

## DESCRIPTION OF THE LINE AND WORKS OF THE SCINDE RAILWAY.

BY MR. JOHN BRUNTON, M. Inst. C.E.

The importance of the valley of the Indus, as the route for commercial as well as for military communication with the Punjab and the north-west provinces of India, was pointed out by Sir Charles Napier, the Conqueror of Scinde, so far back as the year 1812; and its many natural advantages subsequently attracted the notice of other eminent men. When, therefore, railways were introduced into India, attention was soon drawn to the Indus valley route, having Kurrachee as its sea terminus; and a concession having been granted to Mr. W. P. Andrew, the Scinde Railway Company was formed in 1855. This Company embraced under its management not only the Scinde Railway proper, or the line from Kurrachee to Kotree on the Indus, 108 miles, but also the Punjab line from Multan to Lahore and Unrisir, 240 miles, and likewise a flotilla of steamboats for navigating the river from Kotree to Multan, 570 miles. Within the last three months the Government had entrusted to the same Company the construction of a line from Umritsir to Delhi, 280 miles, where a junction would be effected with the northern terminus of the East Indian Railway. The total length of these four sections was 1198 miles, but the accounts of each section were kept perfectly distinct.

The construction of the first section of this line, from Kurrachee to Kotree, which had been graphically described as "the neck of the funnel" of the entire system, formed the subject of this communication. After alluding to the works in progress for increasing the depth of water over the bar at the mouth of the harbour of Kurrachee: which was not only the natural port of Scinde, but also of the Punjab and of Central Asia, and for extending the quay and wharf accommodation, reference was made to statistical returns, showing the rapid increase which had taken place in the import and export trade of the port during the last quarter of a century. Hitherto all commercial communication with the upper districts had been carried on by native boats on the Indus, or by caravans of camels—no roads worthy of the name existing. This led to great expense, inconvenience, and irregularity. The works of the Scinde Railway were commenced on the 29th of April, 1858, their execution having been originally let to Messrs. James and Edwin Bray, contractors; but since June, 1859, the works had been executed departmentally, without the intervention of a large contractor, by the Company's engineers and inspectors, who had thus favourable opportunities for becoming acquainted with the capabilities of the various classes of natives, as well as for ascertaining the cost of each description of work. This mode of carrying on the works was forced upon the Company by the peculiar exigencies of the case; but the author thought, that for the construction of large works in India, under Government guarantee, the employment of a substantial contractor was a preferable plan. To secure the economical execution of the works, a fair tariff of wages was published, and daily payments were guaranteed. This had the effect of collecting a considerable number of labourers. The province of Scinde contained but a sparse population, and the Scindee was naturally indolent and devoid of muscular power, though not deficient in talent. The natives of the surrounding state of Cutch were a much superior race, and from thence came a large proportion of the skilled workmen, such as carpenters, masons, smiths, and other handicraftsmen. From the hill tribes of Beloochistan and Afghanistan a hardy race of labourers were obtained. To maintain discipline amongst this body of men, it was found advisable to organise a regular railway police force; and to facilitate the administration of justice, a special magistrate was appointed by the Government. Owing to these precautions very few outrages of a serious character had occurred. As the line of railway lay at a distance from existing towns and villages, it became necessary to make such arrangements for the feeding, shelter, and health of the different employes as policy, no less than humanity, suggested. The natives worked in gangs under a self-elected muckadum, or ganger, who made all agreements for work, received the earnings for his division, and was himself paid a small percentage by the men. When work was executed by day labour, it was found that its economical execution depended entirely upon the energy and honesty of the muckadum, or native overseer. These qualities were so rare, that piece work had to be resorted to, though it was with difficulty this was established as a rule. The average prices paid for earth and rock work per cubic yard were, alluvial earth excavated from side trenches and placed in embankment, 4.09 pence, firmly set gravel, or soft shaly material 4.9 pence, rock requiring bars, but not blasting, 1s. 9d., and hard rock requiring blasting, the powder, drills, &c., being found by the Company, 2s. Gravel ballast cost 1s., and broken stone ballast 1s. 10d. per cubic yard. The average prices of the principal kinds of work, including the cost of the provisional staff of superintendents, but exclusive of that of the permanent engineering staff, were as follows:—

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|---------------------------------------------------------------------------|-----------|-----------------|
| Earthwork in embankments .....                                            | Os. 11½d. | per cubic yard  |
| " in cuttings, a large portion rock of different degrees of hardness..... | 1s. 6½d.  | "               |
| " in diversion of roads and streams...                                    | Os. 8½d.  | "               |
| Picking slopes .....                                                      | 2s. 0d.   | per square yard |
| Masonry, concrete .....                                                   | 4s. 6d.   | per cubic yard  |
| " dry rubble .....                                                        | 3s. 0d.   | "               |
| " common rubble .....                                                     | 12s. 0d.  | "               |
| " coursed rubble, with rubble backing                                     | 15s. 0d.  | "               |
| " coursed rubble.....                                                     | 20s. 0d.  | "               |
| " block in course .....                                                   | 31s. 6d.  | "               |
| " ashlar .....                                                            | 1s. 7½d.  | per cubic foot  |
| Ballast .....                                                             | 1s. 6d.   | per cubic yard  |
| Leading and laying permanent way.....                                     | 6s. 0d.   | per lineal yard |
| Fence walling .....                                                       | 3s. 0d.   | "               |

The province of Scinde being situated in what was termed the rainless zone, the rainfall was very small, the average quantity measured at Kurrachee during the five years ending 31st August, 1860, amounting only to 5.32 inches per annum. Except during the rainy season, the river beds were dry, but in them water could generally be obtained, by sinking to depths varying from 5 to 30 feet. All the water, however, procured from these wells was more or less saline. In the neighbourhood of Kurrachee, the principal features of the country were low hills varying from 150 to 200 feet in height, consisting of a coarse-grained arenaceous rock, of a dirty yellow colour, abounding with fossils. Most of these hills were capped with conglomerate, more or less disintegrated on the surface. The hills lying north of the Indus to the foot of the Hala range, of which they were spurs, exhibited the effect of great disturbance, and the drainage of the country passed through the fissures thus formed. One of the most remarkable of these was at Dharwat, where during the rains the water of the Bahrun rose at times 70 feet, rushing through the pass with overwhelming force. The Kheytriani hills were composed of pale arenaceous limestone, and those in the neighbourhood of the Rhodh river of calcined clays of various colours.

The distance between Kurrachee and Kotree traversed by the Scinde Railway was 108 miles 10 chains. Of this, 32 miles 50 chains were level, and 76 miles 40 chains were on inclines more or less favourable—1 in 200 being the ruling gradient. The total length of straight line was 74 miles 22 chains; the length of the line on curves was therefore 33 inches 68 chains, the sharpest curve having a radius of 43 chains for 76 chains. The earthworks were generally executed to accommodate a single line of railway, but all the bridges, culverts, and stone viaducts were constructed to carry two lines. In the case of wrought-iron viaducts, the stone piers were adapted to support girders for a double line, while those required for a single way only were erected. Between the workshops at Ghizree junction and the terminus at Bunder head, a distance of 3 miles 15 chains, the line was double; and a short branch of 3½ miles in length had been constructed from the workshops to the eastern delta of the Indus. The permanent way consisted of the ordinary double-headed rail, fixed in chairs, laid on transverse wooden sleepers. A large proportion of the sleepers were of yellow pine creosoted, sent from England. It was intended to complete the required quantity with sleepers of deodar timber, from the Himalayas; but the native merchant having been unable to fulfil the contract, a supply was purchased of Australian blue and white gum, and native red eyné sleepers. Their respective costs were creosoted yellow pine 8s. 11d., Australian blue gum 8s., and eyné 7s. 9d. each, delivered at Kurrachee; that of deodar delivered at Kotree being 6s. each. The deodar sleepers were at first steeped in a solution of sulphate of copper, to protect them from the attacks of the white ant, but a Buruetizing apparatus had since been erected at Kotree, where the cost of applying the process only amounted to fivepence half-penny per sleeper. The result of the author's experience was, that creosoted yellow pine sleepers split and twist to a great extent, owing to the extreme dryness of the climate, and that they become very brittle. The majority of the fencing consisted of a dry rubble stone wall, having a coping of stones on edge, set in mortar. Locomotive erecting and repairing shops had been built where the Ghizree branch left the line. The organisation of these works, with a view to their ultimate utility, and at the same time having regard to economy, was surrounded with many difficulties. To employ entirely European workmen would have involved enormous cost. It therefore became necessary to call in the aid of native carpenters and smiths, as far as practicable. They first had to be induced to stand to their work, and then to be taught the use of European tools. This had been accomplished by degrees, and the result had been most satisfactory; the carriages now framed and erected at these shops by Cutch carpenters displaying admirable workmanship. To keep up a supply of European foremen, fitters, engine-erectors, and engine-drivers, the system of taking the sons of European soldiers and clerks, as apprentices, had been adopted, by which a staff of men thoroughly acclimatised was being educated in all branches railway mechanism. The electric telegraph with two lines of wires, carried upon posts of deodar, let into cast-iron sockets, was laid along the

railway. The block system of working the trains was employed; needle-speaking instruments being used for conveying information between the stations and passing places.

As the line crossed the natural drainage of a great extent of country, a large provision for waterway was necessary. It was comparatively easy to fix the spans of the bridges at the rivers and nullahs, but in crossing wide flat plains the question was difficult. The plain at Pipri was nearly five miles broad. Originally a number of culverts was built there, and catchwater drains were cut to conduct the rain into the river Guggur. In 1861 the rain was very heavy in this locality, and the water was ponded up by the embankment, which was soon breached in several places. The line was then lowered to the natural surface of the ground, being in fact laid in a ditch 16 feet wide and 2 feet deep, and during the unusually heavy rains of 1862, the water flowed over the rails to the depth of 9 inches, without either damaging the line or stopping the traffic. Whenever the height of the embankments would admit of it, and to secure the largest amount of waterway, the culverts had a span of 8 feet 6 inches, the permanent way being carried in such cases upon teak beams, which supported a platform of planks, covered with ballast, as a protection from fire. The heaviest piece of masonry upon the line was the large stone viaduct across the Bahrur river. It was 1728 ft. in length, and its greatest height was 31 ft. 4 in. The superficial measurement of the bridged area was 44,064 square feet. It consisted of thirty-two arches, each 45 ft. span, and having a rise of 10 ft. 6 in. Its total cost was £27,185. This viaduct was completed in twenty-two months and a half. There were six viaducts with iron girders, on Warren's principle, of 80 ft. span each, the total number of these spans being forty-two. From experience the author could not speak favourably of these girders, when contrasted with the plate girder, as there was an amount of vibration, both laterally and vertically, caused by passing trains, which had the effect of breaking or loosening the bolts fixing the longitudinal timber stringers to the cross girders. The viaduct across the Chinese creek would consist of ten openings, each of 100 ft., spanned by girders of plate iron, of elliptic form in elevation.

The extension of railway communications into wild and uncivilised countries demanded from all grades of the employés the exercise of more than ordinary observation, self-discipline and energy. It would therefore be wise policy on the part of all foreign railway companies, and the contractors for the works, to be more strict than they have hitherto been, in ascertaining that the agents sent out from this country at great cost, were something more than proficient in the practical details of their profession, as they ought also to be possessed of gentlemanly feelings and habits, by which alone the respect of the uncivilised native could be obtained, and his services secured, so as to reduce the cost of the work, and convert the railway engineer into a pioneer of civilisation and a missionary of science.

# NOTICES TO CORRESPONDENTS.

**ERRATUM.**—In the last number of THE ARTIZAN, at page 125, under the head of *Locomotive Engineering*, first column, 31st line from the top, instead of reading "if an arithmetical mean be taken between these and the working load, &c.," read "if an arithmetical mean be taken between the extreme limits of ultimate strength and the mean working stress, &c."

**A. CONSTANT READER AND SUBSCRIBER (EDINBURGH)**—cannot do better than consult a very useful little work, written by a Mr. George Ede\* which treats specially of the processes upon which our correspondent wishes to be informed. Should you require further particulars write to us. We shall at all times be glad to hear from you.

**A.**—The working pressure of the "Leinster's" Boiler is 20 lbs. per square inch. The engines are not fitted with any expansion gear, but the steam is cut off by the slide valves at about  $\frac{3}{4}$ ths of the stroke of the piston. The shafts are of wrought iron. The average vacuum in condensers is about 25 in. The total boiler surface exposed to heat is 16,800 square feet. The boilers are not fitted with superheating apparatus.

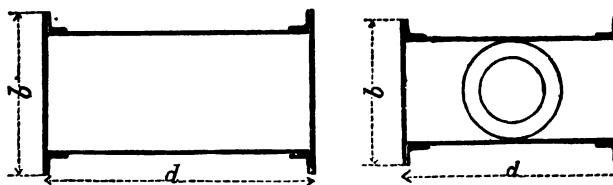
**A. E. D. (Roorkee).**—We question if the plan you propose would answer, and as it is also unnecessarily complicated, we should prefer to employ the scarf joint as shown in the accompanying sketch, the pieces to be joined, being drawn together by a key or by double wedges, and then bolted through, as shown. As an additional security, straps might be added. BARLOW, in Tredgold's Carpentry, states that



"The length of the scarf should be, if bolts are not used, as follows:—In oak ash, or elm, six times the depth of the beam. In fir, twelve times the depth of the beam. If bolts and indents combined, the length of the scarf should be—In oak, ash, or elm twice the depth of the beam. In fir, four times the depth. In scarfing beams to resist transverse strains, straps driven on tight are better than bolts. The sum of the areas of the bolts should not be less than one-fifth the area of the beam, when a longitudinal strain is to be borne. No joint should be used in which shrinkage or expansion can tend to tear the timbers. No joint can be made so strong as the timber itself."

\* The Management of Steel; including Forging, Hardening, Annealing, Shrinking, and expansion; also, the Case Hardening of Iron. By George Ede. Tweedie, 337, S. and London.

**ENGINEER (Tubular Cranes).**—In answer to your enquiry the proportions for cranes of 18 ft. radius, and 20 ft. height, should be as follows, viz., depth  $d = 3$  ft., breadth,  $b = 2$  ft. For compression flange, plates to be  $\frac{3}{4}$  in. thick, for tension



flange,  $\frac{3}{8}$  in. angle irons,  $2\frac{1}{2}$  in.  $\times$   $\frac{3}{4}$  in. thick. The pillar to be 18 in. diameter and 3 in. metal. The proportions for large cranes of 18 ft. radius and 24 ft. height should be, depth,  $d = 3$  ft. 9 in., breadth,  $b = 2$  ft. 6 in., the plates for compression flange to be  $\frac{3}{4}$  in. thick; for tension flange,  $\frac{3}{8}$  in. thick. The angle irons to be 3 in.  $\times$   $\frac{3}{4}$  in. This crane should, instead of revolving upon a cast iron pillar, be constructed similarly to that illustrated in the ARTIZAN of June, 1862. Should, however, special circumstances render it necessary to employ a pillar, it should not be less than 23 in. diameter, and the thickness of metal 3 in. The dimensions given are those at the level of the foundation, the depths and breadths to be reduced gradually towards the end of the jib, as shown in the number of the ARTIZAN we have just referred to.

**O.**—The material to which you refer (Saxifragine) is a recently invented powder for blasting and quarrying purposes which has already gained considerable reputation on the Continent, and has been patented in various countries. The Russian patent has, we understand, been sold to the government of that country, and in Belgium and Prussia, companies have been formed and are rapidly producing the material. The following are some of the objections urged against the use of the ordinary blasting powder:—The ordinary powder is difficult and expensive to transport, on account of the precautions it requires. 2. The expenses for the conveyance, of a small quantity being as great as for a large quantity, consumers must lay in all they require for a considerable time, which is very inconvenient, owing to the great danger involved in storing it. The ordinary Powder being adapted to gunnery and sporting purposes, it has been found that it is often purloined to a large extent. It also presents great danger to workmen in consequence of its scattering fragments, in all directions with great force. It causes constant interrupting interruption of work. It exercises a pernicious influence on the health of men by the thick smoke and sulphurous gas which remain after explosion. Sulphur is used to some extent in the manufacture of ordinary powder, and its pernicious effects are no where more visible than in mine blasting, added to which must be considered its cost. The inventors claim that all these objections are obviated by the use of saxifragine, which is composed chiefly of nitrate of barytes in place of saltpetre, of which only a very small per centage is introduced; sulphur is entirely dispensed with, and consequently the cost of the material is much reduced, whilst, being from the nature of its composition of a very dilatatory or expansive character, its practical value is considerably enhanced. It is much less dangerous to carry and to store than gunpowder. It is not likely to be purloined, as it cannot be used for firearms. It does not cause the men to be constantly interrupted in their occupation. It does not produce thick smoke or sulphurous gas. It blasts the rock as well or even better than the ordinary powder. Its theoretical force, as compared with that of the ordinary powder, is calculated at 18 to 11 in its favour. Owing to its superior force and density, it occupies less space in the hole, so that the centre of gravity of the charge may be placed low with a shallower hole and equal tamping. It is much less expensive. With reference to its practical application, the method of proceeding with Saxifragine is similar to that adopted with the ordinary powder, but the report of the explosion is far less, whilst the expansive power is greater than that of the powder now in use. The stone is fractured as well as, and even better than it would be by the old process, but the fragments detached are not cast to a distance as is now the case; the pieces are completely detached from the rock, and the combustion being less instantaneous than that of the ordinary powder, the gas does not produce a violent shock against the sides of the mine, but rather an increasing and progressive pressure until the rock is ruptured. It may be used in mines and even in some collieries, where, from the danger attending the use of ordinary powder, blasting has, at a great sacrifice, been abandoned. This observation is confirmed by the manner in which saxifragine burns in the open air. Ordinary powder spread on a stone and lighted ignites instantly, and rises in smoke, leaving only a little dust behind it; but saxifragine takes fire upon all the surface which it covers, makes no explosion, but burns with an immense vivacity, and develops an enormous quantity of gas, which is the cause of its great expansive power, and as it leaves behind it a certain blackish residue, it cannot be used for fire-arms. Moreover, saxifragine not being hygroscopic, it is easily preserved, and burns freely in the air without explosion, whilst at the same time it is not more dangerous to keep than tow, hay, or any other combustible matter. We understand that the parties interested in this matter in England have sent over an engineer to Belgium who, in company with the government officials of that country and officers deputed by the Russian and Swedish Legations at Brussels, has made experiments in the limestone quarries on the banks of the Meuse, and also in the granite quarries of Quenaste, which have proved very successful, and which tend to confirm the representations made to them by the inventors of the Saxifragine.

W. J. C.—Particulars received, and will be referred to in our next.

## LONDON ASSOCIATION OF FOREMEN ENGINEERS.

## NEW SYSTEM OF MARINE PROPULSION.

On the night of Saturday, the 6th ult., the ordinary monthly meeting of the above society took place. Mr. Joseph Newton, of the Royal Mint, President, occupied the chair on the occasion, and the main business of the evening consisted of an adjourned discussion of the merit of "Vailes' submerged and feathering endless chain propeller." The conclusion arrived at was, that the general principle of the invention was excellent. As to points of detail some members pointed out the necessity of modification, but it was admitted that a practical application of the scheme might prove that even these objections were not maintainable.

It was stated that a model of Mr. Vailes' propeller, on a rather large scale, might be seen at 22, Basinghall-street.

Mr. Newton, at the close of the discussion, referred in a very feeling manner to the painful position in which a series of accidents had placed Mr. Robert Armstrong, C.E. He rejoiced to think that their own Society endeavoured to raise a fund for the purpose of meeting such cases as that he had just named, and he was sure that his fellow members would sympathise with Mr. Armstrong. The result was that Mr. Newton was requested to draw up a subscription paper to be laid on the table at the July meeting.

## BOOKS RECEIVED.

*Lessons and Practical Notes on Steam, the Steam Engine, Propellers, &c.* By the late W. H. KING, U.S.N., revised by J. W. King, Chief Engineer U.S.N. Fourth edition, enlarged. New York: D. Van Nostrand, 192, Broadway. London: Trubner and Co., Paternoster Row, 1863.

*Results of an Experimental Enquiry into the Tensile Strength and other Properties of various kinds of Wrought Iron and Steel.* By DAVID KIRKALDY. Illustrated by numerous plates and diagrams. Second edition. Glasgow Sold by the author at 4, Cornua-street. London: Hamilton, Adams and Co., Simpkin, Marshall and Co., Charles Griffin and Co.

## RECENT LEGAL DECISIONS

## AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &amp;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.

**SCHIELE V. BRAKELL.**—The plaintiff moved for an injunction to restrain the defendant from receiving, retaining, or opening any letters or letter addressed C. Schiele, or Schiele and Co., C. Schiele and Co., Platt and Schiele, or otherwise addressed to the plaintiff Christian Schiele, or the plaintiff's said firm of C. Schiele and Co., and from availing themselves of these letters for their own benefit. The bill alleged that the plaintiffs had carried on business as engineers and ironfounders at North Moor, Oldham, from 1861 till the autumn of 1862, under the style of C. Schiele and Co. The plaintiffs were the only partners till the 5th November, 1866, when F. Schiele joined them, when the firm became Christian Schiele and Co. On the 1st July, 1869, F. Schiele retired. The business chiefly consisted in the manufacture and sale of articles for which Christian Schiele had obtained patents. Some time since the plaintiffs determined to confine their business to the sale of the patented machines, and to grant licences for the use thereof. In the latter part of 1869, the plaintiffs agreed with the defendants to let them the premises, and to grant licences for the manufacture of parts of the patented machines. The bill alleged that the plaintiffs' names were well known in the trade, and they had extensive connections. On the 1st September, 1869, a formal deed containing the terms of the agreement was executed. The bill alleged that the plaintiffs had discovered that the defendants had received numerous letters intended for the plaintiffs, and had executed orders contained in such letters, which, it submitted, referred to the plaintiffs' patented machinery, for which no licence had been granted. Under these circumstances the plaintiffs filed this bill. Mr. Kenyon and Mr. Hetherington, for the defendants, contended that they were entitled to receive such of the letters as were addressed to the firm of Schiele and Company, in respect of that part of the business which they had purchased. They denied having made any improper use of the letters they had received. The Vice-Chancellor said he thought the defendants had received some of the letters to which they had no right, one from India in particular, relating to Schiele's centrifugal pump. The plaintiff was entitled to the injunction as prayed in the 1st and 4th paragraphs of the bill.

**NEDHAM V. OXLEY.**—The Vice-Chancellor's Court was occupied for three days with a trial in this case, of certain issues as to the validity and novelty of the plaintiff's patent, and the alleged infringement by the defendant of that patent. The plaintiffs in 1853 took out a patent for "improvements in machinery and apparatus for expressing liquid or moisture from substances," their invention consisting, as was alleged, of a new and original combination of portions of various processes for which patents either expired or existing had been already taken out. The patented machine was known as the "Patent Filter Press," and had been used to a considerable extent, especially in breweries. The defendant, who was a brewer's engineer at Frome, Somerset, had constructed a yeast press for Messrs. Thorne, brewers, and for other parties. The yeast press at Thorne's brewery had been inspected by the plaintiffs, who thereupon came to the conclusion that

the defendant had pirated their invention, and accordingly filed their bill in this court to obtain relief. A jury had been summoned to determine the questions of validity of patent and infringement, and the issues were in substance as follows:—1, validity of the patent of the plaintiffs, having regard to the specification; 2, novelty of invention; 3, infringement by the defendant. The trial of these issues occupied three whole days, and the witnesses, including several gentlemen of great scientific and engineering eminence, were numerous on both sides. The evidence was, however, of too technical a character to be given in detail. The defence was in substance as follows:—That the provisional specification filed by the plaintiffs omitted several essential portions of the invention, and was materially different from the complete specification filed six months later in accordance with the patent laws; that the patent was bad for want of novelty, being merely an adaptation, with slight and immaterial differences, of processes already known and in use; and lastly, that the defendant, by using parts included in the plaintiffs' combination which had been used, known, and published before, and by superadding several improvements of his own, so as to form a new combination, had not infringed the plaintiffs' patent. The Vice-Chancellor, in summing up, observed upon the first issue that it was not necessary that the invention should have been perfected in all its details at the time when the provisional specification was filed. It must, no doubt, have been invented in the mind of the patentee. He must have made the discovery then, although the means of perfecting the discovery and making it available might not have been at that time completed. A distinction was drawn in the recent Patent Act between the two specifications, the purpose of the provisional being to describe the nature of the invention, while the complete specification six months later must particularly ascertain and describe the nature of the invention, and, also, in what manner the same shall be performed. The *onus* was not altogether upon the plaintiff's of showing that they had really invented that which they professed to have invented at the date of the provisional specification; but rather the jury must be satisfied that the plaintiffs had nothing of the kind in their minds at that time. If they came to this conclusion, then the verdict must be for the defendant upon the first issue. Upon the second question—as to novelty—it was for the defendant to make out that the plaintiffs' invention had been anticipated. Large sums had been paid for the plaintiffs' machines, and all the scientific witnesses, even those of the defendants, agreed that until the plaintiffs' invention had been brought into use they had seen nothing like it, although Billiter's and other patents had been taken out several years before that of the plaintiffs'. It had been said that the slightness of change was such that the plaintiffs ought not to obtain the monopoly of a patent to the exclusion of others. But the real question was, whether the invention had been largely and practically useful; and he confessed that he thought there was a great amount of evidence in favour of the plaintiff's case in this respect. As to infringement by the defendant, he was not entitled to take the combination of the plaintiffs, even up to a certain point only, and then add additions or improvements of his own. That, he was bound to tell them, would be an infringement, and it was for them to consider upon the evidence how far the defendant had taken the plaintiffs' combination, merely making some additions; or whether he had, on the other hand, substituted an entirely different combination, in which case he would not have infringed the plaintiffs' patent. The jury, after less than half an hour's deliberation, returned a verdict for the plaintiffs upon all the issues.

**DAMAGES AGAINST RAILWAY FURNACES.**—A case was recently tried at the Jury Court, Edinburgh, before Lord Boreland, in which Messrs. Cooper and Wood, bottle manufacturers, Portobello, claimed £1000 damages against the North British Railway Company for injury sustained by the house and grounds of Baileyfield, Portobello (of which the pursuers are proprietors) from smoke, dust, and gases discharged from the defender's works for converting and hardening iron rails. The works in question were erected about three years ago on a narrow strip of ground left vacant between a curve formed for the improvement of the Leith and Portobello branch line and the original railway track, and they were separated from Baileyfield only by the railway line and the Leith and Dalkeith road running alongside. The pursuers alleged that clouds of smoke and dust, as also deleterious gases, were constantly thrown out in large quantities from fourteen low chimneys, rendering the residence at Baileyfield unhealthy and unsafe, or, at least, uncomfortable, and drying up and wasting the trees, shrubs, and vegetation. It was accordingly put in issue whether the house and grounds of Baileyfield were deteriorated by the defenders' works, and the comfort of the occupation impaired, to the nuisance of the pursuers and their loss, injury, and damage. A large number of scientific witnesses, including chemists, medical practitioners, architects, and horticulturalists, were examined on both sides. The evidence was to a very great extent conflicting, but it seemed to be proved that the vegetation had, since the erection of the furnaces, been considerably injured, and that the comfort of the occupation had been interfered with. The jury were divided in opinion, but by a majority of nine to three they found for the pursuers, with £200 damages.

## 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 "10, Salisbury-street, Adelphi, London, W.C." and be forwarded, as early in the month as possible, to the Editor.

## MISCELLANEOUS.

**NEWCASTLE AND WELSH COAL FOR STEAM-VESSELS.**—The Northumberland Colliery proprietors have presented a memorial to the Lords Commissioners of the Admiralty with a view to secure the adoption of a mixture of South Wales and North Country coal

in the navy. They have made trial of various methods of obviating this objection; and, amongst others, have ascertained that when burned in company with the steam coal of Wales, in equal portions, or even with one-third of the quantity composed of Welsh coal, no smoke is emitted. In forwarding the memorial to their lordships, Mr. W. S. Lindsay observed:—"Though I have no interest, directly or indirectly, in any of the coal mines, yet I consume a considerable quantity of coal in my steam-ships, and my firm are large shippers of coal for the use, at distant stations, of the Peninsular and Oriental, and other large steam-shipping companies. I can, therefore, state from my own knowledge, that North and Welsh coals mixed are used to a very large amount, and are also found to answer the purpose named in the memorial. I may further add, for the information of the Lords Commissioners of the Admiralty, that in the tenders for the Peninsular and Oriental Company the proportions—two-thirds of North of England coals and one-third of South-Wales. The coals from South-Wales, though in use at the Mediterranean stations, are not used by that company at any of their stations in the East Indies or in China, on account of their rapid deterioration when stored." In reply to this, Mr. W. G. Romaine writes, "that he has been commanded by the Lords Commissioners of the Admiralty to acquaint you that they have ordered experiments to be made on board several small steam-vessels at home ports, to ascertain the practical results of using North Country coal in combination of Welsh coal."

**SHIPPING.**—A parliamentary return has been issued exhibiting the number and tonnage of vessels employed in the trade of the United Kingdom in the year 1897. The number of British vessels entered "inwards" was 29,654 and the tonnage 7,856,639; and the foreign vessels were 25,906 in number, and the tonnage 5,234,451. The vessels cleared "outwards" were—British, 29,630 of 8,090,221 tonnage; and the foreign vessels were 26,679 in number, of 5,354,128 tonnage. The return also shows that during the year the number of vessels built in the United Kingdom and British possessions was 1215 of timber, of 231,908 tonnage; and of iron, 63, of 40,596 tonnage. The steam vessels of timber were 46 in number, of 2387 tons; and of iron, 159, of 66,032 tons. The number of vessels wrecked in the year, belonging to the United Kingdom, were—sailing vessels, 638, of 154,798 tons; and steam vessels, 36, of 17,468 tons. The number of vessels registered in the United Kingdom as new ships, during the year, was, of timber, sailing vessels, 991, of 228,378 tons; and of steamers 40, of 1018 tons. The iron sailing vessels were 70 in number, of 44,047 tons; and the steam ships 184, of a tonnage of 77,936.

**EXPERIMENTS WITH PETROLEUM.**—At a recent meeting of the Liverpool Dock Board, a report of the Marine Surveyor on some experiments made with petroleum was read. From this it appeared that the oil burned for ten minutes, giving a good flame, when an explosion took place, blowing the lamp to pieces. The lamp used was the ordinary lighthouse lamp, as at present in use, and the explosion is partly to be attributed to the fact that the lamp in question was unsuited for the description of oil to which it was applied; but partly also, to neglect of testing the oil, and the use of too volatile a quality of it. The degree of heat, however, may be so great as to render all such oils improper for such a purpose.

