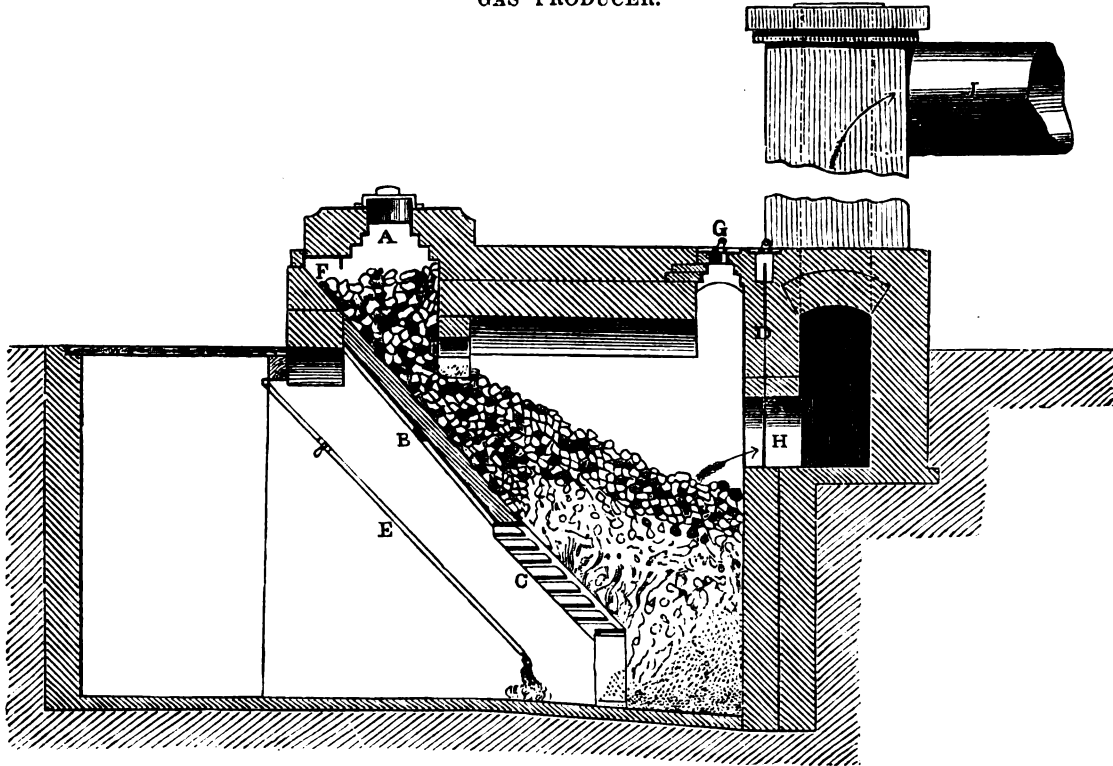
The gas producer consists of two inclined planes, upon which the fuel descends, being gradually deprived in heating of its gaseous constituents, and finally burnt to carbonic oxide by the air entering through the grate at the bottom of the inclines. Water admitted at the bottom also assists in the decomposition of the ignited coke at the bottom, converting the same into carbonic oxide and hydrogen gas.

The saving of fuel which has been effected by this arrangement amounts to from 40 to 50 per cent. In the application to reheating and puddling furnaces a saving of iron has been effected, owing to the mildness of the gas flame, of from 3 to 4 per cent. of the entire quantity put in; the iron also welds more perfectly than it does in the ordinary furnaces. Smoke is entirely obviated.

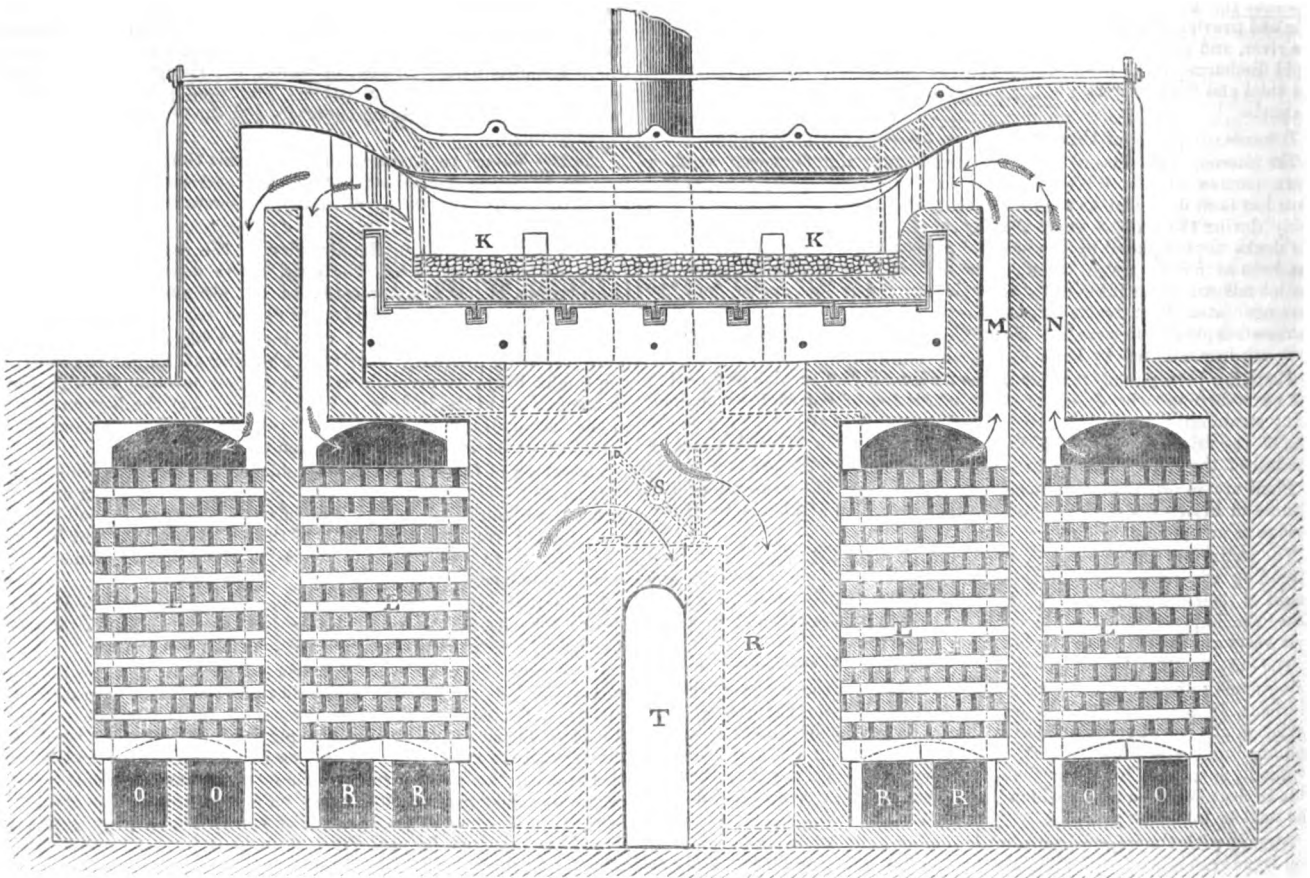
By another arrangement the regenerative principle has been applied also to coke ovens, the result being that the separation of the coke from its gaseous constituents is effected without losing the latter.

In placing the coke ovens constructed on this plan near the works where the iron is puddled and reheated, the latter operation may be entirely effected by the gas generated in the coke necessary for the blast furnace in producing the pig iron. Or the gas resulting from the regenerative coke oven may be used to heat the blast and boilers connected with the blast furnace. These latter improvements are now in course of being carried into effect on a large scale. The gas generated from these last-named producers is of a very illuminating character, and may, it is expected, be used for that purpose in preference to the hydro-carbon now manufactured by a much more expensive process.

GAS PRODUCER.



RE-HEATING FURNACE.



WORKING RAILWAYS BY STATIONARY ENGINES.

By R. AND W. HAWTHORN.

(Illustrated by Plate 251.)

The paper brought before this section is a description of a method of working a certain class of railways by means of ropes from stationary engines—specially adapted to underground railways.

A system of working railways by fixed engines and ropes has long been in use on the colliery railways around Newcastle-upon-Tyne, as well as in other districts, and a plan for the same was made the subject of a patent by Mr. Benjamin Thompson, then of Ayrton Cottage, in the County of Durham, and was introduced on one or two colliery railways. It consisted of a succession of fixed engines at certain intervals from one end of the line to the other, each engine being employed to work a portion of the railway in the following manner.

The engine gave motion to two rope rolls, and the rope from one of those rolls was attached to one end, and the rope from the other roll was attached to the other end of the train. Whilst one of these rope rolls was disengaged from the engine, and allowed to run loose, the other was in gear, and the rope from it was passed along the line and round a loop sheave, then brought back and attached to the train. The engine being put in motion, the train was dragged to the furthest end of the section worked by that engine, at the same time unwinding the rope from the loose roll, and taking it with it to be afterwards employed to drag back the returning train. This was continued throughout the line, each successive engine taking up the train and carrying it over a section of the line.

This method was not a satisfactory one for the conveyance of passengers, as the rider or guard in charge had not sufficient control over the movements of the train, and there is an objection to the carriages being attached directly to the rope, and at such a distance from the motive power. Ropes have been, and are yet applied in other ways; for instance, on gravitating or descending planes, down which a loaded train passes, having the rope attached to the after end, round a sheave at the top of the incline, and thence down to the ascending train, and thus the descending loaded train draws up the ascending light train; or where the load has to ascend, a fixed engine is employed to draw it up, and the descending train takes the rope down with it. Ropes are also applied in a variety of ways, to the working of incline planes on passenger railways. Thus there is nothing new in the use of stationary engines and ropes for working railway traffic.

It will be observed that, in all the cases referred to, the rope is attached directly to the carriages.

In the proposed plan now offered to the notice of the members of the Association, the means of communicating motion to the train gives greater security, as well as the advantage of avoiding the necessity of attaching a train to the end of a rope, thus ensuring to the guard as complete control over the movements of the train, as he now has in the employment of the locomotive engine. In the new system, it may be stated, without exaggeration, that the rope drives the locomotive wheels, and each carriage carries its own railway.

It is proposed, with the ordinary construction and gauge of railway, to place in the intermediate space, between a double line of rails, a series of double grooved sheaves fixed on spindles or axles, which pass across under the rails, extending a little over the centre of each line; a plain wheel or roller is fixed upon each end of these axles, by which the motion is communicated to the train from a stationary engine or engines, placed at a convenient point of the line, by means of an endless wire or other rope passing alternately over and under the grooved sheaves to the extremity of a section of the line, where it is taken round a large loop sheave and returned to the engine now passing over each sheave, which it before passed under, and *vice versa*, the double groove providing for the rope crossing itself without contact.

Having traversed twice along the line of sheaves, the rope goes again on to the large winding sheave of the engine, on which a sufficient number of turns are taken to ensure the requisite friction.

From this arrangement of the rope on the sheaves it will be seen that every alternate sheave runs in the same direction, and every intermediate sheave in the contrary direction; and this motion is communicated to the traction wheels or rollers, before mentioned.

It is proposed to construct the carriages for passenger lines on the principle of those used in America and on the Canadian railways, of a length of from 60 to 75ft., supported on bridges, and capable of seating from 200 to 250 passengers, each carriage to be fitted with traction bars, these bars extending over two or more alternate traction rollers, and to be furnished with the ordinary flanged wheels for running on the rails. The traction bars, of which there are two, are placed side by side at such a distance from each other as may be necessary to meet the requirements of the line, as to curves, &c.; and these traction bars are worked either in connection with, or independent of each other by a suitable arrangement of levers or other gearing, by which either of the bars can be raised or depressed thereby, bringing a portion of the weight of the carriage upon the traction wheels or rollers, thus giving motion to the train of carriages in either direction. Or both these bars can be raised out of contact with the traction wheels or rollers, and the train left free from all tractive force.

The traction bars will be nearly the full length of the carriage, and the traction rollers will be placed about 18ft. apart, or at the rate of 293 per mile.

The carriage made in this way is adapted for running with either end first, being provided at each end with a platform on which the driver stands to work the traction bars; and it is considered that, for ordinary traffic, one carriage will be sufficient to form a train, but two or more may be attached to each other, or the number of trains of a single carriage each may be increased to meet the requirements of the traffic.

The motion of the train can be quickly and certainly retarded or stopped by raising one bar and depressing the other in the manner of a brake, thereby reversing the direction of the driving motion.

A separate, or independent traction carriage may be used, fitted with the

traction bars and gear; but it is considered that such an arrangement would in most cases only be adding a useless and unmeaning weight to the most useful portion of the train.

The present line of Underground Railway through London, from Paddington to Farringdon-street, is favourable to the use of the locomotive engine, where so much of the surface of the ground under which it passes is unoccupied by buildings, and readily admits of a good deal of open cutting and ventilation at the stations, which cannot be the case where the railway passes under the densely-populated parts of a city, as those projected in London must do. In such cases, it will be necessary to provide for working in a continuous tunnel, of perhaps three or four miles in length, in which the steam and smoke of locomotive engines would prove obnoxious to a much greater extent than is experienced on the present line, which is only partially an underground railway. As there does not appear to be any means of remedying these evils, except at a very extravagant cost, it is believed that the new system may be introduced with advantage in such cases as are above referred to, viz., railways passing under large towns, or in situations where opportunities do not occur of having openings to the surface.

The maintenance of the engines will be considerably less than with locomotives, to balance the expense of keeping in working order the sheaves, ropes, &c., which will cost more than an ordinary line.

Both calculations and experiments on the adhesion required to propel a train remove any reasonable doubt of being able, by the new system, to obtain sufficient traction force by the traction bars and pulleys; and it is evidently quite feasible to increase this traction force if required. With a locomotive, a train of 15 or 20 carriages has to be drawn by an intense pressure on 6 or 8 points, and it is this which adds such a heavy item to the cost of railway maintenance. This disadvantage will be to a great extent remedied by the proposed system, the tractive force being more distributed, and, consequently, the wear and tear diminished.

Finally, if such a system as the one proposed can be introduced, free from the objections that have hitherto been considered inseparable from the use of ropes, it will greatly facilitate the construction and extension of underground railways without their present drawbacks.

In the discussion which ensued, after the members had had an opportunity of examining the working models shown in the Exchange Rooms Exhibition,

Professor THOMPSON (Dublin), stated, he considered that the friction of the rope on the sheaves would be excessive, from the frequent bending of the rope. He thought the present locomotive system was much better.

Mr. G. B. BRUCE thought there were difficulties in the way of the practical application of the system. A difficulty would be found in getting the carriage to bear upon three surfaces fairly and equally. That was a mechanical difficulty which might be overcome. He thought the motion of the wheels underneath the carriages would cause a disagreeable motion in the carriage, and the comfort of the passengers would be interfered with. He was also afraid that in going round a sharp curve there would be a danger of the traction bar getting on the wrong wheels.

Mr. J. JAS. TURNER thought the direction of the rope was merely a matter of detail, which might be changed without any great alteration of the scheme. In tunnels, curves were avoided as much as possible, and there would be no difficulty in working round a reasonable curve. It was stated in the paper, that the scheme was intended to be chiefly applicable to underground railways, or in cases where the smoke and steam from locomotives would be objectionable.

Mr. J. FERRIS (Derby), said that curves were not always avoidable in tunnels, and all sorts of curves were made in them. He understood that the invention was intended to be applied, not to the ordinary railway, but to underground railways, such as had been projected in the metropolis and other large towns. He had more faith in another scheme, which had been tried to a small extent. He meant the pneumatic railway.

The PRESIDENT said it was not made clear by the paper, whether the traction bar was to be applied to each carriage of a train, or to one only.

Mr. FLETCHER thought that, when the traction bar had passed over one wheel, it would have a tendency to drop, unless every wheel was at or about the centre, and a great shock would be given.

The PRESIDENT said, as he understood the scheme, the carriage was always supported on two wheels.

Mr. ABERNETHY, C.E., said there was another objection, viz., the using of the "journals" of the axles, which would alter their level; and the wearing of the traction bar would also be unequal, causing the bar to bear upon one wheel and not on another.

Mr. J. F. SPENCER explained that it was intended that every carriage should be a driving carriage. With regard to the difficulty of working round curves, there would certainly be no greater difficulty than existed at present. With reference to the shaking of the carriage, he did not apprehend that, with the arrangement of springs contemplated, there would be more than in the ordinary railway carriage. He thought that it would be found that a much greater incline could be worked up by this scheme than by the ordinary locomotive system. The object of the invention was not to supersede the ordinary railway, but for employment in tunnels, where the use of the locomotive was very objectionable.

Mr. ABERNETHY said that, in going round a curve, the traction bar would be a tangent to the curve, and there would be a slight motion in passing from one wheel to another.

Mr. SPENCER, in reply to a question, explained how the carriages were stopped, when in motion.

Professor THOMPSON said that one part of his objection to the scheme was removed, by the statement that it was intended only for tunnels and not for general use. He wished to know in what respect this mode would be superior to the ordinary system of wire ropes, which was at present used in many tunnels.

Admiral Sir EDWARD BELCHER said that, having something to do with ropes,

and being aware of the difficulty of crossing two ropes in a purchase, he thought the ropes might have a tendency to cut each other if one of them was taut and the other slack.

Mr. SPENCER, in reply to an objection as to the ability to stop the carriages, explained that, by the mechanism connected with the traction bars, the motion of the carriage would be completely under the control of the guard or driver.

Mr. ABERNETHY understood that, in order to stop the train, it would be necessary to disengage the traction bar.

Mr. SPENCER said it would. There would be a guard to every carriage, which would be built on the American principle, to carry about 240 passengers. On a short line, with constant traffic, each train would only consist of two or three carriages.

The PRESIDENT inquired if the carriages would be linked together.

Mr. SPENCER said they would, but not necessarily. In a train of carriages the first one only might be used as a traction carriage, the others being dragged by it as ordinary trains are by a locomotive. He wished it to be understood that the plan was necessarily incomplete as to many points of detail, and, therefore, he hoped that it would be charitably dealt with.

Mr. WM. HAWTHORN replied generally on the subject. He stated that, in cases where this principle was intended to be employed, he supposed that one carriage would generally be all that was necessary to constitute a train. If more were required it would only be necessary to increase the number of trains. The advantage this system had over the ordinary mode of working with wire ropes was in the perfect command of the movement of the train which the driver or guard had, by simply raising the traction bar from the sheaves, when the con-

nection with the motive power ceased at once. The greatest amount of friction would be at the bends of the rope on the sheaves; but the friction of the axle would not be so great as might seem at first sight, and the rapid passage of the train over the wheels would prevent any tendency to heat the bearings, on which the weight would only be for a few moments.

Admiral Sir E. BELCHER.—Supposing you were ascending an incline, and the power was not sufficient, and the train commenced running back, how would you stop it?

Mr. W. HAWTHORN.—It is not intended that this scheme should be applied to inclines that could not be overcome. Supposing you were ascending an incline by a locomotive under the same circumstances, you would be in the same position.

Admiral BELCHER.—But we would have the steam power to help us.

Mr. W. HAWTHORN said there was another thing that had been alluded to—the jar that would be felt by the passengers in the carriage, by the striking of the traction bar. This, however, could only occur from some defect in the line, which would require to be kept in good repair the same as an ordinary railway. The springs which it was intended to apply would render the motion of the carriage quite easy on a good line.

Mr. THOMAS WEBSTER said anything coming from Mr. Hawthorn must be worthy of their attention, and he trusted that the scheme might be followed up, so that they might see how far it would succeed.

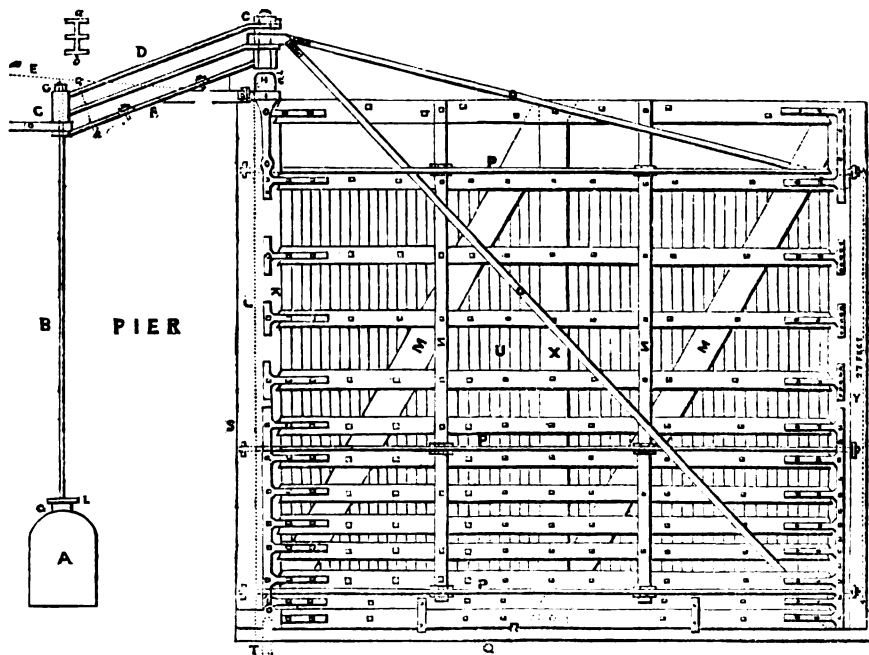
The PRESIDENT said the paper had been well discussed. It was a most ingenious scheme, and had their best wishes for its success.

NEW PLAN FOR HANGING DOCK GATES.

The following is an abstract of the paper read by Mr. R. A. Peacock, of Jersey, upon this subject:—

The works of docks and harbours must necessarily be strong and durable, and therefore expensive; but any new methods of construction which are sufficiently durable and convenient, and by which expense is considerably reduced, are so much gained. He exhibited models of gates, showing how the mortices and tenons were removable. Shipping having gradually, but largely increased in dimensions during the last twenty years, it became necessary to provide wider and deeper water-ways to docks, and consequently dock gates of greater height and length. Rollers for the outer ends of the gates to travel upon, by means of tramways at the bottom of the water, were apparently thought indispensable. These tramways, being below the level of the sill of the lock, necessarily became

more or less covered with mud, sand, &c., and were, as a matter of fact, so difficult to open and shut with suitable expedition, as to render necessary the very valuable, but at the same time very costly, hydraulic apparatus now in use. The question is, can gates be so constructed as to carry themselves without rollers, and so as to save a large portion of their first cost, and the whole of the heavy first cost and annual expense of hydraulic power? After mentioning a number of inconveniences incident to the present system of dock gates, he went on to say—To prevent all these inconveniences, why not treat the dock gate like an ordinary field gate? make all its parts strong in proportion to its weight, which, in the present case, is about 45 tons; make it carry itself, and so dispense with rollers and tramways. He then proceeded to describe, first, the girders and its fastenings, which are to carry our dock gate as a gate post carries its field gate, and then the suspended gate from the girder. He then remarked that this is



clearly an advantage over gates of the usual system, where the pivot is at the bottom and inaccessible on account of the weight of the gate, and also on account of the mud and the water; the bottom of the heelpost fits into a strong cast-iron shoe. He then referred to the construction of the gate, so as to secure sufficient rapidity and enable the gate to carry itself without the use of rollers, and having described the minor details of the gate, went on to show the immobility of the tenons and mortices. He stated that four lockmen could work two pairs of these gates at a cost for wages of only about £200 per annum, and the heavy cost of hydraulic power is got rid of altogether.

We may add that the dock gates referred to in this paper have been described at length in a pamphlet published by Mr. Weale, of High Holborn. This

pamphlet explains the manner in which the gates are formed so as to carry themselves and dispense with rollers and tramways; it also describes the mud recesses into which the gates sweep a portion of mud every time they are opened, both which contrivances the author contends assist materially in diminishing friction. But it is thought the greatest advantage is gained by having the pivot six feet above water, so that grease can be applied at pleasure, instead of, as under the present system, having the pivots constantly immersed in mud and sand and salt water, and totally inaccessible. By these means it is sought to diminish the friction to a minimum, instead of leaving it large as it now is, and then conquering it by sheer force and at great expense. It is also proposed to make the gates of wood instead of iron, the former costing less than half as much as

the latter, and there being no material difference in the respective durability of the two substances, for while wood decays iron corrodes. The paper read by Mr. Peacock at the Newcastle meeting had for one of its principal objects to prove that the proposed wooden gates were so very rigid in their construction, that no movement of the tenons in the mortices could possibly take place. We have reason to believe that the author of the paper, being particularly desirous not to represent his proposed improvements in a more favourable light than subsequent investigation would justify—estimated at the moment that it would take four men five minutes to open or shut a pair of the gates. A calculation has, however, since been made, which is subjoined, from which it appears that four men to each gate can open them in less than one minute; and in that case they will be far cheaper and not less efficient than the present system.