**THE POWERFUL HYDRAULIC PRESS** for bending armour plates, manufactured by Messrs. Westwood, Bailie, and Co., for Her Majesty's dockyard at Pembroke, underwent an official trial on the 9th ult. The press is a duplicate of the one erected a few weeks ago in Woolwich dockyard. Two plates of 4½ in. and one of 3 in. in thickness were placed on the ram cold, and were subjected to a pressure of 4½ cwt. per circular inch of the ram, which is equal to a pressure of 1823 tons, being the greatest pressure yet obtained by any machinery. All the joints of the pumps and press were perfectly tight. The plates bent were 3 ft. 3 in. wide, and were curved 1½ in. in the width. Two plates, one 4½ in. thick and one 3 in. thick, were then turned over and placed in the press with the 1½ in. curved side downwards, and by working the press up to 24 cwt. per circular inch, or 940 tons on the ram, the plates were bent 2½ in.—viz. from 1½ hollow to 1½ round in the width. The same firm are manufacturing three similar presses for the Russian Government, and also the huge iron rudder, to weigh 13 tons, for Her Majesty's 30 gun iron steam ship *Achilles*, 6079 tons, building at Chatham.

**STEAM TRUMPETS.**—It appears that these instruments are the invention of a Dr. Upham, of Boston, U.S. About a year ago he obtained the use of two locomotives for the purpose of an experimental talk by the sounds of the steam whistle. The inventor had attached several contrivances to the whistle in the shape of bells, trombones, and clarionets, and by means of these he was enabled to represent the sounds of the alphabet by very different sounds. He found that by their means he could convey a message to a distance of three miles, which could be heard and understood even amid the more immediate sounds produced by the movement of a railway train. The doctor has, it is said, found it possible, by the simple trumpet, to transmit any message, however long or complicated, the distance of a mile.

**RAILWAY TRAVELLING.**—Dr. W. Lewis, the medical officer of the London Post-office, states in his report just issued that he has arrived at the following conclusions from observations of the health of the travelling-officers of the Post-office.—That railway travelling has little, if any, injurious effect on healthy, strong, well-built persons, if the amount be not excessive, and if they take moderate care of themselves; but that persons who take to habitual railway travelling after the age of twenty-five or thirty are more easily affected than those who begin earlier, and that the more advanced in age a traveller is the more easily he is affected by this sort of locomotion. Weak, tall, loosely-knit persons, and those suffering under various affections, more especially of the head, heart, and lungs, are very unsuited for habitual railway travelling.

**IRON CASTINGS.**—From experiments conducted at Brest by M. le Guen, it is found that castings containing a small percentage of wolfram are far superior to those of the ordinary kind; the principal advantage conferred being increased elasticity.

**THE MAGNETO-ELECTRIC LIGHT AT DUNGENESS.**—Some further reports on the progress of this "magnificent" light, as the committee of the Trinity House have called it, have been printed by order of the House of Commons. In one, dated April 8th, 1893, the secretary says:—"The light has now been exhibited at Dungeness for the period of nine months; and during that time has, with some brief exceptions (generally attributable to want of care on the part of the attendants), been maintained without break or failure, showing a light of exceeding power and intensity, which Mr. Faraday, who took as his standard the revolving light at Grimsby, with which, at equal distances it was of equal power, estimated to be eight times that of a first order fixed dioptric light (see his report No. 1). Every part of the machines and engines has worked well, although one of the boilers has just required repair, causing a pressing demand from the engineer for the third spare boiler, which he has suggested as necessary. The lamps and lenses have been gradually improved until they may now be said to be perfectly satisfactory, and have been under the charge of the ordinary light-keepers, possessing no more than the usual ability of such persons. The engines and machines have been under the charge of two engineers." Various minor objections, however, to the light as it exists, are stated in these reports; but some of these are vitiated by the discovery that the chief engineer has had to be dismissed on account of intoxication. Professor Holmes replies satisfactorily to the objections in a separate pamphlet, and Professor Faraday also discusses some of them. The light seems to be visible at from twenty to thirty miles' distance, but occasionally not so far, a circumstance which Professor Faraday ascribes on certain occasions to local haze. The Trinity House authorities, however, admit the superior advantages of the light in respect to penetrative power and star-like brilliancy, although other first-class lights they regard as practically sufficient.

## NAVAL ENGINEERING.

**THE "ORLANDO,"** 46, Captain G. G. Randolph, was put out of dock at Chatham on the 4th ult. after having undergone very extensive repairs. In order to strengthen her stern two iron plates, each weighing five tons, have been fixed under her quarters, and strong iron knees and bracings, and to those parts of her keel and sides which gave indication of weakness when her powerful engines of 1000 horse power were at full speed. The immense weight of metal put on her stern only brought her down half an inch. After she has shipped her guns and powder, she will proceed to join the North American squadron.

**THE "RESISTANCE,"** 16, screw iron frigate, in No. 10 dock at Portsmouth, has been officially examined and reported upon by the Master Shipwright and his staff relative to the condition of her bottom plates, which when the ship was last in dock were coated on opposite sides with the composition of Mr. Hay, the chymical assistant at Portsmouth dockyard, and that of Messrs. Peacock and Buchanan, as applied to the bottoms of steamships of the Peninsular and Oriental Company. The ship has since then been afloat less than seven months, and, considering the time, both sides of her bottom are foul; one, however, is much more so than the other, and is also more covered with barnacles. The starboard side has long grass in the wash of the waterway at the bow and quarter, and the remainder of that side at the bottom is studded with small tufts of grass averaging one inch in length, and from three to four inches apart. There are also a few patches of barnacles where the composition has been disturbed, but in very few other places; and there are very few spots of corrosion. The port side has the same description and length of grass at the bow and quarter, and the same description of short tufts of grass, studded at about the same intervals, but it has more adhesive matter altogether on the opposite side. The surface of the composition from the keel to the bilge plate amidships is thickly studded with barnacles. This having been the working anchor's side, there is the usual amount of corrosion to be seen on the bow from the abrasion of the composition by the chain cable, which must always attend the use of copper anti-fouling compositions on the bottom of iron ships.

**THE ESK,** 20-gun screw corvette, made her official trial of speed at the measured mile in Stokes Bay, on the 12th ult. She drew 16 ft. 4 in. of water forward, and 18 ft. 2 in. aft.; was complete in stores of all kinds for sea, and had 270 tons of coal on board. Six runs at the measured mile with full boiler power gave results consecutively as follows:—10'31.5, 8'19.1, 10'74.8, 8'10'97.5, and 7'87.5 knots. The maximum revolutions of the engines were 70 and the minimum 68, with a 20 lb. pressure of steam and 24 inches vacuum. With half-boiler power four runs were made at the mile, the speed in each case being, 9'27.3, 7'43.3, 8'63.3, and 6'97.7 knots, the mean speed of the ship during the four runs being 8.2 knots. To test the engines they were stopped in seven seconds from the time of moving the telegraph, were started ahead under the same conditions, in 10 seconds, and were moved astern in 18 seconds. The screw the *Esk* is now using is a common or Admiralty pattern, having a diameter of 12 feet, a pitch of 9 feet 8 inches, and a length of 3 feet.

**THE "COSACK,"** 20-gun screw steam corvette, 1296 tons, 250-horse power, made her official trial of speed at the measured mile off Maplin Sands on the 13th ult., prior to leaving for the Mediterranean. Six runs at full speed, with full boiler power, were made on the mile, which gave an average of 9'05.5 per hour, the pressure of steam being 20 lb.; vacuum, 25; revolutions of engines at full boiler power, 80; at half-power, 56. Two runs were made at half boiler power, giving an average of 6'94.5 knots per hour. The circle was turned with helm to port in 5 min. 29 sec., and with helm to starboard in 6 min. 12 sec. The *Cosack* is fitted with Smith's propeller; diameter, 12 ft. 1 in.; pitch, 16 in., and the immersion of screw was 2 ft. 9 in. At the time of the trial the draught of water was 17 ft. 7 in. forward, and 17 ft. 8 in. aft. The engines are from the eminent firm of Maudslay, Son, and Field.

**THE IRON-CLAD FRIGATE "ROYAL OAK."**—The performance of this vessel in the run from Chatham to Spithead is described as being in the highest degree satisfactory. After leaving the Nore, all the fires were lighted, and the vessel was put at full speed, when, notwithstanding a strong head wind (force 5 to 7) and a heavy rolling sea, the iron-clad attained a speed of 11 knots an hour, and that too against a strong breeze. The *Royal Oak's* steering qualities are described as excellent. Although the sea broke completely over her bows in the run down channel, she exhibited scarcely any pitching or rolling. The ventilation of the ship gives the most complete satisfaction, the engine-room, together with the aft and forward stoke-holes, having remained very cool. The official trial of this, the first of the converted and fully armoured frigates, commenced on the 15th ult., at the measured mile, at Stokes Bay. The engines of the ship are of 800-horse power, nominal, by Messrs. Maudslay, Field, and Son, and are from the same patterns, with the exception of some minor improvements in their detail, as those of Her Majesty's ship *Merborough*. They are on the horizontal principle, with direct action, and have cylinders of 82 in. diameter with a 4 ft. length of stroke. The fire grate surface is 503 square feet, the heating surfaces in furnaces and flue is 2400 square feet, and the heating surface of the tubes is 13,300 square feet. The weight of the engines is 186 tons, of boilers 206 tons, and of water in boilers when filled 119 tons. The coal boxes have a measurement of 24,480 cubic feet, and stow 600 tons of coals—seven days' consumption. The propeller is Maudslay-Griffiths, weighing 11 tons 11 cwt. It is 19 ft. in diameter, with a length of 3 ft. 10 in., and is set at a pitch of 27 ft. 6 in. It has a varying pitch down to 22 ft., but to alter the pitch at any time the ship must be placed in dock, as the screw has been made a fixture, in this following the example of the French Imperial Marine. The following are the results of the trial at full boiler power:—

| No. of Run. | Revolutions of Engines. | Time. min. sec. | Speed of Ship in Knots. | Pressure of Steam. | Vacuum. |
|-------------|-------------------------|-----------------|-------------------------|--------------------|---------|
| 1           | 59                      | 4 55            | 12'20.3                 | 22½ lb.            | 22½ in. |
| 2           | 61½                     | 4 40            | 12'50.0                 |                    |         |
| 3           | 61                      | 4 40            | 12'57.7                 |                    |         |
| 4           | 61                      | 5 2             | 11'92.0                 |                    |         |
| 5           | 61½                     | 4 30            | 13'33.3                 |                    |         |
| 6           | 61                      | 5 9             | 11'65.0                 |                    |         |

First mean speed in knots, 12'35.1, 12'07.3, 12'38.8, 12'62.6, 12'94.1; second mean speed in knots, 12'61.4, 12'53.3, 12'60.7, 12'55.8. Mean speed of the ship, 12'52.8 knots. It is as well here to place in juxtaposition the temperatures of the engine-room and stokeholes at this time, as we have referred at some length to the great want of ventilation in ships coated with armour all round, and the means which have been taken to remedy this evil in the *Royal Oak*. In making the first run at the mile, the temperatures were recorded as follows:—On deck, 68°; in engine room, 73°, 73°, and 76°; in the forward stokehole:—fore part, 84°; middle, 108; and after part, 113°; in after stokehole:—fore part, 103°; middle, 106°; and after part, 103°. In the sixth mile run they were as follows:—On deck, 69°; in engine room, 72°, 72°, and 75°; in forward stokehole:—fore part, 91°; middle, 120°; and after part, 112°; in after stokehole:—fore part, 102°; middle, 104°; and after part, 103°. The speed attained by the *Royal Oak* was considered in the highest degree satisfactory in all the sense of the words, if it is considered that the ship's "official" estimated speed was set down at 11½ knots, and that she actually exceeded that rate by one knot an hour. On the 16th ult. the ship was tested in her power of turning and completing circles under full steam. On reaching the desired position, however, a hot bearing was discovered,—the full speed circles had to be abandoned, and the ship's trials for the day were cut down to six runs, with two boilers (one-third of the

ship's boiler power), and two circles afterwards with the same power. The runs were made as follows:—

| No. of Runs. | Time. min. sec. | Speed of Ship. | Revolutions of Engines. | Pressure of Steam. | Vacuum. |
|--------------|-----------------|----------------|-------------------------|--------------------|---------|
| 1            | 8 19            | 7.214          | 35½                     | 22                 | 24      |
| 2            | 7 43            | 7.775          | 40½                     | 22                 | 23      |
| 3            | 6 49            | 8.901          | 37½                     | 19                 | 24½     |
| 4            | 8 28            | 7.114          | 38½                     | 22                 | 23      |
| 5            | 6 46            | 8.867          | 39                      | 22                 | 24      |
| 6            | 8 43            | 6.883          | 38                      | 22                 | 24      |

Mean speed of the six runs, 7.979 knots. The circles were made under the same conditions of power, and yielded the following results:—

|                                                        | Circle to Starboard. | Circle to Port. |
|--------------------------------------------------------|----------------------|-----------------|
| Time occupied in getting up the helm                   | 47sec.               | 30sec.          |
| Angle of rudder                                        | 26deg.               | 29½deg.         |
| Turns of wheel                                         | 3½                   | 3½              |
| Time occupied in making half circle                    | 3min. 42sec.         | 3min. 43sec.    |
| Time occupied in making full circle                    | 7min. 27sec.         | 7min. 50sec.    |
| Revolutions of engines previous to putting up the helm | 37                   | 37              |
| Revolutions afterwards                                 | 35                   | 31½             |
| Men at the wheel                                       | 7                    | 8               |

The diameter of the circles were little over twice the ship's length. The Royal Oak resumed and concluded her trials on the 17th ult. The following is the result of the trial with four boilers, or two-thirds of the ship's power:—

|                                           | 1st circle to port. | 2d circle to port. | Circle to starboard. |
|-------------------------------------------|---------------------|--------------------|----------------------|
| Time occupied in getting up the helm      | 1' 0"               | 1' 25"             | 1' 32"               |
| Angle of rudder                           | 25°                 | 29°                | 26°                  |
| Turns of wheel                            | 3½                  | 3½                 | 3½                   |
| Time occupied in making half circle       | 3' 7"               | 2' 58"             | 2' 58"               |
| Time occupied in making full circle       | 6' 21"              | 6' 6"              | 5' 44"               |
| Revolutions of engines before helm was up | 48                  | 52                 | 50                   |
| Revolutions after helm was up             | 43                  | 47                 | 48                   |
| Men at wheel                              | 6                   | 6                  | 6                    |

These three circles being considered a sufficient test of the ship's steering power under two-thirds force of her boilers, the ship was steered in for Spithead, and placed on the trial ground in Stokes Bay, to make four runs at the mile with the same amount of boiler power. The results of the four runs were thus:—

| No. of run | Time. m. s. | Speed of ship. | Revolutions of engines. | Pressure of steam. | Vacuum. |
|------------|-------------|----------------|-------------------------|--------------------|---------|
| 1          | 4 51        | 12.371         | 51½                     | 23                 | 24      |
| 2          | 6 0         | 10.000         | 53                      | 23                 | 23½     |
| 3          | 4 53        | 12.287         | 51                      | 23                 | 24      |
| 4          | 6 8         | 9.783          | 52                      | 23                 | 24      |

Mean speed of the ship at two-thirds power, 11.126 knots.

Steam was next got up in the remaining two boilers, and two circles made with the ship's full boiler power:—

|                                           | First circle to port. | Second to starboard. |
|-------------------------------------------|-----------------------|----------------------|
| Time occupied in getting up the helm      | 1' 30"                | 1' 31"               |
| Angle of rudder                           | 26½°                  | 22°                  |
| Turns of wheel                            | 3½                    | 3                    |
| Time occupied in making half circle       | 2' 47"                | 2' 47"               |
| Time occupied in making full circle       | 5' 27"                | 5' 23½"              |
| Revolutions of engines before helm was up | 62                    | 60                   |
| Revolutions after helm was up             | 55                    | 53                   |
| Men at wheel                              | 6                     | 6                    |

With the exception of testing the facility with which the machinery could be worked in answer to the engine-room telegraph, the ship's official trials were now concluded, and these closing tests gave their returns as follows:—Engines stopped dead, from time of moving telegraph handle, in 55 sec.; engines working astern at full speed from rest, ditto, in 18 sec.; engines from full speed astern to full speed ahead, from ditto, in 13 sec. The indicated horse power of the *Royal Oak* on her full boiler power trial of speed at the measured mile, was 3704 horses, and on her four boiler power trial (two-thirds of her boiler power), 2298 horses. It is a remarkable fact that the *Royal Oak's* trial of speed at Portsmouth, with all her guns, stores, provisions, &c., on board,—in fact, ready for sea, should have exceeded in speed that obtained in her light-draught full-power trial off the Maplin Sands, yet such is the case. At Portsmouth she drew 23ft. 8in. forward, and 25ft. 7in. aft. Off the Maplin Sands she drew only 20ft. 4in. forward, and 23ft. 1in. aft. This gives a difference of about 900 tons in the ship's displacement, and yet a greater speed was obtained by the assistance only of a few pounds of steam.

**TRIAL OF THE "ROLF KRAKE," A DANISH CUPOLA ARMOUR CLAD.**—This new Cupola screw armour clad man-of-war, built by Messrs. R. Napier & Sons, Glasgow, for the Danish Navy, recently underwent her trial trip, which was in every way satisfactory. The *Rolf Krake* is of peculiar construction, being low in the water, and of considerably greater breadth than is usual for vessels of her length. She is built from plans approved by Captain C. P. Coles. Her length is 185ft.; breadth 33ft.; depth 14½ft.; tonnage 1246 tons. Her engines are of 240 horse power. She is only some 5ft. above the water line, with bulwarks to fold down in action, and she displays two revolving cupolas rising 4½ft. above the deck, and 21ft. in diameter. She is armour plated from stem to stern, the plates being 4½in. in thickness, and increasing to 7½in. at the port holes, with the addition of 9in. of teak lining inside. Her armament will be four 68 pounders, two in each tower worked from the inside. The deck is entirely clear of obstruction, except the funnel and a small fixed tower aft for steering the vessel.

**TRIAL OF THE "COLUMBINE."**—The screw steam gun vessel *Columbine*, 4 guns, 669 tons, for service in the Channel Fleet, has undergone the official trial of her engines at the measured mile off Maplin Sands. The vessel made six runs at full speed on the measured mile. The following were the results:—Average speed 9.504 knots per hour, revolutions of engines maximum 107, mean 103.5, pressure of steam 23lb., vacuum 23. Four runs were made at half-boiler power, with an average speed of 7.541 knots per hour, the revolutions of engines being maximum 88, mean 80.5, vacuum 25, pressure of steam 20. The *Columbine* is fitted with direct action horizontal engines of 160 nominal and 600 indicated horse-power. She has a Griffith's screw, the pitch of which is 13ft., and the diameter 10ft., supplied by the Greenock Foundry Company. During the trial the machinery worked in a most satisfactory manner, there being no priming or hot bearings. At full speed, with helm to starboard 21½ degrees, the time of turning the circle was 4 min. 12 sec., the diameter of the circle being 238 yards; with helm to port 22½ degrees the time taken was 4 min. 29 sec., the diameter being 318 yards. At half speed, the helm to starboard 25 degrees, the time was 4 min. 27 sec., the diameter 212 yards; helm to port 21½ degrees, the time was 4 min. 59 sec., the diameter being 318 yards. The trial was considered most satisfactory.

**NAVAL APPOINTMENTS.**—The following appointments have taken place since our last, W. Hardie, Engineer, supernumerary to the *Asia*; J. Gray, First-class Assist. Engineer,

to the *Flagard*, as supernumerary; J. West, First-class Assist. Engineer, to the *Columbine*; R. Sampson, Chief Engineer, and H. J. Hall, Assist. Engineer, to the *Indus*, for the *Prince Consort*; T. R. Butters, Assist. Engineer, to the *Victory*, for the *Springfield*; H. D. Garwood and F. Moore, Assist. Engineers, to the *Asia*, for the *Enchantress*; F. W. Sathon, (B) Engineer, to the *Indus*, as supernumerary; E. Fowell, acting Engineer, to the *Orlando*; T. Catchpole, Assist. Engineer, to the *Asia*, for the *Charger*; T. Scott, (B) Assist. Engineer, to the *Cumberland*, as supernumerary; J. Legabe, Assist. Engineer, to the *Edinburgh*, for the *Tender*; B. Barber, Chief Engineer, to the *Cumberland*, for the *Salamanca*; W. Pitt, Chief Engineer, and P. Samson, Assist. Engineer, to the *Indus*, for the *Sanspareil*; H. J. Iles, Assist. Engineer, to the *Cumberland*, as supernumerary; F. C. Ford, Assist. Engineer, to the *Indus*, for hospital treatment; J. Wylie, of the *Valorous*, W. Frazer, of the *Indus*, P. Eckford, of the *Asia*, W. Pearson, of the *Emerald*, and T. Scott, of the *Cumberland*, promoted to First-class Assist. Engineers; J. R. Robinson, of the *Scout*, J. McGough, of the *Surprise*, F. Pointon, of the *Orontes*, J. Crawford, of the *Mutine*, R. Wylie, of the *Bustard*, A. Leitch, of the *Kestrel*, and W. Barclay, of the *Medea*, promoted to acting First-class Assist. Engineers; J. Orchard, in the *Syrian*, promoted to Engineer; E. L. Williams and P. Murray, in the *Asia*, and J. Wilson, in the *Echo*, promoted to First-class Assist. Engineers; W. Read and J. Croll, Assist. Engineers, to the *Dasher* and *Raccoon*, respectively; J. Orchard, in the *Tyrian*, promoted to Engineer; E. L. Evans and P. Murray, in the *Asia*, and J. Wilson, in the *Echo*, promoted to First-class Engineers; W. Read and J. Croll, Assist. Engineers to the *Lagoon* and *Dasher* respectively; C. F. B. Hurt and J. Parry, Assist. Engineers to the *Indus*, as Supernumeraries; J. W. E. Baron, Assist. Engineer, to the *Asia*, as supernumerary; W. H. Sedgwick, Assist. Engineer, to the *Himalaya*; R. Stevens and C. E. Williams, to the *Ajar* and the *Dee* respectively; A. H. Symes, Assist. Engineer, to the *Flagard*, as supernumerary; W. B. Cleverly, Assist. Engineer, to the *Excellent*, for the *Stork*.

### MILITARY ENGINEERING

**TESTING ARMOUR PLATES.**—In the course of some experiments which took place at Portsmouth, between the 3rd and 6th ult., to test the resisting powers of various kinds of armour plates, six made by the Buttery Company, at Alfreton, Derbyshire, were subjected to seven shots each, under the same conditions as the plates by other makers. These plates were all 4½in. in thickness, and varied from 8ft. to 13ft. in length, and from 3ft. 6in. to 4ft. in width. Five of the plates were struck twice in the same spot, but none were penetrated, and so far as substantial protection to anything behind them were concerned, were not injured. The results were satisfactory.

### STEAM SHIPPING.

**TRIAL TRIP OF THE LORD GOUGH.**—This paddle steamer, recently launched on the Clyde by Messrs. Caird & Co., for the Dublin and Glasgow Steam Packet Company, underwent a trial trip on the 15th ult., of which the following is the result:—During the run the engines averaged 29 revolutions, with a pressure of 27½lbs. on the square inch. They worked smoothly and without heating, the average rate being 14½ knots or 16½ statute miles per hour. The dimensions of the *Lord Gough* are:—Length of keel and fore-rake 232ft.; breadth 28ft.; depth 14ft. 9in.; and tonnage 765 tons. She is propelled by a pair of oscillating engines, furnished by the builders, of 270 horse power nominal, having 63in. cylinders, with 6ft. stroke, and fitted with patent expansion valves, the invention of Mr. J. T. Caird. These enable the engineer to cut off the supply of steam when the piston has reached any part of its stroke, thus enabling the pressure of steam in the boiler to remain at a high density, and have all the advantage in oscillating engines of expansion.

**THE "WINANS" STEAMER.**—The Winans, a steamer constructed at Baltimore on the cigar-shaped principle, has arrived at Hull to be lengthened. She is at present 80ft. long, and in the widest part amidships is 8ft. in diameter. On the top or back of the vessel there are four short tubes projecting about two and a half feet, which will answer the purpose of ventilators, and as a means of entrance to the vessel. To prevent the steamer rolling over in the water, she is well ballasted with spelter, and draws about 3ft. of water. There are several screws in her sides, to which stanchions may be fastened. On this a grating to form a deck is fixed, and an iron guard runs from stem to stern. The vessel is propelled by means of a screw, which is placed about 20ft. from the stern.

**AUSTRIAN STEAM NAVIGATION.**—A new Austrian Steam Navigation Company is in course of organisation. The principal promoters are the Prince Colloredo-Mansfeld, Baron Dobloft, Baron de Hohenbruck, Prince Jablonowski, and Herr Louis Mertens. The capital of the company has been fixed at £2,000,000, and this considerable sum is stated to have been subscribed for. The objects at which the new company is to aim are the following:—First, the carriage of passengers and goods between the Mediterranean and the Eastern coast of America; second, the establishment of yards for the construction of ships on a great scale at Trieste; and thirdly, the improvement of the port of Trieste, and the construction of docks and warehouses.

**IRON SHIPBUILDING ON THE MERSEY.**—Iron shipbuilding is in a very active state at Liverpool, twenty-three vessels being at present in progress in the yards of the various builders. Messrs. Laird have on hand a large steamer of 700 tons for the London and North Western Railway Company, and two ships of 1000 tons each for Messrs. Clint. Messrs. Royden have two ships of 1000 tons each for Messrs. C. Moore; and another for Messrs. Fletcher. Messrs. Hart and Simmott have two ships of 1000 tons each in hand for Messrs. Finlay, Campbell, and Co. Messrs. Patterson have a vessel of 750 tons, for Messrs. Boulton, English, and Brandon, in course of construction. Messrs. Vernon have the following:—One of 1166 tons for Messrs. Potter Brothers, just launched; one of 900 tons for Messrs. W. J. Myers and Co.; one of 800 tons for Messrs. Imrie and Tomlinson; and one of 900 tons for Mr. Liston Young. Messrs. Jones and Quiggin are busy, having no less than five vessels on the stocks; one of 1000 tons for Messrs. Semmell and Co.; one of 1194 tons for Messrs. Curry, Kellock, and Co.; one of 900 tons for Messrs. Copeland Brothers; one of 630 tons for Messrs. Blythe Brothers; and one of 630 tons for Messrs. H. T. Wilson and Chambers. Messrs. W. Miller and Co. have in hand a ship of 600 tons for Messrs. Prowse and Co., and two barques; and a small steamer of 60 tons for Messrs. Finlay, Campbell, and Co. Mr. Glover has a ship of 1050 tons for Messrs. Boulton, English, and Brandon, in course of construction. Messrs. Laird have also on hand, in addition to the vessels already mentioned, two gunboats for the Emperor of China, about whose ultimate destination a good deal has been said, and an iron-plated frigate for the home Government. The ships which Messrs. Boulton, English, and Brandon are having constructed are intended for the Calcutta trade, and are designated the "Shire" line. Three of the line—the *Staffordshire*, the *Derbyshire*, and the *Monmouthshire*—are completed.

**STEAM SHIPBUILDING ON THE CLYDE.**—Messrs. W. Denny and Brothers, of Dumbarton, have contracted to build two large paddle steamers, to be employed on the Yang-tze river, in China. One of these vessels is to be built for Messrs. Gibb, and is to be 1400 tons burden, with engines of 350-horse power; and the other, for Messrs. Jardine, Matheson, and Co., is to be 2040 tons burden and 450-horse power. The steamers are to be similar in design to the *Rona*, built last year by the same firm for the same trade for Messrs. Jardine, Matheson, and Co. The steamers, *Eze* and *Foz*, building by Messrs. Caird and Co., of Greenock, for the Clyde and Belfast line, have been sold and Messrs. Caird and Co. have received orders to proceed with two others in their stead. The owners of the Montreal Ocean Steamship line have contracted for another vessel, to be named the *Moravian*, of similar dimensions and power to the *Peruvian*, now under construction, and about to be launched for the same company. The dimensions of these steamers are

—extreme length, 320ft.; breadth of beam, 38ft. 3in.; depth of hold, 26ft. 3in.; giving a measurement of 2600 tons. The cylinders of the engines will be 6ft. 3in. in diameter. Among recent launches may be noted a paddle, built by Messrs. W. Denny and Brothers, of Dumbarton, and intended to be employed for towing purposes on the Hooghly. She is 460 tons burden, has engines of 250-horse power, and is the property of Messrs. Gladstone, Wyllie, and Co., of Calcutta. Messrs. Henderson, Goulborn, and Co., of Renfrew, have launched a screw named the *Aleria*, intended for the Spanish trade. She is about 860 tons burden, and is now being fitted with diagonal engines of 160-horse power. The owners of the Montreal Ocean steamship line recently contracted with Messrs. Steele and Co., of Greenock, for two large steamers of 2,500 tons burden. The cylinders of the engines, which are to be of 400-horse power, will be supplied by Messrs. Macnab and Co., Shaw's Water Foundry, and will be 6ft. 3in. in diameter. Messrs. Steele have on hand a screw of 400 tons and several iron sailing vessels. Messrs. Caird and Co., have received an order from the West India Royal Mail Steamship Company, for a screw of 2,434 tons burden and 600 horse power. The machinery will embrace surface condensation, superheated steam, and a steel shaft by Krupp, of Essen. The steamer will be modelled generally after the *America*, lately fitted by Messrs. Caird and Co. Mr. A. Denny, of Dumbarton, has launched an iron paddle named the *City of Dunedin*, built for the New Zealand coasting trade; she is 463 tons burden, and is to be fitted by Messrs. Denny and Co., with engines of 100 horse power. Messrs. Scott and Son, of Cardfadyke, have launched the *Washington*, a fine steamer of 3250 tons, builders' measurement, constructed for the Compagnie Générale Transatlantique. The *Washington* is 346ft. long, from bow to stern (her bow being a perpendicular one), and her breadth of beam is 44ft., while she has 31ft. depth of hold. She is now being fitted with engines of 850 horse power nominal, the diameter of her cylinders being 95in. Great things are expected of this fine vessel. The *Washington* is intended to ply between Havre and New York, being one of a fleet of 11 steamers now building for the same company—seven of the 11 are in course of construction by Messrs. Scott and Co., who have several of them on hand in France, and two others at their works at Cardfadyke. Each of the boilers and sole plates will weigh 61 tons.

**TRIAL TRIP OF THE "ITALIA."**—The trial trip of the *Italia*, the first steamer of the re-organised London and Mediterranean Steam Navigation Company, took place on the 24th ult., in the Lower Hope. The engines are by Messrs. Maudslay, Sons, and Field, and are of the same pattern as those of the *Royal Oak*. The speed attained during the trial at the measured mile, gave an average of 11½ knots, or 14 statute miles per hour.

**THE "CITY OF LONDON," IRON STEAM VESSEL**, built by Messrs. James Ash & Co., of Millwall went down the Thames to the Nore and back, on her trial trip on the 6th ult., and also to test the superiority of Lumley's improved rudder. It is the first iron vessel fitted with this invention. The *City of London*, starting from Blackwall pier, with her head up the river and her helm a few degrees to starboard, described a half-circle to bring her head down the river in 63 secs. During her passage she gave perfect satisfaction to the various scientific men who accompanied her. She accomplished the measured mile at the rate of 13½ statute miles per hour, and thus proved herself an exceedingly fast vessel. The engines are by Mr. J. Stewart, of Millwall; and the vessel is fitted with patent floats, steam windlass, Graham's patent tiller, and other modern improvements.

**THE "SOUTHERNER,"** built for Messrs. Fraser, Trenholm & Co., of Liverpool, underwent a trial trip from Hartlepool Bay on the 3rd ult. The *Southerner* is an iron screw steamer, 310ft. long from figure head to stern, and 38ft. broad amidships; registered tonnage 2090 tons. Her engines, made by Messrs. Fossick & Hackworth, of Stockton-on-Tees, have direct action, 300 horse power, fitted with superheating and feed heating apparatus; the diameter of the cylinders is 40in., and length of stroke 33in. The speed attained was 12½ knots, the engines working with great ease, considering this was the first time of trial.

**STEAM TO BRAZIL AND RIVER PLATE.**—A new commercial line of steam ships to Brazil and the River Plate has been organised to sail from Liverpool, and will commence on the 7th of August next. The first vessel will be the *Scyllia*, a screw steamer of 1125 tons, and 360-horse power. Her ports will be Rio de Janeiro, Monte Video, and Buenos Ayres. The charges both for freight and passengers are to be moderate, and it is stated that the *Scyllia* can make the run, if necessary, to steam all the way, without having to call anywhere to coal, and that as her consumption of coal is small in proportion to her capacity, she may accomplish the passage in twenty days to Rio and twenty-four to the River Plate.

#### LAUNCHES OF STEAMERS.

**LAUNCH OF THE "TYNE."**—This vessel was launched from the iron shipbuilding yard of Messrs. J. Wigham, Richardson, and Co., Low Walker, on the 6th ult. She is the property of the Shields Steam Shipping Company (Limited). The dimensions of the vessel are—Length, 180ft.; breadth, 27ft.; depth, 16ft. She will be propelled by a pair of engines 70 horse power (cal.), 34in. cylinders, 26in. stroke, which, with a tubular boiler of large capacity, it is expected will realise a speed of from eight to nine knots. She is classed at Lloyd's, fitted with water ballast in double bottom, is to have a steam crane, Turpin's patent reefing gear, &c. Besides coal in bunkers, she will take 700 tons cargo in hold, on an easy draught of water. After her launch she was towed to Newcastle, where notwithstanding the inclemency of the weather, all her machinery, which was supplied by Messrs. R. and W. Hawthorn, was placed on board, and connections made good, when she returned down the river under her own steam, the same evening, and was safely moored at the builder's yard, within 14 hours from her launch.

**THE "OUSE" screw steamer**, intended to ply as a passenger boat between Hull and York, has been launched from the yard of Messrs. Fowler & Co., Hull. She will be propelled on a new principle, having two screws, the blades of which will work within each other. Her engines are of 26 nominal horse power, and she is fitted with surface condensers. Her dimensions are,—length 84ft., beam 20ft., depth 6ft. 6in., registered tonnage about 140 tons.

**THE "BOLIVAR" screw steamer** was recently launched from the yard of Messrs. Richardson and Co., South Stockton. Her dimensions are—Length tons all, 247ft. 6in.; extreme breadth, 32ft. 6in.; depth of hold, 19ft. 6in.; and 1240 tons, old measurement. Her engines, which are of 160 nominal and 630 effective horse power, were from Messrs. Thompson and Co., Newcastle-on-Tyne. The *Bolivar* is intended to run between Liverpool and the West Indies.

**LAUNCH OF THE "GREAT VICTORIA."**—On the 10th ult. this steamer, originally known as the French steamer *Jacquard*, and which has been considerably enlarged and rebuilt, was launched from the yard of Mr. William Patterson, of Bristol. The *Great Victoria* is a steamer of magnificent proportions, being of 2900 tons, built for Messrs. James Baines and Co., of Liverpool, and intended to run in conjunction with the *Great Britain* between that port and Melbourne. Mr. Patterson is engaged building three other iron vessels of about 2000 tons burthen for the same firm.

**LAUNCH OF THE "NORMANDY."**—LONDON AND SOUTH WESTERN RAILWAY COMPANY'S STEAMER.—The launch of the London and South Western Railway Company's new iron paddlewheel steamer *Normandy* took place on the 17th ult., at Messrs. James Ash and Co.'s yard, in the Isle of Dogs. The launch was highly successful. When it was over the vessel was taken in tow, and brought round into Mr. J. Stewart's yard, to be fitted with her machinery of 225-horse power. The engines will be supplied with improved condensers, arranged with separate cylinders, so that a vacuum can be maintained without the assistance of the main engines, which are solely employed to propel the vessel. The boilers are of large size, fitted with brass tubes. The paddles are of the

feathering description, and the engines are fitted with the peculiar link motion applied to work the slide valves, so as to enable one man to start or stop the engines without difficulty. The principal dimensions of the *Normandy* are—Length between perpendiculars, 210ft.; breadth for tonnage, 24ft.; depth in hold, 14ft. The *Normandy* is the third iron vessel launched within a few months from the same yard.

#### TELEGRAPHIC ENGINEERING.

**TRANS-ATLANTIC SUBMARINE CABLE.**—A very important decision has been come to at the Telegraph Congress, at the Foreign Office, Paris. The concession of a trans-Atlantic submarine cable to M. Balestrini, sanctioned by all the Powers represented at the conference was formally ratified. The plan is to connect Europe with the Brazils, and the Brazils with North America, so that a dispatch from Paris to New York will have to go round via Pernambuco. The scheme is a grand one, and its boldness deserves success, but the difficulties in the way of its practical realisation seem very formidable.

**TELEGRAPH BETWEEN SPAIN AND ENGLAND.**—The telegraphic cable, which is to unite the coast of Spain with England, will extend from Corunna to Falmouth—a distance of 600 miles.

#### RAILWAYS.

**CRYSTAL PALACE AND SOUTH LONDON JUNCTION RAILWAY.**—A prospectus has been issued of this company, an extension of the London, Chatham, and Dover line by Peckham to the Crystal Palace. The capital is to be £2675,000, in shares of £10, of which one half are to carry a 6 per cent. preference. The station at the Crystal Palace will be on a level with the floor of the building.

**COPENHAGEN RAILWAY COMPANY.**—A prospectus has been issued of this company, with a capital of £180,000, in shares of £10. The object is to carry out some concessions granted by the Government for the construction of lines of railway, to be worked by horses only, from the centre of the capital to the most frequented parts of the suburbs. The aggregate length of the lines to be first made is ten miles, at a cost of £4500 per mile.

**THE EAST INDIAN RAILWAY COMPANY** have put forth a prospectus for the construction, without a Government guarantee, of an auxiliary loop line of 120 miles between their stations at Barakur and Luckieseral. The main object is to develop a coal district, whence it has become essential for the company to obtain supplies, and at the same time to open an additional channel for the main traffic to the upper part of the Ganges, which will obviate the future necessity of doubling the existing line. As the proposed loop will run along the base of the angle formed by the present railway between Burdwan and Luckieseral it will shorten by sixty miles the distance to Luckieseral and all stations beyond it. The capital of the Auxiliary Company will be £1,200,000, in shares of £20, and the undertaking will technically be entirely distinct from the East Indian Company, although it is contemplated that the capital should be subscribed rateably by the East Indian proprietors, and that the whole system should thus be worked for one body. A good revenue is expected to be obtained from the coalfields, and certain concessions and subventions, which have hitherto been accorded to encourage companies willing to undertake railways in India without a guarantee, will be applied for, and are expected in regular course to be obtained.

**ROYAL DANISH RAILWAY.**—The report of the directors of this company states that the first section of the State lines, extending from Aarhus to Randers, a distance of 40 miles, was opened by the King in September last, and the next section, of about 65 miles, will be opened next autumn. The whole length of the State lines, about 350 miles, will be completed by the summer of 1886. In route with the lines of the Islands of Fyen and Zealand to Copenhagen, the Government has recently decided that large steam ferries shall be constructed to convey trains across the channels of the Belts, and also over the Sound, in connexion with the lines of Sweden. On completion of the line north to Frederickshaven a daily steam service will communicate with Gottenburg. A working agreement for a term of twenty-eight years between the company and the Altona and Kiel Company has been provisionally entered into by the respective boards. By the provisions of this agreement, the Altona and Kiel Company binds itself to make a railway from Altona into the city of Hamburg, and there unite with the lines of Mecklenburg and Hanover. By this project a continuous line from Denmark to the Continent will be established. The Company's engineer reports that the whole of the bridges are now of a most substantial character. The capital account shows that £365,923 had been received and expended.

**METROPOLITAN MAIN TRUNK UNDERGROUND RAILWAY.**—A project is suggested by Mr. Charles Baylis, of the Poultry, for constructing a Main Trunk Underground Line of Railway, to commence at Stratford, to be carried down the Bow, Mile-end, and White-chapel-roads, through the City, down Holborn, Oxford-street, and Baywater-road, and to terminate at Shepherd's Bush. In connexion with the construction of this line of railway, it is also suggested that four lines of rails at the least should be made, and chambers should also be constructed for depositing gas and water-pipes, telegraph-wires, &c., and for any other purposes that may be considered advisable. It is concluded, that if such a railway were constructed, legislative interference would almost become unnecessary, as every other railway company would have but one object in view, namely, to arrange the best modes of bringing their traffic on the line now proposed. Would not the necessity of crossing the Thames by a north and south line of underground railway, however, make this latter line more like the criterion or key to the level of all the other lines than an east and west one?

#### RAILWAY ACCIDENTS.

**ACCIDENT ON THE NORTH UNION RAILWAY.**—On the morning of the 3rd ult. a serious accident happened on the North Union Railway, near Preston, which resulted in the destruction of a large amount of property belonging both to the company and several parties whose goods were being conveyed along the line. On the preceding night a goods train, consisting of twenty-two waggons and a guards' van, left Liverpool for the North. The journey northwards was performed quite safely and punctually until the arrival of a train at a small station called Farrington, about two miles from Preston. Near this station there is a steep gradient, falling in the direction of Preston, and when the engine had reached the base of the decline it seemed to run forward more rapidly than before, and quite beyond the rate produced by the pressure of steam upon the cylinders. This circumstance caused the engine-driver to turn round, when he observed that the whole of the train, with the exception of two waggons immediately at the rear of the engine, had been left some distance behind, the couplings having evidently been jerked loose or broken. The driver brought his engine to a stand still as soon as possible, and imagining that the waggons would follow at a slow rate down the decline, he remained stationary until they came up. It would seem, however, that they had not parted until a considerable speed had been obtained, and that their impetus gradually increased in the descent of the gradient. They ran down at a very swift space, the consequence being that the whole of the eighteen rear waggons and the van dashed into the two trucks behind the engine with great force. Twenty out of the twenty-two waggons composing the train were seriously smashed. The rails of the line were torn up and displaced for several yards, and in some places the ground was ploughed up. No one sustained any personal injury.

**ACCIDENT ON THE LONDON, BRIGHTON, AND SOUTH-COAST RAILWAY.**—On the 29th of May an accident, attended with considerable loss of life and severe injuries to upwards of twenty passengers, occurred on the loop line of the London, Brighton, and South-Coast Railway, near the Streatham common station. An express passenger-train left Brighton at five o'clock, conveying, in addition to the ordinary passengers two companies of

Grenadier Guards, who were returning to head-quarters from a course of rifle practice at Epsom. The train proceeded as usual as far as the Streatham-common station, shortly after leaving which, the engine and the entire train of 16 carriages ran off the metals for a considerable distance, and came to a stop in consequence of the boiler of the engine exploding. The shock was so great that the middle carriages of the train were doubled up, and several completely smashed.

#### BOILER EXPLOSIONS.

**BOILER EXPLOSION AT BILSTON.**—On May 30th, as the day men were replacing those that had been at work during the night, one of the boilers of the old Bilston Works exploded, killing four men, and more or less injuring fifteen others. The boiler, it is presumed, exploded from beneath, as far as can be ascertained; it gave way at a seam immediately over the fire, and extended completely round the circumference of the boiler, and splitting it as clean as if it had been cut in two by a knife. The upper half turned a complete summersault, and passing between the engine-house and the stack, came to the ground bottom upwards, about five yards from the bed from which it was torn. The front half, with the exception of a few fragments, went off in an acute angle, travelled a distance of between 70 and 80 yards in the air, passing between the and over buildings, and falling immediately in front of the principal office door. Singular to state, with these exceptions, this disruption was effected without further injury than the demolition of roof and slates. There were about 200 men and boys in the works at the time.

**BOILER EXPLOSION.**—On the 13th ult. a boiler exploded at the extensive works of the Dowdall Iron Company, Merthyr Tydvil, and the force of the explosion was so great that the ironwork, bricks, and other missiles were hurled in all directions. A lad, who was at work about 60 yards distant, was struck by a brick, and killed. Five others were injured, two of them seriously. The boiler, it appears, had been duly examined, as usual, and the cause of the explosion is not known.

#### ACCIDENTS TO MINES, MACHINERY, &c.

**COLLIERY EXPLOSION NEAR WREXHAM.**—An explosion which caused severe injuries to seven men, one of whom has since died, recently occurred at the Brynbo Colliery, near Wrexham. It appears that a quantity of gas had collected in one of the workings, and the roof unexpectedly falling in, there was a rush of gas, which came in contact with a naked candle carried by one of the men, and an explosion ensued.

**BURSTING OF A TANK IN PORTSMOUTH DOCKYARD.**—In the north east portion of Portsmouth dockyard, and exactly opposite the grounds which enclose the residence of the Admiral-Superintendent, is a large iron salt-water tank, standing on lofty iron columns over some stores of oak planking. It is 160ft. long, 40ft. wide, and 5ft. deep, and is kept filled with salt water to assist in quenching any fire which might break out in its neighbourhood. On the 17th ult. an alarm was given that it had burst, and that the water which rushed out was committing great ravages upon the roadways and the Admiral-Superintendent's grounds and gardens adjoining. It was found on examination that about 70ft. of the iron plates forming one side of the tank had given way, and had been hurled with the water into the roadway. The tank was built up of cast-iron flanged plates, fastened together with bolts, nuts, screws, &c., in the usual manner. Some of the plates have been separated at the fastenings, the nuts having been torn off the screw ends of the bolts by the pressure of the water. In other instances the iron plates have been broken through diagonally, like pottery ware. The weight of the water in the tank was calculated at 890 tons, and the pressure against the side of the tank, which has given way, at about 50 tons. An inspection of the broken parts of the tank disclosed the somewhat extraordinary fact that the wrought iron tie rods in the interior of the tank were very much eaten away at their junction with the cast-iron plates, where they had been submerged in the salt water.

#### WATER SUPPLY.

**THE SOUTH ESSEX WATERWORKS.**—The chalk pits of Grays, where the works are erected, and which were recently opened, are situated about a mile from the Thames; they cover an area of nearly 80 acres, and are filled with water springs, which are so prolific, and are perpetually rising in such large volumes, as to produce a million gallons per day. The Company have now completed their high service works, and have laid on the water to Brentwood and Warley; in the course of time an abundant supply of water will be furnished to the towns in the upper part of the county, and ultimately to the eastern suburbs of London. At present five pumps are employed, and the quantity of water obtained every twenty-four hours is 2,100,000 gallons. The steam-engine employed for raising the water from the chalk-pit to the reservoir at Warley, is constructed upon the principle known as Woolf's double cylinder, and is the most economical and convenient agent that can be employed for this purpose. The steam is first used at high pressure in the small cylinder, where it is allowed to exert its full power throughout the entire stroke; from this it passes into a larger cylinder four times the capacity of the small one, so that it is expanded to four times its first bulk, and, consequently, its final pressure is reduced in a like proportion; it then passes into the condenser beneath the cylinders, where it is again converted into water, and in this process a vacuum is formed which draws down the piston on the large cylinder, and then the whole power of the steam is made available. The water is raised by a pump, which is worked by a rod direct from the wrought-iron beam of the engine. The pump is double acting, having both a bucket and plunger, and thus represents a combination of the common lift pump, with a force pump similar to that used for feeding boilers. The bucket is twice the area of the plunger, and the consequence of this is—that it draws at the up stroke the full contents of the barrel, but only discharges one-half into the delivery pipe, the other half being displaced by the plunger at the down stroke. This causes a pretty uniform flow of water, and enables it to be forced, with the assistance of a large air-vessel, straight into the main, without the intervention of a stand-pipe. It is believed that this is the only instance of water being raised to a height of 400ft. through a main  $9\frac{1}{2}$  miles in length. With regard to the source of the water, it issues from the chalk formation out of vertical fissures which have been formed by some upheaving of the strata, and which takes one general direction. To obtain water, all that is to be done is to cut across these fissures, each of which is separate from the other. Owing to the operations which have taken place in working these chalk pits, very little tunnelling is required. The tunnel in use at present is 25ft. and 5ft. broad, and this can be extended to indefinite proportions according to requirement.

**WATERWORKS AT HAT, NEAR HEREFORD.**—The waterworks of this town are now completed. The reservoir, 175ft. by 54ft., and 11ft. in depth, is supplied by a mountain stream some half a mile distant, which is diverted, and then passed through a filter, 6ft. in depth, of gravel and sand, before entering the reservoir, where it is joined by two springs obtained by boring about 30ft. to rock (old red sandstone formation). Previously to these supplies entering the mains from reservoirs, they have to pass through another filter bed, on the ascension principle, formed of slabs, with a pressure of 12ft. The supply is thus filtered by descent and ascent.

**THE WATER SUPPLY OF PARIS.**—The aggregate of the present water supply of Paris is 5,400,000 cubic feet, 3,700,000 of which are derived from the Ourcq canal. The total length of the water-pipes for the private supply is 63,729ft.; for the public supply, it is 2,476,631ft.; the largest diameter of the pipes is 3ft. 7 $\frac{1}{2}$ in. Two new pumping engines of 100 horse power are now being erected on the Quai d'Austerlitz; they will add from 400,000 to 500,000 cubic feet to the water supply of the suburban districts.

#### GAS SUPPLY.

**GAS WORKS IN GERMANY.**—There are in Germany 286 gas works, of which 66 are worked by townships or individuals, and 200 belong to various companies. The combustible employed is chiefly coal, the largest quantity being supplied from England. Out of 74 million quintals, 3,350,000 are obtained from the English collieries. Berlin, which produces annually 800 million cubic feet of gas, uses about half of this quantity of coal. Hamburg takes more than 500,000 quintals, and the rest is used in the gas works of Altona, Lubeck, Rostock, Stralsund, Stettin, Dantzig, Königsberg, &c. The excellent quality of the English coal for gas-making causes the preference to be given to it over indigenous coal; but if the cost of transport of the latter can be cheapened, it is thought that it will ere long come into use in Hamburg, Berlin, and other towns. The following are the per centage proportions in which the various coal is used in Germany:—

|                        |        |
|------------------------|--------|
| English coal .....     | 48.00  |
| Westphalia .....       | 18.00  |
| Moravia .....          | 11.50  |
| Zwickau .....          | 7.50   |
| Saarbuck .....         | 7.00   |
| Silesia .....          | 5.00   |
| Dresden .....          | 2.25   |
| Bohemia .....          | 2.00   |
| Northern Bavaria ..... | 0.75   |
|                        | 100.00 |

Besides the gas works which consume coal, Germany possesses 20 in which wood alone is employed for distillation; and there are two small works in Holstein, which consume peat or turf at certain times, and at others coal. The retorts used are generally of clay, except in those works where gas is made from wood. The total number of retorts employed is estimated at 7337, made for the most part in the immediate locality of the works; their form and size differs considerably. Assuming that the mean consumption of gas in the 24 hours is 25 millions of cubic feet, and supposing that each retort furnishes daily 4500 cubic feet, it follows that these 7337 retorts must be continually, or three-fourths of the time, in work. The use of extractors is much less general than would be supposed. There are only 90, or less than a third of the whole of the gas works in Germany which employ about 107 extractors. The small works do not employ them at all. The meters in general use are water meters of native manufacture, and may number about 139,000. The mean number of lights of each is about eight.

**PHOTOGENIC GAS.**—A prospectus has been issued of the Photogenic Gas Company for the purpose of introducing the patent of M. Mongruel, which is alleged to produce either from ordinary gas or from atmospheric air, a light more powerful, cheap, and healthy than any hitherto known. The proposed capital is £200,000 (of which one-half is to be first put forth) in shares of £50. The price to be paid for the patent is £5000 in cash and £45,000 in shares.

**MAURITIUS GAS COMPANY.**—The prospectus is issued of this Company with a capital of £100,000, and a first issue of £80,000, in 12,000 shares of £5 each. This company is established to supply gas in the British possession of Mauritius, and it intends to commence operations forthwith in Port Louis, all classes in the community being desirous to adopt the European system of lighting. The company's agent at Port Louis has chosen an eligible site for the works, close to the harbour's edge, where coal and other materials can be landed, and it is stated that the profits will give a minimum return of 12 to 15 per cent. on the capital to be invested.

#### DOCKS, HARBOURS, BRIDGES, &c.

**BLACKPOOL PIER.**—This pier was designed by and erected under the supervision of Mr. Eugenius Birch, C.E., London, and is constructed almost entirely of iron, the only woodwork employed being that used for the deck and the fender piles at the head. The following are the dimensions of the pier:—Approach, 80 feet long; abutment, 120 feet long and 45 feet wide; main portion, 1070 feet long and 28 feet wide; and the head, 135 feet long and 65 feet wide, giving a total length of 1405 feet available as a promenade. The entire superstructure rests upon clusters of iron piles, vertically fixed into the ground by means of screws. The piles at the abutment and main body are wholly of cast iron, and those at the head are partly of cast and partly of wrought iron. The largest of the cast-iron columns are 12 ins. in diameter, and of an average thickness of  $1\frac{1}{4}$  in. and the whole of the columns are filled with concrete, which imparts to them additional stability as a means of support. The piles are placed in clusters, as this mode of arrangement has been found by the engineer to answer in exposed positions; for, the piles being trussed together, and well secured longitudinally, transversely, and diagonally, by the rods and braces, are capable of sustaining sudden shocks of the sea, a most important consideration at this point of the coast, where there occurs an extraordinary rise of tide of 35 feet. The clusters are placed at intervals of 60 feet; and resting upon them are the main girders, constructed of wrought iron, and in lengths of 72 feet. The description of girder employed is the plate girder. Throughout the entire length of the pier an ornamental casing surmounts the main girder; and this forms a very good back for the sitting accommodation afforded by these girders. The head of the pier stands 60 feet above low-water line, and every means have been used to give it strength and stability. The total weight of iron employed upon the pier is 760 tons, consisting of 420 tons cast, and 340 tons wrought. The first column of this pier was fixed in May last year.

**THE CLIFTON SUSPENSION BRIDGE AT BRISTOL.**—The coils of the temporary bridge necessary for the construction of this work have been passed across the Avon. A thin rope was lowered from the Clifton buttress, and the end conveyed across the river in a boat to the Leigh side, and then attached to a thick hawser, which was hauled across and secured. The first of the wire coils, 1100ft. in length, and weighing 2 tons, was then successfully suspended across the chasm at St. Vincent's rocks. Nine coils of this kind have been suspended, a strong cradle will be attached to two of them and swung down to the centre of the chasm, and in this the workmen will commence bolting the planks for the platform, gradually completing this stage as they near the inclines, the declination of which is about 1 in 24. The platform completed, a "traveller" will be attached to one of the wire cables, and the chains, &c., will be conveyed to any part of the platform, above which the suspension bridge will be erected.

#### MINES, METALLURGY, &c.

**NORTHUMBERLAND COAL MEASURES.**—A report has been made to the River Tyne Improvement Commissioners by Mr. T. E. Foster and Mr. John Taylor, relative to the existing state and prospects of the Northumberland Steam Coal-field and the quantities that may be expected to be shipped therefrom upon the Tyne. They report that they have measured the respective royalties in which is being wrought at the present time the Low Main, or best steam coal of the district; and after making full allowance for the quantity already excavated, loss by dikes, small coals left under ground, and screened out on the surface, they find that there is sufficient to endure, in the present rate of shipment of steam coal on the Tyne, in addition to the portion diverted to Sunderland Dock, for a period of 110 years. But the present collieries could produce from 20 to 25 per cent. more than they do at present, were the demand to arise. On this head there would be an increase of, say 300,000 tons; a new colliery is being opened out at

Camboise, from which may be computed an annual vend of 160,000 tons, and from Sleekburn 80,000 tons; and other districts adjoining, 160,000 tons—total, 700,000 tons. The increase of the steam coal trade from the Tyne has been as follows:—1859, 1,275,707 tons; 1860, 1,647,091 tons; 1861, 1,544,067 tons; 1862, 1,955,596 tons. Besides the Low Main seam, there is another coal called the Yard seam, which is capable of being worked in very large pieces, and combines in a great degree many of the excellencies peculiar to the Low Main seam. This seam is almost entire throughout the district, and there is sufficient left to endure, on the existing vend, for a period of 60 years. In addition to the Low Main and the Yard coal seams the following are met with, more or less, in the district on the north and south sides of the Tyne:—The Stone coal seam, Bersham seam, six quarter seam, five-quarter seam, the Townley seam, and Walbottle seam; and to the north, some distance from the large downcast dike of 90 fathoms, the High Main seam, stone coal seam, Bersham seam, gray seam, Plessey coal seam, and Beaumont seams. These seams are not now in operation, because, as demand arises and coal becomes further enhanced in value, that they will come into operation. As regards the inferior description of coal, the time (110 years) is so distant when the steam coal of the first quality will be exhausted, and as in addition the Yard seam will endure 60 years, together 170 years, Messrs. Foster and Taylor did not think it necessary to go into the question of the quantity of inferior coal in reserve, excepting, generally, to remark that the various inferior seams of coal will naturally come into operation as those of superior quality are exhausted.

**ANOTHER NEW METAL.**—A letter from France says that another new metal has been announced there. M. Otravaux, Professor of Geology at Strasbourg, has obtained a hard shining metal, of the colour of gold, but soft as lead, from the mineral waters of Alsace. The metal, not admitting of a high degree of polish, will be useful to employ in the dull or coloured goldsmiths' work so much in fashion for ornament just now. The specimens, submitted to connoisseurs in Paris, have excited the highest admiration.

**EXTRACTING GOLD FROM QUARTZ.**—A new method of depriving gold ores of sulphur has been introduced in America. It consists in reducing the ores to fine dust, then forcing the dust by a draft through a flame of pine wood. The furnace used is a square brick structure, with a grate about 3ft. wide by 4ft. in length, and 3ft. high, in which a fire of common pine wood is built. The flame from this fire-place escapes into a chimney built in the shape of a muffle, and instead of rising upwards, runs down towards the lower floors at an angle of 45 degrees. The tube containing the ground quartz enters this muffle-shaped chimney at its upper end, just where the blaze from the furnace enters, and the strong current carries the flame its whole length. There are several round holes an inch or two in diameter, at intervals of about 3ft. along both sides of the chimney. Through these, when the apparatus is in operation, a further supply of air than that furnished by the blower is sucked in and assists in decomposing the sulphur contained in the ore. In passing down the flue, or chimney, the pulverised ore is blown through a jet of flame, as dust, from a distance of about 20ft., the length of the flue, and each particle being separate, is surrounded by air and a strong flame, and it becomes red hot, giving off its sulphur, arsenic and other volatile constituents. After passing down the flue, it falls into a receptacle of brickwork, whence it is raked out upon an earthenware floor to cool. The ore now presents about the same appearance as that burned in a reverberatory furnace. The amalgamation machinery is simply an arrastra about 8ft. in diameter, with a stone bottom and dragstone. By this process three times more gold, it is stated, are obtained by it than by any of the old processes. Sulphur, arsenic, and iron quartz prevent, in a great measure, the mercury from amalgamation with the gold.

**PLATINUM.**—At the Paris Academy of Sciences, a communication was received from Messrs. Sainte-Claire Deville and Troost, showing that platinum, though apparently a most compact metal, will admit of the passage of certain gases through its pores at a high temperature. To ascertain this, the authors of the paper had caused a platinum tube to be drawn all of one piece, so as to be free from all solder, and to present an uniform and unbroken surface. This platinum tube was introduced into a porcelain one, so that an empty cylindrical space was left all round between the two, properly stopped at each end. Through this space a constant current of hydrogen was made to pass by means of two glass tubes inserted at the extremities, so as not to allow of the slightest communication with the platinum tube which was filled with dry air. On exposing this tube to a high temperature, the air by degrees lost its oxygen, and water was formed; a circumstance which could only be explained by admitting that hydrogen had penetrated through the pores of the platinum tube; and, on the temperature being further raised, a considerable quantity of free hydrogen was found to issue from that tube. This shows that platinum, at a high temperature, is capable of producing the phenomenon of endosmosis with gases.

#### APPLIED CHEMISTRY.

**USE OF SULPHUROUS ACID IN THE MANUFACTURE OF SUGAR.**—M. A. Reynoso points out the use of calcium bisulphite as prejudicial rather than advantageous. The excess of acid uniting with oxygen produces sulphuric acid, which reacts upon the sugar, converting it into grape sugar, and eventually into ulmic and formic acids, and ulmin, thus tending to produce colour, instead of bleaching the saccharine liquid. Hence, he states that when the sulphite is used it should always be with an excess of lime. It is indispensable that the cane-juice should be so alkaline as to turn litmus-paper blue. In the absence of litmus-paper, the alkalinity of the cane-juice may be ascertained by its turbidity, and by the formation of a pellicle on the surface of a small portion when it is breathed upon.