The following is a calculation of the power required to open one of the improved dock-gates, for a lock 70ft. wide and 27ft. depth of water over sill, each gate weighing 45 tons, 4 men to each gate. Pivot, brass upon cast iron, and lubricated with grease; cost of a pair of gates, £2200:—

The area of the pivot, placed 6ft. above water, is 388.77 superficial inches; by which the weight of the gate, being divided, gives a pressure on the pivot of 2.32 cwt. per square inch. And Mr. George Rennie* found this gave a friction of .214, which amounts to 9.63 tons on the 45 tons. The centre of the pivot is

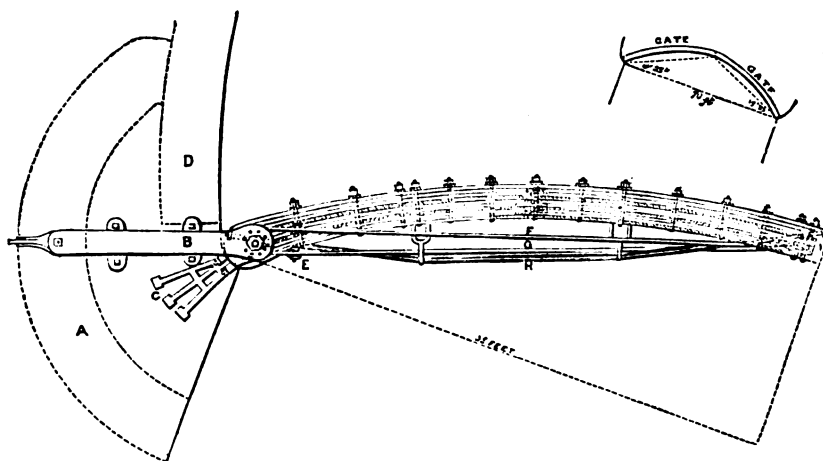
37ft. in a direct line from one end of the gate, and one foot from the other end, giving a leverage of 37 to 1. And $\frac{9.63}{37} = .26027$ ton, or 580lb., the power to be

overcome after allowing for the leverage of the gate. And $\frac{5381b.}{4 \text{ men}}$ gives 1451lb. per man, which is a light load for a man to draw; and so the gate can be opened or shut without any machinery. As a matter of prudence, however, in case of emergency, the £2200 includes the cost of a pair of winches. With regard to time, supposing the men to travel at the rate of only one mile per hour, they will traverse the length of the arc described by the end of the gate, namely, 52ft. 4in. in 36 seconds, to which add (by estimation) 5 seconds for the impediment caused by the mud from time to time deposited. We have thus a total of 41 seconds for opening or shutting each gate by the simple strength of 4 men.

It appears that when once the heavy expense of the hydraulic and its steam engine has been incurred, a seven horse engine, occupying a very small space, may be established for £60. But there must be, no doubt, several men besides to perform the business of the lock and attend to the engine. In course of time, both the hydraulic and the iron gates, as also the wooden gates, must be renewed. The former at a very heavy, and the wooden gates at a comparatively trifling cost. This subject is certainly one well deserving of attention.

We may add that a model of these gates was exhibited in the late International Exhibition.

* See Mr. Rennie's Table on Friction, frequently reprinted in "Weale's Engineer's Pocket Book," now sold by Messrs. Lockwood and Co.



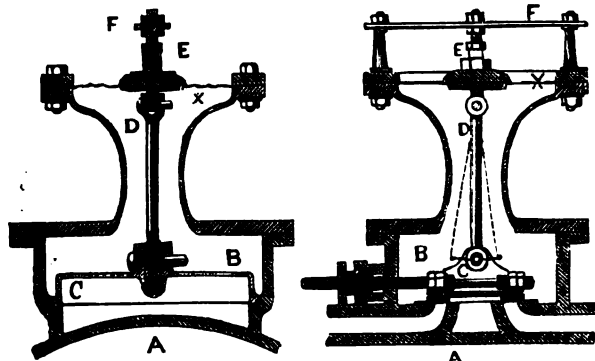
WALKER'S EQUILIBRIUM SLIDE VALVE.

A want has long been felt for some simple means of reducing the friction consequent on the working of slide valves of steam engines. Several plans have been tried for accomplishing this desirable object. The accompanying diagrams illustrate a method recently invented by Mr. E. R. Walker, of Haigh Foundry, Wigan. It appears to us to give promise of being at least as effective as any of the plans previously made use of, while there are peculiar advantages attending its employment not aimed at hitherto.

Figs. 1 and 2 are sections of a cylinder and steam chest with a short slide valve, having Mr. Walker's apparatus attached. A is part of the

FIG. 2.

FIG. 1.



cylinder; B, the steam chest; C, the slide valve; D, a connecting link; E, a screw with nuts for altering the position of the link; F, a flat bar of spring steel; and X, a thin flexible plate of metal.

When the steam fills the chest B, it exerts a pressure in all directions,

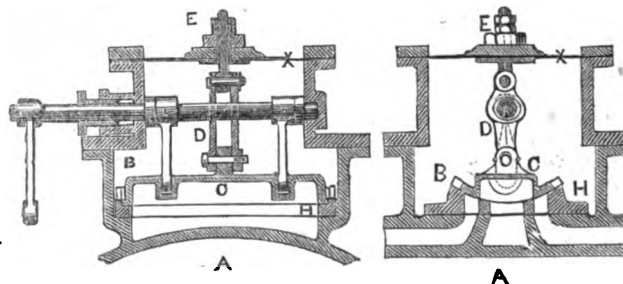
on the back of the slide valve as well as against the inside of the plate, X. The force against the plate is concentrated in the coupling rod, D, and by it buoys up the valve. When the diameter of the disc bears a certain proportion to the back of the valve the effective pressure through the rod, D, so nearly balances the opposite force that the valve can be moved over the ports with the outlay of a very small amount of power.

The flexible plate has a slight undulating motion communicated to it as the rod, D, is more or less inclined to the valve force. The extent of the motion is not allowed to exceed one-eighth of an inch, by making the rod, D, of suitable length; and as the disc is slightly extended with the hammer in the central portion before being attached to the valve, the lifting power of the disc is uniform over every part of the stroke of the valve.

The undulations of the plate have no injurious effect whatever upon it; one reason for this is, that it is evenly heated by the steam while at work,

FIG. 4.

FIG. 3.



and is therefore capable of bearing greater transverse and tensile strain than at the ordinary temperature. When room cannot be spared for the length of the enlarged pipe, the disc is corrugated so as to give it greater elasticity, and the rod shortened accordingly.

Figs. 3 and 4 show a method for disposing of the undulations of the

disc, and also reducing the length of the projecting pipe. H is a loose plate, which, with the valve, is turned in the lathe to the radius of the link D. The plate H is bolted to the ordinary valve face. The valve is moved with levers, which have the same centre of motion. By this means the disc has no movement, and there is only one joint pin liable to wear, as the one next the cylinder preserves the same relative position to the valve at all points. Figs. 5 and 6 show a method of applying the disc to a balance plate G, between which and the port face the valve slides. The

Fig. 6.

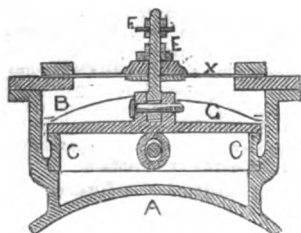
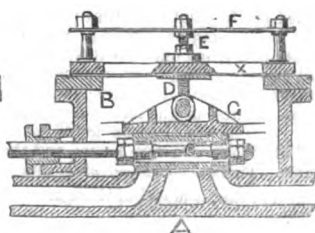


Fig. 5.



valve is open throughout, so that if the plate G were removed the steam would escape to waste down the exhaust pipe. This plan also dispenses with the motion of the disc, and further takes no more room than the ordinary arrangement. Figs. 7 and 8 show a varied application of the

Fig. 8.

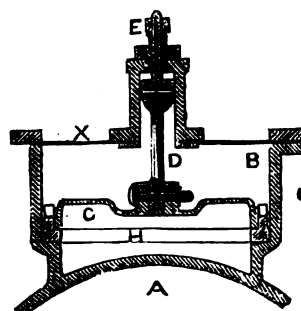
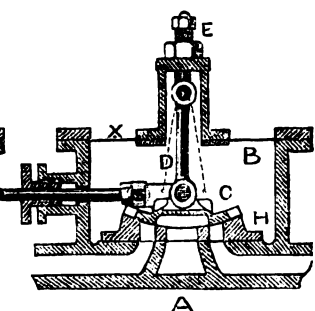


Fig. 7.



disc, having the valve worked with a spindle in the usual way. The peculiar advantage which this method possesses is that the amount of pressure on the valve can be increased or diminished at pleasure, while the engine is at work, either by means of the screw E, or the external spring; or permanently, by altering the diameter of the centre bearing washer. There are several other advantages. It is no more liable to leakage than the ordinary valve, for there is only one working face in most instances, while the equilibrium constructions, with packed rings, hollow pistons, &c., applied to the back of the valve, having two or more working faces, are difficult to maintain in an efficient state. When compared with the balance-piston, the favourite method of Bourne, and other engineers, it is found much less expensive in first cost, and the valve can be accurately balanced, for there is no friction to overcome, which demands an excess of force on the back of the valve, to prevent the piston from raising it from its face, and there is no leakage of steam, as is often observed passing through the ordinary balance-piston.

Water, finding its way into the cylinder by priming or from the condensers—that very fruitful source of accidents—can most readily escape on the least excess of internal pressure in the cylinders, as the eyes of the coupling-rods are oval to allow the valve to rise. It is well known that piston-valves, those of the Cornish construction and the American double beat valve, all require escape-valves of large size to allow water to leave the cylinder as the piston approaches the end of the stroke; here they are not necessary.

We understand that this novel method is giving uniformly satisfactory results, and is coming into general use in Lancashire, where it was first applied.

GREAT WESTERN RAILWAY OF CANADA.—In consequence of the high price paid for re-rolling rails in Canada (being £5 8s. 11d. per ton as compared with £3 1s. 8d. in England), a rolling mill is now in course of erection at the Hamilton Station, of sufficient power to meet the requirements of the permanent way of the line, which, with branches and sidings, now consist of 407½ miles of single track. The Company's engineer estimates the entire cost of the mill when ready for re-rolling at £17,000 sterling. It is expected that the whole will be completed by March or April next.

GOODS LOCOMOTIVE "STEIERDORF."

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

(Continued from page 100.)

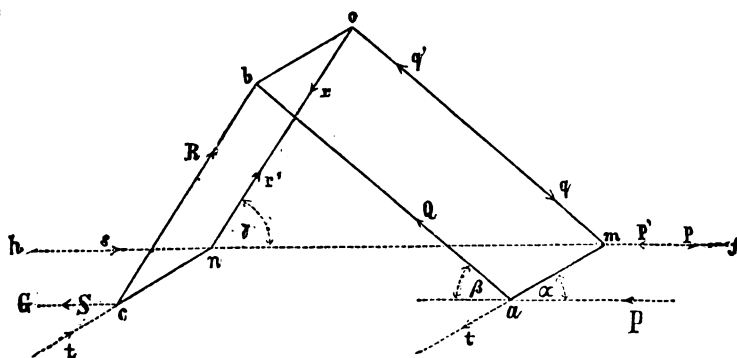
In THE ARTIZAN of March and May we gave copper plate engravings and woodcut illustrations, and a fully detailed general description of this locomotive. We will now proceed to describe more at length the coupling arrangement between the locomotive and tender, and the principles upon which it is based.

Referring to Fig. 14, the motive power acting upon the various axles may be resolved into a series of forces. If we call—

α the angle formed by a horizontal line and the cranks;
 β the angle formed by a horizontal line and the rods of m ;
 γ the angle formed by a horizontal line and the rods of n ;
 P the force derived from the pressure of the piston acting on the crank axle a ;

$p = P$, the force acting in the opposite direction, transmitted from the frame upon the axle m .

Fig. 14.



The force P may be resolved into two forces, viz., Q , acting in the direction of the coupling rod ab ; and t , in the direction of the crank am . The force Q may be resolved again into q , acting along the guide rod om ; and p' , acting horizontally in the direction mf .

We shall find then—

$$Q = \frac{P \sin \alpha}{\sin (\alpha + \beta)}, q = Q, p' = P.$$

These three forces will thus stand for P . The force Q may likewise be resolved into three forces, viz.:—

R working in the direction of the draw bar bc of the tender,
 r working in the direction of the support on ,
 q_1 working in the direction of the guide bar om ,

when we shall have—

$$R = \frac{Q \sin (\alpha + \beta)}{\sin (\gamma - \alpha)} = \frac{P \sin \alpha}{\sin (\gamma - \alpha)}, r = R, q_1 = Q.$$

The three forces, R , r , and q_1 , will then replace Q . The force R may also be resolved into three forces, viz.:—

S , acting in the direction of the horizontal coupling rod, ch ;
 s , acting horizontally in the centre line of shafts, nh ; and
 s' acting along the support no .

We have then—

$$S = \frac{R \sin (\gamma - \alpha)}{\sin \alpha} = P, s = S, s' = R.$$

The forces which worked originally on the engine shaft were P and p ; those transmitted upon the tender are S and s , having the same direction and being equal to P and p ; also the forces p and p' , q and q' , r and r' , acting in the direction of the lines joining the centres of the axles, balance each other.

It will be evident, therefore, that—

1st, The draw bars transmit entirely upon the tender axle the force acting on the engine axle.

2ndly, They have no tendency to cause the axles to deviate.

3rdly, They do not change the load on the axles.

It may here be observed that the friction bolt (Q, Figs. 8 and 9, p. 99, ARTIZAN, May number) would not be required, were it not for the purpose of transmitting a portion of the resistance upon the engine frame.

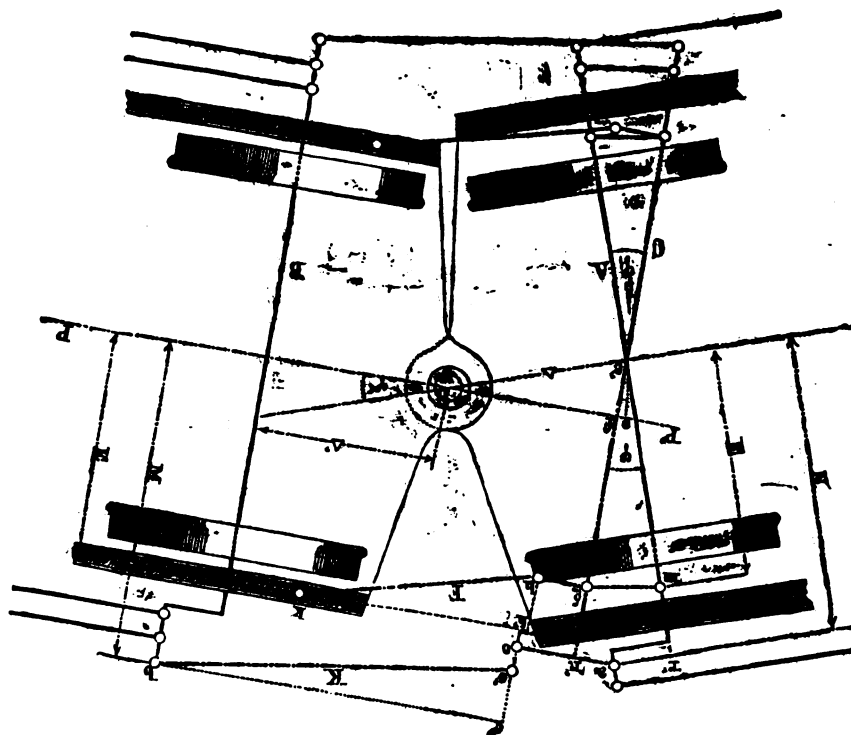
When traversing very sharp curves, the position of the engine and

tender axes will be such as shown in Figs. 15 and 16 (the first being a plan, the other an elevation of part of engine and tender), and the longitudinal axis of both frames will form an angle ϕ . In Figs. 15 and 16, A is the axle of the tender frame, B that of the engine frame, and C the false axle. For the following calculations we call—

Δ the distance of the pivot o from the tender shaft A.
 Δ' the distance of same from the driving shaft B.
 D the distance between the wheels of tender frame.
 D' the distance between the extreme of engine frame.
 ϕ the angle at which the two frames are placed relatively to each other.
 E the distance of pivot from the longitudinal axis of engine frame, or from the centre, m , of the bearing of the false axle.

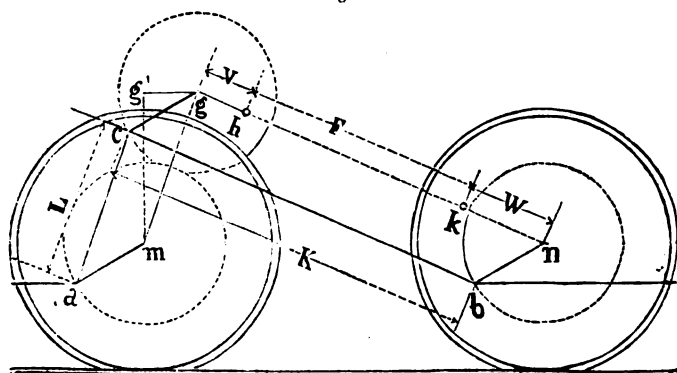
F the length of the bar $k k'$ (s, Fig. 1, Plate 233).
 K the length of the oblique draw bar $b c'$.
 L the length of the vertical draw bar $a c$.
 M the distance of crank pin of the oblique draw bar $b c'$ from the longitudinal axis of the engine frame.
 N the distance of crank pin of the false axle crank from the longitudinal axis of tender frame.
 $2l$ the length of stroke = twice radius of crank.
 R the radius of railway curve.
 v the increase in width of gauge.
 w the lateral space allowed between the tyres and rails on the straight line.

FIG. 15.



When the train enters into a curve, the tender axle, A, will describe the angle ϕ along with the longitudinal centre line of the tender, so that the point e will come into the position e' . The false axle, however, will remain parallel to the engine shaft B, on account of the connection through the bar $k k'$; but at the same time it will describe the angle ϕ round the centre e' , sliding, thus, from the engine shaft at a length = $e'f$. By this motion, the guide and draw bars connecting the engine shaft with the false axle

Fig. 16.



will also be displaced laterally parallel to the engine shaft, to a length = $e'f$. This displacement involves a diminution of the distance of the false axle from the engine shaft, on account of the obliquity of the guide and draw bars, while the effective length of the latter is reduced at the

same time in the direction of the axis of the engine frame; i.e., if the false axle would be displaced laterally parallel to the engine shaft, without coming nearer the engine shaft, the draw bars of the engine frame would be too short. The distance between the engine shaft and false axle has, therefore, to increase or decrease just equal to the increase or decrease of the effective length of the draw bars.

From Fig. 15 will be seen that the lateral displacement of the false axle, parallel to the engine shaft—

$$e'f = \Delta \sin \phi. \quad (1)$$

The decrease of the length of the draw bar $k k'$ to $k k''$ will approximately represent the shortening of the distance between engine shaft and false axle at the displacement of the latter. As $k k' = F$, we have (Fig. 15)—

$$k k' = \sqrt{k h^2 - h k'^2} \quad k k' = e'f$$

$$\therefore k k' = \sqrt{F^2 - (\Delta \sin \phi)^2}.$$

$$\therefore k h - k h' = F - \sqrt{F^2 - \Delta^2 \sin^2 \phi}. \quad (2)$$

(All these formulæ relate to the actual lengths, not to the dimensions of the parts as shown in the diagrams.)

The shortening of the oblique draw bar may now be obtained from Fig. 16. This shortening will be = $b c' - b c''$ (Fig. 15):—

$$b c' = \sqrt{b c'^2 - c' c''^2}$$

$$b c' = K, c' c'' = e'f = \Delta \sin \phi$$

$$\therefore b c' - b c'' = K - \sqrt{K^2 - \Delta^2 \sin^2 \phi}. \quad (3)$$

The difference, δ , between the equations (2) and (3) will, therefore, denote the difference between the shortening of the distance between the

false axle and engine shaft, on the one hand, and the shortening of the oblique draw bars on the other hand; *i.e.* :—

$$\delta = F - K - \sqrt{F^2 - \Delta^2 \sin^2 \phi} + \sqrt{K^2 - \Delta^2 \sin^2 \phi} \quad (4)$$

To find the conditions under which the vertical draw bars work, it must be remembered that the false axle is not displaced parallel to the tender axle, but that it describes an angle, ϕ , against the latter. If, therefore, we draw (Fig. 16) a vertical line, mg' , intersected by the horizontal line, gg' , we shall have a triangle the hypotenuse of which = L , while—

$$gg' = 2E \sin \frac{1}{2} \phi; \text{ or, as } \phi \text{ is very small,}$$

$$gg' = E \sin \phi, \text{ and}$$

$$mg' = \sqrt{L^2 - E^2 \sin^2 \phi} \quad (5)$$

This will be the distance of the centres of the tender and false axles, as measured in the projection, e' ; the distance, mg (Fig. 15), will be = L .

To find the distance of the crank centres, r and r' , from each other, we may perform the same operation of constructing a triangle the hypotenuse of which will be $rr' = L'$. As the vertical side of this triangle will be = mg' (Fig. 16), we have—

$$L' = \sqrt{L^2 + (N^2 - E^2) \sin^2 \phi} \quad (6)$$

and, consequently, the difference between the distances of the points, rr' , and the length of the vertical rod will be—

$$L' - L = \sqrt{L^2 + (N^2 - E^2) \sin^2 \phi} - L \quad (7)$$

The cranks of the false axles of the tender shaft move in two circles, the plans of which form an angle ϕ ; the distances of the crank pins will therefore vary while the cranks revolve. At a certain moment both cranks will form the same angle α with a horizontal plan, and both their horizontal projections will then be = $l \cos \alpha$; the vertical distances of the crank pins from the horizontal diameters will also be equal and parallel; and if, therefore, the centres of the crank pins are joined, and likewise their projections, two more parallel lines of an equal length will be obtained. It suffices, therefore, to determine this length, in order to find the lengths of the vertical draw bars for an angle α .

(To be continued.)

ON THE EXPANSIVE ENERGY OF HEATED WATER.

By W. J. MACQUORN RANKINE.*

As the question of the quantity of mechanical energy which a given weight of water, heated to a given temperature, is capable of exerting in the act of partially evaporating without receiving heat, until it falls to a given lower temperature, has been raised in connection with recent researches as to the bursting of steam-boilers, I may point out that the complete solution of that question, for any given liquid, together with a numerical example in the case of water, is given under the head of Proposition XVII., of a paper on Thermodynamics, which was communicated by me to the Royal Society in December, 1853, read in January, 1854, and published in the "Philosophical Transactions" for 1854.

That solution is expressed by the following formula (page 161, equation, 65):—

Energy exerted by each Pound of Fluid,

$$= K \left\{ t_1 - t_2 \left(1 + \text{hyp. log. } \frac{t_1}{t_2} \right) \right\} \quad (1)$$

in which K denotes the dynamical value of the specific heat of the liquid, being the product of its specific heat expressed in the ordinary way by "Joule's equivalent;" t_1 and t_2 , the initial and final absolute temperatures; the absolute zero being 274° Centig., or 493.2° Fahr. below the melting-point of ice.†

Another equation (Equation 63 of the paper) gives the following value for the excess of the final volume to which the mixed liquid and vapour expand, above the original volume of the liquid:—

$$K \text{ hyp. log. } \frac{t_1}{t_2} \quad (2)$$

$$\frac{dp_2}{dt_2}$$

in which $\frac{dp_2}{dt_2}$ denotes the rate at which the pressure, in lbs. on the square foot, varies with temperature, at the final temperature.

* Read to the Institution of Engineers in Scotland.

† In the original paper the absolute zero of heat was assumed to be $272\frac{1}{2}^\circ$ Centig. below the melting-point of ice. The value now adopted, 274° C., is deduced from later experimental data.

When applied to the water in a steam boiler, these equations take the following form:—

The value of K for liquid water is 772 foot-pounds per degree of Fahrenheit in a pound of water, or

1389.6 foot-pounds per Centigrade degree in a pound of water, or

423.55 kilogrammetres per Centigrade degree in a kilogramme of water.

The final absolute temperature is 212° Fahr. + $461.2^\circ = 673.2^\circ$ Fahr.

The corresponding value of $\frac{dp}{dt}$ for Fahrenheit's scale and British measures is 42, and $772 + 42 = 18.38$.

Let t_2 denote the initial temperature, as Fahrenheit's ordinary scale; so that $t_2 = T + 461.2^\circ$.

Then—

Energy, in Foot-pounds, exerted by each Pound of Water.

$$= 772 \left\{ T - 212^\circ - 673.2^\circ \text{ hyp. log. } \left(\frac{T + 461.2^\circ}{673.2^\circ} \right) \right\} \quad (3)$$

Final Volume of Expansion of mixed Water and Steam, in Cubic Feet per Pound,

$$= 18.38 \text{ hyp. log. } \left(\frac{T + 461.2^\circ}{673.2^\circ} \right) \quad (4)$$

It is worthy of remark, that the energy developed depends solely on the specific heat of the substance in the liquid state, and the initial and final temperatures, and not on any other physical property of the substance.

The following table gives some results of the formula:—

The first column contains the temperature in the ordinary scale of Fahrenheit, with intervals of 36° Fahr. = 20° Cent.