**NOTE ON EXPERIMENTS WITH NITRATES,** BY MR. J. HORSLEY, F.C.S.—If a small portion of pyrogallous acid from the point of a penknife be projected into a vessel containing about two or three drachms of water, it will, in the course of twenty-four hours, or less, assume a dark brown colour, from the absorption of oxygen from the air, but not so if the pyrogallous acid be dissolved in water acidulated with a few drops of sulphuric acid. It therefore occurred to me as an useful means of detecting nitrates and nitrites, as the following experiments prove:—If into a test-glass containing two or three drachms of water, acidulated with a few drops of sulphuric acid, a small portion of pyrogallous acid be projected, and then a little strong sulphuric acid be carefully trickled down the sides to about one-fourth from the bottom, little change will ensue beyond a faint violet coloured line at the point of contact of the two fluids. A grain of chloride of sodium being added, a brisk effervescence runs throughout the sulphuric acid from the evolution of chlorine, which somewhat increases the violet colour, but on projecting the merest particle of a solid nitrate (say nitrate of potash) it will, on falling, carry with it so much of the pyrogallous acid as to be reacted on by the nitre and produce an intense purple colour, which, gradually mixing with the upper layer of the pyrogallous acid solution, gives off streaks or rings of orange-yellow, by becoming oxidised at the expense of the decomposed nitric acid of the nitrate. On the other hand, if the nitrate be first mixed with two or three times its bulk of chloride of sodium, and then projected through the pyrogallous acid liquor to the sulphuric acid below, no purple colour is produced, but the resulting effervescence causes the evolved nitrous acid to act more uniformly on the whole of the pyrogallous acid, imparting a deep orange brown colour. Such is the sensibility of this reaction, that even a drop or so of a solution of a nitrate added to the pyrogallous liquor previous to the projection of the chloride of sodium suffices to show the discolouration caused by the liberated nitrous acid, the intervention of the chloride of sodium, from the smallness of the nitrate, being necessary to its production, and renders it more evident than when the nitrate is used alone. Only part, however, of the drop of nitrate

solution which comes into contact with the sulphuric acid will be decomposed, and even that is sufficient to give an intense colour. The nitrous acid evolved from nitrates by heat or otherwise, is also detected in its dry state by the discolouration of a piece of white paper moistened with a tolerably strong pyrogallous acid solution. In fine, I am of opinion that this method of testing for nitrates and nitrites is far more delicate than any at present in use. Simple, easy of execution, and perfectly unobjectionable. It is desirable that a piece of white paper should be placed at the back of the test-glasses, in order to show the reaction best, and also that no more chloride of sodium be used than is necessary, or equal to the sulphuric acid, so as not to lay undecomposed at the bottom of the glass. Preference would appear to be given to the use of the dry salt with the chloride of sodium rather than a liquid nitrate.

**ACTION OF SULPHUR ON SALINE SOLUTIONS HAVING AN ALKALINE REACTION.**—M. J. De Girard has observed that by boiling a solution of soda pyrophosphate with an excess of well-washed flour of sulphur, the liquid rapidly becomes brown in consequence of the formation of polysulphide. By continuing the ebullition for several hours, hydrosulphuric acid is abundantly evolved. The liquid gradually becomes colourless, meanwhile disengaging hydrosulphuric acid. The filtered liquid contained soda hydrosulphite and a salt of phosphoric acid. Silver nitrate solution was added as long as the white precipitate, first formed, was rendered black by the formation of sulphide, and after separating this precipitate the filtrate gave a yellow precipitate with the silver solution. A solution of sodium sulphide boiled with excess of sulphur evolves hydrosulphuric acid, and when the liquid has become quite colourless and neutral to test-paper, it contains only soda hydrosulphite. Under the same circumstances, sodium sulphide alone, decomposes water at 100° C., evolving hydrosulphuric acid. Water boiled with washed sulphur is also decomposed with evolution of hydrosulphuric acid.

**NEW MODE OF PRODUCING THE ANHYDRIDES OF MONOBASIC ACIDS.**—M. H. Gal has obtained acetic and benzoic anhydrides by the reaction of the corresponding chlorides with anhydrous baryta. It is necessary to avoid using an excess of baryta. Anhydrous lime and oxide of lead produce the same result; the latter at a temperature of 160°; the former with such violence as to become incandescent. The reaction with acetyl chloride commences at the ordinary temperature, and is completed after the mixture has been kept for a few hours at 100° C. In the case of benzoyl chloride, a temperature of 140° to 150° C. is required.

**ON THE ELECTRO-CHEMICAL DECOMPOSITION OF INSOLUBLE SUBSTANCES,** BY M. BECQUEREL.—Whilst seeking to oxidise silicon at the positive pole, in distilled water, with a pile of eighty elements of sulphate of copper, I found that this metalloïd is not, as has hitherto been supposed, a non-conductor, but that it possesses, when traversed by an electric current, sufficient conductivity to produce remarkable caloric effects, by reason of its great resisting powers. By putting small cylindrical crystals of silicon, prepared by M. Deville's process, into a porcelain, or better still, a platinum capsule, in communication with one of the poles of the pile, and closing the circuit with a platinum-wire, at least one millimetre in diameter, then by simply touching with this wire one only of the crystals, the adjacent crystals become incandescent. All the crystals follow the wire when it is raised, forming a small chain with reddish white heat; at the same time a white smoke arises, more or less visible, according to the force of the pile, and also possessing an odour rather like that produced by breaking a piece of flint. The intense heat is really produced by the resistance offered to the electricity when traversing the silicon; for this result is obtained by using a pile of such force, that by touching the platinum capsule with a wire of the same metal only a feeble spark is emitted. In experimenting with a nitric acid pile of twenty elements the heat is so intense that the platinum vessel is perforated, being melted where it becomes in contact with the substance, as well as the end of the platinum wire, and, at the same time, a white smoke is disengaged, with formation of silica, deposited as powder on the melted platinum, and also some silicic acid of this metal. With charcoal electrodes complex effects are obtained, resulting from their combustion and the effects above described. The light is then too brilliant to be borne by the naked eye. In this and the preceding instance it is necessary to operate on a plate of rock crystal, the surface covered with silica; under the microscope this silica appears to be in a vitreous condition.

**NEW METHODS FOR TESTING THE PURITY OF ALCOHOLS AND ETHERS** BY M. BECQUEREL.—Though alcohols and ethers have been carefully purified by distillation and desiccation, there has hitherto been in most cases no means of controlling their purity. The following are the results of my researches:—1. I take as a starting point the fact that a compound ether, if pure, is decomposable by an alkali, by saturating an equivalent weight of this alkali. By this means, as I showed about ten years ago, the analysis of ethers and analogous compounds, is founded on an alcaimetric test, based on the use of a standard solution of baryta. 2. By means of the same liquid the smallest quantities of compound ethers may be recognised and estimated in alcohol or in simple ethers, provided these bodies are not alterable by alkalis. Ten cubic centimetres of a standard solution of baryta, and a known weight of the body to be tested, are enclosed in a flask. It is then heated for about a hundred hours at 100°; if the alcohol is pure, as is oftentimes the case with ordinary alcohol, the standard of the baryta does not change. Amylic alcohol, on the contrary, almost always contains a small quantity of compound ethers, as also does ordinary ether, even after digestion on milk of lime. Glycol prepared by the ordinary methods, and rectified to a certain point, is particularly impure. I have found in it as much as 22 per cent. of combined acetic acid, corresponding to 40 per cent. of monoacetic glycol. This fact may occasion more than one error, and the knowledge of it will be useful to chemists occupied with this curious substance. To recognise the presence, without estimating, of a neutral ether in an alcohol, I heat the alcohol with twice its volume of water, for twenty hours at 150°. Most of the neutral ether changes into acid. 3. The presence of a free acid in an alcohol or an ether is so easily recognised that I need not stay to describe the process. Formic ethers, for instance, are always acid; but they decompose so promptly as to prevent the exact estimation of the free acid. The free acid of other ethers, on the contrary, can be precisely estimated. 4. The presence of a small quantity of water in a neutral ether may be detected by heating this ether to 150° during twenty or thirty hours; the water decomposes an almost equivalent quantity of ether into acid and alcohol. The acid is then estimated by a standard solution of baryta. On submitting acetic ether, carefully purified by the ordinary methods to this test, it will obstinately retain a centieme of water, which is with great difficulty eliminated. 5. The presence of a small quantity of water in alcohol may also be detected by mixing the alcohol with a perfectly anhydrous compound ether, tested as above. It is then heated for twenty or thirty hours at about 150°. If the alcohol is anhydrous the mixture should not become acid. 6. The presence of a small quantity of alcohol in a neutral and anhydrous ether, acetic ether for instance, may be detected by heating the ether with a known weight of pure acetic acid. The standard of the acid will diminish according to the amount of alcohol.

**MANUFACTURE OF OXIDE OF ZINC.**—An invention has been patented by Mr. George Darlington, of Milners, which consists in mixing zinc ores, with or without flux, with any description of smokeless carbonaceous material, for the purpose of reducing such ores, especially with anthracite coal. He exposes the said mixture to the action of heat resulting from the combustion of a further quantity of this smokeless fuel, by placing it in a blast-furnace, or in any furnace where a bar or perforated plate grate, the ash-pit to which is closed, and which form the air-chamber for the reception of air furnished for the combustion of the contents of his furnace, either by fan or otherwise. The furnace is an open furnace. There is a collecting apparatus above the furnace, and into this the gases are turned as soon as the green tint indicating the formation of zinc oxide shows itself.

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 REQUESTED INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTISAN."

DATED MAY 26th, 1863.

- 1321 A. Haley—Jacquard looms.  
1322 J. Munro & R. Scott—Boring, mining, and excavating, or cutting, motive power engines, and pressure gauges.  
1323 E. K. Dutton—Cleaning seed cotton.  
1324 M. Henry—Raising, forcing, and moving fluids.  
1325 J. Buckingham—Ploughs.  
1326 F. W. & J. Kitson—Tyres for railway wheels, and securing the same to the wheels.  
1327 W. E. Newton—Separating the fibre from the flesh of plants.

DATED MAY 27th, 1863.

- 1328 A. P. Hernandez & P. B. Crespy—Soap of rice.  
1329 W. Clark—Offensive and defensive arms.  
1330 A. Easton—Looms for weaving.  
1331 H. C. Coulson—Blow engines.  
1332 H. J. Kennard—Wrought-iron cylinders.  
1333 C. Gammon—Spring fastenings.  
1334 W. Palliser—Projectiles for ordnance.

DATED MAY 28th, 1863.

- 1335 F. R. Filate—Producing ornamental surfaces for decoration.  
1336 W. I. Ellis—Steam boilers.  
1337 C. T. Boutel—Instrument for measuring distances and altitudes.  
1338 G. Gore—Gas burners and furnaces.  
1339 C. E. Luederich—Watches.  
1340 H. Cartwright—Steering vessels.  
1341 C. F. Baxter—Hollow elastic stopper for bottles and jugs.  
1342 T. Richardson & R. Irvine—Treating the waste liquor obtained in the preparation of esparto grass.  
1343 F. Osborn—Pressing, smoothing, and finishing garments.  
1344 H. T. White—Hats, caps, and other coverings for the head.  
1345 T. Jarvis—Obtaining vegetable extracts.  
1346 E. A. Brooman—Paddle wheels.  
1347 W. Needham & J. Kite—Expressing liquid and moisture from substances, and separating the liquid from the solid portions thereof.

DATED MAY 29th, 1863.

- 1348 E. Ironmonger—Loose clip and socket joint.  
1349 A. Abadie—Railway brakes.  
1350 W. Leeder—Rails for railways.  
1351 J. J. Potel—Accelerating the draft in furnaces and fireplaces.  
1352 G. H. Pierce—Heating buildings by means of hot water.  
1353 R. Barker—Matches.  
1354 W. Green—Producing black colouring matters or pigments.  
1355 H. M. Johnson—Lubricating material.  
1356 F. Paterson—Card board or paper boxes or receptacles.

DATED MAY 30th, 1863.

- 1357 E. T. Hughes—Transmission of motive power.  
1358 E. P. Moorman—Obtaining and applying motive power.  
1359 J. Heard—Distributing manure.  
1360 V. Baker—Ordnance.  
1361 S. Bates & J. Jardine—Carriages used in machine employed in the manufacture of lace or other fabrics.  
1362 W. Clark—Manure.

DATED JUNE 1st, 1863.

- 1363 J. Henson—Railway carriages.  
1364 J. Chalmers—Armour for forts and floating batteries.  
1365 W. Clark—Printing fabrics, papers, and other surfaces in colour.  
1366 F. W. Smith—Conveying goods from a warehouse or vessel by pressure of air or by vacuum and atmospheric pressure.  
1367 L. S. Chichester—Drying grain.  
1368 J. Davey—Horse rakes.  
1369 A. V. Newt—Marline spike.  
1370 G. Belcher—Cutting and transplanting turf.  
1371 H. C. Coulthard—Packing for the glands of piston rods and other moving mechanism.

DATED JUNE 2nd, 1863.

- 1372 J. Mellard—Double moulding or ridging ploughs.  
1373 A. Hingworth—Boots and shoes.  
1374 J. H. Briery—Application of leather in the manufacture of gentlemen's scarfs and ties.  
1375 G. H. Cottam—Saddle bracket and bricks for saving stables.  
1376 D. Wilson & E. A. Cowper—Presses.  
1377 G. A. Barrett, W. E. Hall, C. J. Andrews, & A. Barrett—Valves for regulating the speed of steam engines.  
1378 T. Page—Shoeing horses.

- 1379 E. J. Jarry—Cleaning and ploughing land by steam or other power.  
1380 E. H. Letang—Ruling and printing machine to be used either combined or separately.  
1381 R. Crawford—Jacquard machines for weaving ornamental fabrics.  
1382 T. Agnew—Coating moulded or other surfaces with composition.  
1383 W. Gleave & T. Young—Supplying water to steam boilers.

DATED JUNE 3rd, 1863.

- 1384 J. Travis—Preventing incrustation in steam boilers, steam generators, and fuel economisers.  
1385 E. A. Locke—Securing identifying labels or tags to bales of fibrous material.  
1386 T. Claridge—Spur wheels used in the construction of mill and forge gearing.  
1387 G. Davies—Ginning cotton.  
1388 W. Lee & J. G. Winter—Steam fire-engines.  
1389 F. S. Barff—Protecting, preserving, and hardening surfaces of brick, cement, stone, and stucco.  
1390 J. J. McComb—Presses for forming bales of cotton and other materials, and fastenings for and means for applying bands to such bales.  
1391 J. Portlock—Alarm apparatus.  
1392 J. Manroe—Instruments for ruling.

DATED JUNE 4th, 1863.

- 1393 S. Blake, T. Lee, & R. Dutton—Flour and meal mills.  
1394 H. Rigby—Steam boilers and furnaces for the consumption of smoke.  
1395 M. V. L. de Wailly—Preservation of carpets from the effects of dust.  
1396 H. Pollack—Scarlet colour.  
1397 W. E. Newman—Casks, barrels, kegs, and other analogous articles.

DATED JUNE 5th, 1863.

- 1398 S. S. B. Guillaume—Bricks.  
1399 F. A. Calvert—Steam engines, steam boilers, and steam heating apparatus.  
1400 R. W. Sievier—Jacquard machines.  
1401 A. Q. de Gromard—Musical instruments.  
1402 R. A. Brooman—Treating liquorice root to obtain liquid and solid extracts therefrom.  
1403 T. Gray—Flax, hemp, and other vegetable fibrous substances in order to bleach and separate the fibres.  
1404 J. S. men—Inplements for the cultivation of the soil.  
1405 W. Clark—Distillation and separation of hydrocarbons and their derivatives.  
1406 J. H. Johnson—Smoothing irons.

DATED JUNE 6th, 1863.

- 1407 W. A. Brown—Indicator for railway trains.  
1408 E. Wallis—Loading and unloading vessels, and elevating and otherwise conveying sacks, casks, and other packages, and parcels from one locality to another.  
1409 A. J. Hollingworth—Spirit compass with screw level.  
1410 C. E. Newcomen—Treatment of peat and other substances containing moisture.  
1411 J. Hogg—Shoe cards.  
1412 N. Walton—Drying and airing clothes.  
1413 W. C. Brocklehurst, J. Creighton, C. Makinson, & J. Creighton—Winding yarns or threads.  
1414 W. Miller—Ships, vessels, and boats.  
1415 W. Clark—Mounting and fitting bedsteads, chairs, and other movable seats on board ship.  
1416 W. Clark—Device for turning cross head wrists or pins, or for turning any cylindrical part of machinery which is secured between two arms.  
1417 E. A. Schofield—Painting, rasping, and scraping the edges of boot and shoe soles and heels.  
1418 G. W. E. Friederich—Ink.  
1419 W. G. Wedge—Kites.  
1420 J. G. Jones & R. Ridley—Working coal and other mines.  
1421 R. Humphrys—Surface condensers.  
1422 R. C. Furley—Castor and other oils for medicinal use.  
1423 H. Reynell—Substitute for ordinary felt and kamptulicon.  
1424 W. E. Newton—Needles.  
1425 W. E. Newton—Nozzles for hose and water discharge pipes.  
1426 J. Petrie—Washing wool and other fibrous materials.  
1427 T. Page—Propelling vessels.

DATED JUNE 9th, 1863.

- 1428 G. Hills—Obtaining certain products from hops.  
1429 B. Dolson & D. Greenhalgh—Preparing cotton and other fibrous substances.  
1430 E. Barlow, J. Newhouse, F. Hamilton, & W. Hope—Grinding card wool.  
1431 C. Nicquet—Sorting and washing ores.  
1432 J. Edwards—Railway chairs and sleepers.  
1433 R. A. Brooman—Distillation of bituminous substances.  
1434 J. J. Murray—Holders for inserting and fixing photographic pictures in albums.  
1435 H. Martin—Treating and preparing night soil and sewage with other materials as a manure.  
1436 M. Sigrist—Fountains.  
1437 W. V. E. Newt—Inflation of ships and other vessels.  
1438 H. P. McKillop—Compositions for coating ships' bottoms.  
1439 H. Hoesmer—Hydrostatic presses and hydraulic apparatus.

DATED JUNE 10th, 1863.

- 1440 W. Madders—Ornamental fabric.  
1441 R. Aitken—Permanent way of railways.  
1442 W. Roberts—Steam boilers.

- 1443 T. Adams—Slide and other valves.  
1444 J. Brooke—Miners' lamps.  
1445 W. Wells & J. W. Myers—Obtaining artificial light from volatile liquids or fluids.  
1446 T. Evans & E. Hughes—Applying one or more colours of ink to type in letter-press printing by hand.  
1447 W. Clark—Locomotive apparatus.

DATED JUNE 11th, 1863.

- 1448 M. Hatcher—Mashing.  
1449 W. Clark—Obtaining and applying motive power.  
1450 T. M. Harrison—Metallic casks.  
1451 M. Henry—Treating fibres silk and silk waste.  
1452 J. F. Kain—Umbrellas, parasols, sunshades, walking sticks and whips, and brooches and other ornaments.  
1453 R. Deane—Cooking and culinary utensils.  
1454 C. L. V. Tence—Railway wooden sleepers.  
1455 C. L. V. Tence—Daily balance book with moveable tickets or slips.  
1456 J. Webster—Indurating iron, and protecting iron and steel from oxidation.  
1457 W. Walton—Pneumatic hammer.  
1458 J. A. Schlumberger—Preparation of aniline dyes or colouring matters for dyeing, staining, or printing textile substances.  
1459 W. Seed—Drawing, slubbing, roving, and spinning cotton and other fibrous material.  
1460 E. O. Hallett—Sides of ships, batteries, and fortifications, and applying armour plates thereto.  
1461 J. Johnson—Lubricating apparatus for the cylinders of steam engines.  
1462 J. Johnson & W. Braithwaite—Reversing lever for locomotive engines and others.  
1463 T. A. Elliott—Reefing topsails and courses.

DATED JUNE 12th, 1863.

- 1464 W. Sims—Compound extract for the cure of gonorrhoea.  
1465 F. A. & F. Calvert—Burring, ginsing, cleaning, and carding cotton.  
1466 G. Davies—Currying and cleaning leather.  
1467 J. Place—Materials for the purposes of sacking and stiffening.  
1468 J. C. Wilson—Reducing cocoa nut kernels and other substances to a state of pulp.  
1469 J. C. Wilson—Unhusking rice and other seeds.  
1470 G. Beddon—Capitals and blast furnaces.  
1471 T. C. March—Ornamentation of articles of furniture.  
1472 T. H. Milner—Thrashing machines.  
1473 R. Hughes—Scrapping and sweeping turnpike and other highways, carrying drives, and foot-ways.  
1474 H. S. Barron—Steam fire engines.  
1475 J. F. Touse—Prevention of smoke in steam and other furnaces.  
1476 G. Davidson—Paper bags.  
1477 J. Jones—Gas regulators.

DATED JUNE 13th, 1863.

- 1478 G. Davies—Oiling journals or axles.  
1479 T. Wrigley—Filtering or cleansing water or other fluids.  
1480 J. Hopkinson—Fastening the ends of metal bands.  
1481 W. N. Hutchinson—Cleaning ships' bottoms and sides.  
1482 R. Blackburn—Traction engines.  
1483 T. A. Elliott—Ballasting ships and other vessels.  
1484 A. Mehu—Helm for working the rudders of ships or vessels.  
1485 J. S. Benson & D. Jones—Removable head for ships or vessels.  
1486 M. B. Westhead—Adapting tapes, ribbons, and other such narrow fabrics or threads to surfaces from which they may be unwound, or upon which they may be rewound.  
1487 J. C. W. Russell—Nails and spikes.  
1488 H. G. W. Wagstaff—Feeding steam boilers with water.  
1489 S. S. Robson—Working the rudders of vessels and auxiliary steering apparatus.  
1490 J. Shand—Steam fire engines and boilers.

DATED JUNE 15th, 1863.

- 1491 W. W. Box—Fire bars for the boilers of locomotive and other engines, and fire boxes and furnaces generally.  
1492 J. Forrester—Bricks, quarries, slabs, tiles, earthenware pipes, and other earthenware or ceramic articles.  
1493 T. Cope—Rocking horses.  
1494 H. B. Barlow—Opening and cleaning cotton and other fibrous substances.  
1495 I. B. Harris—Flexible and other tubes.  
1496 J. Juckes, jun.—Furnaces.  
1497 C. Pettigrew—Glass.  
1498 R. W. Gordon—Spinning flax and other fibrous substances.  
1499 W. Clark—Engine for obtaining motive power from steam or other liquid.  
1500 P. I. L. Stafford—Fire arms.

DATED JUNE 16th, 1863.

- 1501 J. J. Shedlock—Valves for the passage of steam, gas, and fluids.  
1502 F. S. Williams—Shaping plastic materials and other soft materials by means of pressure, percussion, or rolling.  
1503 W. Manwaring—Harvesting machines.  
1504 R. Grogan—Graveling and macadamising roads and paths.  
1505 T. C. Buford—Fixing mordants in the processes of dyeing and printing textile fabrics and yarns.  
1506 J. G. Jennings & M. L. J. Lavender—Moulding and vulcanising articles of india rubber.  
1507 W. Score—Candles and soap.  
1508 J. Steele & W. Mason—Removing the bran or outer skin from wheat or other grain.  
1509 A. J. Fraser—Apparatus applied to horse and carriage window sashes for the working and fastening thereof.  
1510 W. Neil, jun.—Steam engines.  
1511 J. G. O'Connell—Smiths' and other bellows.

- 1512 R. A. Brooman—Preserving the silvage or quickening on glass, and glass vessels for silvage or quickening.

DATED JUNE 17th, 1863.

- 1513 W. H. Dawes—Iron.  
1514 J. Banwell—Collecting and placing in rows, or collecting and elevating into a wagon or elevator hay, corn, or other agricultural produce.  
1515 J. Mills—Square rigging of vessels.  
1516 J. Newnam—Boiling in vacuo at a low temperature.  
1517 J. F. Spencer—Steam, gas, and water tube joints.  
1518 W. Crofts—Production of fabrics by lace machinery.  
1519 F. de Wyde—Preservation of lead surfaces exposed to the action of water, and for the protection of such surfaces from decomposition by atmospheric action.  
1520 E. Wolf—Article or means for use in smoking tobacco.  
1521 T. Pardie—Plastering, colouring, and decoration of walls and ceilings.  
1522 A. Samuelson—Evaporating liquids.  
1523 W. Naylor—Compressing, holding, and regulating the pressure of gas.

DATED JUNE 18th, 1863.

- 1524 J. A. Sparling—Twisting and winding silk.  
1525 J. L. Gunn—Toy pistols.  
1526 W. S. Lowe & J. Cheetham—Self-acting mules for spinning cotton and other fibrous materials.  
1527 D. Barker—Treatment and preservation of yeast.  
1528 J. Ralph & A. Heald—Sewing machines.  
1529 E. Ivett—Tiles.  
1530 R. Johnson—Moulds for casting metal.  
1531 E. Gossava—Bolts, rivets, and spikes.

DATED JUNE 19th, 1863.

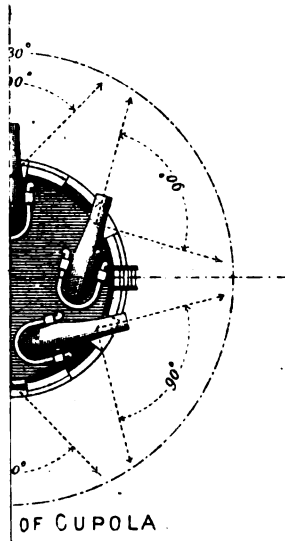
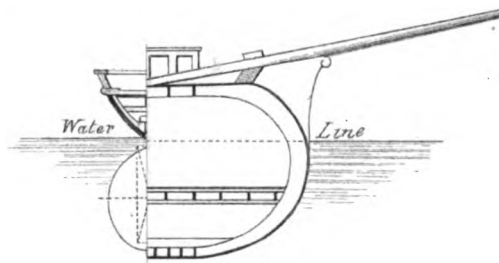
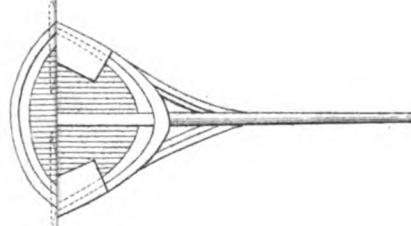
- 1532 H. Reynolds—Rendering atmospheric air fit for illuminating purposes, and of increasing the illuminating power of inflammable gas.  
1533 E. Howarth & J. Brown—Bleaching cotton or other fibrous substances.  
1534 S. Middleton—Iron or other metal shoes, and the securing the same to the hoofs of horses and other animals with nails.  
1535 R. Harrison—Fire-throwing firearms.  
1536 H. A. Bonnevill—Bolts and rivets.  
1537 A. Morel—Combining wool and other fibrous material.  
1538 A. Morel—Traction engines.  
1539 J. Watts—Malt.  
1540 W. Hicklen—Metal screens and sieves for screening and sifting.  
1541 W. E. Neaton—Pipes.  
1542 M. Henry—Decorating grain and seeds, and the application of the products obtained by and materials used in decorating.

DATED JUNE 20th, 1863.

- 1543 T. Smith, T. Moore, & M. Burvill—Reels covered with silk or other suitable material used as machines for the purpose of dressing flax.  
1544 Y. Meirat—Propelling vessels by water power.  
1545 D. D. Kye—Baths.  
1546 G. Haselton—Oil, more especially designed for mixing paints and colours, and new mode of manufacturing the same.  
1547 R. Brownlee—Sawing machinery.  
1548 F. Fiasse—A system or several fire places to be chimney.  
1549 G. Briery—Cleaning spoons and forks.  
1550 C. Peterson—A new material or compound applicable to the manufacture of pipes or tubes, to caulking or covering ships' bottoms, and to other useful purposes.  
1551 J. L. Clarke—Turning over the leaves of music and other books.  
1552 H. Macaulay—Covers or appliances for the rims, borders, or top edges of chamber utensils, applicable also to the products and water closets.  
1553 F. Jenkin—Electric tell-tale compass.  
1554 T. N. Goli—Mountings or settings for precious or other stones.  
1555 W. L. & T. Winans—Construction of steam vessels.  
1556 W. L. & T. Winans—Couplings for propelling shafts of ships or vessels.  
1557 W. L. & T. Winans—Propelling ships or vessels for ocean navigation.  
1558 W. L. & T. Winans—Propelling ships or vessels for ocean navigation.  
1559 W. Clark—Paper pulp.  
1560 J. Booth—Winding machines.

DATED JUNE 22nd, 1863.

- 1561 J. Sainty—Turnip cutter for cutting the last slice.  
1562 E. Wilkie—Portmanteaus and trunks.  
1563 A. Twaddell—Sizing or preparing warps.  
1564 J. McLeus—Treating oil from shale or other bituminous minerals and similar oils, to obtain various products therefrom.  
1565 W. Seel—Gannon, with arrow-shaped projectiles.  
1566 F. Boulton—Obtaining patterns or designs for the arts and manufactures.  
1567 L. A. Majohar—Apparatus for carburetting gases.  
1568 W. Rowan—Pistons.  
1569 W. Clark—Charging air with combustible vapours.  
1570 W. L. & T. Winans—Propelling ships or vessels.  
1571 W. L. & T. Winans—Propelling ocean steam vessels.  
1572 W. L. & T. Winans—Construction or arrangement of the working parts of engines for actuating the propelling shafts of steam vessels.  
1573 W. E. Newton—Printing machinery.  
1574 C. T. Burgess—Reaping machines.



220 220 Feet



# THE ARTIZAN.

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AUGUST 1st, 1863.

## ON IRON-CLAD SHIPS, WITH PLANS AND SPECIFICATIONS OF AN ARMoured CORVETTE PROPOSED FOR THE UNITED STATES GOVERNMENT.

By JOHN W. NYSTROM, C.E.

(Illustrated by Plate 244.)

From the *Journal of the Franklin Institute*.

Armoured ships are yet experiments, and a subject now of considerable importance in this country. It is a rather difficult undertaking to combine all requirements of an iron-clad man-of-war, particularly for one of small size and for shallow water. The most important requirements are,—impregnability, speed, superior ordnance, good sea-going and sailing qualities, comfort on board, simplicity, and no complicated machinery, and lateral strength of the hull of the ship, all of which are to a certain extent combined in the corvette about to be described.

In August, 1861, and February, 1862, the Navy Department at Washington invited the ingenuity of the country to make proposals for the construction and building of iron-clad steamers, which was at both times promptly responded to by a great many plans, of which the corvette herein described is one of the two submitted by the writer.