The second column contains the expansive energy of one pound of water, in foot-pounds.

The third column contains the velocity, in feet, per second, which that energy would impress on a projectile of the weight of the water itself; that is, one pound.

The fourth column, the final volume of expansion of the water and steam, in cubic feet per pound.

For convenience, a fifth column is added, containing the initial, absolute, or total pressures in pounds on the square inch.

The last line of the table has reference to the case in which the water would be totally evaporated:—

TABLE I.

Initial Temperature.	Energy.	Velocity.	Final Expansion.	Initial Absolute Pressure.
Fahr.	ft.-lbs.	ft. per sec.	cubic ft.	lb. to sq. in.
212°	0	0	0	14.70
248	726	214	0.95	28.83
284	2,779	423	1.87	52.52
320	6,052	624	2.73	89.86
356	10,422	819	3.58	145.8
392	15,826	1,010	4.36	225.9
428	22,156	1,194	5.11	336.3
about	about	about		
2360	912,500	7,686	26.36	unknown

In the absence of logarithmic tables, the following approximate formula may be used for temperatures not exceeding 428° :—

$$\text{Energy, nearly} = \frac{772 (T - 212^\circ)^2}{T + 1134.4^\circ} \quad (5)$$

$$\text{Expansion, nearly} = \frac{36.76 (T - 212^\circ)}{T + 1134.4^\circ} \quad (6)$$

In explanation of the formulæ and tables, it may be added that the mechanical energy in column two is the equivalent of the heat which disappears during the process, being the difference between the whole heat expended and the latent heat of that portion of the water which, at the end of the process, is in the condition of steam at atmospheric pressure.

For the information of those who consider that the liquid portion of the water, owing to its small compressibility, acts like a volley of hard

projectiles, a table is added, showing, for each of the initial temperatures in the previous table, what fraction of a pound of water continues in the liquid state, and how much of the energy developed is possessed by that liquid water:—

TABLE 2.

Initial Temperature.	Proportion of the Water which remains Liquid.	Energy Preserved by that Liquid Water.
Fahrenheit.	lb.	ft.-lb.
212°	1·000	0
248	0·964	700
284	0·931	2,587
320	0·897	5,429
356	0·865	9,015
392	0·835	13,215
428	0·806	17,858
about 2,360	0	0

In the formulæ and tables, it has not been considered necessary to take into account the small increase which the specific heat of water undergoes as the temperature rises.

SPIRIT-LEVEL TELESCOPE.

The following is a brief description, by Admiral Sir E. Belcher, of a spirit-level telescope, adapted to a sextant for the purpose of obtaining the altitude of the sun at sea during fog, or for obtaining the elevation of an object of small elevation, which, although obtainable to minutes by a theodolite, could not be obtained by reflection in an artificial horizon.

This invention suggested itself to Admiral Sir E. Belcher when beset by fog on the limits of the Arctic Sea for several days, in the year 1826. His first effort was to attach a spirit-level beyond the horizon glass, and, by keeping a very steady hand, cause the sun to touch the bubble at the moment it became central.

This succeeded well, but was not sufficiently portable or convenient for his purpose; and, on his appointment to the Arctic command in 1852, he had the telescope referred to attached to a Broughton sextant.

The spirit-level occupies a position immediately over the diagonal diaphragm, as in the arrangement of an astronomical telescope. Above the aperture is attached a white reflector, which assists in throwing the bubble on to the level wire in the field; when, therefore, any object is brought down to touch this level gauge when it bisects the reflected bubble of the spirit-level, we have the altitude measured by the arc of the instrument.

To those unaccustomed to measurements by reflecting the object whose altitude is demanded in an artificial or mercurial horizon, it is necessary to observe that no accurate measurement can be obtained by such means where the object, as a mountain, does not exceed 10° of altitude; and in inland situations, where it may only be permitted to carry a sextant, this adaptation of the telescope prevents the necessity of carrying the artificial horizon—an instrument, however, of the greatest importance, and, for every purpose of astronomical pursuit in the last degree of precision, absolutely necessary.

ON THE PAPER MANUFACTURES OF NORTHUMBERLAND AND DURHAM.

By MR. W. H. RICHARDSON.

In consequence of the general disinclination on the part of paper manufacturers to furnish any information or statistics of their operations, this account will necessarily be imperfect. The estimates given have, however, been carefully considered, and are as accurate as possible under the circumstances:—Number of firms in the trade, 12; number of machines making white paper, 10; brown do., 9; quantity of white paper made per year, 3500 tons; brown do., 4500 tons; total, 8000 tons; being about one-twelfth of the entire production of the United Kingdom. Total estimated annual value, £300,000. Coarse materials, as old ropes, &c., used for brown paper, 5200 tons; do. rags, 4000 tons; Esparto grass, 2000 tons; bleaching powder, 400 tons; soda ash, 200 tons; and the quantity of coals used per annum is 35,000 tons. Imports of Esparto grass to

the port of Newcastle-on-Tyne for the last three years—in 1860, 1224 tons; in 1861, 2613 tons; and in 1862, 9534 tons. The principal improvements that have been made in the manufacture of paper in late years are in the details and general efficiency of the machinery, whereby a much larger quantity of paper is made with the same apparatus than formerly; and in the superior management of the chemical processes, whereby material that formerly was entirely useless is now worked up into common shop papers; and inferior rags are cleansed and bleached into a good white paper, which formerly were made into coarse paper. The only notable exception to this is the introduction of Esparto grass, the importation of which has been steadily increasing, and, as will be seen from the statistics already given, amounted to nearly 10,000 tons in the year 1862 into the port of Newcastle alone, the greater part of which was, however, forwarded by railway into Scotland, Lancashire, and elsewhere. Newcastle affords special and peculiar facilities for the importation of this material from the east coast of Spain, where it is principally gathered. Vessels load at Newcastle with coke or coals for Spain, and bring return cargoes of manganese, pyrites, copper ore, lead and lead ore, iron ore, and other minerals for the use of the chemical and other manufactories on the Tyne, and, from the lightness of the Esparto grass, one ton of which occupies the space of three to four and a-half tons measurement, they are enabled to carry a full cargo of it in addition to the minerals which serve as ballast, thus materially economising the cost of freight, so much so that paper manufacturers near Edinburgh and in Lancashire find it cheaper to import *via* Newcastle than by way of Leith or Liverpool.

Esparto, or Alfa, as it is called on the African coast, is a coarse grass which grows in sandy places in almost all the countries bordering on the Mediterranean. This grass consists mainly of ligeum, spartium, stipa, tenacissima, and other species of the last-named genus, all very similar in character and general appearance. It has been used from time immemorial for making mats, ropes, &c., and is mentioned in Pliny's "Natural History" as applied to these purposes. Various attempts have been made to manufacture esparto into paper during the last thirty years; one patent for the purpose being dated as far back as 1839, and in France similar efforts have been made for many years. None of these, however, have been practically successful on the large scale, with the exception of the process arranged by Mr. Thomas Routledge, of Eynsham Mills, in Oxfordshire, who has been making printing paper from esparto for the last nine years, and has taken out three patents for the processes employed. He has lately taken a mill at Ford, near Sunderland, for making printing paper from esparto only. Other manufacturers have, however, used it mainly as a blend with rag material. No material alteration in the machinery or apparatus is required for working esparto, and very much less power is required. The successful working of this fibre depends mainly on the careful and proper adjustment of the quantity and strength of the chemicals employed. The quantity of soda ash required for neutralising the gummo-resinous matters in the fibre so as to admit of its being made into a pulp, is very large, though not so great as is required for straw; and the fibre, unlike rags, never having before been subjected to bleaching or other chemical treatment, also requires very much more bleach powder to bring it to a colour suitable for printing paper. The quantities required are from five to six times as much as for cleansing and bleaching the coarsest rags.

The importations of esparto into the United Kingdom for the past twelve months being about 18,000 tons, the use of this article may be estimated to have caused an increased consumption of soda ash and bleach powder of at least 4000 tons per annum; and these chemicals being dear on the continent of Europe is one obstacle to the use of esparto there.

Nearly all newspapers, not excepting that on which the *Times* is printed, contains a portion of esparto, and some of the penny daily papers published in Edinburgh contain only one-fourth rag material. The large supply of paper-making material from this source has been most opportune. Rags are becoming gradually scarcer; coloured rags suitable for making common printing paper were worth 4s. to 6s. per cwt in 1848, and now worth 9s. to 12s. per cwt., and this notwithstanding the relief produced by the importation of esparto. This scarcity, the existence of which the jurors' report of the Exhibition of 1862 most unaccountably denies, has been aggravated by the almost total cessation of the supply of waste and tares from the cotton mills; and even with the assistance of esparto grass and cheaper chemicals and fuels, the paper makers in this country have been placed in a most disadvantageous position in respect of the supply of material, in comparison with their continental rivals, by recent legislation, which, in the opinion of many, will have a tendency to cripple the progress of the trade in this country; the discussion of this subject is, however, not suited for the present occasion.

The greater part of the paper manufactured in this district is of the coarser descriptions, and Newcastle Brown and Tyne Casing which, from a geographical error, is known in Manchester as Scotch Paper, has a reputation throughout the kingdom for toughness and general excellence.

The printing and writing papers of Messrs. Annandale and Son have a deservedly high reputation in the London market. The other description of white paper made in the district are mainly for the daily newspapers, whose consumption of common printing paper has of late years become so enormous as materially to alleviate the depression consequent on the general dullness of trade, arising from the cotton famine; and it is hoped that, notwithstanding the unfairness with which the trade has been treated by the legislature, that, with the resumption of business in Lancashire, it may recover its former prosperity.

THE ROYAL SOCIETY.

ON MAUVE OR ANILINE PURPLE.

By W. H. PERKIN, Esq., F.C.S.

The discovery of this colouring matter in 1856, and its introduction as a commercial article, have originated that remarkable series of compounds known as coal-tar colours, which have now become so numerous, and, in consequence of their adaptability to the arts and manufactures, are of such great and increasing importance. The chemistry of mauve may appear to have been rather neglected, its composition not having been established, although it has formed the subject of several papers by continental chemists. Its chemical nature also has not been generally understood; and it is to this fact that many of the discrepancies between the results of the different experimentalists who have worked on this subject are to be attributed.

On adding a solution of hydrate of potassium to a boiling solution of commercial crystallised mauve, it immediately changes in colour from purple to a blue violet, and, on standing, deposits a crystalline body, which, after being washed with alcohol and then with water, presents itself as a nearly black glistening body, not unlike pulverised specular iron ore.

This substance is a base which I propose to call *Mauveine*; it dissolves in alcohol, forming a violet solution, which immediately assumes a purple colour on the addition of acids. It is insoluble, or nearly so, in ether and benzene. It is also a very stable body, and decomposes ammoniacal salts readily. When heated strongly it decomposes, yielding a basic oil. Its analysis has led to the formula

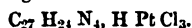


Hydrochlorate of Mauveine.—This salt is prepared by the direct combination of mauveine with hydrochloric acid. From its boiling alcoholic solution it is deposited in small prisms, sometimes arranged in tufts, possessing a brilliant green metallic lustre. It is moderately soluble in alcohol. Carbon, hydrogen, nitrogen, and chlorine determinations have led to the formula—

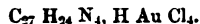


I have endeavoured to obtain a second hydrochlorate, but up to the present have not succeeded.

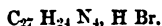
Platinum Salt.—Mauveine forms a perfectly definite and beautifully crystalline compound with bichloride of platinum, which, if prepared with warm solutions, separates in the form of crystals of considerable dimensions. It possesses the green metallic lustre of the hydrochlorate, but on being dried assumes a more golden colour. It is very sparingly soluble in alcohol. The analysis of this salt has led to the following formula—



Gold Salt.—This substance separates as a crystalline precipitate, which, when moist, presents a much less brilliant aspect than the platinum derivative; it is also more soluble in alcohol than that salt, and when recrystallised appears to lose a small quantity of gold. Its analysis has given numbers agreeing with the formula—



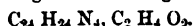
Hydrobromate of Mauveine.—This salt is prepared in a similar manner to the hydrochlorate, which it very much resembles, except that it is less soluble. Carbon, hydrogen, and bromine determinations give results agreeing with the formula—



Hydriodate of Mauveine.—In preparing this salt from the base, it is necessary to use hydriodic acid which is colourless, otherwise the free iodine will slowly act upon the new product. It crystallises in prisms, having a green metallic lustre. It is more insoluble than the hydrobromate. Its analysis has led to the formula—



Acetate of Mauveine.—This salt is best obtained by dissolving the base in boiling alcohol and acetic acid. It is a beautiful salt, crystallising in prisms possessing the green metallic lustre common to most of the salts of mauveine. Combinations of this substance gave numbers agreeing with the formula—



Carbonate of Mauveine.—The tendency of mauveine to combine with carbonic acid is rather remarkable. If a quantity of its alcoholic solution be thrown up into a tube containing carbonic acid over mercury, the carbonic acid will be quickly absorbed. To prepare the carbonate, it is necessary to pass carbonic acid gas through boiling alcohol containing a quantity of mauveine in suspension; it is then filtered quickly, and carbonic acid passed through the filtrate until cold; on standing, the carbonate will be deposited as prisms having a green metallic lustre. This salt, on being dried, gradually loses carbonic acid. From experiments that have been made with the salt, it would appear to have the composition of an acid carbonate, viz.—



In the analysis of salts of mauveine great care has to be taken in drying them thoroughly, as most of them are highly hygroscopic.

I am now engaged with the study of the replaceable hydrogen in mauveine, which I hope will throw some light upon its constitution. From its formula, I believe it to be a tetramine, although up to the present I have not obtained any definite salts with more than one equivalent of acid. Mauveine, when heated with aniline, produces a blue colouring matter, which is now under investigation. A salt of mauveine, when heated alone, also produces a violet or blue compound.

* C = 12.

THE CHEMICAL SOCIETY.

ON THE QUANTITATIVE DETERMINATION OF PHOSPHORIC ACID BY SALTS OF MAGNESIA.

By ROBERT WARINGTON, jun., Assistant in the Laboratory of the Royal Agricultural College, Cirencester.

Phosphoric acid is continually found in nature associated with oxide of iron, and also with alumina. It is in this state of combination that we meet with it in soils, coprolites, and other phosphatic minerals, and also in most animal and vegetable products. The accurate determination of phosphoric acid in the presence of iron and alumina is, therefore, a problem of frequent occurrence; and, from its bearings on agricultural economy, of considerable importance.

A method of analysis frequently followed in such cases is first to separate the silica by the ordinary process, next to precipitate the lime by oxalate of ammonia from a solution feebly acid with oxalic or acetic acid, then to concentrate the filtrate, treat with tartaric acid, and finally to add a salt of magnesia and an excess of ammonia. If the tartaric acid has been used in sufficient quantity, the oxide of iron and alumina are held perfectly in solution, while the whole of the phosphoric acid is precipitated as ammonio-phosphate of magnesia.

This process would seem at first sight to include all that could be required. It really, however, involves a considerable source of error, inasmuch as it is found that, under certain circumstances, as mentioned to me by Dr. Voelcker, a tartrate of magnesia is precipitated together with the ammonio-phosphate. According to H. Rose,* indeed, magnesia-salts, mixed with tartaric acid, are not precipitated by ammonia. Experiment shows, however, that this is true only when the materials are employed in certain proportions, and not universally. Thus if we take a mixed solution of chloride of magnesium and chloride of ammonium, render it strongly ammoniacal (the ammoniacal salt being present in just sufficient quantity to prevent the precipitation of the magnesia), and then add a small portion of tartaric acid, we obtain in a short time a considerable precipitate of tartrate of magnesia. If, however, instead of adding a little tartaric acid, a large quantity is employed, the solution, though made as ammoniacal as the first, remains perfectly clear. This reaction appears at first sight somewhat anomalous. The explanation seems to lie in the fact that the tartrate of magnesia thus formed is completely soluble in salts of ammonia, and among others in tartrate of ammonia. That this is really the case may be shown by adding a larger amount of chloride of ammonium to the magnesian solution, which will be found to prevent any precipitate being formed, quite as well as a larger quantity of tartaric acid.

The precipitate of tartrate of magnesia closely resembles the ammonio-phosphate in appearance. It forms slowly, is white and crystalline, remains long in suspension, and deposits a hard crystalline crust on the sides of the vessel. It is sparingly soluble in weak ammonia, and dissolves readily in a boiling solution of chloride of ammonium. I have not yet had an opportunity of determining with precision the exact constitution of this tartrate. Approximate determinations of the magnesia contained in it seem to indicate that it consists of three or four equivalents of base to one of acid. The further analysis of the substance may, therefore, possess some interest.

The amount of error likely to arise in the determinations of phosphoric acid, from the formation of this tartrate of magnesia, will depend, of course, upon the proportion of ammoniacal salts necessary to ensure its perfect solution. The results of various experiments on this point showed that, while this proportion varied considerably according to the state of dilution and the amount of free ammonia present, yet that the conditions under which a precipitate would be formed were, on the whole, by no means unlikely to occur in the ordinary method of determining phosphoric acid. These conditions being (1) the use of a considerable excess of magnesia-salt, (2) a dilute state of the solution, or (3) the presence of much free ammonia; all of which might very likely be found in actual practice.

Under these circumstances it occurred to me that as citric acid was equally capable, with tartaric acid, of preventing the precipitation of oxide of iron and alumina, it might be well to try its behaviour with magnesia. Some experiments were, therefore, undertaken to this end, and with complete success. Various proportions of the solutions of chloride of magnesium, citric acid, and ammonia, were mixed together, but in no case was there the slightest indication of any precipitate being formed. Here then is an easy solution of the difficulty. We have but to substitute nitric acid for the tartaric acid usually recommended, and the source of error is at once removed, and there is no longer any ground for fear lest the precipitate of ammonio-phosphate of magnesia should be contaminated with another salt. Citric acid will be found more especially useful in small operations, as the conditions favourable to the precipitation of the tartrate of magnesia are then most frequently present.

It is scarcely necessary to add that when either citric or tartaric acid is used to prevent the precipitation of oxide of iron, such a quantity must be employed that the solution when made ammoniacal shall be of a somewhat greenish "lemon tint." If less acid has been added, and the solution is yellow, orange, or of a reddish colour, the magnesia precipitate will be perceptibly contaminated with oxide of iron.

* Gmelin, Cavend. Soc. Ed., vol. x. p. 290.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

The October meeting of this society took place on the night of the 3rd ult., Mr. Joseph Newton, of the Royal Mint, occupied the chair; and the proceedings were commenced, as usual, by the reading and confirmation of the minutes of the preceding meeting. Afterwards the chairman read a communication from M. Achard, C.E., in reference to sundry queries which had been put, but not answered, when, a month before, Mr. Gettiffe communicated his paper on "Boiler Explosions and Railway Accidents." It will be remembered that M. Achard's apparatus, then described, was intended for the maintenance of a constantly level feed in steam boilers; and the first of the queries ran as follows:—"If the float, refusing to act, causes the index to remain at zero, while the water falls in the boiler, how can the alarum bell, in consequence of the non-interruption of the electro current, be made to give the required signal?" The answer to this objection was, that in M. Achard's arrangement a stone float was immersed in the water with a counterpoise on an exterior shaft. The articulation consisted in the friction of a steel roller on a plane of polished cast-iron, instead of the old stuffing-box system, which was in many respects imperfect and liable to derangement. The resistance of the rolling friction was insignificant as compared with the gravitation of the stone float, and with that of the exterior counterpoise weight. The float known as "Bourdon's" also neutralised the objection raised; for it was scarcely possible for it to refuse to work freely, and it indicated alterations in the water level to the minute difference of 1/24th of an inch.

In reply to the second question raised—"Would it not be possible to cause the conducting wire to pass through the boiler, and communicate directly with the float?" M. Achard stated that the plan would be quite practicable. He had carried it out with success at Lyons, in the manufactory of Messrs. Coignet. In that case, the conducting wire was subjected to continual friction, which prevented oxidation, and the current circulated quite as freely as with Bourdon's float. The disadvantage of the arrangement, however, was that it precluded the application of an indicator on the face of the boiler, which legally was imperative in France. The Bourdon float, therefore, superseded it, and it met every requirement.

The third of the series of queries was—"Which would be the best and most economical means of keeping the automatic regulator in operation during the temporary stoppage of the machinery and the absence of the workmen?" It was replied that, in order to secure this desideratum, which had not escaped the early consideration of the inventor of the regulator, he had at first added to it a direct electrical bell, which rang the alarm. It means of the circulation of the electrical current, so that when the current no longer circulated for the regulator, it circulated for the direct electrical alarum—this latter operating notwithstanding the suspended action of the machinery. Of course the alarum in such case might be fixed in any convenient place—the office of the manager of the factory, for example. It had been found that this was but an extra precaution, which it was not absolutely essential to take, for the water in the boiler never descended, during such temporary suspension, more than an eighth or a quarter of an inch. A little reflection, indeed, would show that, when an engine was stopped *pro tem*, the index of the regulator pointing to zero could not, owing to the non-consumption of steam, decrease more in height than had been stated.

Mr. T. Miller then read a very elaborate paper on an "Entirely new Method of Coating Telegraph Wires." This was illustrated by a series of admirably finished diagrams, and was replete with interest. At a future period we may give an extended report of this communication, but lack of space at present compels us to summarise its principal features. Mr. Miller proposes to cut sheets of india rubber from blocks in such a manner that the knife-cuts or corrugations shall run in a longitudinal direction, or nearly so, with the sheet. He has also constructed an apparatus for preparing the strips for the covering machines, as well as covering machines themselves. In the latter, the principal points of improvement consist in the employment of sets of hollow spindles placed one within the other, and to be driven at different speeds. Another arrangement is the drawing or stretching apparatus, mounted on spindles, and to act independently of the friction of the bobbin on its spindle. A third main characteristic of the series of ingenious contrivances in question is the application of a current of electricity, by the action of which the working of the covering machine will be self-actingly stopped, when the insulation is imperfect.

The chairman remarked, at the conclusion of Mr. Miller's paper, that he had rarely heard a more complete description of a variety of ingenious combinations of machinery for the effecting of an important object than that which he had just listened to. In every way Mr. Miller deserved their thanks—in the first place, for the demonstration of his skill as a mechanic and draughtsman; and in the next, for the clear and intelligible manner in which he had put the whole subject before the meeting.

BOOKS RECEIVED.

"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.

"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. No. 2.

"Acids, Alkalies, and Salts: their Manufacture and Applications." London: H. Baillière, 219, Regent-street. 1863.

"Victoria Toto Cælo: or, Modern Astronomy Recast." By JAMES REDDIE, F.A.S.L. London: Robert Hardwicke, Piccadilly. 1863.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

To the Editor of THE ARTIZAN.

SIR,—I think such a paper as that of Mr. Grier, on "Momentum and Fluid Resistance," ought not to be allowed to pass without remark in your journal.

I have made some hundreds of experiments similar to those of Mr. Grier, and the results which I have obtained appear in every case to be totally opposite to his peculiar doctrines. Let every one who takes an interest in the subject, and has any doubt, repeat them for himself.

Tubes of different sizes were allowed to drop from different heights, or to slide down nearly perpendicular grooves into small damp sand. The weight of the tubes could be increased at pleasure, by placing weights in the inside. Their ends were conical, rounded, flat, or concave. The height of fall was measured from the surface of the sand to the bottom of the hole. To ensure similar conditions as nearly as possible, the sand was stirred up after each experiment, and a 24oz. weight placed gently on it. From ten to twenty experiments were tried in the same way, and the average taken.

1. It was found that the depth penetrated into sand, weight being the same, was nearly proportional to the velocity, as measured by the square root of the height fallen.

2. It was found that the penetration, other things being equal, was nearly proportional to the square root of the weight; for instance—

	oz.	oz.	oz.	oz.
Weight.....	1	2	3	4
Penetration	210	270½	370	429
Ratio of square roots of weight ...	210	290	360	420

Now, it will scarcely be doubted that, all other things being the same, the momentum of a falling body is proportional to its weight. It follows that the penetration is proportional to square root of momentum. But we have seen above, and Mr. Grier himself states, that penetration is proportional to velocity. Therefore, velocity is proportional to square root of momentum, and momentum to square of velocity.

3. It was found that a weight 2 falling a depth 1 penetrated almost exactly the same depth as a weight 1 falling a depth 2; weight 3 depth 1 = weight 1 depth 3; weight 4 depth 1 = weight 1 depth 4, nearly. On the other hand, a weight = 2 with velocity = 1 penetrated a much shorter distance than a weight = 1 with velocity = 2. Thus—

Weights.....	1oz.	2oz.	2oz.
Heights	16ft.	8ft.	4ft.
Penetration in sixteenths of an inch.....	59	61	44

Twenty experiments each:—

Weights.....	1oz.	2oz.
Heights	14in.	7in.
Sum of penetrations	181	152½

Ten experiments each:—

Weights.....	1oz.	2oz.
Heights	3in.	1in.
Penetration	65½	69

It will be observed that the penetration in each case is rather less for the higher elevations. This may be easily accounted for. In the 16ft. experiment the weight of the tube was about 4½oz., area of greatest section, 0.6in. If the resistance of the air be calculated, and the height fallen be measured, as in fact they ought to be in every case, from the very bottom of the cavity made by the penetration of the weight, the force expended being actually proportional to the entire height fallen, it will appear that the number 59 in that experiment should be raised to about 60½. By the same rule, in the next series, 181 would be raised to 184, and in the last 65½ should probably be about 67½, actual height in inches uncertain.