The two sizes of armoured steamers which I proposed to build were constructed to accommodate the stipulations of the Navy Department's advertisement. It is, however, believed that smaller boats would answer better for the present requirement peculiar to the country, but in all cases small gun-boats are best suited for home service; a greater number could be built in a shorter time, which would be more effective in blockading the long American coast. Armoured gun-boats of 125 feet long, 20 feet wide, with only 7 feet draught of water, mounting one or two heavy guns, could go by inland navigation from New York to Fortress Monroe; they could even be made to draw 10 feet water by taking in coal and ordnance after arriving in sufficiently deep water. The object of which would be to surprise or attack an enemy's fleet at Sandy Hook, Delaware Bay, or in the Chesapeake. If the Navy Department would allow themselves to part from the Erie experiment principle and employ our present knowledge in steam engineering, gun-boats of this size could easily be made to carry fuel for six days' steaming. A number of small gun-boats are not so easily surprised, and if a blunder is made in one or more of them the risk is not so great as in a line-of-battle. They are, however, easier managed, and if damaged they can go behind islands and shoals out of the reach of the enemy's fire. An experimental gun-boat of this size could be built in two months, and if proved successful almost any number could be built in the next two or three months.

Armoured ships must yet be considered an experiment, for which a number of large ones bears a greater risk in expense and blunders. The large size armoured steamers built in European navies are intended more for service abroad, for which they are well suited and less expensive than a number of smaller ones, but our case is of a different nature.

In the Russian war with England and France, an English officer proposed a plan to attack and bombard Cronstadt with a number of small gun-boats, which was considered the most safe and effective, but peace was restored and the plan abandoned.

A corvette on the plan about to be described will be as impregnable as any iron-clad now building in Europe. As regards speed, the conditions set forth in the Navy advertisement were such that speed could not possibly be attained, for the greatest speed I can with safety guarantee is 10 knots, but am able to construct an iron-clad of the same or smaller size with 15 knots per hour. Although speed is of great importance, there are no men of war in the U. S. Navy with good speed, and some of the iron-clads lately built can hardly walk by themselves, but must have a tow-boat to help them along; also the gun-boats built on the Erie experiment principle can only walk.

The sea-going and sailing qualities of the corvette will be as good as that of any merchant vessel of the same proportions; it is in every respect a ship-shaped vessel. A man-of-war may come in battle once or twice, or say a dozen times in a lifetime; it would be improper to sacrifice comfort, health, and life for some temporary importance; in the corvette proper

attention is paid to the comfort of officers and men on board by a house placed between the cupolas on the main deck. This house does not interfere with the proper management of a battle,—should it be injured by the enemy, repair it,—should it be shot away entirely, build a new one.

The lateral strength of an armoured ship for shallow water, requires the greatest consideration both in design and workmanship: wooden vessels can hardly be made strong enough for that purpose. An iron-clad now building at the Philadelphia Navy yard will hardly have lateral strength enough for the waves of the Delaware breakwater.

### Specifications of an Armoured Corvette with six 11-inch guns.

In the accompanying Plate 244, Fig. 1 is a longitudinal section, showing the internal arrangement, and Fig. 2 a plan of the boat; the arrows show the limit of angle in which the guns can be trained in each port hole.

Fig. 3 is a transverse section through the line A B, Figs. 1 and 2, showing the armour guards and cupola with one gun. The armour guards above the water line are at an angle of 45° and of 5 inches thick iron plates; under the water-line the guards are at an angle of 67½°, and of three inches thick iron plates.

Fig. 4 is a plan of the cupola, showing the three guns, of which it is proposed to use two at a time, and have one for reserve in case the others should get injured or hot during the firing. With some practice it might be possible to employ the three guns at the same time, depending on the enemy's position.

Fig. 5 represents the outer appearance of the corvette, with two armour cupolas on deck, in each of which are to be placed three 11-inch guns.

### DIMENSIONS OF THE BOAT.

|                                             |                  |
|---------------------------------------------|------------------|
| Length on the water-line .....              | 225 feet.        |
| Breadth of beam moulded.....                | 40 "             |
| Extreme breadth over guards .....           | 45 "             |
| Draft of water .....                        | 12 "             |
| Greatest immersed cross section .....       | 436 square feet. |
| Greatest cross section including guards ... | 450 square feet. |
| Displacement .....                          | 2125 tons.       |
| Speed in miles per hour.....                | 10 knots.        |
| Horse-power of engines.....                 | 900 horses.      |

The corvette to be made wholly of iron, with two propellers, and schooner rigged.

*Description of Iron Work.—Keel.*—The centre keel to be made of plate iron 1½ in. thick, by about 2 ft. wide, bent to suit the form of the boat; also two keels of solid rolled beam iron 12 in. deep, one on each side, as shown in Fig. 3.

*Sternpost* to be of wrought iron in one piece, with a stuffing-box and heel for the rudder, as shown in Fig. 1, and to be made in one piece from deck to keel, as shown in Fig. 1.

*Plating.*—The hull to be of ½ in. plate iron, lapped longitudinally and butt-jointed vertically, the butts to be double riveted in each plate. The streaks to be about 3 ft. wide from centre to centre of rivets, except in the stern and bow, where it diminishes according to the ordinary mode of iron shipbuilding. All the seams to be caulked, in and outside. The ½ in. iron plating to extend in about 150 ft. under the guards, the balance at the stern and bow to be plated with 4 in. thick iron plates above the water line; to 6 ft. depth, to be plated with 3 in. plates; from 6 ft. under water line the keel to be plated with ½ in. iron, except in the bow, where one streak from 6 to about 9 ft. depth to be 2 in., and from 9 to about 12 ft. depth to be 1 in. thick. The butt pieces in the armour streaks to be 1½ in. thick, screwed on with 1½ in. tap screws, 2½ in. into the 4 in. armour plates; under the water-line the butt pieces are to be rivetted.

*Ram.*—The ram of the corvette is to be formed by the armour-plates, terminating in the form of the stem, as shown in Fig. 1. The object of making the ram in this round shape, is to distribute evenly on the vessel the shock of a collision; also for preventing the ram sticking fast in the vessel run into. The rams now made for some vessels in the navy, with a small piece of iron sticking out from the stem, is a rather unsafe contrivance; should it stick fast for only one minute, the enemy's vessel will likely be hung upon it, which may give time enough for the enemy to

board us, and should the enemy's vessel have a velocity forward while attempting to run into it, the ram may be broken off and injure our vessel more than the enemy. The *Merrimac's* ram was broken while running into our vessels in Hampton Roads.

**Frames.**—The frames to be spaced 18in. apart; every other of beam iron, solid rolled 12in. deep, and every other of beam iron  $\frac{1}{2}$  (6 + 4) inches. The frames to be in as long pieces as possible with broken joints. In the most curved parts of the stern and bow where it is not possible to bevel the beam iron, the frames to be made of  $\frac{1}{2}$  (6 + 4) inches angle iron; also the frames on the bulkheads to be of the same iron.

**Beams.**—The beams to be of beam iron, solid rolled, 12in. deep, spaced 3ft. apart, one on every other frame, bent at the gunwales in continuation of the frames, as shown in Fig. 3. The joints of the frames and beams to be riveted with butt pieces  $\frac{1}{2}$ in. thick by 3ft. long, one on each side, with one inch rivets. The beams over the bulkheads to be of angle iron  $\frac{1}{2}$  (6 + 4) inches. Under deck beams to be 6in. solid rolled beam iron, riveted to the frames as shown in Fig. 3. Under each cupola to be six intermediate beams of 9in. solid rolled beam iron, as shown in the section fig. 1.

**Stringers.**—The gunwale stringer to be of plate iron 1 (12 + 12) inches, firmly riveted to the iron deck and side of the vessel, as shown in Fig. 3. The stringers to circumscribe the entire vessel.

**Keelsons.**—To have 3 keelsons, the centre one to be of solid rolled beam iron 12in., and one on each side of 9in., spaced 9ft. 6in. apart, as shown in Fig. 3. The keelsons to be firmly riveted to each frame.

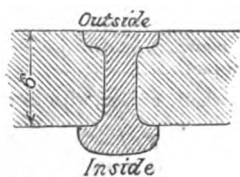
**Longitudinal Beams** to be of 9in. solid rolled beam iron, spaced 9ft. 6in. apart, and firmly riveted to the deck beams.

**Bulkheads.**—To have five water-tight bulkheads of  $\frac{1}{2}$ in. iron diagonaled on both sides with angle iron  $\frac{1}{2}$  (3 + 2) inches, as shown in Fig. 3.

**Decks.**—To have two decks, the upper one to be of  $\frac{1}{2}$ in. thick plate iron next to the beams, butt-jointed in all seams with  $\frac{1}{2}$ in. butt pieces; the longitudinal seams to run in one line, and broken cross seams. The iron deck to be covered with 8in. thick planks, screwed fast from underneath. The under deck to be of  $\frac{1}{2}$ in. iron with longitudinal lap seams and butt-jointed cross seams, covered with 4in. thick plank, screwed fast from underneath.

**Rudder.**—To have a balance rudder of wrought iron, fitted so as to be protected from enemy's shots. The rudder to be worked either in the pilot house on deck, or under deck in the mariners' room abaft. I have made this kind of rudder on several steamers in Russia, and found it to answer exceedingly well; it has many advantages above the single rudder,—it is easier managed, the vessels steer better with it, and it is less effected by the sea.—Fig. 1 shows how it is arranged.

**Armour Cupolas.**—To have two armour cupolas on the main deck, of a spherical form 25ft. diameter at the base and 10ft. high. The armour-plates to be 6in. thick, jointed in 12 segments with 8in. solid rolled beam iron, as shown in the accompanying woodcut. Each cupola to have six



port holes, in which the guns can be trained in a horizontal angle of 90°, and vertically about 47°. The port holes to be 3ft. wide by 4ft. high, covered with a sliding shutter  $\frac{1}{2}$ in. thick, as shown by figs. 3 and 4. The shutters to be worked from the inside. Each cupola to admit firing in a horizontal angle of 330°. The tops of the cupolas to have a hatchway 6ft. in diameter, covered with a plate  $\frac{1}{2}$ in. thick, which latter to have a hole 2ft. in diameter, covered with an iron grating. Cupolas of this description are considered strong enough without any backing of wood, which latter would greatly interfere with the proper training of the guns. The spherical form renders them as strong as 9in. thick flat iron, and exposes the least possible surface to the enemy.

**Armour Guards.**—The armour guards to extend about 185ft. on each side of the boat; the armour plates to be 5in. thick, placed on wood at an angle of 45° from the water-line to the bulwark, as shown in Fig. 3. The plates to be fastened with tap bolts from the gunwale stringer, and with screw bolts at the lower edge or water-line, through the wood to the hull of the boat. The armour plates will be 6ft. 6in. wide, and in as long pieces as possible, but not less than 10ft. The lower armour plates to be 3in. thick, by 5ft. wide, placed at an angle of 67 $\frac{1}{2}$ °. The wood backing to be of the hardest dry oak. The ends of the armour plates to be butt-jointed, but not riveted; under each cross-joint of the 5in. plates to be laid a butt piece 2in. thick by 9in. wide, fitted into the wood, and under the 3in. plates a similar butt piece  $\frac{1}{2}$ in. thick. The guards to extend on each side

to where the armour plates of the stern and bow commence, so that nothing of the  $\frac{1}{2}$ in. plating will be exposed.

An armour plate placed at an angle, increases in horizontal thickness as the *secant* of the angle of inclination to the vertical plan. On this principle English engineers argue that a vertical plate of the same horizontal thickness as the inclined one has the same strength: which theory will hold good as regards lateral strength,—but it is the reflecting power which is taken advantage of in the inclined plate. The reflecting power is in proportion as the *tangent* of the angle of inclination; that the *secant* and the *tangent* added together, and the sum multiplied by the true thickness of the inclined plate, will give the relative value to the vertical one. The lateral strength of an armour plate is in proportion as the square of the thickness when the breaking force acts slowly,—but in the sudden shock of a projectile, the inertia of the armour plate acts as a die in a punching machine, where the resistance of the plate is in proportion direct as the thickness.

**Deck Fittings.**—Bulwark to be made of wood boarded with 3in. plank, intended to be made fast and not to be saved in a battle, but should it be desired to make it removable it can easily be made so.

**Capstans.**—To have two capstans, one forward and the other abaft, arranged so that each can be worked by any number of men from 1 to 16, without change of gearing or other complicated machinery; also to be made so as to pinch hold of any size of chain or hemp cable.

**Deck Lights.**—To have deck lights to the officers' and mariners' rooms, as shown in the plan, Fig. 2,—with frames ground water-tight in the deck, and arranged so as to be easily opened for ventilation under deck; also to be provided with stand pipes of about 2ft. high above deck, for ventilation in rainy or stormy weather.

**Davits.**—To have two anchor davits in the bow, and eight boat davits, two for each boat, as shown in Figs. 1 and 2.

**House on Deck.**—To have a house on deck of an elliptical form, as shown by the strong dotted lines Fig. 2; length 85ft. by 20ft. wide, to be made wholly of iron about  $\frac{1}{2}$ in. thick. The window shutters to be made of  $\frac{1}{2}$ in. iron, perforated with rifle holes. The roof beams of the house to be made of angle iron  $\frac{1}{2}$  (2 $\frac{1}{2}$  + 3) inches, covered with iron plates  $\frac{1}{2}$ in. thick, on the top of which to be wooden boards  $\frac{1}{2}$ in. thick. The house to contain two kitchens, dining room for officers, cabin, &c., and arranged to suit the requirement. The top of the house to be circumscribed by a brass railing. To have two iron stairways, one forward and one abaft of the cupolas. The house is not intended to be saved in time of battle: if a ball should strike it there will only be a hole. All the furniture in it to be made of iron or other incombustible materials, that it cannot take fire.

**Water Closets.**—To have two water closets on the fore deck, mounted on hinges, so that they can be felled down when it is required to fire forward. Also water closets under deck with pumps.

**Pilot House.**—To have a pilot house made wholly of iron, located as shown in Figs. 1, 2, and 4. During a battle the helmsman is stationed in the mariners' room abaft, and is directed by a dial worked from either of the cupolas.

**Rigging.**—To be three-masted schooner-rigged, as shown by Fig. 5. All standing rigging to be of wire rope. It is schooner-rigged for the sake of making it simple, and the least possible number of ropes.

**Life Boats.**—To have four life boats of the most approved form, complete, with oars.

**Hatchways.**—To have nine hatchways, covered with spherical armour plates as shown in Fig. 1. The two hatchways in each cupola to be covered with flat plates level with the floor. The combings to be of iron, riveted to the iron deck and projecting one foot above the wooden deck.

**Figure-head and Bowsprit** are arranged so that they can be removed in one minute, when the stem is a ram for running into an enemy's vessel.

**Accommodation.**—Under main deck is a space of 114ft. in length, occupying the whole width of the boat, of which 48ft. is abaft and 66ft. forward; also a forecabin of 30ft. to the stem; all to be arranged in the most suitable manner for officers, mariners, and crew. The water tanks are placed under the lower deck, as shown in Fig. 1, arranged with pumps, cocks, and pipes, as may be required.

**Machinery.**—The machinery to consist of two horizontal condensing engines, working separately, each on a propeller shaft, as shown in Figs. 1 and 2; to be of the most simple construction and most efficient in its performance, arranged with expansion, superheating of steam, and fresh water condenser, all up with the present knowledge of steam engines.

#### Dimensions of Engines.

|                                 |                                |
|---------------------------------|--------------------------------|
| Diameter of cylinders.....      | 42 inches.                     |
| Stroke of piston .....          | 30 "                           |
| Pressure of steam.....          | 50 lbs.                        |
| Expansion .....                 | $\frac{1}{2}$ to $\frac{1}{3}$ |
| Actual horse power engines..... | 900 horses.                    |
| Propellers, diameter.....       | 10 feet.                       |

**Steam Boilers.**—To have three cylindrical boilers of the most simple construction; every part of the inside to be accessible for cleaning.

|                                          |                 |
|------------------------------------------|-----------------|
| Outside diameter 9 feet by 15 feet long. |                 |
| Area of fire-grate .....                 | 96 square feet. |
| Fire surface.....                        | 2880 " "        |
| Consumption of fuel per hour .....       | 2450 lbs.       |
| Consumption of fuel per day of 24 hours. | 26·3 tons.      |
| Consumption of fuel per seven days ..... | 160 "           |

**Ventilators.**—To have two ventilators (fans) in the engine-room, each 42 in. diameter by 15 in. wide. Air pipes to lead under the fire-grates, between decks and cupolas, as may be required for ventilating the ship.

**Donkey.**—To have one donkey engine with double-acting pump, arranged with cocks and pipes, so as to be used for feeding the boilers, bilge-pump, and fire engine.

**Propellers.**—To have two brass propellers 10 feet in diameter, each with four blades, arranged on the shafts so as to be easily shipped or unshipped as may be required at sea.

**Coal-bunkers.**—To have coal-bunkers divided into two water-tight compartments, with capacity for 100 tons of coal.

**Ordnance.**—The ordnance to consist of six 11-inch guns, three in each cupola, mounted on carriages made wholly of wrought-iron. The gun carriages to be mounted each on three wheels on vertical spindles turned in the direction the gun is desired to be moved. The two wheels under the gun to be turned by a worm screw, and the hind wheel by a lever; the course of the gun to be steered by the lever both in the recoil and when moving it. The floor in the cupolas to be made of iron and perfectly flat, that the guns can be hauled on it in any direction. When the gun is to be fired, the two wheels are turned crosswise with the screw, the recoil is then taken partly by the friction of those wheels on the floor, and the balance by a friction wheel around which is a chain or hemp cable fastened with one end in the cupola. By this arrangement the guns can easily be trained in a horizontal angle of 90° in each port-hole. The axis of the guns will be only 7 feet above the water-line, for which it would rarely be required to dip it under the horizon, but should it be required to fire in the direction *ab* Fig. 3, the enemy must be very near, when the bulwarks is of little importance; fire it away, and the projectile will strike the water at a distance of 19 yards. The guns can be elevated to an angle of 35°. At the circumference in the cupolas are six holes of about 14 in. diameter, for handing up ammunition during firing. If more complicated gun carriages are adopted, it will necessarily throw out one of the three guns in each cupola.

Under the cupolas are steam hoisting machines *H*, Fig. 3, composed simply of a cylinder 12 in. diameter by 15 ft. stroke, to be used for hauling the guns, which dispenses with a great number of men and confusion in the cupolas. With 50 lbs. of steam, the machine can pull 2½ tons.

The principal armour plates in the vessel herein described are independent of the hull of the same. Should it at any time be desired to dispense with the heavy armour, it can easily be removed, and there remains a comfortable and well proportioned steamer. It is practically demonstrated by the *Warrior* that it is not good to make the principal armour plates constitute the hull of the vessel, for the difficulty of keeping it tight after having worked in heavy sea. It is also believed that it is not practical to combine iron and wood in the hull of an armoured vessel, particularly for shallow draft, but even the size of *La Gloire* has proved a failure in that respect, and the objection will become more serious for lighter draft. A vessel can be considered a long girder, of which the strength is in proportion as the square of the depth. Neither is it practicable to make water-tight bulkheads and iron decks in a wooden vessel, for one material will tear the other to pieces in a heavy sea.

It may be remarked that the anchors and propellers are not protected by a bill and tail as in the Monitors; to which I beg to reply that if the tail really protected the propeller, and if it could be made so as not to injure the speed and sea-going quality, and not endanger the safety of the ship, it would be proper to put such a thing on; but, as long as that is doubtful, it is preferable to avoid the trap, in consideration that it is better to lose both the propellers in a battle than to have the vessel foundered at sea, before it reaches the enemy. It is of equal importance to get safe into a battle as to get safe out of it—both the purposes should be equalized and not neglected. The temporary importance of the bill and tail make the vessel more unsafe out of battle than in the battle. The chance of a propeller being hit in the water is very rare; at any rate, it would be better to make the propellers of cast iron, and with at least four blades each, so that if it should be struck by a projectile, one blade may break off without further injury to the shaft or the stern-bearing. Two propellers would have eight blades, and suppose that even seven of them were shot away, still the steamer would make a good speed with one blade left. If a blade of a brass propeller is struck, its strength does more harm to the shaft and stern of the vessel than if broken off; and it may bend so as to prevent the propeller from turning in its determined space.

It will require twelve months to complete such a vessel as that which I have described.

## REFLECTIONS ON THE EXISTING BRITISH COINAGE.

To the present Government is due the credit of having effected a most important and valuable reformation in the inferior denominations of the British coinage. The heterogeneous, cumbrous, and sadly deteriorated copper pieces of money, which were so long a reproach, and, indeed, a nuisance to the community, have almost entirely disappeared from the channels of circulation, and in their place we have a convenient, uniform, and not inelegant coinage of bronze. This change has been made in a comparatively short space of time, and it exhibits in a favourable light the mechanical resources of the Royal Mint.

It may be permitted us to hope, however, that the Ministry under whose auspices the transformation of the timeworn copper currency into a more durable one of bronze has taken place, will not rest satisfied with their labours in this direction. The re-coinage of which we speak should be regarded in the light of a highly successful experiment, which points the way to other and yet more momentous improvements, rather than in that of a final measure of monetary reform.

What is now required is that the superior coinages—those of gold and silver—should also be re-cast and re-modelled. With reference to the highest denomination of coin current in this country—the sovereign—and which is in its way a fair specimen of Imperial Mintage, we have some objections to offer. The first of them is that the obverse impression does not represent at all faithfully the features of her Majesty the Queen. The die engraved by the late W. Wyon, in 1837, for imprinting the coin, was at the time named an excellent work of art, and it transferred with much fidelity the lineaments of the royal face to the discs of metal stamped at the Mint. A quarter of a century has passed away since the Queen ascended the throne. The die which in 1837 did duty by coining sovereigns bearing “the image and superscription” of Victoria I. is actually employed in this present year 1863 in the same operation! Is it not high time that the old die should be placed on the shelf of the Mint Museum, and that a new one should be engraved to take its place in the Mint presses?—a die not representing our loved Monarch as she was when a girl, but as she is now.

As it is, the Mint is engaged in coining falsehoods, and thus is lying to posterity! The same remarks apply to the coinage of half-sovereigns.

The reverse of the sovereign has a certain amount of beauty about it undoubtedly, but it is a fair matter for consideration as to whether, if the obverse of the coin were remodelled, a more artistic and elaborately engraved design should not take the place of the reverse. A completely distinctive character would thereby be given to the new coin, which ought also to bear its value stamped upon some portion of its surface. It would be quite possible for one of our artist-engravers to furnish such a design as should meet the requirements both of taste and utility.

Whatever devices might be selected for the ornamentation of the sovereign, the same should be adopted for those of the half-sovereign. At present there is great incongruity between the reverses of the two coins. The sovereign reverse impression comprises, as is well-known, the Royal arms quarterly, 1 and 4, England, 2, Scotland, 3, Ireland, shield plain, crowned, within a wreath formed of two olive branches tied together at the bottom by a riband, and beneath the shield the rose, thistle, and shamrock. The half sovereign, on the contrary, exhibits as its reverse the Royal shield as before, without the wreath, but mantled and crowned. Why should this strange diversity have been permitted in the first instance, and why should it not be put an end to now?

If the alterations we propose were made, the accuracy of the standards of weight and of fineness, for which the gold coins of the Royal Mint have long been celebrated, need not be interfered with. The diameters, too, of the pieces might be allowed to remain as at present. Both coins are well proportioned, a valuable characteristic, and one affecting much the durability of the coins.

It is a question whether double sovereigns would not be found a serviceable addition to the metallic currency of the present day. If introduced they might very properly be christened under the name of “Victorias,” their obverse and reverse designs, corresponding with those of the sovereign and half sovereign.

There also seems to us to be no good reason why dies of identical character with those used for impressing gold coins at the Royal Mint, in London, should not be supplied to the Australian Mint, at Sydney. The latter is really a branch of the former, and its productions should be of the same stamp. The distinction which now exists between Sydney struck sovereigns, and those impressed on Tower Hill, is an anomaly which requires sweeping away at any rate, and it could well be done on the occasion of introducing a new gold currency.

We are bold enough to record our conviction, that if the foregoing suggestions were acted upon, the gold coinage of Great Britain would become, artistically and mechanically speaking, what it has long been intrinsically, the most perfect metallic currency in the world! Since the year 1851, when a number of automaton balances were introduced into the British Mint for the purpose of testing the weight of individual coins

and when other improvements were made there, no sovereign or half-sovereign forwarded from its coining presses, to the Bank of England, has ever been known to violate the legal limits of weight or of fineness. Why should not the same amount of perfection be attained to in the ornamentation of those coins? It is of the highest moment that beauty of workmanship, in our coinage, should interpose itself as a barrier to the nefarious proceedings of false coiners, as well as to demonstrate the superior talent and taste of our English artists and engravers.

We have said nothing of the gold coins of reigns previous to that of Queen Victoria, but as many of them are still in circulation, they increase the inconvenience arising from diversity of design, and strengthen our argument in favour of a reformation of the whole currency of gold.

The silver currency of the United Kingdom is, generally speaking, in a deplorably deteriorated state, and this resulting from hard work and consequent wear and tear. It is an incongruous and inharmonious jumble of coins, and its re-casting is as urgently demanded as was that of the old copper coinage.

Let us examine the various denominations composing the silver currency, and consisting of crowns, half-crowns, florins, shillings, sixpences, groats, and threepenny-pieces. Of crowns there are several varieties of each in circulation, and this fact of itself constitutes a strong inducement (not at all neglected) to the manufacturers of counterfeit coins. The oldest of the crown pieces in circulation, that of George III. has for its obverse a dexter bust profile of that monarch, the bust undraped, laureated, and the hair short. The reverse exhibits George and the Dragon within the Garter with abbreviated legend. Of the crowns of George IV. there are at least two varieties still in circulation. The obverse of those struck previous to 1826 display a similar bust profile of the king, laureated, and undraped. In those which emanated from the Mint in that year, and subsequently, the bust differs, the neck and head are much narrower in proportion, and it is not laureated.

The reverse in each case consists of St. George and the Dragon, but with minute differences of detail. That of the latter mintage is perhaps the more beautiful. St. George is represented in this on horseback, undraped, helmeted, with loose vest flying behind, in his right hand a dagger, his left holding the reins; under the horse a dragon, a broken lance lying beside, no legend, date in exergue, and with edge inscription. The early crowns of this reign were the work of Pistrucci, the later ones that of W. Wyon.

Few crowns were coined during the reign of William IV., and, for the most part, these exist in the cabinets of coin collectors. It is scarcely necessary, therefore, to describe their type here.

There are two kinds of Victoria crowns in circulation. One of these is a very fair specimen of art, and the other is a very discreditable specimen. Of the former, unfortunately, few exist, except in cabinets and museums. The dies from which these latter were struck still survive, we believe, at the Mint, and we are not aware of any reason, why—if crown pieces are to be retained in the British coinage—those dies should not be put into requisition, and a large issue of pieces resulting from them be made.

Of the second named crown of our present Majesty, too many are in existence. The obverse exhibits a sinister bust profile of the Queen, undraped, round the head two plain bands, hair parted on the forehead carried over the top of the ear, and all gathered together at the back of the head. The reverse comprises the Royal arms quarterly, shield plain, crowned, within a wreath of two olive branches tied together at the bottom by a riband. Beneath the shield is seen the rose, shamrock, and thistle. These coins altogether are wretched specimens of workmanship, and the sooner they are consigned to the melting pot the better. Of half-crowns of the four reigns previously mentioned there are an equal number of varieties, but as it is believed there is no intention to coin more of this denomination, it is only necessary to say that the sooner it merges into the florin the better.

Opinions are divided as to the claims of the well-known florin to public admiration, but it is an exceptional piece of money, and was only introduced as a stepping-stone to the obtaining of a decimal coinage. That desideratum does not appear to be arrived at yet, and the consequence is, that the florin has an *outré* appearance that ill-befits it for companionship with the non-decimal money in circulation.

Of shillings there are no less than six different kinds in circulation, but what the original ornamentation of some of them was it is difficult to ascertain. They have arrived at the stage of which we are the advocates, viz., uniformity; but unhappily theirs is the uniformity of plain surfaces.

Similar observations will apply to the sixpence, and this with intensified force. In these bustling days perhaps no coin is so overworked as this. The consequence is that an enormous per centage of so-called sixpences are unrecognisable as emanations from the Mint.

The inconvenience arising from the commingling of fourpences and threepences of the same diameter, but of humorously varying designs is understood, and need only be mentioned here. The fact is, that the

fourpennypieces should be removed altogether from the channels of circulation and converted into twopennypieces.

We trust that a sufficient case has been made out for the interference of the Government, in respect to the re-casting and re-modelling of both the gold and silver coinages of the United Kingdom. It would be quite possible to effect the reform within a year or two from the present time if the work were set about in good earnest. If the Mint be not mechanically powerful enough for the duty, it might easily be made so, and there is no doubt that designs would be forthcoming which would approve themselves to the community at large, and reflect lustre on the artistic talent of the country. It would be no difficult task to support with further evidence the position we have assumed, but it is our honest impression that the public will join in the demand for a re-coinage of the silver and gold monies of the state, because the public are aware from practical and painful experience of its necessity. It may be trusted that the Chancellor of the Exchequer will take the initiative in the matter, as he did in that of the copper currency; and there can be but little doubt, if he does, that it will be carried forward to a successful issue.

## ON MOMENTUM AND FLUID RESISTANCE.

### MOMENTUM.

There is no term used by writers on the mechanical sciences that seems more important to define than this, and none which appears to have a more indefinite meaning.

By the term *momentum*, I mean "the force accumulated in a moving body." Two terms, *momentum* and *vis viva*, are generally used to express this accumulation of force. Sometimes it is defined as a quantity varying as the weight multiplied by the velocity,—then again as half the weight multiplied by the square of the velocity, and, again, as the weight multiplied by the square of the velocity. The latter is I believe the most generally accepted theory among the leading constructors of our railroads and bridges,—our armaments,—our engines and vessels.

If this large class of most eminent men made no mistakes, or taught no errors, I would not dare to pen this article. However, I will advocate no really new dogma, as Olmstead, Playfair, and Newton are among its supporters, yet I do not wish to hold them responsible for any of my own deductions.