These facts, I think, are in accordance with the law which Mr. Grier himself affirms, but which his experiments appear to contradict—that the momentum is proportional to the square of the velocity, when it is measured by the distance which a body is propelled against a uniform resistance. It must be remembered, however, that the resistance of sand to a falling body is not uniform, but increases with the depth penetrated. In Mr. Grier's experiments with the steel spring, it is evident, from his own account, that the forces expended in compressing the springs were 1, 4, and 9. In the first case, distance compressed 1 mean force ½, product ½; second case, distance 2, mean force 1, product 2; third case, distance 3, mean force 1½, product 4½. Then ½, 2, and 4½ are as 1, 4, and 9.

The result of the collision of oscillating non-elastic bodies, though apparently contrary, are, in reality, perfectly consistent with the doctrine that $V^2 = M$.

With regard to fluid resistance, if the foregoing observations be correct, and if action and reaction are equal, it must necessarily be proportional to square of velocity for a given distance, and to cube of ditto for a given time. The simplest experiments, of which I have tried many myself both in air and water, abundantly prove that such is the fact, in my opinion at least. Nothing can be easier than to insert a few feathers, radially, in the edge of a thread bobbin, put a wire through for axis, and hang a weight to the thread; then observe the time of descent by the oscillations of a plummet, when it will be found that a fourfold weight is required to double the velocity, and of course an eightfold force will be expended in a given time.

A few years ago, I saw in THE ARTIZAN a list of the performances of certain ships, which convinced me that the same thing was true with regard to them: or, at all events, much more nearly true than the contrary opinion, and which list

was contributed by a person holding just the same opinions as Mr. Grier. Whether ships could avoid this vast increase of resistance by being forced out of the water, or driven over its surface, is quite another question.

M. C.

Obituary.

WILLIAM BUCKLE, ESQ., C.E., M.E.

ASSISTANT COINER, ROYAL MINT.

We have the painful duty, this month, of recording the decease of the above named estimable gentleman. Mr. Buckle was one of a rather numerous class in this country, and who may well be designated, as its "unrecognised great men." It is well known that in the engineering profession, especially, there are many in England who may, with great propriety, be so classed, men, whose names are seldom brought before the public during their own lifetime, but whose careers are not the less fraught with usefulness to the community.

Mr. Buckle's example may well be submitted to those who are at present working at the bench or the lathe, as one worthy of imitation. Mr. Buckle's father was a millwright and engineer, and was born at Alnwick, on the 10th of October, 1752. He devoted much attention to the improvement of agricultural machinery in his earlier years, and at a later period was associated with the celebrated Earl of Dundonald in the realisation of his numerous schemes and inventions. In 1840, and at the mature age of 90 years, the elder Buckle died. The subject of our present remarks was the second of three children and was born at Alnwick on the 29th of July, 1794, very soon afterwards his parents removed to the town of Kingston-upon-Hull, in Yorkshire. At this place he received his education, and the family again migrating, he came to London, in his fourteenth year. Messrs. Woolf and Edwards shortly after received him into their employment as an apprentice, and as their work was of a varied character, embracing millwork as well as engineering, young Buckle was most favourably situated. He gained a general knowledge of both, and in his leisure hours supplemented the defects of his early education by attending evening schools and drawing classes. On the completion of his apprenticeship, his employers recommended him to the Prince of Hardenburg, as a fit and proper person to superintend the introduction of steam-boats upon certain rivers and lakes in Prussia. The recommendation was accepted, and Mr. Buckle departed for Memel. Did space permit, many interesting details might be given of Mr. Buckle's exertions in Prussia, and of the successful way in which his mission to that country was effected. It must suffice, however, to state that he gained the approbation of those who had engaged him, and after four years he returned to England. Providentially, he had been fortunate enough to save from drowning a young lady of the Prince of Hardenburg's family, and for this service he was awarded a gold medal. The steam-boat experiences of Mr. Buckle in Prussia was deemed valuable enough to qualify him for home service of a similar character, and we find him next in the employment of Messrs. Boulton and Watt.

In the early part of 1824, the Government determined to institute a steam packet service between Holyhead and Dublin, and to the eminent firm just named was entrusted the task of fitting engines to the boats intended for the work. The *Ivanhoe* was the first of them, and Mr. Buckle was sent down to Milford Haven for the purpose of putting in her engines. By dint of very extraordinary exertion, and by availing himself of all the hours of each week including Sundays, the young engineer speedily started the engines of the *Ivanhoe*. She was the precursor, therefore, of that magnificent line of packets which now connects this country with the Emerald Isle, and Mr. Buckle had the honour of superintending her first trip across the Channel.

To the same gentlemen was committed the honour of conducting, so far as his speciality was concerned, King George IV. to and from Ireland. This voyage took place on board the *Lightning* steam ship, and her name in memory of the event, and at the request of the king, was soon after exchanged for that of the *Royal Sovereign*. For many years subsequently she was known by that title, but eventually becoming dilapidated, and, by contrast with newer vessels, unsightly, her name was again changed for that of the *Monkey*. At this moment the identical vessel is used under the latter contemptible designation, as a tender to H.M.S. *Fisgard*, at Woolwich, and not unfrequently does duty on the Thames as a tug.

Mr. Buckle is next heard of at the Soho Foundry or factory, whither he had been summoned by Messrs. Boulton and Watt, to take the post of foreman, and that office he continued to fill until the year 1851; and during the whole of the intermediate time was in the enjoyment of the confidence and the friendship of

the heads of that gigantic establishment. Of his works, during this period, more will, probably, be said bye-and-bye. They were numerous and varied, and much of the celebrity attained by the Messrs. Boulton and Watt is, undoubtedly, due to the skill and energy of their talented foreman.

In 1851 Mr. Buckle bade adieu to Soho, and came, at the instance of Sir John Herschel, to the Royal Mint, Tower Hill. A total change in the internal management of the Mint was consummated in the year rendered memorable by the first International Exhibition, and Mr. Buckle then became one of its principal officers. Captain (now Colonel) Harness, R.E., was undoubtedly the main-spring of the movement for re-organising the Mint at the time named, and had justice been done to that distinguished officer, he would thenceforth have been created Master of the Money Manufactory. Mr. Buckle, however, rendered efficient aid in the task, and afterwards, with the rank of a senior clerk, he enjoyed the title and emoluments of Assistant Coiner. This post he continued to fill until the day of his death, which unhappy event took place on the 30th ult., at his residence within the walls of the Mint.

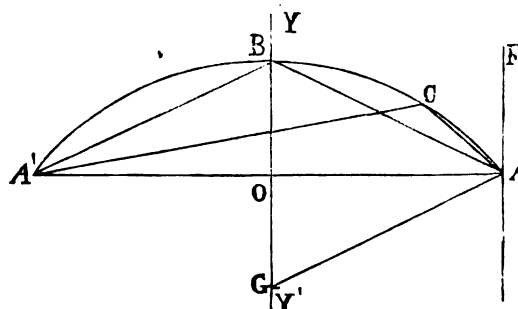
Few men have led a more blameless life than William Buckle, or have been more fortunate in possessing true friends. He was the incarnation of kindness and amiability, and his family, consisting of a widow and a son and daughter, have therefore to lament the loss of a most affectionate husband and father. The deceased gentleman, who had nearly completed his seventieth year when the "icy hand of death" arrested his earthly pilgrimage, was buried at Kensal Green Cemetery on the 6th inst., his grave being surrounded by a crowd of sorrowing relatives, and friends, and workmen who had served under him.

We believe that his colleague in the Coining Department at the Royal Mint, and who should become his successor in the Assistant Coinership there, is preparing a lengthy memoir of Mr. Buckle, and that before many months are past it will be in the hands of the public.

NOTICES TO CORRESPONDENTS.

WORKMAN.—1. The hole in centre of beam may be increased without affecting the strength of the beam, provided the dimensions of the cast-iron centre piece be increased in proportion. 2. No openings, whether circular, square, or diagonal, will affect the solidity of the construction, if you consolidate the beam by the beads alluded to in No. 3. 3. The bead proposed at the top and bottom of the beam will considerably contribute to impart additional strength to the construction; the rivet holes will diminish this effect to a very small extent only. We should, however, suggest to add on each side a central longitudinal rib, of about the same proportions or a little larger than the bead, the latter being all but useless without this rib. We do not know upon which of Templeton's formula you have calculated the strength of your beam; we cannot, therefore, tell you whether your calculation is correct or not.

C. B.—We have been favoured with Dr. Rankine with the following in reply to your query referring to the diagram given in THE ARTIZAN of September last, illustrative of Dr. Rankine's paper read at the British Association Newcastle Meeting—"Abstract of an Investigation on Plane Water Lines:—



Through two points, A and A', to draw a circular arc which shall contain a given angle. Bisect A A' in O, through which draw Y O Y' perpendicular to A O A'; through A draw A F parallel to O Y; from A F, at the point A, lay off F A G equal to the given angle; the point G, where A G cuts Y O Y', will be the centre of the required arc, which may then be drawn. Let A B A' be the arc, then every angle contained in it, such as A B A', or A C A', will be equal to F A G. If the middle point O is given, it is obviously unnecessary to lay down A' on the paper.

INQUIRER.—The particulars shall be given in our next.

A SUBSCRIBER (Manchester).—We have not yet succeeded, but should we find information to the point, we will insert the particulars in the next or any of the following numbers of THE ARTIZAN.

A SUBSCRIBER (Hull).—1. Apply by letter to the Secretary of the Admiralty, Whitehall. 2. We do not know of any work giving the information you seek.

"SILENTIO."—1. Both are very good and useful. We should, however, recommend the preference to be given to the former. The price is 7s. 6d.—2. A cylindrical boiler with two internal flues. 3. Thanks for your suggestion.

C. K. (Sweden).—We have a communication for you awaiting your arrival in England.

E. S.—In reply to the enquiry made by you and other correspondents, as to what is known as the *Swedish Piston*, we are informed by Mr. Nystrom that this arrangement of piston was invented by Capt. Carlsund some twenty years ago.

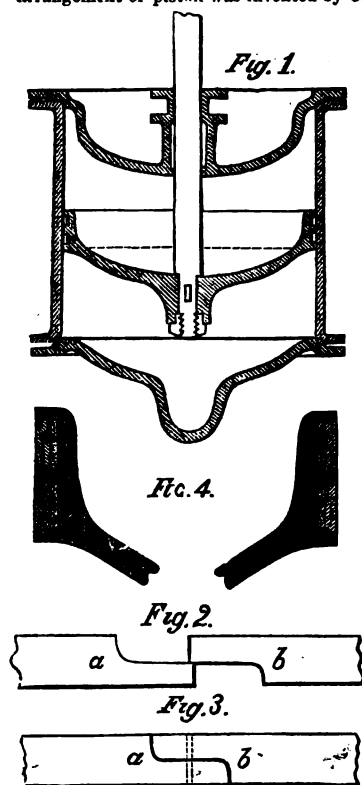


Fig. 1 represents a section of a steam cylinder, with Carlsund's piston; figs. 2 and 3, portions of the packing rings; and fig. 4, a section of the periphery part of the piston. The higher the steam is used, the more concave should be the piston; that in fig. 1 is proportioned to about 30lb. pressure to the square inch. This form makes this piston and cylinder-heads sufficiently strong with very thin metal. The two packing rings surrounding the piston are made of cast-iron, each in one piece, jointed as shown in figs. 2 and 3. The diameter of the ring is cast about the same as that of the cylinder; for large cylinders a little larger, and for small ones smaller. The rings are turned on the four sides, and the joint cut, as shown in fig. 2; the line *a b* should be perfectly parallel with the sides. The joint is then finished as in fig. 3, with the greatest care that the seam *a b* is perfectly tight, and the outside diameter of the ring a little larger than that of the inside of the cylinder, sufficient to allow for turning. A strap is now screwed around the ring, to keep the joint in position; a hole of about one-quarter the thickness of the ring is drilled in the joint, and a pin *c* inserted, and the ring is placed on a centre-plate turned to the correct diameter of the inside of the ring, the strap taken off, the ring turned to the correct diameter of the cylinder, and the sides to the correct size of the grooves in the piston. This work requires a skilful work-

man, and the greatest care must be taken that the rings be not too small for the grooves; should there be any play, it will jar when the piston is in motion. The breadth of the ring is made about 0.3 the square root of the diameter of the cylinder in inches, and the thickness about one-third of the breadth. Capt. Carlsund used to put canvass in the bottom of the grooves, but with high steam the canvass will burn. Mr. Nystrom prefers to employ vulcanized india rubber in the grooves, as shown by the dotted part fig. 4, which is found to answer very well; when the india rubber becomes hot, it expands, and presses the ring gently and uniformly to the sides of the cylinder, and makes the piston perfectly tight. Pistons and cylinder-heads of this shape will weigh about one-half of the ordinary form.

THE MANUFACTURE OF IRON AND STEEL.

Professor Fleury, in a paper lately read by him at the Franklin Institute, Pennsylvania, U.S., stated that chemical analysis has demonstrated the cinder or slag drawn from puddling and re-heating furnaces (and which is generally thrown away as useless) to contain invariably from 25 to 50 per cent. of metallic iron, combined and mixed with sulphur, silica, lime, and alumina, forming a very peculiar brittle compound, defying the most ingenious devices of ironmasters to separate. Prof. Fleury states he has, after many unsuccessful attempts, succeeded in extracting good cast, as well as wrought iron, and has even been so fortunate as to produce from this refuse material a good quality of cast steel.

Two great difficulties had to be overcome. 1st. The oxides and metallic iron in these cinders are 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 the high heat in a steel crucible. 2nd. By re-working the cinder with lime alone, or with lime mixed with charcoal and clay, the product is red-short, and often red and cold-short. The sulphur, silicon, and phosphorus remains still combined with the iron. All the attempts to extract good neutral iron from the puddling cinder by dry admixture of lime were unsuccessful; no other means remained but to destroy or loosen the tenacious chemical combination of these substances before they were placed into the furnace.

Unslacked burnt lime possesses the peculiar property of decomposing silicates during hydration, or slacking, as it is commonly called. This can easily be demonstrated by pouring water slowly into an intimate mixture of sand and freshly burnt lime: the outside of the sand grains will yield to the lime gelatinous siliceous, and, when dried, form with it a strong chemical combination, silicate of lime—the base of a good mortar. Taking advantage of this fact, a proper per centage of powdered burnt lime was mixed with the fine ground cinder, and after wetting the whole with water, the mixture was exposed to the drying influence of the atmosphere. The dry compound was then heated in a common puddling furnace, and treated like pig-iron. 50 per cent. of wrought iron was obtained, which however retained still some traces of sulphur, leaving the iron somewhat red-short. To extract these last traces of sulphur, a small per centage of a chlorine salt was dissolved in the water used for slacking the lime, and the desired result was attained. The process is also applicable to the working of siliceous ores, and can be performed in the puddling, cupola, or blast furnace. The preparation of the cinder, cost of lime, salt, &c., does not, we understand, exceed 9s. per ton, and, if properly worked, the result is invariably a good quality of iron.

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.

SOLICITORS TO PUBLIC COMPANIES.—In *re* the Phoenix Life Assurance Company, before Vice-Chancellor Wood, an important question was raised as to the right of the solicitors of the company (which is in course of winding-up), to be allowed certain costs claimed by them in respect of actions brought and defended on behalf of the company, in reference to marine insurance business, which had been already held to have been *ultra vires*; and the Vice-Chancellor decided that where a company engaged in a business not authorised by its deed of settlement, and the solicitors to the company, knowing that the business was unauthorised, were employed by the directors to bring an action, and to defend other actions in respect of claims arising out of the unauthorised business, the solicitors must be considered with respect to such actions as the solicitors of the directors, and not of the company, and that they could not prove for their bills of costs upon the company's assets. His Honour said, that without laying down any rule, that every solicitor was to be considered aware of all the consequences of acting in matters which might or might not be within the scope of a company's powers, he might say that solicitors appointed by the directors of a company were retained on behalf of the company, and were not the mere servants of the directors. On the contrary, it was their duty to advise the company to adhere to the regulations of the deed of settlement, and not to carry out the whims of the directors.

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.

COST OF THE CENSUS.—The expense incurred at the central office (exclusive of postage) and in payment of the local officers in taking the census of England and Wales, was £93,728 in 1841, £93,132 in 1851, and £95,719 in 1861. This was in 1841 £5 9s. per thousand of the population, in 1851 £5 4s., and in 1861 £4 15s. 6d., or rather more than a penny per head for every man, woman, and child in the kingdom. 33,966 local officers were employed in taking the census of 1861.

IMPORTANT SANITARY MEASURE FOR LIVERPOOL.—The Liverpool town council, on the recommendation of the health committee, have at length resolved to apply to Parliament for powers to purchase the courts and alleys of the borough, in order that they may effect comprehensive improvements, and prevent, if possible, the continuance fever and other diseases in these localities. One-fifth of the population of Liverpool at present reside in

these courts and alleys, which are 3108 in number, containing 18,610 persons, and many of which places, are so ill-ventilated that fever is never absent. It is proposed to charge the cost of purchasing this property on the general rate authorised to be levied by the local sanitary Acts, the rate not to be increased beyond 1d. in the pound in any one year.

ARTIFICIAL LIGHT.—The foundation-stone of the new retort-house of the Manchester Corporation Gasworks, at Gaythorn, has been laid by the Mayor (Mr. Abel Heywood), and at the luncheon, which was afterwards held at the Town Hall, Mr. Curtis, the chairman of the gas committee, stated that by Mr. Macfarlane's arrangement, as it would be carried out in the new works, they would be prepared to carbonise in each stack 4 tons 16 cwt. of Cannel, producing 48,000 cubic feet of gas, in 24 hours, with an expenditure of 15½ cwt. of coke. Thus in the same space of building they would double the amount of their production, without increasing the cost of their expenditure for fuel. Whether they had arrived so far as they could go in these respects time alone will show, but he thought they had already accomplished a great deal. He found, by looking at the books that the consumption of gas on one day recently had been 3,233,000 cubic feet. He had calculated how many sperm candles would be needed to give the amount of light supplied by that quantity of gas, and he found it would be 3,960,000. Mr. Rumney, in responding to the toast, "The Chairman of the Sub-Committee, and Successors of the Building," said that one of the chief questions in connection with the extension of their gas-producing power was whether it was likely that there would ever be a cheaper artificial light? He thought there was no probability of such a thing at present. Experiments were made last winter by Dr. Frankland, an eminent chemist, now resident in London, and formerly of Owen's College, the result of which deserved to be widely known. He found that the illuminating power of 20 sperm candles for ten hours would cost as follows in the several artificial lights named:—Spermaceti candles, 6s. 8d.; paraffin candles, 3s. 10d.; tallow candles, 2s. 8d.; sperm oil, 1s. 10d.; paraffin oil, 6d.; coal gas, 4½d.; Cannel gas, 3d. Another consideration was that some persons complained of gas causing heat and impurity in the air, and it became a question as to whether it created more heat and impurity than other artificial lights. The same gentleman conducted experiments to find that out, with these results:—Taking the illuminating power of 20 sperm candles as the standard, it was found that in a room of a certain size, and in a given time, tallow candles produced 10 cubic feet of carbonic acid gas, and an amount of heat represented by 100; spermaceti candles produced 8½ cubic feet of carbonic acid gas, and heat, 82; paraffin candles, 6½ cubic feet of carbonic acid gas, and heat 66; coal gas, 5 cubic feet of carbonic acid gas, and heat 47; and Cannel gas, 4 cubic feet of carbonic acid gas, and heat 32. This disposed of the idea that gas caused more heat, and made the atmosphere more impure, than other artificial lights.

INSPECTION OF STEAM-ENGINES EMPLOYED IN AGRICULTURE.—A general meeting of the Suffolk Agricultural Association has been held at Ipswich, to consider the propriety of adopting some precautionary measure for preventing accidents from steam power employed in agriculture, the necessity of some provision of this kind having been most forcibly shown by the recent calamitous accident at Charsfield. The meeting was presided over by the Earl of Stradbroke. After some remarks from the chairman, Mr. C. Welton proposed the following resolution:—"To meet the present emergency, it is proposed that for this county the Agricultural Association appoint a competent engineer as inspector of steam-engines employed in agriculture, such inspection to be made at least half-yearly, at a certain fixed payment per engine for each inspection, which, with the exception of a small annual sum from the funds of the association, is to be at the expense of, and paid by, the owners of the engines respectively. The inspector will be required to keep a registry of all engines inspected by him from time to time, with the name of the makers, the date or age of the engine, and limited amount of pressure in pounds to the square inch upon the boiler, together with the date of the last inspection, all of which to be painted in large and legible letters (of not less than half an inch) upon the outside of the boiler. He shall also examine the engine-driver as to his fitness, and if satisfied give him a certificate, which will enable him to wear a badge on his right arm above the elbow, having a number upon it corresponding with the inspector's book; this badge or distinction he will be obliged to wear when at work with the engine. The inspector shall, once in every year, make out a schedule of engines examined by him, with a report upon their condition, together with any suggestions which may occur to him in the course of his inspection, and forward a copy of the same to the secretary at least one week before the annual general meeting of the association; which report shall be read before the general body of the members, and printed in the books of the rules and regulations of the society." This was seconded, and after a long discussion was finally adopted, but left, however, for reconsideration. A committee was then appointed to obtain such information as might seem necessary for carrying the resolution into effect; and it was understood that it would report in the course of a month.

LARGE HAMMER CASTING.—At the Ouseburn Engine Works there has been cast a large frame for a steam-hammer, on Mr. Robert Morrison's patent. The pit for the same was 45ft. long, 24ft. wide, and 12ft. deep, and required about 56 tons of metal, 28 tons of which were held in a large air furnace erected for the purpose, and the remainder in two ladles. The running of the metal occupied five minutes and nine seconds. The whole of the operations were under the management of Mr. James Turnbull, and were successfully carried out.

STEAM BOILER GAS FURNACES.—The patentee of this proposed substitute for coal is Mr. A. Jackson, of the East-India Chambers. A boiler to which the gas fuel is applied in Messrs. Cutler's works, in Wenlock-road, City-road, is about 3½ ft. in diameter, and it is perforated by a great number of perpendicular tubes, through which the heat of the gas flame passes so as to present a large heating surface. The quantity of gas consumed per hour is stated not to exceed 200 cubic feet, which will guarantee 2lb. weight of steam per minute. The engine supplied with steam from the boiler is equal to four-horse power. The steam indicator showed that the pressure was not steadily maintained above 30lb. to the inch. As there is no smoke from such a furnace no chimney is required, the vaporous products of combustion being carried off by a small tube. It is stated by Mr. Jackson that in his application of gas its cost is considerably greater than that of coal for generating an equal quantity of steam, but he asserts that the extra cost of fuel is more than compensated by the saving of labour.

THE PARIS UNIVERSAL EXHIBITION.—The permanent exhibition now building at Auteuil, with the whole of its annexes, will cover a space of about 29 acres; out of these, the "palace" proper is to occupy 10, the annex devoted to machinery, agricultural implements, and the flower-show, 3½ acres. Squares and gardens will be placed in those parts not occupied by the building. The palace proper will form a large parallelogram of about 440 yards in length, by 160 yards wide. Four pavilions will project at the transverse axis of the building; the doors will be placed between them, and in the centre of the fronts, viz., the main entrance on the Boulevard Neuf, and the egress on the road facing the Parc-aux-Princes. Between the pavilions and the doors will be 100 "arcade windows," the height of which will be equal to that of the highest houses of Paris, so as to enable them to throw light both on the ground and first floor of the building. The palace is divided inside longitudinally into three parts, which form in the centre a grand nave of a width of 44 yards. The side galleries have a width of 35 yards each. An iron and glass tower will be placed in the centre at a height of 110 yards from the ground to top of tower. The building is to consist of wrought and cast-iron, the total weight of which is 10,500 tons; stone will be partly used for the exterior only of the building. The main doors will be adorned with sculptures and statues, denoting the object of the undertaking. The ground floor will communicate with the first floor through eight staircases of 26ft. width each.

THE VIENNA INTERNATIONAL EXHIBITION.—We understand that the plans for the Vienna Exhibition of 1865, drawn by the Architect Herr Lohr, are now ready. The building will be erected in the Prater, on the right side of the main avenue, near the Sophienbrücke. It is to consist of a main building of 466 yards in length, by 53 yards in width, and two uncovered annexes behind, in which the agricultural show is to take place. The whole of the building will consist of stone and timber. The reservoir and waterworks inside the building will be supplied from the Danube Canal, by means of a steam engine, and a tramway will connect the exhibition with the Vienna Metropolitan Railway, so as to allow the goods to be conveyed from the stations direct to the building. The total cost is estimated at 3,000,000 florins (£300,000). The Austrian Government is to guarantee the interest and make up the deficit.