I will endeavour to prove that the momentum or quantity of force accumulated in a moving body, varies as the weight multiplied by the velocity; and that the resistance a moving body will overcome, varies as the momentum, and that the velocity will vary as the quantity of force expended. The laws of gravity are so well understood, and for our present purpose are most convenient. The force of gravity is a uniform force, and hence in equal times, will exert equal quantities of force whenever it is left free to act upon a moving body. Omitting to take any account of atmospheric resistance, and neglecting what are in the present consideration unimportant fractions, we find that a body near the surface of the earth left free to the action of gravity, or free to fall, will move through sixteen feet of space during the first second, and acquire a final velocity of thirty-two feet per second, and during two seconds will move through sixty-four feet of space, and acquire a final velocity of sixty-four feet per second.

By inquiring into the cause of this increased space moved through and increased velocity acquired during the last of the two seconds, we see that it is most easily explained. The uniform force of gravity is exerted on the moving body equally during each of the two seconds, yet the results at first sight do not appear the same. As we have seen during the first second, sixteen feet is moved through and a final velocity of thirty-two feet per second is acquired, while during the last second, forty-eight feet is moved through, and a final velocity of sixty-four feet per second is acquired. However, we wish to prove that the expenditure of force is the same during each second, and also, that although a body in this case moves over four times as much space in two seconds, as it does during the first of these two seconds, still the space moved through, is no true criterion of the force expended, or of the resistance overcome.

Gravity exerting its full force on this body for one second moves it through sixteen feet, and gives it a final velocity of thirty-two feet per second; this final velocity will carry the body through the next thirty-two feet during the last of the two seconds without any extra expenditure of force by gravity, but the body receiving the same quota of force during the last second that it did during the first, hence the body is moved through forty-eight feet during the last second, and acquires a final velocity of sixty-four feet per second.

Thus it appears that although the space moved through during two seconds, is four times as great as that moved through during the first of these two seconds, when a body is left free to the influence of the force of gravity, yet the quota of force expended during two seconds is not four

times as great as the quota of force expended during the first of these two seconds.

Hence "the actual work done," "the resistance overcome," "the mechanical effect," "the force accumulated or stored up in the moving body," "the momentum," "the vis viva," or by whatever term we may choose to call this result of the action of the uniform force of gravity on the moving body, is only twice as great for two seconds as it is for the first of these two seconds.

At any point of descent a body would return to the height from which it fell, if all the force expended on it down to that point were left free to act upon it in an upward direction. At the end of two seconds as the velocity of the falling body is sixty-four feet per second, then let it commence to ascend at that point; during the first second of its ascent it will move through forty-eight feet, and have a final velocity of thirty-two feet per second, and during the next second it will go through sixteen feet, and have a final velocity reduced to zero.

Hence again it is true that the work done or resistance overcome in the first of these two ascending seconds, is equal to that done during the last of these two ascending seconds. Because the only resistance overcome is the uniform force of gravity which resists the ascending body with a certain definite quota of force during each second of the time it is left free to act. The time during which any uniform force acts freely on a body, and not the space through which it moves the body is the only unvarying and true criterion of the work done, or of the force stored up, or accumulated in the moving body. If the force expended by gravity during two seconds is four times as great as the force expended during the first of these two seconds, then the accumulated force should be four times as great at the end of the two seconds, as it would be at the end of the first of these two.

We have shown that this quadruple force has not been expended and hence it is not accumulated. As the velocity varies as the time, then the force accumulated varies as the velocity, or as the weight into the velocity. Thus a double expenditure of force gives a double velocity, and a double velocity gives a double momentum. Hence the momentum will vary as the weight multiplied by the velocity.

If we measure the force accumulated in a moving body by the length of time it is expending this accumulated force in overcoming a resistance uniform as to the time, then it is evident that it varies as the weight multiplied into the velocity.

But if we measure the force accumulated by the force expended in overcoming a resistance uniform as to the time—but not uniform as to the space—by the space through which a body is moved while the accumulated force is being expended, then it will vary as the weight multiplied by the velocity squared.

The former of these measures is usually called *momentum*, while the latter is called *vis viva*, and in reality there is no more difference between their meaning, than if we at one time should say a yard was three feet, and at another time thirty-six inches in length: momentum being the term used when the element time is taken into consideration, *vis viva* when space is taken into consideration. But when the resistance is not uniform as to the space, space cannot be a true criterion of the force expended; hence the term *vis viva* understood in this way is very indefinite. From this simple cause alone arises the great confusion of ideas on this subject.

Some persons may consider this a dispute about words only, but when we see authors of eminent practical abilities, such as Bourne, boldly teach that the momentum of a moving body varies as the weight multiplied by the square of the velocity, and that it is necessary to double the expenditure of force to obtain a double velocity; it is most evident that the dispute is not only about words.

It is on this hypothesis that he advances and endeavours to prove that the force necessary to be expended in overcoming the front resistance of a vertical plane moving through a fluid in a vertical direction, will vary as the cube of the velocity.

This theory is so generally believed, I almost fear that the prejudice in favour of it alone, may prevent many from ever giving this article a patient thought.

In the study of the abstruse subject of fluid resistance, my attention was first attracted to the confusion of theories taught on this vital principle of momentum. It is fit, then, that I should mention it in connexion with the present subject. The bearing that this question has on projectiles and iron-clads is also eminently practical.

Does the resistance a shot would overcome vary as the weight into the final velocity, or as the weight into the square of the final velocity, other things being equal? Our deductions would teach us to believe in the former of these measures, in opposition to the theory usually taught by practical men on such matters.

Both in steamship propulsion and in gunnery there are so many varying elements brought to bear in developing the force as well as in expending it, that it is impossible to determine the exact quota of force expended in overcoming each species of resistance.

I will conclude this article with an account of some crude experiments I have made, having a relation to this subject.

I dropped a small iron rod from the height of four feet so that it acquired a velocity of sixteen feet per second, and then dropped the same rod through sixteen feet, so that it acquired a final velocity of thirty-two feet per second, and on measuring their respective penetration in sand found that the penetration varied as the velocity.

Then I dropped a rod of the same sectional area, but of half the length of the first one, from the height of sixteen feet so that it acquired a final velocity of thirty-two feet per second. Its penetration in the sand was the same as the larger one, dropping with a final velocity of sixteen feet per second. These results were not mathematically as I have stated, but the average penetration in these crudely conducted experiments is all I profess to give. To me they appeared as very conclusive evidence that the penetration of shot, other things being equal, will vary as the weight into the velocity, or as their momenta.

I also arranged a delicate steel spring with a trigger attached, so that I could let it re-act suddenly when compressed.

A weight bent it one degree, a double weight two of these degrees of tension, a triple weight three degrees. On allowing the spring to re-act at one degree of tension, it would throw a shot lying on it a certain height, but when let go at two degrees it would throw the shot to four times the former height, and at three degrees to nine times the height. Thus again seeming to prove that a double force would throw the body to a quadrupled height, and a triple force to nine times the height. The time the force of gravity would act on the respective ascending shots would vary as one, two, and three for their respective efforts.

These experiments were but rudely executed, but, in all their simplicity, they seemed to be very conclusive.

I hope a patient reading of this brief article may do something towards reconciling any discrepancy that may exist on this most important and interesting subject.

#### FLUID RESISTANCE.

In this short article I will not attempt to investigate the abstruse question of fluid resistance as a whole, but simply desire to attract attention to a single phase of this most interesting subject.

If I am able to make my views distinctly understood, concerning the front resistance which a vertical plane meets with and has to overcome, in passing through a fluid in a direction perpendicular to this plane, I will have accomplished my design.

The amount of resistance for any one velocity is not desired,—but simply the relative resistance at different velocities.

The theoretical question is this: Suppose we have a vertical plane totally submerged, and moving through a fluid in a direction perpendicular to this plane but at variable velocities, how will the resistance and the power necessary to overcome this resistance vary, in order to move the plane with these variable velocities?

In order to be more distinctly understood, I will explain that I understand the resistance overcome to be a true criterion of the power expended, in whatever way this power may be developed.

The well known law always given and never disputed is: That the resistance varies as the square of the velocity.

But this law is differently understood, some understanding it to mean the resistance for a certain space moved through, and others for a certain time.

So to avoid this ambiguity of expression that is so easily mistaken, I would lay down my views of this law more explicitly, thus: The front resistance that a plane moving through a fluid in a direction perpendicular to this plane will meet with, during a certain time, will vary as the square of the velocity. And that the front resistance which this same plane will meet with, while passing through a certain space, will vary simply as the velocity.

This view of the question is taken by Olmstead and Arnott, while a different view is more generally accepted by men eminent for their practical and theoretical abilities in engineering. I will simply cite two instances, Bourne, the great English author on steam engineering, and J. Scott Russell, the builder of the *Great Eastern*.

Olmstead and Arnott say, that the power necessary to be expended to overcome the front resistance of a steamer for a certain time varies as the square of the velocity, but Olmstead and Arnott were not practical men, perhaps,—so Bourne, Russell, and hundreds of others, who are the practical builders of our steamers, say that the power necessary to overcome this theoretical front resistance varies as the cube of the velocity.

And engineers of all kinds, who try to add just one knot more to the speed of their vessels, when they have already attained a high speed, know that the fuel expended in obtaining this extra knot is an increase of a very large per centage on the normal quantity of coal consumed.

But that to increase the speed of a vessel from half her average speed to her average speed, would increase the consumption of coal as much as

eight-fold as Bourne and the believers of the cube theory teach, is something with which my own experience for several years does not agree.

So first we will endeavour to settle the question practically in this manner. If there is to be an increase of speed of a steamer beyond her ordinary fast speed, the expenditure of power or the expenditure of fuel is increased in a greatly increasing ratio, sometimes even exceeding the cube of the velocity.

This can be accounted for by the increased inefficiency of the propelling instrument (whether it be a screw or a side-wheel), moved at very high velocities, and to the forced and incomplete combustion of the fuel. There are other causes, but these two are the principal ones.

When the vessel's speed is increased from half her average speed to her average speed, these two causes affect the results but very little; hence we may not wonder if by increasing the quantity of fuel per hour four or five-fold, it does increase the speed from half the average speed to the average speed. It is an experiment I have frequently tried with these results.

But let the practical question be settled as it may, for the present the theoretical front resistance is what we wish to consider.

The reasoning on this subject is this: If, during a certain time, we double the velocity of the plane we double the number of particles struck during this certain time, and also strike each one with a double velocity.

As the resistance varies as the number of particles struck, multiplied by the velocity with which they are struck, we have this fourfold resistance for this certain time accounted for. Or we have a reason for this law; that the resistance to our plane for certain time will vary as the square of the velocity.

If the resistance for a certain time varies as the square of the velocity, the power which will be necessary to be expended during this time to overcome this resistance, will also vary as the square of the velocity.

And from this it is also deduced, that the resistance for our plane moving through a certain space as well as the power that is necessary to be expended in overcoming this resistance varies as the velocity simply.

Hence, practically speaking, if the front resistance of a steamer was alone to be considered, to double the speed while going from one part to another, would require an engine of the ability to develop a quadrupled quantity of power during a certain time, but consuming only a double quantity of fuel.

The quadrupled increase in the engine's capabilities to develop power would be required, in order to develop this double quantity of power required in one-half the time that the engines would have to develop it, if the steamer was moving at the slower speed.

Hence, to double the speed of a steamer, if the front resistance was the only resistance to be overcome, and if there was no direct loss of power on account of the increased velocity of the engines or forced combustion of the fuel, then the quantity of fuel consumed to drive the steamer at a double speed for a certain space would have to be increased two-fold only, and this double quantity of fuel would develop from our four-fold increased engine only a double quantity of power.

If this four-fold increased engine in our fast steamer was to develop power for the same length of time, as the single engine in the slow steamer, then the quantity of fuel consumed, or power developed, would also be increased four-fold.

These exact results in practical steamship propulsion, of course, could not be expected, but because they are not realized we are not obliged to arrive at erroneous conclusions on the whole subject.

Although the angular entrance of an ordinary steamer decreases the front resistance to a very great extent when compared with the resistance the bow would meet with if rectangular, yet the principle holds good, that the particles of water must be driven from a bow of a certain form, with velocities varying as the speed of the steamer.

Now, I will endeavour to explain the deductions from experiments on which the advocates for the cube theory base that principle.

I will endeavour to prove most conclusively why it is that this erroneous theory receives so general acceptance.

By direct experiment it has been shown, that if a weight be attached to a cord running over a pulley, and then made fast to a body floating in a fluid, so that the descending weight will pull the floating body through the fluid with a certain velocity, then, to double the velocity of this floating body, the weight must be increased four times.

And as at this double velocity the large weight would have to move through twice the space to overcome the resistance of the floating body for the same length of time, it is estimated that the power developed by the force of gravity acting on this descending weight, in order to double the velocity of the floating body for a certain time varies as 8 : 1.

Thus, weight 1 multiplied by space 1 is said to represent the mechanical effect of the small weight; while weight 4 multiplied by space 2 is said to represent the mechanical effect of the large weight.

A most accurate and careful set of experiments were made by the French Academicians D'Alembert, Bossuet, and Condorcet, in 1781, and

the results of these experiments seem to have been so conclusive as to have been received without doubt. The height through which the weight fell, multiplied by the weight, varied nearly as the cube of the velocities with which they drew the float through the fluid.

However, these experiments are not the only foundation for the cube theory, as Bourne, in discussing this subject, asserts that Newton is wrong in thinking that if a body is put in motion by an expenditure of a certain definite quota of power, then to put this same body in motion again with double its former velocity will require but a double expenditure of power.

Bourne's theory is, that if a body is put in motion by a certain expenditure of power, then it would require a quadrupled expenditure of power to give a similar body a double velocity. This theory he thinks he proves conclusively by the laws of gravity, and if his views on that subject are not erroneous, he undoubtedly proves this theory on momentum is correct, as well as his cube theory on fluid resistance.

In the preceding article on momentum, I have asserted:—"That the generally received criterion of 'work done,' or 'mechanical effect,' 'power expended,' or resistance overcome,' being the space through which a body was moved, was erroneous."

The height through which a body is raised multiplied into its weight is a gauge for "work done" or "mechanical effect," more universally used than a two foot-rule is for measuring dimensions.

If an incorrect gauge is used, no wonder that there are some striking discrepancies in conclusions.

If we can determine the actual resistance overcome, when a body is moved through a space during a certain time, that, and that only, will be a true, unvarying criterion for mechanical effect.

It is well determined, both from theory and experiment, that if an initial velocity be given to a body in an upward direction, sufficiently great to raise it 16 feet during one second, it will overcome the uniform resistance of gravity for one second. Then to give a similar body double this initial velocity, it will raise the body not 32 feet, but 64 feet, and be two seconds in doing this work, or it will overcome the uniform resistance of gravity for two seconds.

Hence, although the spaces through which these bodies are raised vary as 1 : 4, the resistance of the force of gravity overcome, or the power expended in overcoming this resistance of the force of gravity varies as 1 : 2.

No example can be more simple or more striking. If it fails to convince, reading the remainder of this article will, I fear, be time lost to the reader.

It is on this false criterion of mechanical effect—"weight multiplied into space," that Bourne defiantly plants his flag as an advocate for the truth of the cube theory.

This false criterion receives universal approbation from all writers on mechanics. It is taught in all our books, and from the desk of every professor of natural philosophy in our schools.

If this is not sufficient evidence to rob it of even a shadow of error, then we may have the temerity to boldly question its correctness. My "*ipse dixit*" is not worth the paper on which it is written—and perhaps it will be said my reasoning is on a par with it in value, but if my reasoning on this subject will bear the test of examination, then our books on mechanical science will stand a slight overhauling to advantage,—and our philosophical professors may re-write some of their lectures. For several years I have particularly noticed the discrepancy on this subject, and have anxiously and patiently waited for some master mind to unravel the mystery. Page after page has been written, but no one appears to have drawn the curtain to one side.

If success should crown my effort, I shall be sufficiently repaid for my seemingly independent course of thinking, and thus trifling with the opinions of high authorities.

The criterion of resistance overcome is the pivot on which the whole subject beautifully turns.

If in any of the experiments recorded where the velocity varies as 1 : 2 we multiply the height through which the weights descended for a certain time, by the weights, while they were overcoming the resistance of the floating body,—to obtain the mechanical effect of the force of gravity developing power—then it would vary as the cube of the velocity.

But, if we multiply the times during which the uniform force of gravity was developing power (which times being equal), into the weights, which varied as 1 : 4, to obtain the mechanical effect which the uniform force of gravity developed, then it would as 1 : 4, or as the square of the velocity simply.

This fact is elegantly illustrated in the experiments made by the French Academicians as recorded in their Memoirs.

They may not have observed it particularly,—as this series of experiments were introduced to prove the cube theory beyond a doubt, and are referred to for such proof to this day.

If it is true that the force of gravity does develop four times as much power when it draws a body through a space of 64ft. in two seconds, that

it does in drawing it through 16ft. in the first of these two seconds, then the cube theory is correct.

It is evident that experiments and deductions made with a false criterion of mechanical effect are vitiated in their conclusions.

With this understanding, several years ago, I made an experiment on fluid resistance with the following results:

The experiment was a rude one however, the details of which I have lost, and with my present facilities, I cannot repeat it.

Two light metallic planes were so weighted as to keep the top side uppermost, and of a specific gravity but little greater than the water, and so filled in on the under side as to diminish the resistance of the water dragging after them as much as possible. So that when these planes were drawn up by cords from a depth of water of about 20ft. the great portion of the resistance was front resistance.

By a crank and axle having two diameters varying as 1:2, a coincident motion was obtained for each, but with velocities varying as 1:2.

A common spring balance was secured on the cord between the surface of the water and the axle.

This spring balance self-registered the maximum strain on each side. This strain on the cords as registered by their respective balances varied nearly as 1:2,—and not as 1:4.

To me it seemed to prove conclusively that the resistance for these planes, while moving during a certain time, varied as the square of the velocity,—and for a certain space as the velocity simply.

Hence the power required to overcome the resistance for a certain time would vary as the square of the velocity, and for a certain space as the velocity simply.

The practical bearing of this subject on the grand question of steamship resistance and propulsion, is very important, to say nothing of its influence on other great engineering questions.

The settling of it beyond dispute is a subject well worthy of the attention of those whose authority on such subjects could be received with confidence.

My authority, I know, is worthless,—my views on mechanics are bounded by narrow limits, and my attainments are very moderate; therefore, I should deeply regret leading any one astray,—if my firm convictions on this subject are erroneous.\*

## ROYAL NAVAL ENGINEERS.

In our last number we referred to a document put forward by the Royal Naval Engineers. We are glad to know that our comments upon that document have been the means of drawing attention to this subject in quarters where information is much needed.

Our attention has since then been directed to some of the charges which appear to have been suggested and recommended by the gentleman who was examined on behalf of the engineers of the navy, before the Committee of the House of Commons on Naval Promotion and Retirement.

The most important change recommended by the gentleman referred to, (Mr. Rumble, inspector of steam machinery at Sheerness,) relates to the reduction of the number of engineers required in our ships of war, and the substitution of a class of "skilled workmen" to do the actual mechanical labour involved in the various repairs which are from time required in the steam machinery.

This suggestion, which by the way is not entirely a new one, appears to have arisen out of one of the questions concerning the present standard of qualification required of candidates for entry into the navy. Members of the committee seemed to think that the proposed elevation of the standard of examination, would be the means of reducing the number of candidates from whom the Admiralty at present are able to select.

While on this question of examination, we must confess that our impression previously has been, that the statement of qualification required by the Admiralty was of such a nature that the examining officers were not limited in any way as to the extent to which they might test the professional abilities of the candidates, but that their tests were too frequently applied in so lax a way as to admit individuals of very questionable ability, either as regards theoretical knowledge, or mechanical skill, while the general education and intelligence of the candidate was never tested or inquired into at all. We have always looked upon this subject as a very fruitful source of evil in the service.

\* The above articles on Momentum and Fluid Resistance, written by Mr. John A. Grier, Chief Engineer in the U.S. Navy, were originally intended for THE ARTISAN, the author having to leave England suddenly for America before the completion of the articles. They afterwards appeared in the *Journal of the Franklin Institute*. Both articles have since been revised by Mr. Grier, and we are now enabled to reproduce them, denuded of some typographical errors which rendered some of the statements apparently very contradictory.—ED. ARTISAN.

Surely, there is not really anything incompatible between sound general education and the possession of that amount of mechanical skill which every marine engineer ought to possess. Professional knowledge and mechanical ability are, doubtless, the primary essentials for an engineer, but we believe if better means were taken to ensure some higher educational status in the candidates, we should hear less of that unfair and invidious treatment of which the class has so long had to complain.

This absurd idea of a sort of incongruity between gentlemanly manners and work, is, we fear, entertained by many of those who agree with the suggestion for the introduction of "skilled mechanics." We would warn such engineers, if they imagine that the introduction of such a class will relieve them from the necessity of possessing, and very frequently of exercising, that skill themselves, they will make a grievous mistake. It is an error to suppose that there is any real degradation in the work which is at times absolutely required of the young engineer; on the contrary, the possession of that very skill, if accompanied with the education and good manners which are essential to any one who aspires to be considered an officer and a gentleman, will be an additional claim to consideration and respect, in the estimation of all whose respect and consideration is really worth having.

One point in the examination of Mr. Rumble we would take exception to, is the proposal to draw the supply of engineers for the navy exclusively from the Dockyard Steam Factories. We believe such a course would be unfair, and at times detrimental to the public interest; many very valuable young engineers would be entirely excluded from competition; and we think the Admiralty might, with as much propriety, use our naval hospitals for the training of their medical staff.

It was suggested, also, that the proposed class of skilled mechanics, consisting of engine-fitters, boiler makers, coppersmiths, &c., should be made petty officers in Her Majesty's service. We have very little hesitation in saying that any attempt to induce skilled workmen in the above trades to go to sea as petty officers, at the rate of 2s. 3d. per day, will not, can not, and ought not to succeed. We think skilled workmen who can obtain five, six, or seven shillings per day on shore, will smile to hear that such a proposition could have been seriously entertained by any naval engineer whatever.

This question, altogether, is one of great importance and requires more consideration than it appears to have received at present. At any rate we would recommend caution in its introduction, and great care and taste in its carrying out. That the suggestion itself may be a good one, and that it may ultimately be successfully adopted, we readily believe; in fact, it does appear to strike any ordinary observer that it cannot possibly be necessary, for the management of the machinery of any single ship, to carry a large staff of scientific engineers, every one of whom expects to become an Inspector of Machinery, or, perhaps, a dockyard Chief Engineer; at the same time common sense seems to indicate that proper information should be obtained, and proper precautions taken before such a change is attempted, or the inevitable result will follow that another class of men will be introduced into Her Majesty's Service to worry the authorities with their grievances and demands for redress.

Two things appear to our minds absolutely necessary to the successful introduction of any such scheme. The first is to give the engineers, already in the service a much higher status both as regards pay and position, and by demanding a higher educational standard than has hitherto been deemed sufficient; and, secondly, by giving the proposed class of skilled workmen such a rate of pay as shall induce really decent workmen to enter, and such a position in the service as shall remove them from the possibility of being subject to the treatment at present inflicted on the stokers and engine-room petty officers now in the navy.

It cannot be doubted that to carry out, with any degree of success, such an important change will, indeed, require the hearty co-operation of the present staff of engineers, and the fear which many of these already feel lest the contemplated change should ultimately lead to the reduction of the entire class to the old position of warrant officers, might very wisely be removed by the introduction of those liberal measures which, even on other grounds, the class is justly entitled to.

Some other points in connexion with this subject, which were referred to before the House of Commons Committee, we must leave for consideration in a future number; in the meantime we commend the above remarks to the attention of the Admiralty, as being dictated by a real desire to benefit the public service as well as to ameliorate the condition of an important and a deserving class of officers.

We are glad to learn that the Admiralty have, within the last week or two, given an installment in the matter of pay, by granting a small additional sum per day—as "charge money" or "store allowance"—to those officers who are in charge of machinery in commission.

We trust we may soon have to announce that the question of naval engineers' pay, at last, has been settled in a satisfactory manner, by a liberal improvement being made in the pay of all classes from the Second Assistant to the Inspector of Machinery.

## SCOTTISH SHIP BUILDERS' ASSOCIATION.

## ON A NEW SLIP DOCK MODEL.

By MR. ROBERT DUNCAN.

In describing the model of the slip dock cradle, with the various suggested improvements, I may previously assume that the application for slip docks for the repairing of vessels is so well known to you all, that little more is left than merely to describe my plans, with the uses that might be advantageously obtained from them; their easy application to the present existing cradles, and the general superiority of slip docks, for the repairing of vessels, over all other docks.

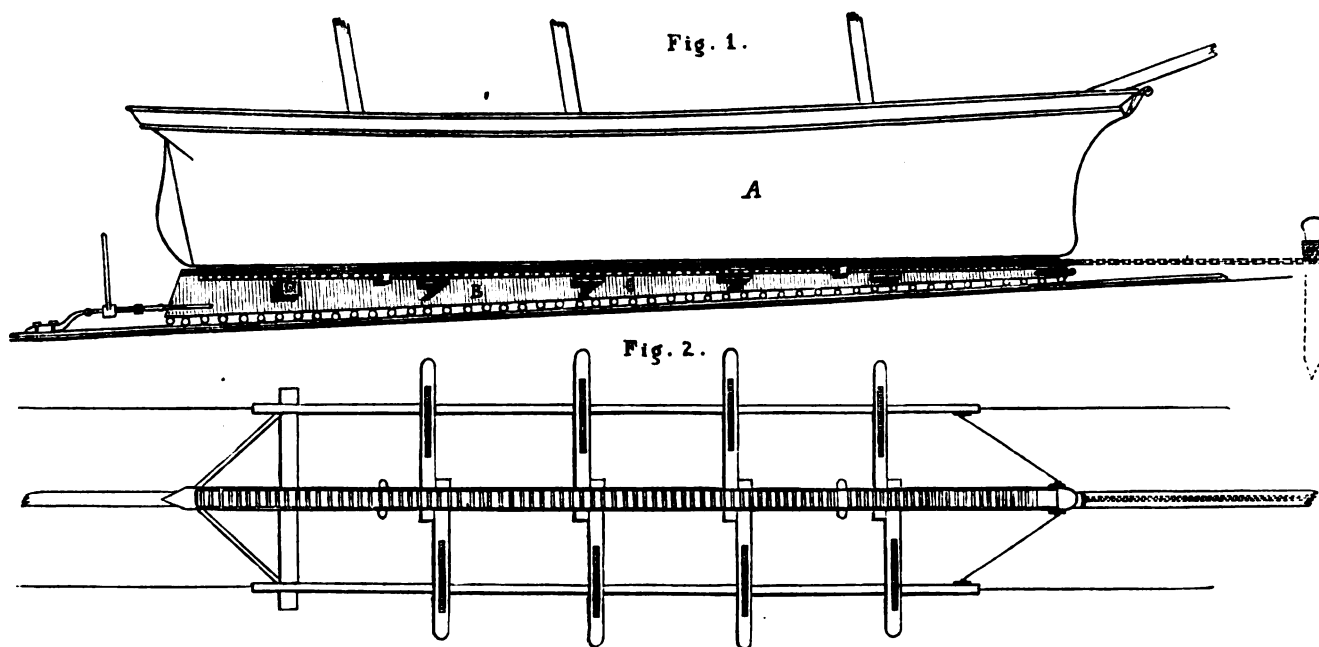
In the first place, the principal advantage I aim at is to do the same amount of work that is done on other slips in a shorter time, and at a comparatively less cost, which, if attained, you will all admit, is the great desideratum of the times we live in.

With reference to the model, in the accompanying illustrations, Fig. 1 is a longitudinal section, showing the cap with vessel resting on rollers. Fig. 2 is a plan of the cradle, &c. I will first draw your attention to the main or centre part of it. In external appearance there is little difference between it and the present existing cradles; but by a closer inspection, or from the drawings you will at once perceive my object, which is to simplify its removal from underneath vessels, when repairs, on the keel or otherwise, renders its removal absolutely necessary. The removal of the cap,

length to work easy in the recess. The flat pieces of wood that lie in the recess are intended to keep the rollers from twisting or slanting when in motion; but they can easily be dispensed with, as the distance they require to travel is so small (being about two feet or three feet at most on a working cradle). Supposing the rollers did incline to slant or twist when revolving, this could be avoided by fixing centre pivots in the rollers, as shown in the woodcut on next page, with long strips of sheet iron, and holes cut in them at the respective distances, so as the pivots of each roller would fit in them; or there could be grooves cut in the rollers, and made to fit into corresponding longitudinal guides; but I consider the plain roller quite suitable.

The arms of the cradle fit into notches in centre part, so as to give an even surface for the working of the rollers. The two preventative keys or lockers, that are placed at the most suitable position for them, owing to their dovetail shape, serve the double purpose of binding the cap and main centre together whilst vessels are being hauled up on the slip, and prevent the cap from floating from off the centre part, whilst the cradle is submerged in the water.

In order to show you the method of relieving the cradle from underneath the vessel:—Suppose the vessel to be resting on cap of the cradle, with the rollers suitably placed in centre recess, and the two preventative keys in their places, the palls that are hinged on under side of centre part of cradle and fit into the ratchets of centre rails (in the usual way),



or sliding part, will enable you to see a recess that is cut in the main or centre part. It is a cut to a depth so as the rollers that are placed in it may project a little above the flush of the side flanges, in order to prevent the under side of cap or sliding part from rubbing on the top of the side flanges, thereby evading the friction that would necessarily ensue. In the event of the centre part being made of pitch pine, or any sort of soft timber, the bottom of recess would require to be laid with good hard British oak, or other such timber most suitable, or, in order to prevent the rollers from great friction, it might be covered with iron.

Owing to the thinness of the sliding cap, it could be made wholly of British oak, which I think is of sufficient solidity to prevent the rollers from sinking into it when the weight of the vessel is upon the cradle. On the sides of the cap are two guide flanges, that fit and work easily on sides of the centre part, and are intended to keep the cap from twisting to either side when the relieving of the cradle is being performed. The small blocks on the top of the cap are fixtures, never requiring to be raised or lowered, as on present existing cradles; on account of the accommodating nature of the hinged blocks on tops of the cradle arms,

The rollers are placed all along from fore to after part of recess, and quite close to each other, with the exception of the allowance required at fore part and at keys, for the removal of the cradle from the cap, thereby giving the cap an almost solid bearing on its whole length. The rollers would require to be of British oak or lignum-vitæ, and made of sufficient

are also supposed to be down, and holding the cradle from running backward. The hauling-up chain or rods are unshackled from centre part and shackled to the cap, and securely fixed, either to a pall at head of the slip or to the engine. This done, the cradle is again eased up a little bit, in order to lift up and gag the palls; the blocks on which the vessel rests are, of course, laid along her bilges, slightly wedged, but with no attempt to raise her; and the preventative keys driven out. The screw at after part of the cradle is then shackled to it, and turned by the handle or lever that fits into holes in its boss, thereby screwing the cradle backwards, whilst the cap remains stationary, or rather falling perpendicularly with the vessel till she rests on the blocks; the cap then can be unshackled, when both it and the cradle can be lowered down the slipway for the completion of the vessel's repairs. When the repairs are completed she can in a similar manner be raised from off blocks to her original position on the cradle.