THE IRISH EXHIBITION OF 1864.—The organisation of this enterprise is making satisfactory progress. In various parts of the country meetings have been held in furtherance of the movement, and in every instance the proposal has been favourably received. Messrs. Bagot and Walker represent the Royal Dublin Society, under whose auspices the exhibition will be held.

WATER-PIPES.—Wrought-iron water-pipes, lined and coated with hydraulic cement mortar, are in use in San Francisco. These pipes have spigot-joints, can be back-filled as soon as laid, and capped in the same manner as cast-iron pipes.

NAVAL ENGINEERING.

THE "SALAMANDER," paddle wheel sloop, 6 guns, 818 tons, 220 horse-power, having undergone repairs and been fitted with new boilers in Sheerness Dockyard, underwent the final trial of her engines (previous to her being commissioned) off the measured mile at Maplin Sands, on the 8th ult. She attained a true mean speed of 6.721 knots, with 18½ revolutions of engines; pressure of steam, 13; load on safety valve, 13; vacuum starboard, 26; and port, 25½. Her draught of water was, forward, 15ft. 11in., and aft, 15ft. 10in.; diameter of wheels, 20ft.; immersion of floats, 2ft. 2in. The circle was turned at full boiler power in 5 min. 30 sec.; helm starboard, 33 degrees; diameter of circle, 460ft.; the half circle was turned with helm starboard, 30 degrees, in 2 min. 20 sec.; with helm port, 30 degrees, in 2 min. 22 sec. The trial equalled all that had been expected.

THE SCREW STEAM CORVETTE "PELORUS," 22, Capt. Boys, made a trial trip outside Plymouth Breakwater on the 8th ult. Her mean speed in six runs at the measured mile was 10.913 knots; mean revolutions, 45.7. Under half-boiler power she made 9.053 knots; revolutions, 45. The engines and boilers worked in a very satisfactory manner, and the speed attained was half a knot more than on the former trial. On the 17th ult., at 5.15 p.m., when the *Pelorus* was 330 miles south-west half west of the Lizard Point, the chief engineer, Mr. James W. Stell, reported to the captain that the foremost starboard boiler was red hot, and that the felt over it was on fire. That part of the maindeck immediately contiguous was at once scuttled in two places, so as to allow water to pass on and behind the boiler, and a plentiful supply being sent down from the pumps and by buckets from over the side, the boiler was completely cooled by 9 p.m. One of the stokers first discovered the accident by the smell from the burning felt. The crowns of the furnaces have dropped, and the boiler is so much injured that it will have to be removed, which will be done at once.

THE SCREW STEAMSHIP "GIBRALTAR," 81, Capt. J. C. Prevost, recently put in commission, made an experimental trip outside Plymouth Breakwater, on the 2nd ult. Six runs made at the measured mile, under full boiler power, gave a mean speed of 10.897.

LUMLEY'S RUDDER.—The *Columbine*, 4, screw sloop, was docked on the 10th ult., at Portsmouth, in course of her refit preparatory to proceeding to the Pacific. An opportunity was thus afforded to examine the jointed or "Lumley" rudder with which she was fitted some months since at Sheerness. No part of the rudder or its chain is worn or strained in the slightest degree, but is all as perfect as on the day it was first fitted. The *Columbine* has just returned from the coast of Scotland, where she has experienced a considerable amount of rough weather both under steam and canvas, during which the rudder has been tested in every possible way. With the vessel under canvas it was found an angle of tiller of eight degrees was sufficient to put the ship about. In ordinary steering, more especially under steam, a very small touch of the helm was found sufficient. In entering and leaving the docks at Aberdeen, where the entrance is very narrow and the turnings sharp, the pilot on board was surprised to find that Commander Ward intended to trust to his vessel's rudder alone in taking her in and out of the docks.

THE "FALCON," 17, screw-corvette, completed her course of trials, prior to commission, at Portsmouth, on the 13th ult., under the supervision of the officers of the steam factory and reserve. She is 751 tons measurement, and is driven by a pair of auxiliary engines of 100-horse collective, nominal, power. There was a strong breeze from the southward, which rendered some of her runs over the mile against wind and tide of unusual length, and therefore detracted from the ship's average speed. She made one mile under such circumstances, when trying her speed with half-boiler power, in 18 minutes and 37 seconds. The *Falcon* is rigged, armed, and stored for sea, and only waits her crew and ammunition to complete her to her sea-going draught of water. At the commencement of her trial, she drew 14ft. 3in. of water forward, and 14ft. 5in. aft. The load on the safety valve was 20lb., and the vacuum ranged from 23in. to 24in. Six runs were made with full boiler power, the mean of which gave the ship a speed of 5½ knots. Four runs were made with half-boiler power, and the mean of these gave a speed to the ship of 6.260 knots. Two circles were made to port and starboard with full power in 5 min. 9 sec. and 4 min. 56 sec. respectively; and at half-power the two circles were made in 6 min. 30 sec. and 6 min. 54 sec.

THE UNITED STATES' RAM "DUNDERBERG."—The following are some of the dimensions, &c., of this vessel, built by Mr. W. H. Webb:—Extreme length, 378ft.; extreme breadth, 68ft.; whole depth, 32ft. The whole upper surface is to be iron-plated to six feet below the water line. Above the deck she has a large casemate to carry ten heavy guns, and above these are to be placed two revolving turrets. To form her enormous ram the bow of the vessel is solid wood, running back over fifty feet. This is to be plated with the best quality of iron. The sides of the vessel, before the plating is put on, are solid oak wood. She will have two rudders, which are protected by the peculiar construction of the overhanging stern. Her engines will be 6000 horse-power; and, to give stability to the hull at all times, and especially at the time of impact, when ramming a vessel, she is provided with one main and four sister keelons, which run the entire length of the vessel and meet at either end. These are of solid oak. The entire frame of the vessel is diagonally strapped with iron, which gives her great strength. At some distance from the side of the vessel inboard is a ceiling or skin which furnishes a large number of store-rooms, and at the same time makes a water-tight compartment the whole length of the vessel. She has three decks, or, counting the bombproof deck of the casemate, she is a four-decker. The lower decks are of the same thickness as ordinary vessels; but the casemate deck is much heavier, while the bombproof deck over the casemate is twenty-one inches thick of wood, with two inches of plating to cover it. The casemate is 163ft. long in the clear, and it extends the entire breadth of the vessel. Its sides are sloping, and over three feet in thickness. This fort upon deck is pierced for ten heavy guns—three in each broadside, and two at each end. Surmounting this are to be two turrets twenty-four feet internal diameter and fifteen inches in thickness. Her armour-plating alone will weigh over 800 tons, while her turrets, pilot-houses, &c., will weigh over 300 tons; so that at a rough estimate the weight of armour she will carry will not be far from 1300 tons. The large

casse-mate "tumbles in," or inclines inward, at an angle of nearly forty-five degrees; so that it is not necessary to have the iron so thick as may be supposed. The wood backing, which makes a cushion for the armour plates, is much thicker than has ever been used before in a plated vessel, so that in the event of the angular sides of this casse-mate being struck and the iron penetrated, there is an enormous quantity of oak and pine wood yet remaining to be pierced. The plating of the hull is put on in upright slabs, and not horizontally, the plates varying in length from eleven to twelve and a-half feet, and twenty-eight inches in width. These slabs are three and a-half inches thick, and are secured to the vessel by means of a peculiar screw bolt. The plating of the casse-mate is four and one-half inches in thickness, from eleven to twelve and one-half feet in length, set upright, and twenty-eight inches in width. At the bottom of these plates and the top of the hull plates they are bevelled so as to form a snug joint. The turrets are built in sections or slabs, which are five inches thick, eleven inches high, and nineteen feet in length. These are bent so that it requires four of these slabs to make the circle. The inner courses of the turrets are two one-inch plates, and outside of the slabs are six courses of one-inch iron. Each turret is nine feet in height. The inside diameter of the turrets is twenty-four feet. All of the iron used in this vessel is of the best quality of hammered cold blast charcoal iron, and comes from the Reading Forge.

LAUNCH OF THE "RE DOM LUIGI DI PORTOGALLO" FOR THE IRON-CLAD ITALIAN NAVY.—Mr W. H. Webb, of New York, United States, launched the new frigate *Re dom Luigi di Portogallo* for the Italian navy. The vessel is a sister ship of the *Re d'Italia*, which was launched from the same yard on the 18th April. She is 295ft. in length, 55ft. beam, 30ft. 6in. depth of hold, and 5500 tons, carpenter's measurement. Her build does not materially differ from ordinary vessels of war, except that from the water-line upwards she falls in considerably, so as to give an angle to shot. Her frame is of the best white oak, and put together with iron strappings, which render her one of the best constructed vessels ever built by Mr. Webb. The gun deck has ports for seventeen guns. On each side the portholes are of a peculiar shape, being very narrow and bevelled inward, like the embrasures of a fort. Her engines are building at the Novelty Iron Works, and are direct back action, with eighty-four inch cylinders and forty-five inch stroke. She has six horizontal tubular boilers, with thirty-six furnaces. She will be propelled by one composition propeller. The propeller can be hoisted out of the water when it is desired to make a passage under canvass alone. She will be bark rigged, and will not look unlike the United States steam frigates of the Wabash class, except she will have no yards on the mizenmast.

THE LAUNCH OF THE "VALIANT," from the yard of Messrs. Westwood, at Poplar, took place on the 14th ult. The *Valiant* is a connecting link, so to speak, between the *Warrior* and vessels of the *Defence* and *Resistance* class. Her length over all is 290ft., her extreme breadth, 56ft., and her depth from her spar deck, 39ft. Her lines are finer than the broad bow vessels like the *Defence*, but yet are not to be compared in fineness to the *Warrior*, while, on the other hand, her bows, without having a regular beak to be used as a ram, are still sufficiently projecting beneath the water line to enable her if she got a chance of striking an enemy to inflict fearful mischief, without risking the safety of her own hull. She may be called a sister ship to the *Hector*, which was launched from the Clyde at the close of last year. In the construction of the hull the principle is the same as that of all the iron frigates. Like the new frigates, however, she is to be plated from stem to stern in armour, the stern being almost as fine as her bows, and with an additional plating of iron over her outer stern-post and rudder head. About 80ft. from the bows inboard she is fitted with a semi-circular shield, which extends from one side of the vessel to the other, and rises from the main deck to the level of her bulwarks on the spar deck. This is coated with 4½in. armour plates, and lined with teak as with the broadside. On the main deck it is closed, but on the upper is pierced for two of the heaviest guns for use in chasing an enemy, or when bearing down on one to strike her as a ram. It is intended that the *Valiant* shall be fitted with a pair of horizontal engines of 300 horse nominal power, on the double piston-rod principle, manufactured by Messrs. Maudslays. The cylinders are each to be 32in. diameter, with a stroke of 4ft. They will both be surrounded with steam jackets, which are supplied with steam direct from the boilers; the ends of the cylinders and the cylinder covers are also to be cast hollow and supplied with steam in the same manner. The screw propeller is 20ft. diameter, with two blades, constructed so that the pitch can be varied from 22ft. 6in. to 27ft. 6in. When working full power the engines are expected to make about 60 revolutions per minute. There will be six boilers placed, three on either side of the vessel, with the stoking-room between them. There will be also a pair of auxiliary engines of the collective power of 40 horses, to work two double acting force pumps, arranged with a system of pipes throughout the vessel for the purpose of extinguishing fire. These engines will be also used for driving two fans for ventilating the cabins by means of two lines of pipes, ranged one on either side, throughout the length of the vessel, with gratings for regulating the supply of air into each compartment. These engines will also be used for driving a blast for a cupola furnace, for melting iron for shells, placed at the end of the stokehole, and for driving an apparatus for raising the ashes on to the upper deck, so as to save labour. Externally the *Valiant* looks as ugly as the *Hector*, though better in the water than either the *Resistance* or *Defence*.

NEW GUNBOATS.—At Chatham a notification has been received that the Admiralty have decided on constructing a squadron of iron gunboats, to take the place of those wooden gunboats which have been sent round from the Medway to Deptford Dockyard to be broken up. The new gunboats are to be constructed on an entirely new system, from plans proposed to the Admiralty by Mr. Reed, the Chief Constructor of the Navy. They will be armour-plated, and will be driven by twin screw propellers, each boat being adapted to carry two heavy Armstrong guns. The design of the proposed gunboats is at present being worked out at the Admiralty, and as soon as the plans have been finally adopted the construction of the proposed squadron will at once be commenced.

THE TRIAL TRIP OF THE "SALAMIS," paddle wheel yacht steamer, 835 tons, 250 horse-power, took place on the 23rd ult., at the measured mile off Maplin Sands. At her former trial the *Salamis* drew 9ft. 2in. forward, and 9ft. 10in. aft. With 120 tons of coal and nearly the same quantity of stores, shot, cable, water, Armstrong, and other guns, she on this occasion drew 10ft. forward, and 9ft. 11in. aft, and was therefore not in the best possible trim for making her trial. The immersion of the paddle wheels from the inner edge of the floats was 9in., and the total dip 4ft. 2in. She is fitted with Morgan's patent feathering floats, which materially increase her speed. The diameter of the paddle wheels is 21ft. 6in. The engines, which are by Messrs. Ravenhill, Salkeld, and Co., are fitted with all the latest improvements, including superheaters, &c. Six runs were taken at full boiler power, with the following results:—In the first run the time was 3 min. 54 sec., speed in knots 15.385, and number of revolutions 334 per minute; in the second run the time was 5 min. 6 sec., the speed 11.765 knots, and the number of revolutions 35; in the third run the time was 3 min. 52 sec., the speed 15.617 knots, and the number of revolutions 34; the time in the fourth run was 4 min. 42 sec., the speed 12.766 knots, and the number of revolutions 34; in the fifth mile the time was 4 min. 3 sec., the speed 14.815 knots, and the number of revolutions 34; in the last mile the time was 4 min. 35 sec., and the speed 13.091 knots. The mean vacuum was 26, and the average temperature of the stoke-holes 90 deg., and of the engine-room 78 deg., during the trial. The average speed attained by the *Salamis* during the six runs was 13.84 knots,—that is to say, 16 statute miles per hour. This is exactly a knot an hour less than on the occasion of the former trial of this steamer, when she attained a mean average speed of 14.843 knots an hour. This falling off in her speed is to be attributed to her uneven trim, the vessel being down more by the head than the stern; the heavy nature of her rigging, masts, and

spars, which operate disadvantageously to the speed of the steamer; and, lastly, to the foul state of her bottom, from the lengthened time she has been in harbour. At the close of the trials at full speed two of the boilers were cut off, and a couple of runs taken over the measured mile at half-boiler power with the following results:—First run—time 4 min. 40 sec., speed in knots, 12.857, and number of revolutions 30; second run—time 5 min. 2 sec., speed 11.921 knots, and number of revolutions 12.359, giving a mean speed at half-boiler power of 12.389 knots per hour, as against 12.648 knots per hour at half speed on the occasion of her former trial on the 21st August. From these figures the *Salamis* is out of proportion a much faster vessel under half-boiler power than when steaming at full speed, the difference in the two rates being less than a knot and a half an hour. During the trial, Admiral Bullock was busily employed on board in making experiments with and recording the results of the trials with his new description of log for enabling the speed of ships at sea to be instantaneously ascertained. The apparatus used for the purpose is a kind of steelyard, which is suspended from the vessel's taffrail, and attached to which is a line of some 150ft. in length with the log at the end. The pressure on the hand of the dial causes it to revolve, and a series of numbers on its face will indicate the true speed of the vessel at any moment. The *Salamis* was placed in the first division of the steam reserve in readiness for any service for which she may be destined.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—J. L. Bastrick, of the *Miranda*, promoted to acting First-class Assist. Engineer; W. Stretton, Assist. Engineer, to the *Scylla*; J. Anderson, of the *Indus*, H. Aitken, of the *Edgar*, G. Boyd, of the *Asia*, E. C. Legh, of the *Dawntless*, J. King (b.), of the *Havock*, J. Watson (b.), and R. Blackwood, supernumeraries of the *Indus*, and C. E. Uffindell, supernumerary of the *Figard*, promoted to First-class Assist. Engineers; J. M'Master, of the *Vulcan*, T. Russell, of the *Tartar*, G. O'Brien, of the *Rapid*, D. Grant, of the *St. George*, James Jack, of the *Aboukir*, T. N. Crowder, of the *Jason*, and D. Ferguson, of the *Nile*, promoted to acting First-class Assist. Engineers; E. Lilley, Engineer, to the *Indus*, for the *Cordelia*; T. Pattison, of the *Hornet*, promoted to First-class Assist. Engineer; J. Rinnale, Assist. Engineer, to the *Indus*, for the *Gladiator*; J. C. Gauchy, Chief Engineer, to the *Tamar*; F. T. Elliott, Engineer, to the *Cumberland*, for the *Pawn*; J. F. Channon, Engineer, to the *Tamar*; F. W. Henderson, Assist. Engineer, to the *Cumberland*, for the *Sepey*; G. Tidcombe, F. Pursell, and J. Milne, Assist. Engineers, to the *Tamar*; T. Stanley, Assist. Engineer, to the *Asia*, as supernumerary; H. Griffin, Assist. Engineer, to the *Figard*, as supernumerary; J. E. Callagan, Assist. Engineer, to the *Indus*, as supernumerary; C. Moore, Chief Engineer, to the *Figard*, for the *Valiant*; J. Bonney, Chief Engineer, to the *Cumberland*, for the *Clio*; J. V. Thompson, First-class Assist. Engineer, to the *Rattlesnake*; J. H. Wills, Assist. Engineer, to the *Cumberland*, as supernumerary; J. F. Channon, Engineer, to the *Figard*, as supernumerary; W. Todner, Engineer, to the *Tamar*; J. Downes, Engineer, to the *Cumberland*, for the *Bullfrog*; J. Rice, Engineer, to the *Indus*, as supernumerary; T. S. Gissing, Engineer, to the *Falcon*; P. Murray and H. Thomson, Assist. Engineers, to the *Falcon*; J. Watson (a.), of the *Sepey*, promoted to Acting First-class Assist. Engineer; J. Leys, J. A. Burton, and J. W. German, Chief Engineers, to the *Cumberland*, for the *Achilles*, *Bombay*, and *Amphion* respectively; G. H. Weeks and H. W. Fitzgerald, Assist. Engineers, to the *Asia*, as supernumeraries.

MILITARY ENGINEERING.

IMPORTANT TRIAL OF ARMOUR-PLATES.—The trials of 5½-in. armour-plates on the side of the *Monarch* target ship at Portsmouth were attended with an unusual degree of interest, owing to the fact of their being the first time the four leading firms in England had supplied plates of equal thickness of metal for trial. They consisted of one each from Messrs. John Brown and Co., of Sheffield, the Mersey Iron and Steel Works, the Thames Ironworks and Shipbuilding Company, and the Millwall Company. All four were good plates, but with varying degrees of excellence. Messrs. John Brown and Co.'s plate was the best of the four. Four shots struck this plate in a vertical line, but they opened no cracks in the same direction nor otherwise, except in the indentations. Two of these shots overlapped each other 3in., but the result of the two blows only produced an indent of 2½in. in depth—an unprecedentedly favourable result, as showing the excellent resisting power of the iron. Eight shots struck within 3ft. of the left of the plate, and three of them on the very edge, but only produced the usual small cracks exhibited by the firm's plates within the circumference of the indentations. No signs of concentric cracks were shown round the indentation of these edge blows. The Mersey plate received 13 shots in all, and stood very well for the "first" rolled plate produced by this firm. The metal has a soft appearance, and seemed of good quality, but there was a tendency in it to crack vertically—a fault which will, doubtless, be guarded against in further productions. The Millwall plate was not of so good a quality as the 5½in. plate previously sent in for trial by this firm. The welding was very faulty.—It received 11 shots. The Thames Company's plate was very severely injured by the 9 shots fired against it striking on the weakest points. Five struck in an area of 3ft. by 18in., and three of them joining in the circumference of indentations. The effect, however, was only slight, though numerous cracks were made from the severe pounding the iron had received. The gun used was the ordinary 63-pounder, and cast-iron shot with 16lb. of powder, at 280 yards range. On the day following the trial of the plates a smooth-bore 100-pounder gun was shipped from the *Excellent* on board the *Foam* gunboat, and the latter vessel proceeded up the harbour, and took up a 200 yards' position from the target-ship and the plates she had fired at with her 63-pounder of the previous day. A shot was fired at each plate with a 25lb. charge of powder, and in all but one instance the damage inflicted appeared to be commensurate with the increased weight of the shot and size of the charges, as compared with the 63-pounder. A further careful inspection hardly confirms this belief. In all but one instance the plates had been damaged by previously firing from the 63-pounder, and no fair inference could, therefore, be drawn from the results. In the one instance referred to the Millwall plate was struck fairly in an un injured part by the round 100-pound shot, and the result was—diameter of indent, 10in.; depth of indent, 3in. There were cracks across the centre of the indent. The average diameter of the indent from the blows of a 63-pounder is 2½in., with a depth of 2½in. The *Monarch* is now having plates bolted on her sides for further experimental firing, including a trial plate for the *Research* from the Buttery Company, and one from the Thames Company for the *Minotaur*.

TRIAL OF ARMOUR PLATES, STEEL GUNS, &c., AT ST. PETERSBURGH.—Some trials have recently taken place at St. Petersburg with the experimental 9-inch rifled cast steel gun. This gun is of solid cast steel, made by Krupp, and throws a 300lb. shell or a 450lb. solid shot. The results of some previous experiments with this gun led the Russian Government to order fifty of them, which are now in course of delivery. The principal object of the experiments on this occasion was to ascertain the best description of shell, and to test the quality of armour plates supplied by Messrs. John Brown and Co., of Sheffield. First, a series of cast-iron shells, 300lb. each, were fired at different ranges, and then shells made by Krupp were fired at the 4½-inch armour plates. The first shell, of hard cast steel, was 22½ inches long (two and a half diameters), with a flat end four inches in diameter. Fired with 50lb. of powder at 700ft. distance it passed through the plate, oak and teak backing, and broke into many pieces, although filled with sand only. The second and third shells were also of Krupp's steel, the same length, but with 6½" ends. These shells pierced plates, wood, &c., and also went to pieces, although only filled with sand. The fourth shell was made by M. Potefoff, of puddled steel, on Aboukoff's system, the same dimensions as the second and third, and went through iron, teak, &c., but was only bulged up from 9" to 12", and the end flattened, not a single crack being visible in the shell. The fifth shell, the same as the fourth, passed

through iron, teak, and the second target, and went at least a mile beyond. The sixth and seventh shells were from Krupp, and were charged with powder; they were quite flat-ended, 9" diameter. One exploded in the plate, the other in the wood. The eighth and ninth shells were of cast-iron, and although they passed through the plates, were of course destroyed. Evening prevented further trials, which will yet be made on the same plate. The results on the plate were highly satisfactory. In a space of 4' 0" x 3' 0" eight holes were made without any crack of the slightest description; and the marine officers present were highly satisfied, because they are obtaining 4000 tons of plates from Messrs. John Brown and Co. for their different ships.

STEAM SHIPPING.

THE "GREAT EASTERN."—The Committee of the Great Ship Company, in their report, recommend that the ship be placed on the longest voyages, where there can be the least competition and highest receipts, and that the shareholders contribute for the liquidation of the existing debts, rather than sell the ship at an enormous sacrifice. The gross outlay of the company, for the three and a half years, has been £278,359, the ship having been only 200 days at sea, whereas, had she been running on the Australian route, she would have been 450 days at sea, and the expenses would have been much less, except for coal. The gross receipts have been £153,000, while the receipts from five Australian voyages would probably more than treble this amount, the balance affording an ample profit to pay the shareholders. The report was adopted.

THE TRIAL TRIP OF THE "RESOLUTE," one of the most powerful steam tugs in the kingdom, took place at Liverpool, on the 6th ult. The *Resolute* has had new boilers put in her, machinery overhauled, and refitted, new feed heaters put in, and rigged to make the voyage out to Calcutta, where she will make an addition to the Hooghly Steam Tug Company. During the trial trip of 54 nautical miles, which was performed in four hours, the engines worked most successfully, there being no heated bearing, the supply of steam being abundant, and the temperature of the feed water raised to nearly boiling point. The effect of the recent improvements, which were executed by Messrs. J. Jones and Sons, of Liverpool, has been to reduce the consumption of fuel from 30 to 18 tons per day, while the speed of the vessel has been considerably increased.

TRIAL OF THE STEAM TUG "COLUMBUS," at Liverpool, took place on the 14th ult.; and, notwithstanding she was heavily laden with coals and stores for her voyage out to Calcutta, she made 12 knots per hour. The *Columbus* is to form an addition to the fleet of tugs already sent out to the river Hooghly from Liverpool.

THE TRIAL TRIP OF THE "LUCY," steel plate built steamer, has taken place at Liverpool, under the superintendence of the surveyors to the underwriters' registry. During the trial, notwithstanding a strong wind and tide against her, she maintained a speed of 16½ knots. The pressure of steam was about 30lb., and the revolutions about 36. The results were considered highly satisfactory.