The arms of the cradle are made to turn on a pivot, which gives great ease in shipping or unshipping them, and also safety to workmen, as the pivot prevents them from falling off side parts of the cradle.

The bilge or steadying blocks placed on the arms, as shown in the woodcuts annexed, are intended to suit any vessel's bottom that may go on the slip, without further labour in altering them, as is a constant occurrence with the existing mode of bilge blocks. Their action is at once apparent. A

socket is fixed on the arm, and made so as it can be shifted out or in upon it; the inner end of the bilge block is fitted into this socket, and hinged by a bolt that passes through both; on the outer end of the block is hinged, by a bolt, a three-legged pall; these legs fit successively, as the block is raised up, into a ratchet indented or sunk into the cradle arm. The rope for lifting the block up to the vessel's bottom is placed at its outer end, and a line fastened to one of the legs of the pall, for the purpose of lifting it out of the ratchet, so as the blocks can be lowered, in the event of an accident of any kind occurring. The pall is relieved from the ratchet by a screw-pin that works in lower end of the pall, the point of which presses against the ratchet.

The guide-rods aft are so arranged that they fit into what may be termed the dead wood of the cradle, and are always shipped ready for use, and easily wrought. I may here mention that the above plans could, with little expense, be easily applied to the present existing cradles.

The foregoing descriptions constitute the improvements I propose for slip dock accommodation, with the exception of the removal of cradles and

vessels, especially in places where there is sufficient length to admit of more than one vessel at a time; whereas, by this plan, three could be undergoing repairs at the same time, viz., one on each side and one on centre of the slip.

New vessels could also be built on either side, and launched down the slip way, thereby saving the expense of laying launching ways, &c.

I may mention that there could be various methods adopted for the relieving of vessels from the cradle by the sliding cap other than that of the rollers; for instance, cast metal shot or balls could be laid in the recess, or, the cap could slide on a plane surface on top of centre part by being soaped or greased, but would perhaps entail more trouble and expense in doing so.

With regard to the advantages derived from the various constructions of docks for the repair of vessels, including the graving or dry dock, the floating dock, the hydraulic dock, and the slip dock, the latter I consider most preferential for executing repairs, on account of the free current of air that passes along and through vessels when on the slip,

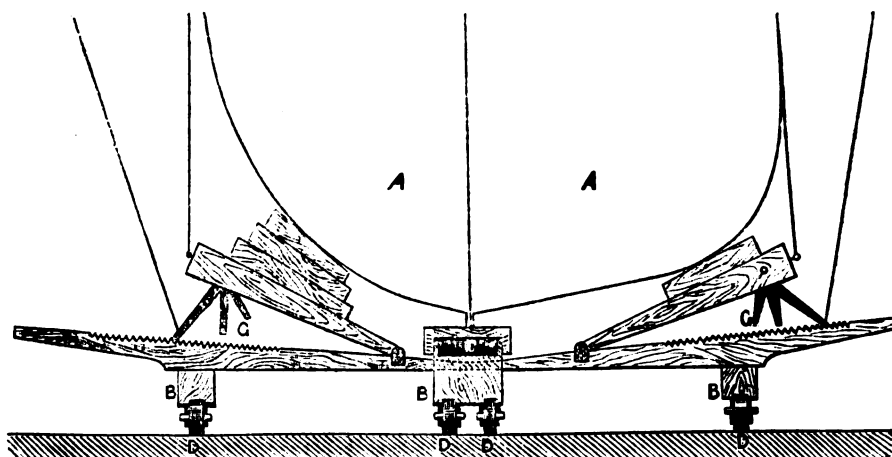


FIG. 3.



Fig. 5.

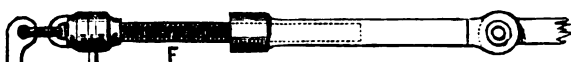


Fig. 6.



Fig. 7.

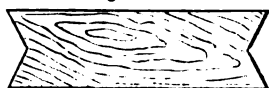


Fig. 8.

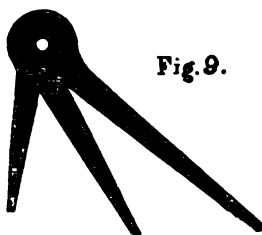


Fig. 9.

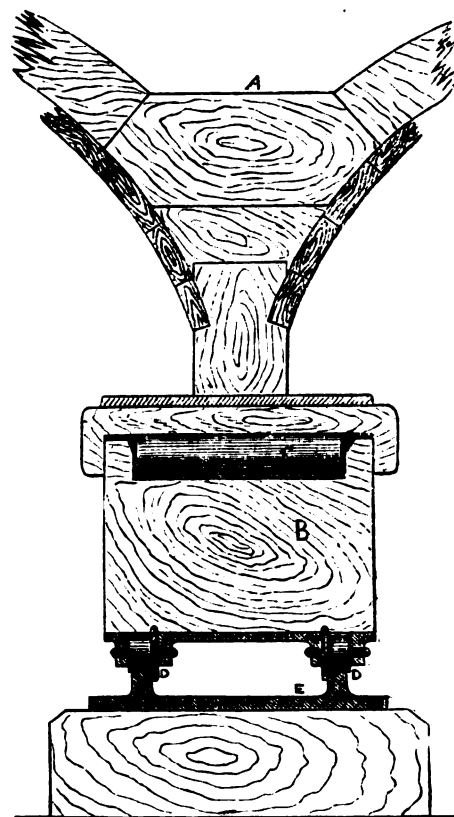


FIG. 4.

vessel to either or both sides of the slip, which plan is confined to the construction of the longitudinal rails with thin sleepers or bearers, and is as follows:—

Supposing the length of cradle required is 100 feet, I would accordingly have 100 feet of rails, and the sleepers they are attached to, made portable—that is, the under side of longitudinal sleepers thickly studded with wheels, to run on rails placed at right angles to the line of slip; the centre and two side longitudinal rails would require to be connected to each other by distance-rods, so as, when the power was applied to remove the cradle with vessels to either side, they would all move in a uniform parallel direction. Two hinged lockings would be required to keep the stationary and portable rails in a secure line of position, whilst the cradle with vessel was being hauled up.

By this plan beneficial results would be obtained for the repairs of

which is a great advantage, especially for wooden vessels. When being re-classed and when freely exposed, the free current that passes through them revives and freshens the timber, and dispels the damp stagnant air which engenders dry rot. The same beneficial result is also obtained in iron vessels when being painted, as the air, for the purpose of making the paint adhere to the iron, may well be termed a good patent dryer. Similar advantages are not to be obtained in a graving or floating dock. Workmen can also continue their labours longer during the winter, by having the daylight longer by about half an hour at evening and morning, than in the two first-named docks, which is of course a great advantage to ship-owners, and well worthy of their notice.

The hydraulic has equal advantages to that of the slip dock with regard to air and light; but it has one disadvantage more than the others, by being more fraught with danger.

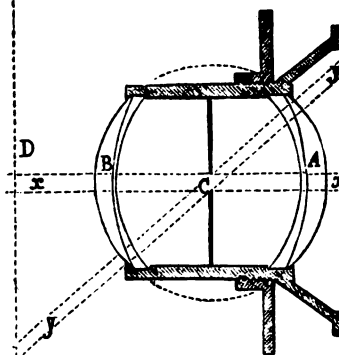
## THE GLOBE LENS FOR PHOTOGRAPHIC CAMERA.

We extract from a recent number of the *American Journal of Science and Art*, the following article by Mr. Coleman Sellers, on the nature and advantage of the globe lens for the photographic camera. The subject being one that has attracted considerable attention and discussion, more especially amongst those interested in photography, we will allow Mr. Sellers to state his opinion and the results arrived at by him from the use of this description of lens:—

Photography, with the discovery of the use of collodion, seemed to leap into its present high position at one bound, at least so far as the chemistry of the art is concerned. The negatives of to-day look like the negatives of the first experimenters, and the chemical process of their production is essentially the same. But with the optics of photography the case is different—here there has been a steady improvement. The wants of the portraitists have been met by the construction of new objectives suited to the style of pictures to be produced. In these instruments depth of field with free admission of a large volume of light was what was most sought for. Theory could not dictate what shape or combination of lenses would best produce this result, and patient experiments were resorted to. The requirements of landscape photography are quite different from those of portraiture. A portrait tube may be used to take views if it be provided with a stop or small opening to limit the amount of rays passing through it and thus to deepen the field, or increase the "reach" of the instrument, as it is technically called. This involves loss of light, and consequently diminishes the quickness of its working. We hear continually of rapid or instantaneous photography, and we are often led to believe that the rapidity is to be ascribed to some wonderful sensibility of the chemicals used; but this is only partially true, and to the optician is due the most of the merit of instantaneous pictures. A portrait tube with its full opening will, in a sky-light room, produce a picture in perhaps ten or fifteen seconds. This same instrument, with the same opening and same chemicals, exposed to an extended view in bright sunlight, could not be opened and shut quick enough; the immense volume of light reflected from so large an area of space being concentrated on the same sized plate as in the first case, would be too violent in its action, and from the nature of the instrument near and distant objects could not be brought into focus at the same time.

The human eye, when the head is at rest, takes in an angle of view of at least  $70^\circ$  or  $80^\circ$ , the whole of which is not seen clearly at once, but can be examined in detail by the almost unconscious rolling motion of the eye in its socket—the actual included angle of clear vision at any one instant being only  $1^\circ$  or  $2^\circ$ . Hence a picture of a landscape, for instance, to fill the eye and seem a true representation of nature, should include an angle of at least  $60^\circ$ . Ordinary instruments, such as have hitherto been used, do not include an angle of more than one-half this amount, and hence has originated the complaint that photographic views represent mere patches of scenery and not pictures. I remember once standing on a bridge—camera in hand—and looking up the romantic Wissahicon. The picture presented to my eye was very beautiful—the centre a waterfall framed in on both sides by wild and rugged rocks and spanned above by the arch of a railroad bridge crossing at the tops of the cliffs. The foreground was made up of a stony bed, where danced and foamed the rapid current. I planted the camera and hoped soon to peel off from this charming view a cuticle (as Dr. Holmes says) which like plates of mica could be split and re-split for the collections of my friends. But on the ground glass I found nought but the tumbling water. No rocks, no bridge, no stony river bed—the poor camera in its empty head was incapable of taking in the whole of the charming picture. One of the dreams of the photographer has been of an instrument which should embrace a large angle and thus satisfy the wants of the eye; but, with the majority of the attempts in this direction came other evils, the greatest of which was distortion of the marginal lines. The aplatic lens of Grubbe is said to comprise an angle of  $70^\circ$ , but in a view before me of Trinity College, Dublin, taken with this lens, there is a curvature of the straight lines of the roof of more than one-eighth of an inch in its length. Mr. Sutton's panoramic lens, a sphere of glass filled with water, includes a very large angle, over  $100^\circ$ , on the base line, but the pictures are produced on curved plates, which require curved holders, baths, and printing frames, and, in the case of architectural pictures, the right lines are distorted, unless the picture be bent to the curvature of the plate upon which it was taken, and thus viewed near the centre of the curvature.

The Harrison and Schnitzer globe lens consists of two achromatic meniscus lenses placed with their concave sides together, and so made that their outer curved surfaces form part of a perfect sphere and the light is admitted through an aperture placed midway between the two lenses, i.e., in the exact centre of the external sphere. The annexed figure represents



one of these instruments, A and B being the meniscus lenses, and C the centre opening through which the rays of light pass. The focus of such a lens one and three-quarters inches in diameter is two and one-half inches for distant objects, measuring from the surface of the back lens to the ground glass D. The circle of light produced is five inches in diameter, and from this may be cut the ordinary 3 inches square of a stereoscopic picture. The included angle of light in the five inch circle is  $75^\circ$ , and in the three inch square picture cut from it is contained just four times the area of any instrument I have ever tried, suited to similar work.

The remarkable property of this lens consists in its absolute correctness of reproduction. If it is used for copying purposes, the marginal lines are copied as straight as the originals, and, if a copy be made the same size as the original, the photographic copy will, if laid upon the original, match it in every line. I have said that the globe of 2½ in. focus will make a circle of light of 5 in. diameter. This is when a distant landscape is in focus. If it is used for copying, the circle of light increases in diameter as the object approaches the front lens and the ground glass recedes to focus, so that an instrument which will cover a given size plate for views will cover one of twice the size, when reproducing the size of the original. As the lenses increase in size and length of focus, the plates covered increase in size, and the amount of glass in the lenses bear a larger proportion to the brass work in which they are mounted, and hence the included angle of vision is increased, so that while in the 2½ in. globe the included angle is  $75^\circ$ , in a 12 in. globe (that is, one of 12" focus) the included angle is over  $90^\circ$ . It has been said that the light, being admitted through a round hole in a plane plate in the centre of the instrument, must be much more intense at the centre of the field than at the margin, and some writers have stated this fault to be one of great magnitude. Practice, however, does not show the evil to be so great as they represent, if it exists at all. By reference to the cut, it will be seen, that the dotted lines x x representing a pencil of light of the diameter of the centre opening passing through the axis of the instrument, and y y representing a pencil of light passing through the same opening obliquely, doubtless the area of the centre one will be the largest, but as it passes through much thicker glass than the rays y y, may not the ultimate effect of each be equalised? I do not pretend to any knowledge of the theory of optics, and must confine myself to facts. In the trial of many of these lenses, of different sizes, I have never found the evil to exist, and all the pictures I have made with the globe lens are remarkable for the even illumination of the field. At the last two meetings of the Photographic Society of Philadelphia (February, 1863), the merits of these lenses have been discussed—full credit for correctness of reproduction was recorded to them by all; but the quickness of working was questioned by one gentleman, who stated that in broad sunlight he had exposed an engraving for several minutes and had obtained an under-exposed negative, while all others present who had tried them were unhesitating in their assertions that they were remarkably quick workers when the size of aperture was taken into consideration. A few days ago I placed in bright sunlight an engraving from the London Art Journal, and copied it on a 6½ by 8½ plate with the same size instrument as was used by the gentleman who questioned its quickness. An exposure of 25 seconds gave an impression which flashed up instantly under the developer, assuming great intensity in the light and showing unmistakable symptoms of over exposure, so that I can see no reason why the same law should not hold good with these lenses as with others, viz: that, with the same area of opening to admit light, the shorter the focus the quicker they will work. For interiors, the short focus and large angle of vision possessed by these instruments render them invaluable, and as they are provided with a revolving diaphragm plate in the centre (not shown in the cut) various sizes of aperture can be brought into position, just as the stops under the table of some compound microscopes are arranged, and thus the largest amount of light, consistent with sharpness, admitted.

In the English journals, when the accounts of this instrument were first published, it was denounced in no measured terms, as being constructed on erroneous principles, and the assertion has even been made that its very shape must give fearful distortion to marginal lines, but since it has been proved to be no failure, and its success is no longer an experiment, comes the unwilling acknowledgement: "The principle of its construction must ensure correct marginal lines," and last of all comes the declaration that it is "old, very old." Everybody had been making them for years, and there is no merit of invention due to the patentees! Granting that lenses may have been made with an external spherical

focus, as is the Sutton case, it will be difficult to produce a lens, made previous to the invention of this now described, composed of two achromatic meniscus lenses combined, as these are, and producing a like result. The theory of operation and mode of construction of the globe lenses admit of their being readily made of various focal lengths, and thus, by the use of a series of instruments, the whole included angle can be made available on any size plate that may be desired; the six inch focus covering a 6 $\frac{1}{2}$ in.  $\times$  8 $\frac{1}{2}$ in. plate and the 12in. focus lens covering 14in.  $\times$  18in., each including the same angle. One great advantage of short-focus lenses, when there is no spherical distortion, is in the appearance of perspective produced. If, for instance, we would view a machine or statue to the best advantage, we stand at such a distance from it as will admit of our viewing the whole of it in the eye at once, and can then best judge of its proportion. If now a picture be made by an instrument of long focus, it will be so far away from the object to be depicted as to make, as it were, too nearly a plane or flat view of it, deficient in perspective effect. With the very shortest focus of this new lens (the 2 $\frac{1}{2}$ in. focus), this perspective effect may be too much exaggerated, but with all the other sizes it is not, and with the globe lens and with this only have been produced pictures which seem to me to convey a just idea of size and proportion. The shortness of their focus adds much to their portability, as the camera is made smaller than usual, and amateur field photography with the globe lens and dry plates is a pleasure in place of labour. Its advantages may be summed up in a few words. Short focus, clear definition, wide angle of included vision, absolute correctness of copy on a plane surface, and tolerably quick work. It takes the place entirely of the orthoscopic lens, giving absolute correctness to marginal lines, while the orthoscopic was only approximately correct. It fills all the requirements of a lens for landscape and architectural work, and is wanting only in the one thing of absolute instantaneity of action.

# ROYAL INSTITUTION OF GREAT BRITAIN.

## AN ACCOUNT OF SOME RESEARCHES ON RADIANT HEAT.

By JOHN TYNDALL, Esq., F.R.S.

In his former researches on the radiation and absorption of heat by gaseous matter, the speaker compared different gases and vapours at a common thickness with each other; one part of his present object was to compare different thicknesses of the same gaseous body with each other as to their action upon radiant heat. A few years ago he would be deemed a bold man who would attempt to measure the action of an inch, or indeed of many feet of gas, on radiant heat; but the present experiments commence with plates of gas only 0.01 of an inch in thickness, and extend to thicknesses of 49.4in. Thus, the greatest thickness is to the least nearly in the ratio of 1 to 5000. The apparatus employed for the smaller thicknesses was a hollow cylinder, one end of which was closed by a plate of rock-salt. Into this fitted a second cylinder, with its end also closed by a plate of the salt. One cylinder moved within the other like a piston, and by this means the two plates of salt could be brought into flat contact with each other, or could be separated to any required distance. The distance between the plates was measured by a *cerometer*. The cylinder was placed horizontal, being suitably connected with a source of heat. This latter consisted of a plate of copper, against which a steady sheet of flame was caused to play.

The absorption of radiant heat by carbonic oxide, carbonic acid, nitrous oxide, and olefant gas was determined with this apparatus, and such differences as might be ascertained from former researches were found. Olefant gas maintained its great superiority over the other gases at all thicknesses. A layer of this gas, not more than 0.01 of an inch in thickness, intercepted about 1 per cent. of the total radiation; and the delicacy of the apparatus may be inferred from the fact that this absorption,—great, relative to the thickness of the layer of gas, but small absolutely—corresponded to a deflection of 11 degrees of the galvanometer. (It would be certainly possible to measure the action of a layer of this gas of less thickness than the paper on which these words are printed.) A layer of olefant gas, 2in. in thickness, intercepts nearly 30 per cent. of the entire radiation. The influence of a diathermic envelope surrounding a planet may be strikingly illustrated by reference to this gas. A shell of olefant gas, 2in. thick, surrounding the earth, would offer no appreciable hindrance to the solar rays in their earthward course; but it would intercept, and in great part return, 30 per cent. of the terrestrial radiation: under such a canopy the surface of the earth would probably be raised to a stifling temperature. A layer of the gas, 3-10ths of an inch thick, intercepts 11.5 per cent. of the whole radiation. Such a layer, if diffused through a stratum of air 10ft. thick, would be far more attenuated than the aqueous vapour actually diffused through the air; still it would produce an absorption greater than that which the speaker had assigned to the atmospheric vapour within 10ft. of the earth's surface. In the presence of such facts, the arguments which we might be disposed to base on the smallness of the quantity of atmospheric vapour are entirely devoid of weight.

In measuring the action of larger thicknesses of gas, the following method was pursued:—A brass cylinder, 49.4in. in length, had its two ends stopped with plates of rock salt, and a suitable source of heat placed at one end; the rays from this source passed through the tube, and were received by a thermo-electric pile placed at its opposite end; this radiation was exactly neutralized by the heat emitted from a cube of boiling water and incident on the opposite face of the pile. The interception of any portion of the heat emanating from the source by a gas or vapour introduced into the tube destroyed the equilibrium previ-

ously existing, and the amount intercepted was declared by the galvanometer. The thickness traversed by the calorific rays was varied in the following way:—The tube was divided into two distinct compartments by the introduction of a third plate of rock salt. Let us agree to call the compartment most distant from the pile the first chamber, and that adjacent to the pile the second chamber. The experiments began with the first chamber short and the second chamber long, and ended with the first chamber long and the second chamber short. The alteration consisted solely in the shifting of the intermediate plate of salt, which lengthened the first chamber and diminished the second one by the same quantity; the sum of the lengths of both chambers being the constant quantity, 49.4in.

The absorption effected in the first chamber acting alone was first determined; then the absorption effected in the second chamber acting alone; and, finally, the absorption effected when both the chambers were occupied by the gas or vapour. This arrangement enabled the speaker to check his experiments, and also to examine the effect of the sifting which occurred in the first chamber on the absorption of the second one. The thermal coloration of the various gases was rendered strikingly manifest by these experiments. For the vast majority of the rays, for example, carbonic oxide and carbonic acid are transparent. Placing a stratum of carbonic oxide, 8in. in length, in front of a column of the same gas, 41.4in. long, these 8in. intercepted 6 per cent. of the whole radiation; placed behind a column, 41.4in. long, the absorption of the same 8in. was sensibly nil. So also with carbonic acid; 8in. in front absorbed 6 $\frac{1}{2}$  per cent., while placed behind the effect was almost zero. Similar remarks apply to the other gases, the reason manifestly being that when the 8in. stratum is in front, it stops the main portion of the rays which give it its thermal colour, while, when it is placed behind, these same rays have been almost wholly withdrawn, and to the remaining 94 per cent., or thereabouts, of the radiation the gases are sensibly transparent.

An extension of this reasoning enables us at once to conclude, that the sum of the absorptions of the two chambers taken separately must always be greater than the absorption effected by a single column of the gas of a length equal to the sum of the two chambers. This conclusion is illustrated in a striking manner by the experiments; and it is further found that when the mean of the sums of the absorptions is divided by the absorption of the sum, the quotient is sensibly the same for all gases. It may also be inferred from considerations similar to the foregoing, that the sum of the absorptions must diminish, and approximate to the absorption of the sum, as the two chambers become more unequal in length, and that the sum of the absorptions of the two chambers is a maximum, when the medial rock-salt plate divides the long tube into two equal compartments.

In these days a special interest attaches itself to the radiation of any gas through itself or through any other gas having the same period of vibration. The speaker referred to the results of an elaborate series of experiments on this interesting question. The experimental tube, 49.4in. long, was divided into two compartments by a partition of rock-salt. All external sources of heat were abolished, and the pile, furnished with its conical reflector, stood at the end of the tube. The compartment nearest the pile contained the gas which was to act as absorber, while that most distant from the pile held the gas which was to act as radiator. It is known that the destruction of the motion of a sensible mass of matter is always accompanied by the evolution of heat. A weight falling to the earth, and a ball striking a target, are heated on collision. The same is true for atoms, and in the present experiments the gas in the radiating chamber was heated by the collision of its own particles against the inner surface of the tube when they rushed in to fill the vacuum. The radiation was, in fact, what the speaker had named "dynamic radiation." The lengths of the two chambers were varied, the radiating column being lengthened and the absorbing one shortened at one and the same time; the sum of both was always the constant length 49.4in.

The experiments with the vapours were thus executed. Both the chambers into which the tube was divided were, in the first place, occupied by the vapour to be examined; the usual pressure being 1-80th of an atmosphere. The entrance of the vapour was so slow, and its quantity so small, that the radiation due to the warming of the vapour by its own collision was insensible. The needle being at zero, dry air was allowed to enter the chamber most distant from the pile. This air became heated dynamically, communicated its heat to the vapour, and the latter immediately discharged the heat thus communicated to it against the pile. It is quite evident, that not only does this case resemble, but that it is actually of the same mechanical character as that in which a vibrating tuning-fork is brought into contact with a surface of some extent. The fork, which before was inaudible, becomes at once a copious source of sound. What the sounding-board is to the fork, the compound molecule is to the elementary atom. The tuning-fork vibrating alone is in the condition of the atom radiating alone, the sound of the one and the heat of the other being alike insensible. But in association with sulphuric or acetic ether-vapour the elementary atom is in the condition of the tuning-fork applied to its sound-board, communicating through the molecule motion to the luminiferous ether, as the fork through the board communicates its motion to the air.

The experiments demonstrate the great opacity of a gas to radiations from the same gas. They also show in a very striking manner the influence of attenuation in the case of vapour. The individual molecules of a vapour may be powerful absorbers and radiators, but in thin strata they constitute an open sieve through which a large quantity of radiant heat may pass. In such thin strata, therefore, the vapours, as used in our experiments, were generally found far less energetic than the gases, while in thick strata the same vapours showed an energy greatly superior to the same gases. The gases, it will be remembered, were always employed at a pressure of one atmosphere.

A few striking experiments were referred to in illustration of the influence of a paper lining, or a coat of varnish or lampblack, within the experimental tube. In dynamic radiation it is not possible to do entirely away with the action of the interior surface of the tube itself. When the tube is of brass and well

polished within, the entrance of the air produces a deflection of 7.5 degrees, this being due to the emission from the warmed surface of the tube. A lining of paper two feet long raises the radiation sufficiently to drive the needle through an arc of 80 degrees, while a ring of paper 1½ in. long placed within the tube radiates sufficient to urge the needle through an arc of 56 degrees.

The speaker finally examined the diathermancy of the liquids from which his vapours were derived, and the result leaves no shadow of a doubt upon the mind, that both absorption and radiation are molecular phenomena, irrespective of the state of aggregation. If any vapour is a strong absorber and radiator, the liquid whence it comes is also a strong absorber and radiator. The molecule carries its power, or want of power, through all its states of aggregation. The order of absorption in liquids and vapours is precisely the same; and the speaker looked forward with hope to the application of these results to other portions of the domain of thermotics.

#### ON THE DIRECT MEASUREMENT OF THE SUN'S CHEMICAL ACTION.

By PROFESSOR ROSCOE, B.A., F.C.S.

The life of the animal may be described chemically as a process of oxidation; the tissues of his body are continually undergoing combustion; he is constantly breathing out carbonic acid gas, and thus deteriorating the ocean of air at the bottom of which he lives and moves; so that, were not a counteracting influence at work, he would, during each moment of his existence, be working his own destruction. This counteracting influence is exerted by vegetables, whose life is chemically characterised by a change opposite to that of the animal, that, namely, of deoxidation or reduction. Animals take up oxygen and give off carbonic acid; plants reverse the process, they take up carbonic acid and give off oxygen; and thus the balance of atmospheric life is kept always true.

The animal derives its power from the forces locked up in the vegetable organisms which constitute its food, and of which it builds up its tissues. When they are destroyed by the action of the atmospheric oxygen, these forces become evident either in motion of the masses, constituting mechanical action, or in the motions of the particles constituting heat, or other manifestations of energy. The animal cannot create force; he can only direct its application: he cannot move a muscle without a certain given quantity of force being changed, without a certain portion of the tissues undergoing oxidation, an amount which is regulated by the grand principle of the conservation of force—so that the total energy which the animal exhibits is regulated by the same laws which apply to the work of the steam or electro-magnetic engine. Every pound of carbon burnt to carbonic acid in the animal body evolves heat enough to raise the temperature of 8080 lbs. of water 1° centigrade, or can produce a mechanical effect sufficient to raise 2784 tons one foot high.

The source of the power of the animal is evident; it lives upon the force which has been accumulated by the plant. The animal world cannot continually withdraw energy from the plant, unless the latter receives as continual a supply. The source of this energy is the sun; the plant sucks up or absorbs the rapidly vibrating solar radiations and stores them up to be given out again in the various forms of energy; when the vegetable tissue is destroyed by oxidation.

It is only in the presence of the sunlight that the true function of plant life can be exercised. It is the sunlight which, acting on the green colouring matter of leaves, decomposes the carbonic acid of the air into its constituent elements, enabling the plant thus to assimilate the carbon and to turn the free oxygen back into the air.

Only those of the solar rays which vibrate the most rapidly are able thus to tear the particles of carbon and oxygen asunder, or to effect a chemical change; and these most refrangible or violet rays have, therefore, been called the chemical rays—not that there is any difference in kind between these and the other solar radiations; they all differ only in a wave length and in an intensity of vibration.

These blue rays then, falling on the green portions of plants, are absorbed to do work; their rapid vibrations are used up to set free the carbon and oxygen, and the heat equivalent to these absorbed vibrations is again given off when the carbon thus produced is burnt.

The speaker illustrated the chemical activity of the blue rays, and the inactivity of the red rays, by showing that a bulb filled with chlorine and hydrogen explodes when exposed to an intense blue light, but is unacted upon by an equally bright red light.

The measurement of the amount of these chemically active rays falling at a given time upon a given spot, must be of the highest meteorological interest; as their variation forms a most important element in the changing plant and animal-producing power of a country.

Three years ago (March 2, 1860), the speaker brought forward the results of a series of experiments undertaken by Professor Bunsen and himself for the purpose of obtaining a means of accurately measuring the chemical action of sunlight.

The measure consisted in the quantity of hydrochloric acid formed by the action of light upon a mixture of equal volumes of chlorine and hydrogen gases. The authors succeeded in arranging a most accurate and reliable chemical photometer, by help of which the laws regulating the chemical action of light were investigated, and the distribution of direct and diffuse sunlight upon the earth's surface determined when the sky is unclouded.\* The delicate nature of the instrument, which the sensitive substance rendered necessary, precludes the general use of this chlorine and hydrogen photometer, and the method is likewise inapplicable when we wish to measure the total effect produced by the varying cloud and sunshine of our changing climate.

The object of the present research, carried on by Professor Bunsen and the speaker, has been to invent an easy and reliable mode of measuring the daily

variation in the sun's chemical intensity which should be applicable to regular meteorological registration.