THE LAUNCH OF THE "ANDALUSIA," screw steamer, from the yard of Messrs. Swan and Co., Maryhill, on the Clyde, took place on the 14th ult. She is of 400 tons burthen, and is to be employed in the Spanish trade. Her engines will be supplied by Messrs. Forrest and Barr, Port Dundas, Glasgow.

THE TRIAL TRIP OF THE "SEA KING," iron framed and wood planked steamship, launched by Messrs. A. Stephen and Sons, for the direct trade between China and London, has taken place. The vessel made the run between the Cloch and Cumbranes, on the Clyde, at a speed of 12½ knots per hour down, and up, against a strong gale of head wind, at 9.99 knots, a result highly satisfactory, considering the small power of engines to the size of the ship.

STEAMSHIP BUILDING ON THE CLYDE.—Messrs. Randolph, Elder, and Co. have completed the *Chile* for the Pacific Steam Navigation Company; she is the first of three large steamships ordered by the company from the same firm. The *Chile*, which has been fitted with double cylinder engines of 400 horse-power, left the Mersey on the 15th ult. to take her station on the company's main line between Panama and Valparaiso. In running from the Clyde to the Mersey she attained a mean speed of 13½ miles per hour against a strong tide, her engines working with an average pressure of 20lb. of steam, and making 21 revolutions per minute. Annexed are the dimensions of the *Chile*, which is 1600 tons burden:—Length between perpendiculars, 265ft.; beam, 36ft.; depth, 24ft. Messrs. McNab and Co. have launched from their yard near Albert Harbour, Greenock, a screw steamer of 340 tons, named the *Beatrice*, and built for the Bristol and Cork Steam Navigation Company. She will be provided with engines of 60 horse-power by Messrs. McNab. A fine ocean screw of 2000 tons burden, completed by Messrs. W. Denny and Brothers, of Dumbarton, has made a trial trip, at which she attained a speed of 13 miles per hour, her engines working with great smoothness. The *Infanta Yaabel* is to be employed as one of the Spanish Royal Mail steamers between Cadiz and Havannah. She is a sister ship to the *Principe Alfonso*, built recently by Messrs. Denny for the same undertaking, and her dimensions are as follows:—Length, 270ft.; breadth, 38ft.; depth to spar deck, 27ft. Her engines are of 400 horse-power, and she has state rooms for about 350 first and second-class passengers, in addition to accommodation for a large number of steerage passengers. Messrs. A. and J. Inglis have completed two steamers for Australia. The first is a paddle of 800 tons burden, named the *City of Brisbane*, built for the Australian Steam Navigation Company, and intended to trade between Sydney and Brisbane. The dimensions of the *City of Brisbane* are as follows:—Length of keel and fore-rake, 230ft.; breadth of beam, 27ft.; depth, 13ft. 6in. She will be propelled by oscillating engines of 250-horse power, her paddlewheels will have feathering floats, and her boilers will be fitted with superheating apparatus. The other steamer, the *Wallabi*, is intended for the Australian coasting trade. Her length of keel and fore-rake is 105ft., her breadth of beam is 18ft., and her depth of hold 7ft. She is of 162 tons burden, and her engines, which are of 30 horse-power, were fitted before she was launched. She will proceed to her destination under canvas, and will take out, in pieces, a screw steamer similar in dimensions to herself. Messrs. Scott, of Carlsdyke, have launched the *Lafayette*, another of the great ocean steamers which they are building for the Compagnie Générale des Paquebots Transatlantiques. The *Lafayette* is 3400 tons builders' measurement, and her dimensions are as follows:—Length, 350ft.; breadth, 45ft.; depth, 33ft. She has four decks, the upper one being flush from stem to stern. The three lower decks have each a height of 7ft. 3in., and the steamer will accommodate 330 first-class passengers, and will have capacity for 1000 tons of goods, besides stowing 1500 tons of coal in her coal bunkers. Her machinery is being fitted by the Greenock Foundry Company, and will consist of a pair of side-lever engines of 850 horse-power nominal. The cylinders are 7ft. 11in. in diameter, and 9ft. 6in. stroke. Steam will be supplied from four tubular boilers, each weighing 61 tons; each sole plate weighs 55 tons, and the paddlewheels will be 37ft. 6in. in diameter. The *Lafayette*, which is the largest steamer ever built in Greenock, is a sister vessel to the *Washington*, launched in June. A third steamer in course of construction on the Clyde for the company's line will be ready in December, while five other equally large steamers are being built by Messrs. Scott, with French workmen, at St. Nazaire. Messrs. Swan and Co., of Maryhill, have launched the *Andalusia*, a screw of 400 tons, built for Messrs. Mories, Munro, and Co., and a consort for the *Cokina*, lately completed by the same firm. Both steamers are intended for the Spanish trade. The *Andalusia* is now receiving engines by Messrs. Forrest and Barr.

THE SCREW STEAMER "BEATRICE," above referred to built and engined by Messrs. McNab and Co., in her trial trip ran the lights of the Clyde at a speed of 10½ knots.

THE SCREW STEAMER "MARIA PIA," built by Messrs. John Reid and Co., Port Glasgow,

for the Lusitania Steam Navigation Company, Lisbon, having had her machinery fitted on board by Messrs. McNab and Co., Greenock, recently underwent her trial trip, and ran the distance, between Greenock and Knock Castle, at a speed of 12 knots per hour.

TELEGRAPHIC ENGINEERING.

THE TELEGRAPH CABLE FROM ALGERIA TO SPAIN.—It is stated in the *Annales Télégraphiques*, that the French Government has arranged with Messrs. Siemens and Halske, of Berlin and London, for the supplying and laying of a telegraphic cable between Oran and Carthage, or another port on the coast of Spain. This distance is about 103 nautical miles, the greatest depth about 1420 fathoms. The cable will be a fac-simile of the one exhibited by Messrs. Siemens at the International Exhibition, 1862.

PERSIAN GULF TELEGRAPH.—On the 19th ult. her Majesty's ship *Tweed*, laden with the last consignment of the telegraphic cable about to be laid down over a length of 1200 miles from the mouth of the Persian Gulf along the sea coast to Mekro, left the works of Messrs. Henley and Co., the contractors and manufacturers, at North Woolwich.

THE ELECTRIC TELEGRAPH COMPANY'S submarine communication with the Isle of Man has been restored, and messages can now be forwarded to Douglas, Peel, and Ramsey.

RAILWAYS.

GREAT WESTERN RAILWAY.—It appears that the directors of this company are about allotting to the shareholders, in rateable proportion to their holding, 4½ per cent. perpetual irredeemable preference shares to the amount of £1,237,562. They state that it will not create any fresh or additional charge upon the revenues of the company, being issued in substitution of monies borrowed from bankers and others in the form of temporary loans, renewable at short periods. Though the state of the money-market and the credit of the company have enabled the directors to borrow this money at 4 or 4½ per cent., yet the commission and other expenses of frequent renewals have increased the yearly charge to an amount more than equal to 4½ per cent. So then, when taken up as proposed, the interest payable upon that amount will be rather less than it has hitherto been, and the company will thus be secured against all contingencies in respect thereof. The allotment will be in the proportion of one new share of £10 for every £100 ordinary stock or shares in the company. The shares will be treated in respect of dividend as fully paid up from the 29th ult., being equivalent to a bonus of £2 per cent. A discount at the rate of 4½ per cent. per annum is to be allowed on any instalments paid in advance.

THE EAST INDIAN RAILWAY will be open to the public from Delhi to Calcutta on the 1st of February next at the latest, with the exception of crossing the Jumna at Allahabad. Orders have already been given for compiling the new time tables, and for making the other arrangements requisite for the increased length. As a temporary measure, the railway will either have a pontoon bridge over the Jumna or a steamer to convey the traffic across the river.

THE LYONS AND LA CROIX ROUSSE RAILWAY.—In a paper lately read before the Paris "Société des Ingénieurs Civils," M. Molines gave a description of this railway, from which the following is an extract:—The total length of this railway is only 635 yards, on an incline of 16 per cent., being a height of 85.6 yards. Owing to this enormous gradient, the trains are set in motion by means of stationary engines and ropes winding round drums, similar to the arrangement formerly in use on the Liege and Aix-la-Chapelle "Seilbene." Two stationary engines of 150-horse power each are employed, the one for passenger and the other for goods traffic; they have two cylinders, no condensation, and uniform expansion;—on account of the shortness of time of travelling (three minutes). The stroke of the pistons is 2 metres (6ft. 7in.), and they are connected directly with the drums, the diameter of which is 14ft. 9in., so that the speed of the piston is about half that of the rope. There is a "directing mechanism" for setting the rope properly upon the drum, and there are, moreover, two steam brakes. The feeding water is heated by the exhaust steam, by means of a superheating apparatus. The boilers are tubular, and work a maximum pressure of 75lb. each per square inch. The rope undergoes a tension of 9 tons; it is made of cast steel, of a thickness of 2½in. (6 centimètres), and was tried at a strain of 90 tons. The rolling stock consists of carriages with two floors, holding 103 passengers each; they are furnished with an improved kind of brake, which is self-acting, and stops the train at once in case of the ropes being broken. This is effected by an arrangement of counterweights, which are supported by springs and balanced while the rope is strained; but when the rope is broken they fall down and produce a friction sufficient to prevent the carriages going on.

IRON RAILWAY SLEEPERS have been adapted on the railway connecting a colliery with the Couillet Iron Works, near Charleroi, Belgium, for a length of rail of about 450 yards. These sleepers are made of H shaped, drawn out iron, laid down horizontally, about 7in. wide, placed under the rails at distances of 3ft. 4in. from centre to centre, each sleeper having a length of 8ft. 2in. (2½ metres), while the rails themselves are of the usual Vignole's shape, of a weight of about 25lb. per foot; the weight of the sleepers is about 31lb. The rails are fixed on the sleepers by means of two bolts, a cushion of oak being laid between both, in order to render the connection more elastic, and to allow of tightening the bolts. The railway on which these sleepers are used has a gradient of 1 in 100, and curves of less than 320 yards radius; it is travelled upon by four-wheeled engines of 20 tons weight, the weight being distributed upon the rails at the rate of 11 tons on the fore and 9 tons on the hinder axle. The sleepers have, answered remarkably well for twelve months, as shown by the engineer's returns.

THE LONDON AND BRIGHTON TERMINUS AT LONDON-BRIDGE.—Operations have been commenced by the London and Brighton Company for the accommodation of their increasing traffic at London-bridge, the station room at present existing there being found inadequate for the purpose. The widening of the main line leading into the terminus at London-bridge, together with the viaduct, about 100 feet wide and 2000 feet in length, leading up to the terminus, has been commenced by a large body of workmen, and others are engaged in demolishing the buildings bought by the railway company in St. Thomas-street, Webb-street, Broadway, and Maze-pond, Bermondsey, leading up to the Brighton terminus and International hotels. Parallel with the viaduct a new street will be constructed between 300 and 400 yards in length, leading from the railway station into Bermondsey. There will be shops and warehouses underneath the viaduct.

A GRAND TRUNK RAILWAY, 1858 MILES LONG.—This line of railway starts from Missouri, passes through Kansas, crosses the Sierra Nevada Mountains, and terminates at tide water in Sacramento, California; thus opening up a direct railway communication across the North American continent from the Atlantic to the Pacific Oceans. The work, which is divided into three sections, has been commenced at both ends, and in a short time will be energetically pushed on in the centre. The eastern portion has been taken by a Kansas company, and already the line has been graded for over 300 miles from the junction of the Kansas and Missouri rivers going west; and by the end of the present year, if labour can be procured, the line will be completed, as far as the earthworks are concerned, entirely through the State of Kansas. The central portion, a distance of about 1000 miles, is the most difficult part; it crosses the Sierras at Summit Valley, at an elevation of 7027ft. above tide water level at Sacramento City, but the line has been so laid out that the steepest gradients do not exceed 106ft. to the mile—a rate of inclination several feet less than one of the lines passing through Virginia. The western slopes of the great mountain range have presented many difficulties. There are many rivers run-

ning through gorges from 500 to 2000ft. deep, with their precipitous slopes varying from perpendicular to an angle of 45 degrees. To avoid these the surveyors have run the line along the most unbroken ridges, and although somewhat extending its length will, it is said, only cross one river (the Little Bear river) of any magnitude. The eastern declivity is not so difficult, although there will be eighteen tunnels to drive, varying from 300 to 2000ft. each. Part of this section, or about 155 miles, will cost 85,000 dols. per mile. A special chartered company has been formed to construct this central portion, called the Pacific Union Company. They will be assisted to an extent of about 350 miles by the Mormons, should it be decided to make a short divergence of the line, so as to pass through Salt Lake City, in the Utah territory. The western territory is being constructed by a Californian company. They have already completed 60 miles of the road at the Sacramento end, and are now only waiting the arrivals of the metals from England to get it into running order. This section of the line passes through heavily wooded forests of fir, cedar, pitch, pine, oak, and tamarac, furnishing cheap and ample materials for sleepers, bridges, and buildings. The capital is 15,000,000 dollars, the estimated traffic returns are 4,000,000 dols. per annum, while the working cost is not to exceed 1,000,000 dols. If the work can be done within these figures, and their estimated returns realised, the stockholders may anticipate a dividend of about 25 per cent. This western portion of the line will speedily open up immense mineral wealth, now lying dormant for want of transportation. It is a well-known fact that there is at the present time large quantities of low grade silver ore being thrown aside that would pay for returning if some cheap means of carriage to the coast could be obtained, beside rich lead and copper mines in abundance. The cost of the entire line will amount to 90,000,000 dols., or £13,974 per mile.

RAILWAY ACCIDENTS.

RAILWAY ACCIDENT IN SPAIN.—A serious accident has occurred on the railway from Barcelona to Granollers. The bridge thrown over the Hahera having been undermined by the violence of the torrent, which had been considerably increased by the heavy rain, had suddenly given way during the passage over it of a railway train coming from France, composed of nine carriages. The locomotive and seven carriages were thrown into the river, causing a very heavy loss of life.

RAILWAY ACCIDENT AT PORT GLASGOW.—On the morning of the 9th ult., while the Belfast mail-train, which had been detained behind its usual time, was leaving Port Glasgow station on its way from Greenock to Glasgow, a goods engine with break-van attached came up at a great speed and dashed into the hindmost carriage of the train. There were seven persons in the carriage at the time, one of whom was killed, the rest being more or less seriously injured.

COLLISION AT KENSINGTON STATION, LONDON.—An accident took place on the night of the 11th ult., about twenty minutes past seven o'clock, just outside the Kensington Station of the West London Railway Extension. It appears that as the London and Brighton train, which leaves Kensington at 7.15 p.m., was in the act of issuing from the station, a few minutes behind its proper time, and while it was proceeding on a portion of the rails common to the Brighton and South-Western trains, it was run into by the South-Western train, which left Clapham Junction at 7.10 p.m., the latter being due at the Kensington Station a few minutes before the collision took place. The two trains were both running at a slow rate of speed, the two engines ran into each other with a crash, throwing the passengers from their seats.

COLLISION ON THE GREAT NORTHERN RAILWAY.—A collision occurred on the evening of the 1st ult., about nine o'clock, at the Huntingdon station of the Great Northern Railway, between an express and a coal train which resulted in a smash of the coal train, and the strowing of the line with broken trucks and tons of coal. The up coal train, it appears, arrived at the station about nine o'clock, and was followed by the up Manchester express, which is due at this station a few minutes before nine, and which usually passes by without stopping. On this occasion when the express train turned the curve of the line about a mile and three-quarters distant, in sight of the station, the distant signal showed danger, and the driver in consequence shut off his steam and allowed his train to approach slowly—in fact it almost came to a stand; but perceiving the near signal-light in his favour, he put on his steam with the intention of passing the station on his journey. The train had only arrived at a few yards beyond or at the end of the middle platform when it came into collision with the coal train, which had not yet shunted out of its way. The result of the collision was that the break-van of the coal train was smashed, and also two trucks containing coal. The engine of the express, one made expressly for the Great Northern for running long distances, mounted over the wheels of the break-van, and those wheels were firmly jammed beneath it. The broken fragments of coal-trucks and coals were scattered about the line for a considerable distance. The forewheels of the engine of the express train appeared to be the only wheels of that train not in their place on the metals.

ACCIDENT ON THE IRISH NORTH-WESTERN RAILWAY.—An accident, resulting in the injury of several parties, happened on the above line of railway, to the train which left Derry at one o'clock, on the 10th ult. The train proceeded as usual, and reached Fintona, which it left at 2.40. The train had proceeded but a short distance when the engine and train ran off the line, and fell over a precipice. Both engine and carriages were completely reversed by the accident. Fortunately, no lives were lost, but the engine-driver was much injured. The stoker was also severely bruised.

COLLISIONS AT HEATON CHAPEL AND GUIDE BRIDGE.—A collision, attended with serious injuries to several persons, occurred at Heaton Chapel, on the 23rd ult. The early market train from Manchester had reached the above place, and while standing it was run into by a single engine. One of the carriages was driven off the line by the force of the collision, and the guard received severe injuries. A fatal accident also occurred on Thursday night at Guide Bridge, with a cattle train from Liverpool to Peterborough. The train, by some means, became divided, when one portion, to which was attached a third-class carriage, with some drovers, was run into by a goods train from Ardwick for London.

ACCIDENT ON THE NORTH-EASTERN RAILWAY.—On the 20th ult., the boiler of the engine of the goods train, which left Leeds between eight and nine o'clock in the morning, on arriving at Arthington station, burst, and caused considerable damage to the goods warehouse, which is adjacent to the station.

BOILER EXPLOSIONS.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the monthly meeting of this Association, held September 29th, 1883, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 319 engines and 471 boilers. Of the latter, 4 have been examined specially, 4 internally, 40 thoroughly, and 414 externally, in addition to which 1 of these boilers has been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 5 (2 dangerous); corrosion, 16; safety valves out of order, 2; water gauges ditto, 20 (1 dangerous); pressure gauges ditto, 10; feed apparatus ditto, 2 (1 dangerous); blow-out apparatus ditto, 14; fusible plugs ditto, 8; furnaces out of shape, 1. Total, 78 (4 dangerous). Boilers without glass water gauges, 3; without blow-out apparatus, 21; without back pressure valves, 17. Three boilers, not under the inspection of the Association, have exploded during the past month. One of the boilers has been personally examined since the explosion, while this was prevented in the other cases by distance. No. 30 explosion, from which one

person was killed and two others injured, happened to an agricultural boiler, while at work at a farm, driving a thrashing machine. The boiler, which was about twelve years old, was a portable one, of the multitubular locomotive type, and was worked at a pressure of about 40lb. per square inch. It was stated at the inquest that the safety valve worked freely, and that there was a due supply of water, the explosion being attributed entirely to a defective plate in the fire-box, which had been eaten away by corrosion, until reduced to one-sixteenth of an inch in thickness. This plate had been previously repaired, and at the time of the explosion was cracked through, and though it had for some days been leaking in consequence, had yet been worked on in that state. The owner of the boiler was brought in guilty of manslaughter, the jury adding that they thought the appointment of a Government inspector to be highly necessary. No. 32 explosion occurred to a new Balloon or Haystack boiler during the operation of testing at the maker's yard. It had not been constructed for raising steam for purposes of power, but was intended to be used as a chemical evaporating pan or still. The boiler—as another of similar construction and dimensions had recently been—was proved with steam, in order to test the tightness of the joints. The pressure, which appears to have been about 50lb., being raised, not by generating the steam within it by means of a fire underneath, but by communication with another boiler in work, to which it was temporarily connected for the purpose. Some five or six men were engaged upon it in caulking the seams at the time of the explosion, four of whom were blown to a distance from it; one of them, who was killed upon the spot, being thrown upon the roof of a house about forty yards off, while two others died subsequently from the injuries received. The boiler was laid upon its side during the test, and gave way at the bottom, which was blown out entire, and thrown upon a roof about 10ft. high and 13 yards distant, the shell rearing up on its dome end and remaining in that position supported by a sheer leg. Its dimensions were as follows:—The height was 11ft.; the dome, from the appearance of which the term Balloon boiler probably arose, was 9ft. 3in. in diameter, and the base 8ft. 9in., while the cylindrical sides were drawn in to 7ft. 9in. in the waist. The bottom, like that of a bottle, was concave, as is usual in these boilers, and rose 19in. at the centre, in order to enable it to resist the downward pressure, being connected to the sides of the shell by a 3-in. angle iron, half an inch thick. The plates, which were from seven-sixteenths to half an inch in thickness throughout, were, some of them, second-hand, those forming the dome being new, the remainder having been used in a boiler before. They had however been worked to their new shape, their edges sheared, and the holes punched afresh. The rivets, which were three-quarters of an inch in diameter, were centred from one and seven-eighths to two inches apart, and the general workmanship appeared satisfactory. The rent between the bottom and sides of the boiler had occurred, for the most part, at the lower ring seam of rivets in the cylindrical portion of the shell, but not altogether so, some portion of the rent running through the rivet holes at the outer edge of the circular bottom plate; while, from the upward position in which the latter was thrown by the explosion, it appeared most probable that the rent had commenced at that part of the boiler which lay nearest the ground at the time of the explosion, and thus, from the position of the fractures, must have started at the cylindrical part, and not at the bottom plate. The reason of this is not very apparent,—since there were two other ring seams of rivets in the cylindrical portion of the boiler which were quite uninjured, although subjected to the same direct pull, which, after allowing for the rivet holes, did not amount to two tons per square inch of metal; added to which, the longitudinal strain thrown upon these circular seams in cylindrical boilers, is only half of that which occurs in the transverse direction, so that it is difficult to account for the rent selecting the lower ring seam of rivets, or indeed for its occurring at all. Whether, however, the rent in question was due to some undetected flaw in the iron, or whether the plates had been crippled in being brought together, which is too frequently the case, or whether an unfair strain was caused by the springing of the bottom plate, which, although arched eighteen inches in the centre, was yet flat as compared with the hemispherical top, or whatever may have been the cause that started the rent, one thing is certain,—that the application of the hydraulic test would have detected and exposed the weakness, prevented the explosion, and saved the three lives.

BOILER EXPLOSION AT ARBROATH.—A boiler explosion, causing three deaths, took place on the 2nd ult., at the small flax spinning mill in Hume-street belonging to Mr. John Findlay. The mill is a one-storied building near the line of the railway, the boiler-house standing a little out towards the street, which is narrow. The work is situated in the very centre of the mill district of the town. The explosion occurred about seven minutes before six o'clock, the steam having been newly got up, but the machinery not being then in motion. At that hour a large number of workpeople, among them many girls, were passing along Hume-street to their employment in the adjacent works, and one of the girls was killed on the spot, and two others received injuries so severe that they died during the day. The boiler which exploded was 20ft. long, and 2ft. 6in. diameter, and was what is known as a Cornish boiler, and was fitted up about eight or nine years ago by Messrs. Gourlay and Mudie, of Dundee. It was made of the best iron, and there can be no question as to the excellence of the metal originally. Until a short time before the explosion, the boiler was employed to drive an engine of 10 horse-power. At that time Mr. Findlay got one of 25 horse-power, which has been used only up to between 16 and 20 horse-power. The boiler was at the same time overhauled, the top part of the flue—the same plate as finally burst—had been repaired on a former occasion. The body of the boiler remained entire, and was scarcely shifted from its position. The water gauge and steam indicator were not broken. The crown of the fire-box or tube was burst downwards, and fragments of the plate, which showed a bad fracture, and was slightly laminated, and which was 5-16ths of an inch thick, along with the furnace door and bars, were blown into the street.

ACCIDENTS TO MINES, MACHINERY, &c.

COLLIERY ACCIDENT AT COLKORTON.—On the morning of the 8th ult., about half-past eleven, an alarm was given that water had broken into the Colifal, one of the Colkorton pits, the property of Messrs. Worswick and Walker. The men rushed to the pit's mouth, and many were drawn up. The rapid rush of the water, however, prevented all from reaching the spot, and six men perished. It appears that about three o'clock in the morning water was perceived coming through a side of one of the stalls in the workings, and between six and seven it was increasing so that several of the men refused to go to work, but upon an assurance being given that all was safe and that, if it increased, an alarm would be immediately given, all went to work. A carpenter, who lost his life, was sent down to plug the holes through which the water was flowing, but about half-past eleven the sliding gave way, and the water rushed in with the greatest impetuosity. Fortunately there was a reservoir which received a large quantity of the water before reaching the bottom of the shaft, which gave most of the men time to ascend before it was upon them.

A **COLLIERY EXPLOSION IN SOUTH WALES** occurred on the 17th ult., at the Morfa Colliery, Margam, Glamorganshire, causing the death of thirty-five people. The Morfa Colliery (in which two previous accidents have occurred) is situated about eight miles from Neath. It is the property of, or situate on the estate of, C. R. M. Talbot, Esq., M.P., and lord lieutenant of the county, but is leased to and worked by the Messrs. H. Hussey Vivian, M.P., and Sons, Mr. Pendarvis Vivian being the resident manager. The Morfa Colliery is one of the largest in South Wales, and, generally speaking, there are about 800 colliers engaged in the pit, which works between 600 and 700 tons of coal per day, which is shipped at Port Talbot, Neath, and Swansea. The colliery is known as a "fery" one, has literally miles of underground workings, is ventilated by means of a furnace with two

shafts for the down and return air, and is always worked with locked safety lamps. The explosion occurred about half-past ten in the morning. There were about 400 men in the pit at the time, but the effect of the explosion was confined to the Old Mine Foot Vein, where 43 men and boys were at work.

GAS SUPPLY.

PRODUCTION AND GENERATION OF GAS.—Mr. J. C. Jeffcott, of Cork, has patented some improvements in the production and generation of gases, and also in apparatus connected therewith. The object sought to be obtained in the production and generation of gases by the invention consists chiefly of utilising the heat not used, or which escapes without being used, in steam or other furnaces and fire-places of every description. The means to do this consists of introducing into or placing within the furnaces or fire-places vessels of various forms, according to the construction of said furnaces or fire-places, so as that the said heat may be used; these vessels, retorts, or chambers must be formed and placed and correspond with the form of the furnaces or fire-places now in use, or to be used for this or other purposes. The form to be generally used will consist of a retort or retorts to be placed lengthways or at the sides, or as may best suit the fire-bars of the different fire-places; these retorts or other vessels will have mouth-pieces or other close covers, so as to be air-tight, and through these mouth-pieces or covers are to be introduced the animal, vegetable, or mineral substances from which the different gases are to be obtained, by their cohesiveness being destroyed by the heat before referred to, and not hitherto used for that purpose. The gases, after being set free in the retorts, chambers, or other such vessels, are then conducted by pipes in the way usually done, and applied to and for the different purposes for which they are now used. He likewise claims to be the inventor of a new description of furnace for these purposes, to be entirely composed of wrought or cast metal, and this consists of—first, a fire-place, with fire-bars on which the combustibles or heating substances are to be placed, the chamber, retorts, or vessels for holding the different materials rich in the different gases; these chambers, retorts, or other vessels to have the mouth-pieces for introducing the substances to be used, and then another casing to be placed over the entire, so that the heat may be prevented from escaping when the gases are disengaged, to be conducted by pipes in the usual manner. Lastly, Mr. Jeffcott purposes a new system of lighting and heating railway carriages, and the different railway stations along the different lines; he effects this by an apparatus first composed of a cast-iron or clay retort placed in the furnaces of the locomotive, and the gas obtained from coals and distilled in the retort by the heat of the fire then being used for generating steam is conveyed by pipes or tubes composed of metallic substances, or of India rubber, gutta percha, or other flexible materials, to the tank and gasholder containing the purifying water, as aforesaid, attached, annexed, or placed near the engine; it is then conveyed by tubes or piping to the carriages, and by the action of the gas when ignited on metallic plates, or the agency of a gas stove, the compartments of the carriages are heated and lighted. On the arrival of the engines at the stations along the line the gas already distilled and placed in the gasholder attached to the engine, as aforesaid, is conveyed by pipes to a gasholder erected at the station, when it is ready for use.

GAS AT NOTTINGHAM.—The prospectus of a limited Nottingham and District Gas Consumers' Company has been issued. The capital will be £100,000, in 210 shares, deposit 10s. a share. The company has been projected by large consumers for the purpose of supplying the town of Nottingham and the surrounding district with gas of a purer and more brilliant character, and better adapted for manufacturing and domestic purposes, than that hitherto supplied; and at as low a charge as is attainable by the adoption of the most recent improvements in its manufacture, and consistent with a fair return for the capital employed. Calculations have been made that, charging for gas at a great reduction on the present scale, a dividend of 23 per cent. will be realised upon the shares; and although the maximum rate allowed by Parliament is £10 per cent., it is proposed to pay all money beyond 23 per cent. in aid of such rates in the town as may be afterwards determined upon.

LARGE GAS-HOLDER AT THE CITY GAS WORKS.—For some time past numerous workmen have been engaged in erecting a vast gas-holder at the premises of the City of London Gas Company, Whitefriars. It is a three-light gas-holder, and has (except the painting) lately been completed. The works connected with it have been carried out by Messrs. Westwood and Wright, of Dudley, gasholder builders. When full it is of the great height of 100ft. (the highest ever built). Messrs. Westwood and Wright are now engaged in constructing extensive works at Para, in Brazil, which are rapidly progressing.

TREATING GAS OBTAINED FROM COAL AND MINERAL OILS.—Mr. J. Leigh proposes to subject the gas obtained in the distillation of coal, cannel, bituminous shale, boghead minerals, oils, petroleum, or other combustible substances, to the action of nitric acid, or of a mixture of nitric and sulphuric acids, by which nitro-benzole, and other compounds, are obtained, and certain substances removed from the gas employed. For this purpose, there is introduced into a series of earthenware vessels, arranged in the form of Woulfe's bottles, a quantity of fuming nitric acid, or a mixture of nitric and sulphuric acids, and through this is pressed a current of gas produced from any of the substances named, continuing the operation so long as any action is exerted by the acids upon the gas. When the operation is completed, the nitro-benzole is removed, and other products separating themselves from the acid liquid; this may be employed for purposes where weak nitric acid, or a mixture of it and oxalic acids, are required. This process may be used for the formation of the products of the action of the gases upon the acids, alone; but where the purification of the gases is desired for the purposes of illumination, it is preferred to use fuming nitric acid alone, which removes from the gases certain constituents that render them more liable to give off smoke in their combustion, whereby the odour of the gas is improved. In the process, a quantity of acid vapour is mechanically carried forward with the gas, and this may be brought into contact with alkalies, or mineral salts, capable of removing it from the gases. Where a mixture of nitric acid, and of rectified sulphuric acid is employed, it is preferred to use one part of nitric to two parts of sulphuric acid, and when fuming nitric acid is used, the strongest is preferred.

ILLUMINATING POWER OF THE GAS SUPPLIED BY THE PARIS GAS COMPANY.—The Paris Gas Company is bound, according to its contract, to supply a gas with the illuminating power such that the consumption of 0.88 or the maximum specified 0.99 of a cubic foot under a pressure of one-tenth of water, should give as much light as 154 grains of purified colza oil burnt during the same time in a carcel lamp regulated to consume 648 grains of oil per hour. From the 1st of April to the 30th of June of the present year the result of the daily tests gave an average consumption of 0.85 of a cubic foot of gas to 154 grains of oil; the company thus supplied during that period a gas whose illuminating power was above the maximum required by the contract.

DOCKS, HARBOURS, BRIDGES, &c.

LARGE SWING-BRIDGE FOR RAILWAY AND ORDINARY TRAFFIC AT HULL.—Messrs. Grissell, of the Regent's Canal Ironworks, have obtained the contract for, and just commenced the erection of, an immense swing-bridge, of peculiar design and massive proportions, at Kingston-upon-Hull. The bridge is intended to span the river Hull at points very near to the citadel and garrison of the town, and the extensive shipbuilding and engineering establishment of Messrs. Samuelson. It is to consist of one principal opening of 100ft. and a smaller one of 38ft. The superstructure of the principal opening will be carried back landwards, and is to be made to swing or open by aid of powerful mechanism. It will be supported by an abutment on the eastern bank of the river, and, when closed, by two cast-iron cylinders, also sunk into its bed. The superstructure of the

smaller opening, which will not be moveable, will also be supported by the same cylinders and a western abutment. Both abutments will rest on foundations of pilework and concrete, and will consist principally of brickwork, with stone copings. The hollow in the eastern abutment will be filled in with concrete, as will the cylinders themselves. The traffic portion, or upper face of the bridge, will comprise an ordinary roadway, a tramway, and two footpaths, and the total width over all will be 40ft. The roadway, tramway, and footpaths will be carried over the principal opening by two main wrought-iron girders, which will be continued back landwards. The roadway, tramway, and footpaths are to be carried over the side opening by two smaller main wrought-iron girders. The roadway and tramway platforms will pass in between the main girders, and be supported on wrought-iron cross girders. These latter will project on either side beyond the main girders, for the purpose of carrying the footpath platforms. Railway and roadway trams will be laid on the bridge, and fencings, or parapets, of wrought-iron will protect the outsides of the footpaths. For the purposes of opening and shutting, the two larger main girders will be bolted to an upper roller frame, turning round a central pivot, and which rests again on rollers working in a live ring on the ends of radial bars. The radial bars themselves will be connected to and will work round the central pivot, fixed on a lower roller frame, upon and around which the rollers run. This lower frame will be bolted to stone blocks resting on the eastern abutments. Dwarf walling is to be erected around and within the space occupied by the bridge when opened for the navigation of the river, and the space is to be also pitched. Fender pilework and dolphins will be constructed so as to protect the eastern abutment, the cylinders, and the bridge itself from injury by shipping, or craft of a lesser kind. The gun metal bearings, in which the massive rollers of solid wrought-iron will turn, is to be composed of a hard mixture accruing from the following materials:—Copper, 84 parts; tin, 13 parts; and zinc, 3 parts. The construction will be known as the Hull South Bridge. It is to be completed within eighteen months from its commencement. The Hull South Bridge Company are the promoters of the work, but as the garrison will derive considerable advantage from its existence, the Government bears a share of its cost.

NEW BRIDGE IN DERRY.—This new bridge has been opened by the Lord Lieutenant of Ireland. The site is about 250 yards south-west of that occupied by the wooden one. The new bridge is 1172ft. in length, 30ft. wide, and consists of six principal openings—119ft. each—a double swing bridge, spanning two openings of 45ft. each, and two subordinate openings, 82ft. each, landwards—one on each side of the river. The piers for the principal openings are each composed of two cylinders, 11ft. in diameter, and 24ft. apart, from centre to centre. The pier for the swing-bridge is composed of seven cylinders, each 8ft. in diameter, sunk into the bed of the river, and all enclosed in one large cylinder, 30ft. in diameter. The cylinders are all filled in with concrete. The principal openings are spanned by large girders, placed transversely, 24ft. apart, resting on granite blocks imbedded in the concrete contained in the cylinders. The bridge is a double one, the lower level being constructed for the transit of railway carriages, to be drawn across by horses, and the upper one being designed for ordinary traffic. The upper roadway is 20ft. wide, divided down the centre into two channels by the water tables; on either side of the carriage-road is a pathway 5ft. wide. The height of the railroad part over low water mark is 14ft., and the depth of water at high-tide under the swing-bridge is 33ft. The bridge is of iron.

MINES, METALLURGY, &c.

ON THE SEPARATION OF LEAD AND ANTIMONY. (READ AT NEWCASTLE, AT THE BRITISH ASSOCIATION MEETING, BY DR. T. RICHARDSON).—In the metallurgical treatment of lead ores, a certain proportion of the lead remains mixed with the impurities of the ore, in the form of slags. When these slags are smelted in the ordinary hearth, a hard lead is obtained, the hardness of which is generally due to the presence of antimony. Previous to 1840, these slag leads were with difficulty sold by the smelters at a lower price than soft lead, but in that year I introduced at Blaydon the process of softening or calcining these leads, by which plan 95 per cent. and upwards of good soft lead was obtained, and the dross produced was afterwards reduced, yielding a very hard lead. The calcining process consists in exposing the hard lead, in a melted state, to a current of hot air, when the antimony, with a certain quantity of lead, becomes oxidised, and this dross floats on the surface of the melted lead, whence it is skimmed off from time to time. The soft lead is then run off and ladled into moulds. The dross is reduced in the ordinary manner; but I have found that, by mixing a small quantity of alkali with the dross, the heat may be reduced and a better produce is obtained. The hard lead obtained from this reducing process can be treated in the same way as the original slag lead, but a much longer time is required to effect the removal of the antimony, and the produce of soft lead falls as low as 50 to 60 per cent. The following analyses illustrate the changes which take place in the hard lead by these operations:—

English Hard Leads.

	Original Lead.	1st Calcination.	2nd Calcination.
Lead	99.27	98.53	52.94
Antimony	0.57	11.29	47.16
Copper	0.12	traces.	traces.
Iron	0.04	0.34	traces.
	100.00	98.16	100.00

Soon after the commencement of the calcining operation at Blaydon, a quantity of hard lead was imported from Spain, and the late Mr. Burnett, by my advice, submitted it to this softening process, but he found that the usual brick furnace could not be made to retain the lead after it was melted. He then employed a cast iron pan, built into the brick furnace, and this simple arrangement was perfectly successful. The foundation was thus laid for the extraordinary trade in Spanish hard leads which is carried on to so great an extent in Spain, France, and England. The Spanish hard lead, when submitted to a similar treatment to that already described, furnishes the following analytical results:—

Spanish Hard Lead.

	Original Lead.	1st Calcination.	2nd Calcination.
Lead	95.81	64.93	56.60
Antimony	3.86	29.84	43.40
Copper	0.33	5.90	traces.
Iron	0.21	0.20	traces.
	100.00	100.92	100.00

I have already mentioned the beneficial action which a small quantity of alkali exercises in the reduction of the hard dross, which is strikingly shown in the following analyses of two samples of lead, reduced from the same parcel of dross, with and without the addition of the soda:—

	With $\frac{1}{2}$ per cent. of alkali.	Without alkali.
Lead	58.70	82.99
Antimony	40.66	16.09
Copper	0.32	0.68
Iron	0.32	0.35
	100.00	100.00

In these operations a quantity of refuse products accumulate in the smelting works, which are sometimes reduced, especially in Spain, in a small blast furnace. After some time, the hearth of these furnaces is filled with a spongy, semi-fused mass, called a *cusco* by the Spaniards, one of which was found to contain:—

Lead	61.35
Antimony	29.50
Copper	8.30
Iron	.61
Nickel	traces.
	99.76

The antimony-lead obtained from the second calcination answers very well for the casting of type furniture, and also for the coarser kind of type.

COPPER MINING IN ITALY.—An interesting account of the operations at the Monte Catini Copper Mine, Tuscany—the most successful in Italy, and perhaps one of the most profitable in Europe, has been contributed by Mr. Nelson Boyd, Mining Engineer.—“The existence of copper in this district appears to have been known in remote antiquity. From old workings discovered, it is proved that the Etruscans were aware of the value of these hills, and worked them for copper. It is also found from records that Monte Catini was also worked in the middle ages; but that the works were stopped by the terrible plague which raged in 1300, and which changed the fertile and populous Maremma into a wilderness; from which condition it has only been recently attempted to be rescued by drainage and cultivation. In the year 1820, some unsuccessful trials were made on the site of the present mine; and again, in 1830, a shaft was sunk—the lode discovered—and several levels (among them a deep adit) driven, but only an insignificant quantity of ore raised. It was not till the year 1837, shortly after the mine came into the hands of the present proprietors, Messrs. Hall and Sloane, that the workings showed any importance. In that year a large mass of ore was discovered, from which sufficient was raised to pay all working expenses for a year—which appeared to establish beyond all doubt the success of the undertaking, a view fully realised by subsequent events.”

PIG IRON.—The computed make of pig iron in England and Wales last year was 2,863,469 tons against 2,763,390 tons in 1861, 2,883,752 tons in 1860, and 2,273,245 tons in 1854. The make in Scotland last year was computed at 1,060,000 tons against 1,040,000 tons in 1861, 1,000,000 in 1860, and 775,000 tons in 1854. The total number for the United Kingdom consequently advanced from 3,048,243 tons in 1854 to 3,943,469 tons in 1862. The number of furnaces in blast last year was 566 against 568 in 1861, 539 in 1860, and 554 in 1854. The average price last year was 35s. per ton against 40s. 3d. per ton in 1861, 53s. 6d. per ton in 1860, and 79s. per ton in 1854. Of the 566 furnaces in blast last year, 436 were in England and Wales, and 130 in Scotland.

COLLIERY VENTILATION.—A successful trial of a machine for this purpose has been made at Bonville's Court Colliery, near Tenby. The machine is a large circular fan, improved and constructed by Mr. Waddie, of the Lamore Works, Llanelli, of 18ft. diameter, by 4ft. breast, and is so arranged on the surface over the upcast shaft that it absorbs all the foul air and gas from the colliery without any leakage, and thus, probably, may supersede the large furnace at the bottom of the shaft, which is so often placed in such dangerous proximity to these large reservoirs underground. This fan-wheel is driven by a steam engine of 18 inches cylinder and 20 inches stroke, producing an average of 120 revolutions per minute in the fan.

APPLIED CHEMISTRY.

ON THE VARIOUS KINDS OF PYRITES USED ON THE TYNE AND NEIGHBOURHOOD IN THE MANUFACTURE OF SULPHURIC ACID; (READ AT THE MEETING OF THE BRITISH ASSOCIATION, NEWCASTLE, BY J. PATTISON, ANALYTICAL CHEMIST).—Iron pyrites or bisulphide of iron has been used on the Tyne in the manufacture of sulphuric acid since about the year 1840. At that time, and up to 1856, the only supplies of this mineral were obtained from Ireland, Cornwall, and the collieries of this district, where it occurs and is associated with coal, and is known by the name of coal brasses. But since 1856 other and more abundant supplies have been obtained from Spain, Portugal, Belgium, Westphalia, Norway, Sweden, and Tuscany. At present the total consumption of pyrites on the Tyne and neighbourhood is about 70,000 tons per annum, representing a value of about £105,000. The following table represents the composition of the principal kinds of pyrites at present used. The samples analysed are chiefly fair average samples of cargoes brought to the Tyne:—

	1.	2.	3.	4.	5.	6.	7.
Sulphur	44.90	49.30	45.01	45.60	46.80	44.20	36.10
Iron	39.70	41.41	39.68	38.22	39.22	40.52	34.44
Copper	3.80	5.81	...	...	1.80	0.90	trace
Lead	0.58	0.96	0.37	0.64	...	1.50	...
Zinc	0.30	trace	1.90	6.00	1.18	3.51	...
Thallium	trace	trace	trace	trace	...	...	...
Lime	0.14	0.14	0.25	0.11	2.10	0.24	4.96
Magnesia	trace	trace	...	...	0.01	...	0.33
Carb. acid	...	...	...	...	1.86	...	5.11
Arsenic	0.26	0.31	trace	trace	...	0.33	trace
Oxygen	0.23	0.25	0.42	0.37	0.45	0.25	0.31
Coal and loss	...	...	...	...	...	...	14.46
Gangue	11.10	2.00	12.23	8.70	9.08	8.80	1.40
Moisture	0.17	0.06	0.25	0.36	0.17	0.90	0.90
	99.98	99.93	99.91	100.30	100.16	100.34	100.3

No. 1. Spanish pyrites, obtained from the districts of Huévia in Spain and Algarve in Portugal. About 90,000 tons per annum used on the Tyne. No. 2. Ditto. No. 3. One of the Belgian varieties, obtained from the Rochoux mine, Theux, near Spa. About 12,000 tons of Belgian pyrites used on the Tyne per annum. No. 4. Westphalian pyrites. Consumption on the Tyne about 6000 tons per annum. This is one of the most abundant sources of the newly-discovered metal thallium. No. 5. Norwegian pyrites, obtained from the island of Hitteren, in the Bay of Drontheim. About 6000 tons per annum used on the Tyne. No. 6. A rich variety of Irish pyrites, obtained from the Wicklow mines. About 4000 tons of Irish pyrites used on the Tyne per annum. No. 7. Coal brasses, sample obtained from the Walker Colliery. About 7000 tons per annum used on the Tyne for the manufacture of sulphuric acid. Other analyses of pyrites are also given in the paper. The methods of burning, the treatment of the residuum, and various objectionable varieties of pyrites are also described.

RESULTS OF AN EXAMINATION OF THE PROCESS FOR MANUFACTURING PRUSSIAN POTASH, BY THE LATE MR. JOHN LEE AND DR. RICHARDSON.—These experiments were made as far back as 1847, but the notes had been overlooked, and were only found when it became necessary to prepare an account of the manufacture of this salt for the new edition of the Chemical Technology. The experiments were made in gun-barrels, and the same mixture of materials was employed in each case. Clean horn, carefully rasped, was mixed with the best potashes and iron filings. A small quantity of water was added, to assist in making an intimate mixture, which was carefully dried and reduced to a fine powder. This mixture was composed of—

Horn	16.00
Potashes	17.73
Iron	3.00
Moisture	3.28
	40.00

A potash-charcoal was made by soaking 13 parts of wood-charcoal with a solution of four parts of potashes, and then perfectly dried. A gun-barrel was partially filled with the mixture, and exposed to a red heat in a separate furnace. In the first and second series of experiments, the gases generated in the gun-barrel were passed through the potash-charcoal, which was maintained at a red heat in an iron tube placed in another furnace. In the third series of experiments, the gases were passed through hydrochloric acid, and in the last experiments the gases escaping from the iron tube containing the potash-charcoal were conveyed through hydrochloric acid and then through a solution of potash. In the last series, the gases which escaped were collected and analysed. In each case the prussiate was extracted and crystallised. The ammonia was determined in the usual way, but in the tabulated results which follow the ammonia is given in its equivalent of crystallised prussiate of potash. The theoretical yield of prussiate was 332.50, and the actual quantities obtained were as follows:—

	1.	2.	3.	4.
Retort	101.97	135.46	146.93	141.08
Tube	68.25	63.54	...	71.00
Acid	...	...	140.24	58.80
Potash	...	...	...	2.75
Total	170.22	199.00	287.17	273.63
Loss	212.28	183.50	95.93	106.87
Produce per cent. .	44.5	52.2	75.1	71.5

The gases were not collected until the air had been expelled from the apparatus, and consisted of—

Hydrogen	46.00
Carburetted hydrogen	14.86
Carbonic oxide	23.34
Nitrogen	14.00
	100.00

It would therefore appear that part of the nitrogen of the animal matters is eliminated in its ultimate form, and cannot be made available in this manufacture. It would also appear that a modification of the apparatus used by manufacturers would probably be followed by a much larger produce than is at present obtained.

DETECTION OF NITRIC ACID IN POTABLE WATER BY MEANS OF BRUCINE; (READ AT THE BRITISH ASSOCIATION MEETING, NEWCASTLE, BY R. KRISTING).—The author makes a solution of one part of brucine in 1000 parts of water. He pours a cubic centimetre of this solution into a glass, and adds a cubic centimetre of the water under examination for nitric acid; he then pours very slowly down the side of the glass a cubic centimetre of sulphuric acid, so that the acid may form a layer at the bottom of the glass. Then, if nitrates are present in water, a zone of rose-colour appears on the surface of the acid. The rose turns yellow on its lower surface, but remains without further change for some hours. By carefully shaking the glass the rose colour may be made to reappear above the yellow zone. A cubic centimetre of water containing 1 ten-thousandth of nitric acid shows the reaction very decidedly, but it may be seen when the amount of acid is ten times less. As the sulphuric acid, the brucine, and water employed to dissolve it may contain nitric acid, this source of fallacy must be guarded against, and the author recommends that the water should be distilled from potash, the sulphuric acid distilled with about 5 per cent. of carbonate of ammonia, collecting only three-fourths of the acid, and the brucine well washed with distilled water.

PRESERVATIVE PROPERTIES OF COAL TAR.—M. Rottier has placed a paper before the Royal Academy of Belgium, upon the preservation of wood by the heavy oil of coal-tar, in which he states that, after reviewing the number of compounds this complex product contains, the volatile hydrocarbons, aniline, phenic acid, and naphthalene, do not possess any preservative properties; but that a green oil, which is produced in the distillation of coal-tar at a temperature of about 572 deg. Fahrenheit, is the substance alone that resists the decay of wood.

ON THE PRESENCE OF SULPHUR IN MATERIALS USED FOR LIGHTING PURPOSES, AND THE MODE OF DETECTING THE SAME; BY M. H. VOHL.—Endeavours have always been made to separate from gas for lighting purposes the sulphur which it generally contains, so as to prevent in its combustion the formation of sulphurous acid. This acid not only exercises a deleterious influence upon the respiratory organs, but also destroys the vegetable colours of tapestry, paper-hangings, &c. It is generally considered that the sulphur found in coal gas is in the state of sulphuretted hydrogen or sulphuret of carbon, and metallic oxides are used for the absorption of these impurities. M. Vohl has made experiments upon different samples of commercial benzine, and from the result he concludes that benzine often contains sulphur in combination, which is found in that portion that boils under 176° Fahr. The sulphur in combination with the carburetted hydrogen cannot be separated without destroying them. On passing gas obtained from the distillation of coal through metallic pipes, kept cool, we obtain, beside water, a mixture of naphthalene and benzene, an oil of an unpleasant odour, boiling below 176° Fahr., and containing the hydrocarbonated combination of sulphur. The apparatus employed by M. Vohl is composed of a tin worm about 11 yards long and half-an-inch internal diameter, surrounded by a mixture of ice and salt. The benzene water and naphthalene form in the interior of the worm oily concretions, whilst the sulphuretted hydro-carbonate falls into a glass receiver at the bottom of the worm, also surrounded by a freezing mixture. The gas submitted to trial was free from sulphuretted carbon, and the sulphuretted hydrogen removed by its having been washed in basic acetate of lead. To discover the sulphur in benzene and in the oil obtained from coal gas, M. Vohl employs the following method.—Introduce 30 to 45 grains of the oil, supposed to contain sulphur, into a dry test tube, to which add a piece of potassium, the surface being freshly cut; this mixture is then submitted for 10 to 15 minutes to the temperature of boiling oil. If the suspected oil contain sulphur, the brilliant surfaces of the potassium become covered with a red or brown pellicle, composed of sulphuret of potassium. On then adding a few drops of distilled water, it becomes partly decomposed by the potassium, and dissolves the sulphur set free; one drop of alkaline nitroprussiate, if now added to this liquor, is sufficient to obtain the beautiful violet colour characteristic of sulphur. The purified commercial benzene almost always contains a certain quantity of sulphur, which may be detected by the above means. Sodium may be employed as effectively as potassium. It often occurs that oils originally exempt from sulphur, contain it after having been treated by sulphuric acid. As, for example, the oily products arising from the distillation of bituminous schists are composed of a mixture of aldehydes and acetones, which both easily combine with alkaline sulphates. When oils contain the sulphur in the state of sulphurous acid, the potassium test can also be employed; the sulphurous acid is decomposed, and an alkaline sulphuret is formed. The brown appearance upon the surfaces of potassium preserved in naphthalene arises very often from the sulphur contained in the oil.

LIST OF APPLICATIONS FOR LETTERS
PATENT.

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

DATED SEPTEMBER 25th, 1883.

- 2362 C. de Wailly—Improved slipper or elop, principally intended for bath rooms.
2363 A. V. Newton—Joint for the tube of surface condensers.
2364 P. Spencer—Production of sulpho-cyanide of ammonium and other sulpho-cyanides.
2365 E. Lloyd—Improvements in rotary engines to be worked by water, steam, air, and other motive power.
2366 M. Schaffhauser—Making paper tubes used in spinning manufactories.

DATED SEPTEMBER 26th, 1883.

- 2267 G. Spill, T. J. Briggs, & D. Spill—Manufacture of driving straps or bands and of flexible tubes or hoses.
2368 W. T. Rowlett—Improvements in crinolines and hoop skirts.
2369 R. Clarke—New application of material for covering crinolines, and the manufacture of the said material.
2370 W. B. Clark—Improved fabric for the production of permanent creases.
2371 J. Spencer—Improved plastic composition applicable to the coating of metallic and other surfaces.
2372 A. Glerup—Improved construction of gas burner.
2373 L. H. Norris—Manufacture of India rubber and gutta percha compounds.
2374 W. Maier & W. Tie—Apparatus for supplying gas to railway carriages and other moving structures.
2375 E. B. Wilson—Steam boilers and other furnaces and fireplaces.

DATED SEPTEMBER 28th, 1883.

- 2376 T. Lowe—Self-acting lock, lever, band, railway engine, tender, carriage, wagon, or conveyance car brake.
2377 L. J. J. Jean—Construction of steam boilers and their fire grates.
2378 P. Boucheau—Improved wax-light or candle stand.
2379 P. Cato—Construction of combined iron and timber ships.
2380 J. T. & E. Harlow—Improvements in breech-loading fire-arms.
2381 W. E. Gedge—Apparatus for heating by means of illuminating gas.
2382 J. H. Johnson—Manufacture of boot and shoe toe pieces or tips.
2383 J. Bailey, G. W. Blake, & W. H. Bailey—Regulating and indicating the flow and pressure of liquids and fluids.
2384 G. Thomas—Louvre shutters and Venetian blinds.

DATED SEPTEMBER 29th, 1883.

- 2385 F. Preston—Rolling, and cutting files and rasps.
2386 F. G. Mulholland—Manufacturing submarine telegraph cables.
2387 B. Meudel—Manufacture of woven fabrics, applicable to covering telegraph wires.
2388 H. Heigh & R. Hutton—Dyeing cotton or other vegetable fibrous substances.
2389 W. Clark—Improvements in the soles of boots and shoes.
2390 W. E. Gedge—Parts of the permanent way of railways.
2391 J. Cooper—Improvements in the construction of harrows.
2392 P. A. & J. Llewellyn & J. W. James—Water closets.

DATED SEPTEMBER 30th, 1883.

- 2393 J. J. Chibley—Improved bottle and stopper.
2394 W. Clarke—Improvements in musical instruments.
2395 H. E. Skinner—Conical packing for taps.
2396 E. S. Attree—Cigar holder.
2397 E. W. Ballard—Machine for turning and spreading hay.
2398 G. Elliot—Props and supports for coal and other mines.
2399 B. Brown—Sight-piece for rifles.

DATED OCTOBER 1st, 1883.

- 2400 W. Smith—Improved process for re-crystallising sugar.
2401 J. Mackay—Improvements in fire arms, ordnance and projectiles.
2402 T. Bell—Dricks and tiles.
2403 H. A. Bousquet—Improvements in railway and other breaks.
2404 L. N. le Gras—Improvements in cooking stoves and apparatus.
2405 P. Reid—Collecting and saving the spirit of alcohol generated by spontaneous fermentation in raw sugar, conserve, m-lado, and molasses, and thrown off during the process of boiling or refining.
2406 J. Bell—Improvements in couplings for railway carriages.
2407 W. E. Newton—Apparatus for cleaning rice and other grain.

- 2408 G. Dickey—Winkers or eye-screening apparatus for horses and other animals.
2409 P. Leslie—Preserving the bottoms of ships or vessels and other surfaces from the prejudicial effects of marine animals and vegetable substances.
2410 T. Halsey—Improvements in breech-loading fire-arms.
2411 J. J. Anderson—Manufacture of boots and shoes.

DATED OCTOBER 2nd, 1883.

- 2412 J. Farrar—Spinning and doubling wool, alpaca, mohair, cotton, silk, flax, and other fibrous substances.
2413 J. E. F. Ludeke—Improvements in obtaining motive power.
2414 R. Charlton—Improvements in metallic bedsteads.
2415 J. Tees—Improvements in packing for stuffing boxes and pistons.
2416 J. G. Tongue—Compound reactive agent and universal mordant to be employed in the processes of dyeing and printing.
2417 W. E. Gedge—Improved pen holder and nib.
2418 J. J. Landy & R. Irvine—Manufacture of paper.
2419 W. A. Torrey—Lubricating the axles of railway carriages.
2420 G. T. Bousfield—Improvements in revolver fire-arms.
2421 G. & W. T. Shepherd—Storing the crystals of lump or refined sugar.
2422 J. Bowron & G. Robinson—Improvements in the manufacture of soda.

DATED OCTOBER 3rd, 1883.

- 2423 J. Schofield, J. Kirk, & W. Spivey—Looms for weaving.
2424 G. R. Tilling & J. Park—Filling tobacco pipes of an improved construction.
2425 E. B. Wilson—Manufacture of iron and other metal.
2426 T. & J. Fogg—Manufacture of boots and shoes.
2427 E. Pratt—Finishing woollen fabrics made on twist loom machinery.
2428 I. Bonomi—Construction of arches and other like structures.

DATED OCTOBER 4th, 1883.

- 2429 W. Huehl, C. Brakell, & W. Gunther—Improvements in rotary engines worked by steam, water, or other motive power.
2430 C. Brakell, W. Huehl, & W. Gunther—Motive engines worked by water, steam, or other motive power.
2431 J. M. & J. Stanley—Improvements in propelling.
2432 C. Tomlinson—Improvements in taps, cocks, hydrants, or valves.
2433 J. W. Gullmett—Substitute for whitening, pipe clay, and other analogous substances to be employed to produce a white coating or surface.
2434 W. H. Bailey—Combining wool and other fibrous substances.
2435 G. H. Ellis—Apparatus for aiding the combustion of fuel.
2436 B. G. George—Tablets, show bills, and trade announcements.
2437 T. Ivory—Steam engines and furnaces and boilers for the same.
2438 J. Towilson—Improvements in apparatus for cooling liquids.
2439 R. Pepper—Machine for pressing or crushing spent hops.
2440 W. Legg—Improvements applicable to sewing machines.

DATED OCTOBER 5th, 1883.

- 2441 B. Mathews—Improvements in breech-loading fire-arms.
2442 E. Whitehouse—Manufacture of wrought iron shackles.
2443 W. H. & T. Holgate—Improvements in the manufacture of pickers.
2444 R. A. Bissman—Improvements in steam boilers and furnaces.
2445 W. Baucke—Moulding and modelling plates, teeth, and gums for dental purposes.
2446 G. Dyer—Improvements in the construction of railway carriages.
2447 A. Johnston—Improvements on railway carriages.

DATED OCTOBER 7th, 1883.

- 2448 E. Jones—Pumping.
2449 D. Dunn—Regulating and working window blinds.
2450 E. Leek—Apparatus to be used in placing glist chums and earthenware in ovens and kilns for firing, burning, or baking such ware.
2451 J. Cuddick—Runners, runner notches, and top notches for umbrellas, and parasols.
2452 G. F. Graham—Improvements in high pressure cocks.
2453 C. P. Button—Lamps especially applicable to the burning of hydrocarbons.
2454 C. P. Button—Pumps.
2455 C. P. Button—Harrows.
2456 R. Zux—Improvements in the manufacture of academic caps.
2457 A. Rigg, jun.—Improvements in propelling vessels.
2458 E. Slaughter—Improvements in locomotive engines.
2459 J. Gibson—Improvements in cast iron pit tubing.
2460 G. Wright—Washing apparatus.
2461 J. H. Johnson—Improvements in the permanent way of railways.

DATED OCTOBER 8th, 1883.

- 2462 J. H. Johnson—Propelling ships.
2463 A. F. Chaperonier—Improvements in the manufacture of watches.
2464 C. Crosswell—Improvements in breech-loading fire-arms.

- 2465 M. Smith—Washing, cleaning, salting, and packing butter.
2466 G. Canouil & F. A. Blanchon—Shooting toy fusées, toy rockets, or other similar toy missiles, by means of toy pistols or other toy fire-arms.
2467 W. Lober—Improvements in the manufacture of gas from tar.
2468 J. D. Dougall—Camel guns and other light artillery.
2469 R. G. Watson & W. J. Kendall—Walking stick umbrella.
2470 J. Mead—Construction of various articles of furniture.
2471 J. Spencer—Machinery for separating different sizes of roots.
2472 A. V. Newton—Improvements in the construction of condensers.

DATED OCTOBER 9th, 1883.

- 2473 L. Lefebvre—Improvements in vapour bath apparatus.
2474 J. Wood, J. Whitehead, & T. Tetlow—Governor of the speed of steam engines.
2475 J. Elsom—Parallel turret.
2476 E. W. James—Raising sinking or submerged ships.
2477 G. Parry—Improvements in refining crude pig iron.
2478 J. McInnes—Sheathing for navigable vessels of iron and steel.
2479 J. Mather—Improvements in friction or glazing calenders.
2480 D. Lange—Railway wrappars.
2481 N. Jellows—Extinguishing fire in chimneys and flues, regulating and promoting draught therein, and to act as a ventilator.
2482 R. Martyn—Condensing and purifying the fumes and gases arising from the treatment of metals and metallic ores and substances.
2483 A. A. Brooman—Amalgamating and separating gold and silver from quartz and earth containing the same.

DATED OCTOBER 10th, 1883.

- 2484 G. W. Reynolds—Manufacture of bands or strips for crinolines.
2485 J. Vaughan—Purifying waste gases from blast and other furnaces.
2486 S. Hamner—Storing petroleum and other like oils and spirits.
2487 J. Ruchardt & F. Thiele—Purifying and increasing the illuminating power of gas.
2488 W. B. Fairbanks & J. F. Lavender—Manufacture of brasses.
2489 D. Proudfoot—Printing or dyeing textile fabrics.
2490 J. W. Gundry—Improvements in musical instruments.
2491 T. Hughes—Lathorns.

DATED OCTOBER 12th, 1883.

- 2492 A. Inglis—Taps or cocks.
2493 F. H. Jackson—Hops and tyres for railway wheels.
2494 W. Hutchinson—Manufacture of fittings for powder flasks.
2495 J. G. Hartley—Iron and wooden ships and boats.
2496 J. Henp—Perforating machines.
2497 W. T. Bury—Baths for containing heated metals and fluxes employed in the processes of hardening and tempering at el.
2498 T. Branning—Metallic caaks.
2499 T. Gidlow—Bearings for axles for railway or other carriages.
2500 T. Fox—Cleaning out the tubes of steam boilers.
2501 W. E. Gedge—Shears for cutting metals and other substances.
2502 C. Humphrey—Purifying hydrocarbons.
2503 R. Atken—Improvements in the permanent way of railways.
2504 G. Mowbray—Cotton gin.
2505 J. J. Anderson—Cutting and finishing the edges of the soles and heels and the bottoms of boots and shoes.

DATED OCTOBER 13th, 1883.

- 2506 J. D. dge—Rolling, shaping, or forging metals.
2507 G. Morgan—Bag for postal and other purposes.
2508 J. M. Poynter—Throwing projectiles by means of explosive agents.
2509 J. P. Pine—Fishing paper.
2510 A. Rolfe—Propelling carriages on railways, tramways, or on common roads.
2511 T. C. Craven—Cotton glass.
2512 T. Scott—Floating docks.
2513 J. Fowler—Apparatus used for hauling agricultural implements.
2514 A. Crellin—Omnibus indicator.

DATED OCTOBER 14th, 1883.

- 2515 J. Rowley—Washing, scrubbing, scouring, bleaching, and discharging impurities or other matters from woven or other fibrous materials.
2516 J. Luchley—Valves for double cylinder steam engines.
2517 E. P. Colquhoun & J. P. Ferris—Fire bars for the furnaces of steam boilers.
2518 M. F. D. Cavalier—Obtaining centrifugal motive power.
2519 H. Milner—Looms.
2520 W. J. Rideout—Boiling rags.
2521 O. E. Suenstein—Reflecting apparatus.
2522 H. A. Brooman—Cleaning ships' hulls.
2523 R. H. Smith—Application of wheels to railway carriages.

DATED OCTOBER 15th, 1883.

- 2524 R. Bewley, jun.—Wrenches.
2525 P. Leslie—Rails for railways.
2526 H. Clayton—Buildings for drying bricks, tiles, and other articles.
2527 S. R. Smith—Connecting chain cables, clearing a ship's passage when foul, and preventing strain to the chain cables when ships are riding at anchor.
2528 H. W. Hart—Suspending T fastenings.

- 2529 B. F. Weatherdon—Removing dirt from boots or shoes.
2530 S. Fixen—Ventilating apparatus.

DATED OCTOBER 16th, 1883.

- 2531 J. Polignac & J. Cos—Cleaving stone.
2532 E. Rowley—Steam engines and boilers.
2533 M. A. Brooman—Pumps.
2534 P. A. E. G. de Masse—Smut machines.
2535 F. G. Stuber—Application of blast heat.
2536 S. Jay—Stockings and drawers.

DATED OCTOBER 17th, 1883.

- 2537 M. Meisel—Weighing apparatus.
2538 S. Berrisford & W. Ainsworth—Looms.
2539 J. Shanks—Valves or taps.
2540 W. Hampson—Looms.
2541 W. Roadledge & F. F. Ommaney—Baling boxes.
2542 W. Clark—Rotary engines.
2543 V. Merritt—Propelling vessels.
2544 W. Clark—Sewing and embroidery machines.
2545 L. R. Chabrough—Let-off motion for looms.
2546 J. H. Johnson—Washing machines.
2547 W. Darlow & R. H. Lawson—Obtaining motive power.
2548 J. Wright—Cutting railway sleepers.
2549 E. H. C. Mackintosh—Joining sheets of metal.
2550 F. de Wyde—Induration of stone, cement, stucco, brick, and other materials.
2551 F. de Wyde—Separation of molasses and other impurities from sugar crystals.

DATED OCTOBER 19th, 1883.

- 2552 J. Champion—Preparing, spinning, and doubling fibrous materials.
2553 H. Gilbey—Rendering boots and shoes waterproof.
2554 W. Fletcher—Breech-loading fire-arms.
2555 A. Baden—Blasting powder.
2556 J. Vintley—Permanent way of railways.
2557 I. Edward—Brakes.
2558 W. Clark—Separating ores from their gangues.

DATED OCTOBER 20th, 1883.

- 2559 J. Taylor & J. J. Lees—Opening, cleaning, and mixing fibrous materials.
2560 E. H. Lockhart—Substitute for cotton.
2561 W. Luchin—Copper rulers.
2562 C. T. Morley—Combination of gas.
2563 J. Vaughan—Picks, hoes, and other tools.
2564 D. Mills—Moulds for casting studs for chains.
2565 J. Michelson—Purses and pocket-books.
2566 W. Small—Condensers for steam engines.
2567 H. Hennessy—Projectiles.
2568 M. Petenkoff—Regenerating the surface of pictures.
2569 J. Bryan—Vent apparatus.
2570 H. B. Burlew—Boots and shoes.
2571 W. A. Dixon—Making aluminate of soda.
2572 G. Davies—Forming catches over the edges of fabrics.
2573 J. W. Nottingham—Hansom cabs.
2574 H. H. Douglas & T. Windus—Banding plates for iron ships.
2575 C. Garton & T. Hill—Evaporating, cooling, and melting.
2576 W. N. Hutchings—Ordinance.
2577 T. Restell—Walking stick umbrella.

DATED OCTOBER 21st, 1883.

- 2578 W. Hartcliffe—Mules.
2579 T. C. Clarkson—Making and ornamenting various articles.
2580 J. Hinton—Breech-loading fire-arms.
2581 C. Schiele—Garners.
2582 N. F. Taylor—Increasing the power of gas.
2583 G. Howell—Combustion fumes.
2584 T. Hodson, W. Nightingale, & R. Laird—Carding cotton.
2585 G. Haselme—Weighing machines.
2586 E. Alcan—Ornamenting cloths.
2587 H. A. Brooman—Treating hideous substances.
2588 E. Colburn—Steam engines.
2589 W. Cooke—Saponaceous compounds.
2590 J. Dodd—Mules.
2591 W. E. Newton—Sewing machines.

DATED OCTOBER 22nd, 1883.

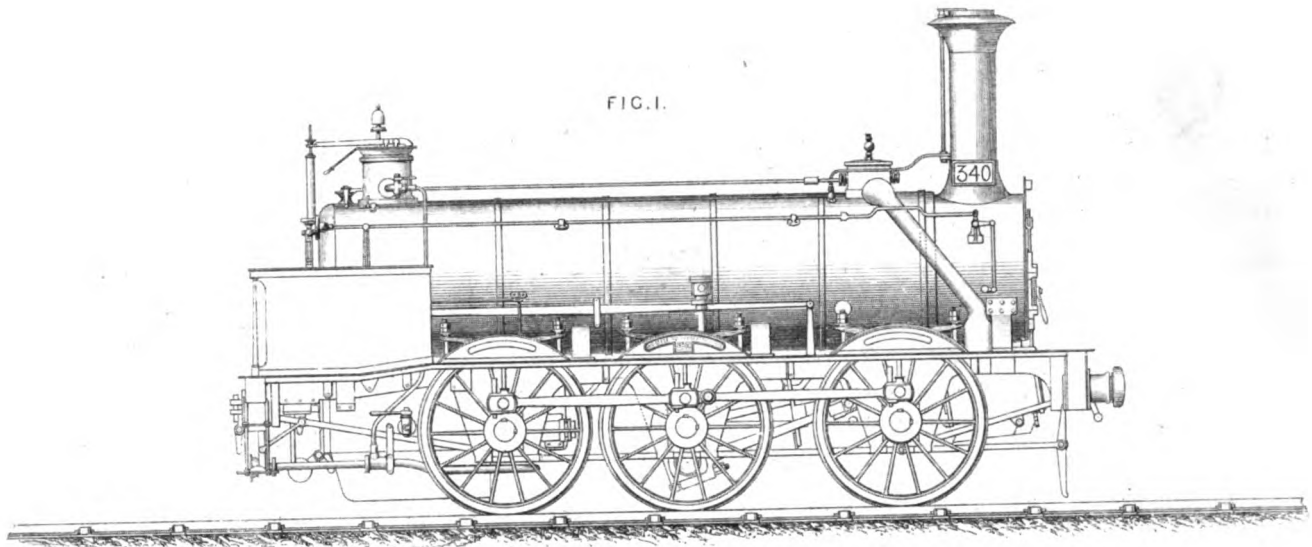
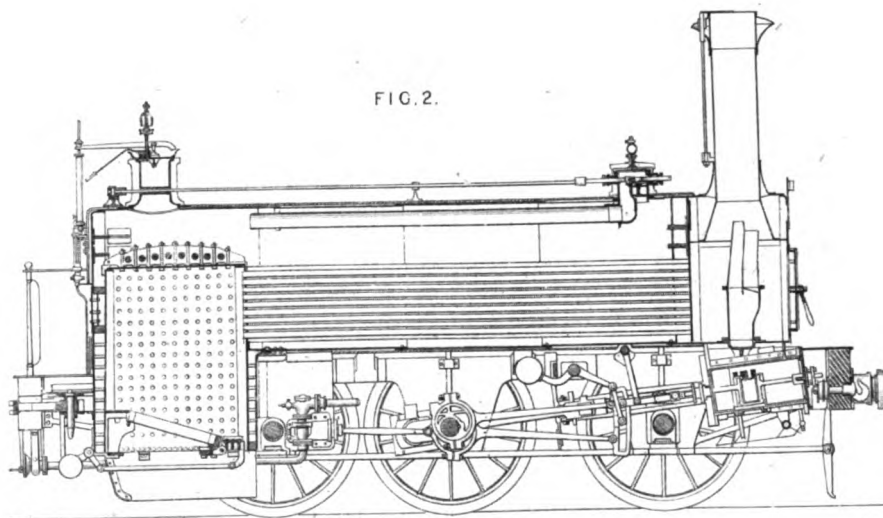
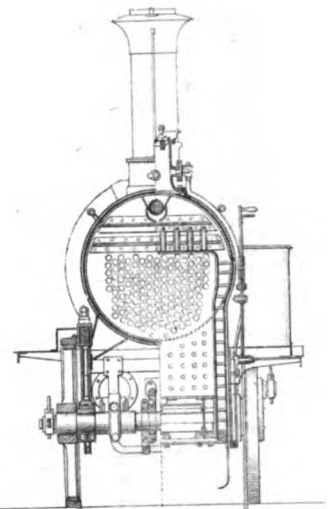
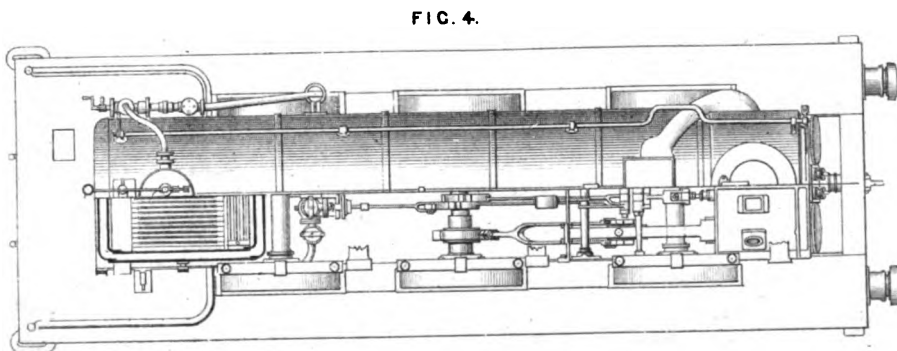
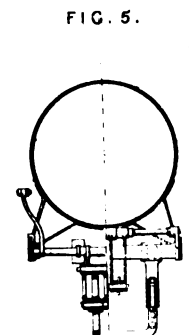
- 2592 G. Cutler, jun.—Boilers.
2593 K. Baillie—Floating docks.
2594 H. Wilson—Lubricator for steam engines.
2595 J. Craven & S. Fox—Punching, shearing, and planishing.
2596 A. A. Crill—Disinfectants.
2597 C. Tumor—Cart edge bottoms.
2598 J. W. Friend & B. F. Weatherdon—Valve and valve gear for regulating the passage of fluids.
2599 F. Hollock—Ship's lugs.
2600 J. Mitchell—Excavating in the earth.
2601 C. Parker—Winding yarn or threads.
2602 J. Weene—Drying, cleaning, and cooling grain.
2603 A. Kinder & J. Ingles—Metallic foils.
2604 B. Nokes & F. J. Wood—Metallic caaks, bottles, and other vessels.
2605 G. J. Pownall—Repairing and cleansing vegetable fibres.
2606 W. W. Hurdon—Paper and pulp.
2607 H. A. Brooman—Tanning.
2608 H. Brooman & J. Alcock—Initiating or folding fabrics.
2609 T. and A. L. Dickens & H. Heywood—Dyeing the ends of silk.
2610 A. Turner—Looms.

DATED OCTOBER 23rd, 1883.

- 2611 J. L. Jurgens—Vessels of war.
2612 B. Marriott—Cylindrical dome beat independent centre second watches.
2613 M. A. Boyie—Portable writing cases and despatch boxes.
2614 A. J. Martin—Improved lamp burner.
2615 J. Cines—Regulating the emission of gas.
2616 J. T. Webster—Driving the spindles of doubling and spinning frames.

LOCOMOTIVE ENGINEERING

GRAFFENSTADEN GOODS ENGINE.



0 1 2 3 4 5 10 15 20 Feet