Thermometric observations, giving the mean monthly or yearly temperature of a country, by no means yield all the data required for the estimation of the true climatology of the place, or of its plant and animal-producing capabilities. For this purpose we require to have not only the amount of solar heat directly or indirectly reaching the spot; but likewise the amount of chemically active solar light which falls there. This is strikingly seen when we compare the mean annual temperature of Thorshavn (Faroe Islands) with that of Carlisle.

|                 | N. lat. | W. long. | Temp. Fah. | Diff.   |
|-----------------|---------|----------|------------|---------|
| Thorshavn ..... | 62° 2'  | 6° 48'   | 45° 6'     | } 1° 3. |
| Carlisle .....  | 54° 54' | 2° 58'   | 46° 9'     |         |

In these two situations the mean annual temperature is nearly equal, but the quantity of sunlight falling upon these two places differs most widely, and we have a corresponding difference in the true climatological relations. Owing to the constant moisture and cloudy state of the atmosphere, which the sun's chemical rays cannot penetrate, the flora of the Faroes and Shetlands is of the most limited description, only the most hardy variety of shrubs and no trees flourishing; whilst at Carlisle we have the most luxuriant vegetation accompanying a more sunny sky. Thus, too, the mean summer temperature of Reykjavik in Iceland is only 3° 8 Fah. below that of Edinburgh, whilst the difference between the mean summer temperature of Edinburgh and London is 5° 4 Fah. Yet in Iceland no tree grows; whilst between London and Edinburgh we notice no marked difference as regards the development of vegetable life. Hence we see that places upon the same isothermal do not necessarily possess a truly corresponding climate; this can only be attained when, amongst other conditions, the places are situated upon the curve of equal mean chemical intensity.

Although many fruitless attempts have been made to construct photometers by a comparison of the blackness produced by sunlight upon photographic paper, it was found that in this way the desired end could be attained by attention to certain essential conditions.

For this purpose it was necessary to construct an apparatus in which photographic sensitized paper could be exposed to the sunlight for definite times measured by small fractions of a second. This instrument consists essentially of a pendulum vibrating about 2 seconds, by whose oscillation a sheet of darkened mica is withdrawn from, and brought back over, a horizontal strip of paper prepared with chloride of silver, and fixed in a constant position relative to the pendulum and sheet of mica. The time during which each point in the length of the strip is exposed is different, and the time of exposure for each point can be calculated when the length and position of the strip, and the duration and amplitude of the pendulum's vibration are given.

The strip of sensitive paper presents, after exposure, a gradual diminution of shade from dark to light, and for each shade the time of exposure is known. In order that such a graduated strip may serve as a means of measuring the chemical action of light, we require:—

1. To know the relation existing between the several tints and the intensity of the light necessary to produce such tints.

2. To construct sensitive paper which shall always possess the same degree of sensitiveness, and can easily be prepared when required.

It was found, by a long series of experiments, that it was possible, by adhering strictly to a certain mode of manipulation, to prepare standard papers which, when made, possess a constant degree of sensitiveness; so that if the same light falls upon them, the papers are always coloured to the same tint.

Experiment likewise showed that the tint attained by such a paper was constant when the quantity of light falling upon it also remained constant; so that light of the intensity 50 falling upon the paper for the time 1, produced the same blackening effect as light of the intensity 1 falling upon it for the time 50.

Knowing this law, which regulates the degree of shade of the paper, and having a surface of a perfectly constant degree of sensitiveness, it is easy to obtain absolute measurements of the chemical action of light. For this purpose an arbitrary unit of measurement is chosen, by making a standard tint or paint which can be easily and exactly reproduced at any time.

The quantity of light which shall, in a second or the unit of time, produce a blackening effect on the standard photographic paper equal to that of the standard tint, is said to have the chemical intensity 1. If the time needed to produce this same tint is found by experiment with the pendulum-photometer to be 2 seconds, then the chemical intensity is one-half, and so on.

All that is needed, in order to obtain accurate measurements of the chemical action of diffuse daylight or sunlight, is to be able to find the time necessary to effect a blackening of the normal paper equal in shade to the standard tint. This is done by the means of the graduated strip made in the pendulum photometer.

For the purpose of accurately comparing these tints, the ordinary daylight or even lamplight cannot be used, as a change would thereby be produced on the sensitive paper. A light which does not act chemically must be used: such a light is the monochromatic soda-flame. The light from this flame possesses another advantage, namely, that the unavoidable differences of colour are not seen; variation in shade alone being perceptible. The speaker exhibited the accuracy of this method of observing coincidence in shade by means of a large model of the instrument.

By help of this soda flame the coincidence of shade of the graduated strip with standard tint can be read off with the greatest precision. This fact, as well as the possibility of preparing a constant sensitive paper, is seen by reference to the following tables, extracted from the detailed paper printed in the Philosophical Transactions for 1863.

Papers variously prepared were exposed for the same time to the same light. Each reading is the mean of several observations; identity in the numbers shows identity in the shade, and, therefore, the constant sensitiveness of the papers.

The standard paper is prepared by soaking photographic paper in a solution of common salt of given strength (3 to 100), and then allowing it to lie upon the

\* Phil. Trans. for 1867, pp. 356, 381, 601; for 1869, p. 679.

surface of a silver solution (12 NO<sub>6</sub>Ag to 100 of water). When the strength of salt solution varies, the sensitiveness of the paper alters very rapidly. Variation in the strength of the silver-bath produces, on the contrary, but little change in the sensitiveness of the paper. Different qualities of paper and alterations of atmospheric moisture and temperature do not affect the sensitiveness of the paper.

1. *Effect of altering the Strength of the Silver-bath. Paper salted in a Solution containing 3 parts Chloride of Sodium to 100 of Water.*

| Ag NO <sub>6</sub> to<br>100 of water. | READINGS.   |             |
|----------------------------------------|-------------|-------------|
|                                        | Observer A. | Observer B. |
| 12 . . . . .                           | 128'6       | 129'7       |
| 10 . . . . .                           | 128'7       | 127'0       |
| 8 . . . . .                            | 128'7       | 128'0       |
| 6 . . . . .                            | 129'7       | 130'0       |

2. *Effect of altering the Strength of the Salt Solution.*

| Na Cl to<br>100 of water. | READINGS.   |             |
|---------------------------|-------------|-------------|
|                           | Observer A. | Observer B. |
| 1 . . . . .               | 62'6        | 60'4        |
| 2 . . . . .               | 95'7        | 94'6        |
| 3 . . . . .               | 132'6       | 129'6       |
| 4 . . . . .               | 167'0       | 168'0       |

3. *Experiment showing the constant Sensitiveness of the Standard Paper.*

| Paper.                    | Na Cl to<br>100 of water. | Intensity No. 1. |             | Intensity No. 2. |             |
|---------------------------|---------------------------|------------------|-------------|------------------|-------------|
|                           |                           | Observer A.      | Observer B. | Observer A.      | Observer B. |
| Upper part of sheet 2...  | 2'950                     | 70'2             | 70'0        | 101'3            | 101'5       |
| Lower part of sheet 2.... | 3'026                     | 70'6             | 69'3        | 101'5            | 101'7       |
| Middle of sheet 1 .....   | 3'026                     | 70'0             | 69'5        | 100'9            | 100'9       |
| Middle of sheet 3 .....   | 3'000                     | 70'0             | 70'4        | 101'0            | 100'0       |

All these papers were silvered in a solution containing 12 parts of nitrate of silver to 100 of water.

In order to measure the chemical intensity of the daylight at any time, all that is needed is to expose a strip of standard paper in the pendulum-photometer for a given number of vibrations, and then to find upon the strip, thus exposed, the point at which a shade equal to the standard tint has been produced. Reference to a table give the time of exposure necessary to produce this tint, and the reciprocal of this time represents the intensity of the acting light. If the time necessary were 3 seconds, the chemical intensity would be  $\frac{1}{3}$ ; if the time were  $\frac{1}{2}$  second, the intensity would be 2. In this way curves of daily chemical intensity were exhibited, which show the variation caused by clouds, or by the changing altitude of the sun. These curves show maxima and minima exactly corresponding to the appearance and disappearance of the sun behind a cloud. The difference between the sun's chemical intensity in summer and winter is thus also clearly depicted.

Based upon the principles of the pendulum-photometer, a much simpler method of making these measurements has been arranged, as follows. A graduated strip made in the pendulum-photometer is fixed in hyposulphite of soda, and pasted upon a board furnished with a scale. The shades of certain points on this fixed strip are compared with the shades on given points upon a graduated strip prepared in the usual way, and not fixed in hyposulphite. The fixed strip is thus calibrated in terms of the unit of measurement, and it may then be used as a means of measuring the chemical action of light. Small pieces of the standard paper are then exposed for a given time to the light which it is desired to measure, until the shade approaches that of a part of the fixed strip. The point of exact coincidence is then read off by the soda flame as usual. In this way a piece of standard paper of 1 square inch of area will serve for 20 separate determinations, and the whole arrangement for exposure may be carried in the pocket. The curve of the chemical intensity of day and sunlight in Manchester, on May 15th, 1863, made with this small instrument, fully bears out the accuracy and ease with which these measurements can be made, and the results of his experiments induced the speaker to express a hope that before long these instruments may be introduced into meteorological observatories.

The determination of the chemical brightness of the various portions of the sun's disc is an interesting application of this new method of photometric measurements.

By help of a camera placed on a 3in. refractor, the speaker allowed the image of the sun—of about 4in. in diameter—to fall upon the standard paper. The sun-picture thus obtained presents interesting features; in the first place, the chemical intensity of the central portions are 3-5 times as great as that of the portions on the limb. A difference of this kind, in the case of the luminous and calorific rays, has already been observed by astronomers, and it is doubtless caused by the absorption effected by the solar atmosphere.

The following results were obtained by measuring the chemical brightness at various points on the sun's disc, on May 9th, 1863; from these numbers it will be seen that the luminous intensity varies very irregularly.

*Chemical Brightness of Sun's Disc.*

| 1. At Centre of Sun's<br>Disc. | 2. 15° from Edge of Sun's<br>Disc. |          | 3. At the Edge of Sun's<br>Disc. |                            |
|--------------------------------|------------------------------------|----------|----------------------------------|----------------------------|
|                                | N. Pole.                           | Equator. | S. Pole.                         | N. Pole. Equator. S. Pole. |
| No. 1 .....100'0               | 38'8                               | 48'4     | 58'1                             | 18'7 ..... 30'2 ..... 28'2 |
| No. 2 .....100'0               | 52'8                               | —        | 56'6                             | 30'5 ..... — ..... 41'0    |

Bright patches of considerable area were seen on the picture; these patches, which were not caused by irregularity in the paper or in the lenses, are probably owing to the presence of clouds in the luminous atmosphere of the sun, and they may probably have some intimate connection with the well-known phenomena of the red prominences seen during the solar eclipse.

The speaker concluded by stating that he hoped, with the assistance of his friend Mr. Baxendell, to make a series of regular observations of the variation of the chemical intensities of many points on the sun's surface.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The thirty-third meeting of the British Association for the Advancement of Science will commence in Newcastle-upon-Tyne, on Wednesday, the 26th of August, 1863, under the direction of the following officers:—President: Sir Wm. G. Armstrong, F.R.S. Vice-Presidents: Sir Walter Trevelyan, Bart.; Sir Charles Lyell, LL.D., D.C.L., F.R.S., F.G.S.; Hugh Taylor, Esq.; Isaac Lowthian Bell, Esq.; Nicholas Wood, Esq.; the Rev. Temple Chevallier, B.D., F.R.A.S.; Wm. Fairbairn, Esq., LL.D., F.R.S. General Secretaries: William Hopkins, Esq., M.A., F.R.S., St. Peter's College, Cambridge; John Phillips, Esq., M.A., LL.D., F.R.S., Professor of Geology in the University of Oxford, Museum House, Oxford. Assistant General Secretary: George Griffith, Esq., M.A., Deputy Professor of Experimental Philosophy in the University of Oxford, Jesus College, Oxford. General Treasurer: William Spottiswoode, Esq., M.A., F.R.S., F.G.S., F.R.A.S., &c., 19, Chester-street, Belgrave-square, London. S.W. Local Secretaries for the meeting at Newcastle-upon-Tyne: Capt. Noble, Augustus H. Hunt, Esq., and R. C. Clapham, Esq., 5, Grey-street. Local Treasurer for the meeting at Newcastle-upon-Tyne: Thomas Hodgkin, Esq.

The General Committee will meet on Wednesday, the 26th of August, at one p.m., for the election of sectional officers, and the despatch of business usually brought before that body. On this occasion there will be presented the report of the Council, embodying their proceedings during the past year. The general committee will meet afterwards by adjournment.

The first general meeting will be held on Wednesday, the 26th of August, at eight p.m., when the President will deliver an address; the concluding meeting on Wednesday, the 2nd of September, at three p.m., when the Association will be adjourned to its next place of meeting.

At two evening meetings, which will take place at eight p.m., discourses on certain branches of science will be delivered.

There will also be other evening meetings, at which opportunity will be afforded for general conversation among the members.

The Committees of Sections will meet daily, from Thursday, the 27th of August, to Wednesday, the 2nd of September inclusive, at ten a.m. precisely.

The Section will meet daily, from Thursday, the 27th of August, to Tuesday, the 1st of September inclusive, at eleven a.m. precisely.

The following are the titles of the sections to which communications may be presented:—Section A. Mathematics and Physics. B. Chemistry and Mineralogy, including their applications to Agriculture and the Arts. D. Geology. D. Zoology and Botany, including Physiology, Sub Section D. E. Geography and Ethnology. F. Economic Science and Statistics. G. Mechanical Science.

Notices of communications intended to be read to the Association, accompanied by a statement whether the author will be present or not at the meeting, may be addressed to George Griffith, Esq., M.A., Assistant-General Secretary, Jesus College, Oxford; or to Capt. Noble, Augustus H. Hunt, Esq., and R. C. Clapham, Esq., Newcastle-upon-Tyne.

TRIAL OF STEAM FIRE ENGINES.

We give on the following pages the tables of the performance of steam fire engines, at the public competition which took place in the grounds of the Crystal Palace Company, on the 1st, 2nd, and 3rd ult., under the auspices of the Steam Fire Engine Committee who had provided a fund for the purpose, giving premiums to the exhibitors of such steam fire engines as should, upon trial, prove to be the most efficient for the purposes for which they were constructed. The committee consisted of the following gentlemen, viz.:—Chairman, His Grace the Duke of Sutherland; the Right Hon. the Earl of Caithness; Lord Richard Grosvenor, M.P.; J. G. Appold, Esq.; J. T. Bateman, Esq.; W. M. Browne, Esq.; T. R. Crampton, Esq.; W. M. Crossland, Esq.; W. Fairbairn, Esq.; T. Hawkesley, Esq.; J. E. McConnell, Esq.; Henry Maudslay, Esq.; J. Mathews, Esq.; J. Nasmyth, Esq.; J. Penn, Esq.; William Smith, Esq.; and Capt. E. M. Shaw.

The engines were divided into two classes, the large class consisting of those weighing over 30 cwt. and not exceeding 60 cwt., and the small class of those not exceeding 30 cwt. The prizes offered were £250 for the best engine, and £100 for the second best, in each class.

The chief points to which the Committee directed their attention, in addition to the consideration of cost and weight, were those relating to the general efficiency of the machines as fire engines, combining, among other points of excellence, rapidity in raising and generating steam; facility of drawing water; volume thrown; distance to which it can be projected with the least amount of loss, and simplicity, accessibility, and durability of parts.

The descriptions given on the following pages, except the weights, have been furnished by the exhibitors themselves, and are therefore placed in separate tables.

Can metal-faced valves be fitted, and can be used if preferred, † Giumetal-faced valves are fitted, and can be used if preferred, ‡ Rotary pump with reciprocating brass valves or pistons,

LARGE CLASS.

FIRST TRIAL.

Delivering 1000 gallons into a tank at a true distance of 67ft., and 27° from the horizon. Depth from which water was drawn, 4ft. 6in. The water in the boiler being cold when the signal was given to commence, each engine commencing to work on attaining steam pressure of 100lb. to the square inch.

SECOND TRIAL.

Delivering 1000 gallons into tank at same distance commencing with full steam.

| No. | NAME.                    | Time of raising Steam to 100lbs. | Time of filling Tank. | Total Time. | Remarks.                                                                                                                                                                        | No. | NAME.                    | Steam at Beginning. | Steam during Work. | Time of filling Tank. | Remarks.    |
|-----|--------------------------|----------------------------------|-----------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------|---------------------|--------------------|-----------------------|-------------|
| 1   | Easton & Amos ...        | 13 14                            | 6 16                  | 19 30       | Began to work at 100lbs., fell directly to 40lbs., and continued so throughout; stopped and steam rose to 130lbs.<br><br>Suction pipe choked; left off working about 2 minutes. | 1   | Shand & Mason...         | 100                 |                    | 3 0                   |             |
| 2   | Merryweather & Son ..... | 10 25                            | 9 42                  | 20 7        |                                                                                                                                                                                 | 2   | Butt & Co. ....          | 100                 |                    | 3 3                   |             |
| 3   | Shand & Mason...         | 10 51                            | 12 19                 | 23 10       |                                                                                                                                                                                 | 3   | Merryweather & Son ..... | 145                 |                    | 3 7                   |             |
| 4   | Butt & Co. ....          | 16 30                            | 6 48                  | 23 18       |                                                                                                                                                                                 | 4   | Roberts .....            | 80                  |                    | 12 30                 | Not filled. |
| 5   | Roberts .....            | 11 40                            | 20 24                 | 32 4        |                                                                                                                                                                                 | 5   | Easton & Amos...         |                     |                    |                       |             |

THIRD TRIAL.

Delivering into Large Tank.

| Name.                    | No. | Time.         | No. of Deliveries Open. | Length of Hose. | Size of Nozzle. | Depth from which Water was Drawn. | Horizontal Distance in Feet. | Vertical Height in Feet. | True Distance in Feet. | Angle from Horizon. | Average Steam Pressure. | Average Water Pressure. | No. of Gallons Delivered. | Time of Raising Steam. | Remarks.                                                                                                                                                                                                                                                                  |
|--------------------------|-----|---------------|-------------------------|-----------------|-----------------|-----------------------------------|------------------------------|--------------------------|------------------------|---------------------|-------------------------|-------------------------|---------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                          |     | hr. min. sec. |                         |                 |                 | ft. in.                           |                              |                          |                        |                     |                         |                         |                           |                        |                                                                                                                                                                                                                                                                           |
| Merryweather & Son ..... | 1   | 1 24 55       | 2                       | 440             | 1½              | 16'4                              | 40                           | 40                       | 56                     | 45°                 | 91                      | 89                      | 16'086                    | {10'32" to 80lbs}      | Fire lighted at 4h. 1m. 55s.; guage moved at 4h. 8m. 20s.; engine started at 4h. 12m. 37s.; water drawn in about 10 revolutions; pumps not primed, valve box leaked slightly, and engine worked satisfactorily in every respect.                                          |
| Shand & Mason ...        | 2   | 2 0 0         | 2                       | 440             | 1½ & 1½         | 16'4                              | 40                           | 40                       | 56                     | 45°                 | 96                      | 62                      | 12'917                    | {11'21" to 120lbs}     | Fire lighted at 11h. 25m. 46m.; guage moved at 11h. 32m. 53s.; engine started at 11h. 37m. 7s.; pumps primed at 11h. 45m. 48s.; drew water at 11h. 47m.; water first through nozzle at 11h. 48m. 58s.; in hood at 11h. 49m. 18s.; shifted nozzle (3¼m. delay); high wind. |
| Roberts .....            | 3   | 2 0 0         | 1                       | 420             | 1½              | 16'4                              | 40                           | 40                       | 56                     | 45°                 | 75                      | 75                      | 9'936                     | {11'20" to 80lbs}      | Fire lighted at 11h. 17m.; engine started at 11h. 25m. 20s.                                                                                                                                                                                                               |
| Butt & Co. ....          | 4   | 0 46 50       | 2                       | 440             | 1½              | 16'4                              | 40                           | 40                       | 56                     | 45°                 | 78                      | 78                      | 8'280                     | {14'10" to 45lbs}      | Fire lighted at 5h. 55m. 10s.; started engine at 6h. 9m. 20s.; repeatedly stopped from slide valves not acting, and stopped entirely at 6h. 46m., from cylinder cover breaking.                                                                                           |
| Easton & Amos ...        | 5   | 1 32 35       | 2                       | 440             | 1½              | 16'4                              | 40                           | 40                       | 56                     | 45°                 | 96                      | 41                      | 3'036                     | {12'30" to 80lbs}      | Fire lighted at 2h. 2m. 35s.; guage moved 2h. 10m.; started engine at 2h. 15m. 5s.; pumps primed, worked till 2h. 54m. 6s.; stopped to shift plungers; went to work again, and stopped entirely at 3h. 35m. 10s., from two fire bars falling out.                         |
| Nicol (Manhattan) .....  | 6   | 0 4 55        | 2                       | 420             | 1½              | 16'4                              | 40                           | 40                       | 56                     | 45°                 | —                       | —                       | None.                     | {13'9" to 45lbs}       | Fire lighted at 10h. 51m. 14s.; guage moved at 10h. 59m. 20s.; drew water directly; steam up to 140lbs. at 11h. 8m. 46s.; stopped two minutes; started again; made a few revolutions, and fly wheel broke.                                                                |

FOURTH TRIAL.

Vertical Jet against Tower.

| No. | NAME.                    | Size of Jet. | Greatest Height Thrown. |
|-----|--------------------------|--------------|-------------------------|
| 1   | Shand & Mason .....      | 1½           | Feet.<br>180            |
| 2   | Merryweather & Son ..... | 1½           | 180                     |
| 3   | Roberts .....            | 1½           | 150                     |
| 4   | Lee & Co. ....           | 1½           | 55                      |

Gray's Engine lighted fire at 7h. 7m. 40s.; steam 9lbs. at 7h. 17m. 0s.; got to work at 7h. 23m. 40s. to blow fires; at 7h. 27m. 0s. water through hose. Owing to some of the pipe connected with the steam guage breaking no further experiments could be made.

## SMALL CLASS.—EXHIBITORS' DESCRIPTION.

| Makers.              | Weight.                  | Number and Size of Cylinders. |        | Stroke of Piston. | Description, Size, and Material of Boiler. | Quantity of water contained in Boiler when at work. | Steam Space (cubic).                                                                                                                                                                                                                               | Fire-box Surface.           | Tube Surface.     | Total heating Surface.                           | Mode of Feeding. | Suction Valves.      |                                                            |                                   |                                                                                            | Delivery Valves. |                                |                                                                                        |                       | Size of Suction pipe. | Size of ordinary Hose used. |  |
|----------------------|--------------------------|-------------------------------|--------|-------------------|--------------------------------------------|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------|--------------------------------------------------|------------------|----------------------|------------------------------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------|------------------|--------------------------------|----------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------------|--|
|                      |                          | Steam.                        | Water. |                   |                                            |                                                     |                                                                                                                                                                                                                                                    |                             |                   |                                                  |                  | Size.                | Material.                                                  | Lift.                             | Area.                                                                                      | Size.            | Material.                      | Lift.                                                                                  | Area.                 |                       |                             |  |
| Shand & Mason        | T. c. q. lbs.<br>1 9 2 0 | 1                             | 7in.   | 1                 | 9in.                                       | 8in.                                                | Vertical, tubular; diameter at fire-box, 2ft. 10in.; ditto at barrel, 2ft. 1in.; height, 4ft. 6in.; iron with brass tubes.                                                                                                                         | 16½ gal-<br>lons            | 3ft.<br>1068in.   | 14½ sq.<br>feet                                  | 49 sq.<br>feet   | 62½ sq.<br>feet      | 1 feed-<br>pump and in-<br>jector                          | 2½in.                             | India rub-<br>ber discs<br>(7)                                                             | ½ lift           | 21<br>sq. in.                  | Same as suction valve's but<br>6 in number only                                        | 18in.                 | 4½in.                 | 2½in.                       |  |
|                      |                          | 1                             | 7½in.  | 1                 | 4½in.                                      | 9½in.                                               | Upright, tubular; with sub-<br>merged smoke-box; iron mate-<br>rial; diameter, 27in.; height,<br>60in.; tubes, 1½in diameter out-<br>side; 199 in number.                                                                                          | about<br>26<br>gallons      | 4 23<br>c. feet   | 9½ sq.<br>feet                                   | 97½ sq.<br>feet  | 106 feet<br>(nearly) | 1 plunge<br>pump<br>1½ in. by<br>12in.<br>worked<br>direct | 4 at each<br>end 3½in.<br>diam.   | Rubber discs<br>on central<br>stem cover-<br>ing opening<br>in valve seat<br>4 at each end | ¾ in.            | equal<br>to area<br>of<br>pump | Same as suction valves                                                                 | 4in.                  | 2½in.                 |                             |  |
| Merryweather & Sons. | 1 10 1 12                | 1                             | 6½in.  | 1                 | 4½in.,<br>1 ½ 46 gal-<br>lons.             | 12in.                                               | Vertical, tubular, circulat-<br>ing; height, 48in.; diameter,<br>29in.; shell of homogeneous metal<br>full ¼ in. thick; tube and top<br>plates, Lowmoor iron, nine-six-<br>teenths of an inch thick; tubes<br>of solid drawn homogeneous<br>metal. | from<br>15 to 30<br>gallons | about<br>4 c. ft. | 7½ sq.<br>feet, in-<br>clud-<br>ing sur-<br>face | 57 sq.<br>feet   | 64½ sq.<br>feet      | By injec-<br>tor, main<br>pump,<br>and feed<br>pump        | 9½in.<br>long,<br>1002½in<br>wide | Gun metal<br>leather faced<br>(India rubber<br>can be used<br>if preferred)                | 1in.             | 10<br>sq. in.                  | Gun metal<br>9½in.<br>long,<br>(India rubber<br>1in. wide can be used<br>if preferred) | 1in.<br>9½ sq.<br>in. | 3½in.                 | 2½in.                       |  |

## SMALL CLASS.

## FIRST TRIAL.

Delivering 1000 gallons into a tank at a true distance of 50ft. and 3½" from the horizon. Depth from which water was drawn, 4ft. 6in. The water in the boilers being cold when the signal was given to commence, each engine commencing to work on attaining steam pressure of 100lb. to the square inch.

## SECOND TRIAL.

Delivering 1000 gallons into tank at same distance, commencing with full steam.

| No. | NAME.              | Time of raising Steam to 100lbs. | Time of filling Tank. | Total Time. | Remarks.                                                           | No. | NAME.              | Steam at Beginning Work. | Steam during Work. | Time filling Tank. | Remarks.          |
|-----|--------------------|----------------------------------|-----------------------|-------------|--------------------------------------------------------------------|-----|--------------------|--------------------------|--------------------|--------------------|-------------------|
| 1   | Shand & Mason      | 11 36                            | 5 24                  | 17 0        |                                                                    | 1   | Shand & Mason      | 85                       | —                  | 5 49               |                   |
| 2   | Lee & Co.          | 11 55                            | 6 3                   | 17 58       | Owing to a broken bolt, there was great leakage in water cylinder. | 2   | Lee & Co.          | 125                      | —                  | 5 50               | Leakage remedied. |
| 3   | Merryweather & Son | 12 15                            | 9 14                  | 21 29       |                                                                    | 3   | Merryweather & Son | 100                      | —                  | 6 17               |                   |

## AWARDS.

At a meeting of the Committee held on the 8th July, 1863, his Grace the Duke of Sutherland in the Chair, the following prizes were awarded:—

## LARGE CLASS.

Messrs. Merryweather & Sons, 1st Prize, £250.  
Messrs. Shand & Mason .....2nd Prize, £100.  
Mr. W. Roberts, highly commended.

## SMALL CLASS.

Messrs. Shand & Mason .....1st Prize, £250.  
Messrs. W. Lee & Co. ....2nd Prize, £100.

(Signed) On behalf of the Committee,

SUTHERLAND, CHAIRMAN.  
E. M. SHAW, HON. SEC.

THIRD TRIAL.  
Delivering into Large Tank, commencing with Full Steam.

| NAME.              | No. | Time.<br>Hr. Min. Sec. | Number of De-<br>liveries open. | Length of<br>Hose. | Size of Nozzle. | Depth from<br>which Water<br>was Drawn. | Horizontal<br>Distance<br>in Feet. | Vertical Height<br>in Feet. | True Distance<br>in Feet. | Angle from<br>Horizon. | Average Steam<br>Pressure. | Average Water<br>Pressure. | No. of Gallons<br>Delivered. | Remarks.                                                                                                                                  |
|--------------------|-----|------------------------|---------------------------------|--------------------|-----------------|-----------------------------------------|------------------------------------|-----------------------------|---------------------------|------------------------|----------------------------|----------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Shand & Mason      | 1   | 1 0 0                  | 1                               | 420                | 1 & 1½          | 16' 4"                                  | 40                                 | 40                          | 56                        | 45°                    | 146                        | 80                         | 8142                         | Steam ready at 150 lbs.; started at 7h. 3m. 32s.; stopped at 7h. 12m. 5s. to put on an additional length of hose; worked well throughout. |
| Merryweather & Son | 2   | 1 0 0                  | 1                               | 420                | 1               | 16' 4"                                  | 40                                 | 40                          | 56                        | 45°                    | 86                         | 45                         | 4885                         | Steam ready at 110 lbs.; commenced work at 3h. 45m. 30s.; pumps primed.                                                                   |
| Lee & Co.          | 3   | 1 0 0                  | 1                               | 420                | 1               | 16' 4"                                  | 40                                 | 40                          | 56                        | 45°                    | 80                         | 60                         | 4275                         | Steam ready, started at 2h. 1m. 0s.; worked well, without any stoppage.                                                                   |

# IRON FLOATING DOCK, SOURABAYA, JAVA.

IN THE ARTIZAN of February last we gave a short account of the successful launching of an iron floating dock at Sourabaya, Java. We regret, however, to learn since our first notice that, in an engineering and commercial point of view, the undertaking has resulted in a decided failure. The dock is, it appears, now entirely under water. It was put together at Grisse, on the coast of Java, about nine miles from Sourabaya, and was launched in the novel manner described in our February number, viz., by letting the water to it, and then towing it away. The dock floated then fairly enough, drawing, with engines and appurtenances, about two feet of water. Without testing the capabilities of the dock or the machinery in any way, it was brought into six fathoms water, anchored, and sunk to receive a small steamer, the *Prince of Orange*. But now came the real test; the dock sunk, not slowly but surely, going down with great rapidity, one end about eight feet lower than the other. So violent, indeed, was the descent that the *Prince of Orange*, which was waiting just outside, was drawn into the vortex, shooting into the dock like an arrow, fortunately without sustaining any damage. The parties in charge endeavoured to set the pumps (which are on the centrifugal principle) to work, but as the engines, which were intended to run at 60 revolutions, could only be got to work up to 30, the pumps would not draw at all. The dock meanwhile continued to sink until the engine fires were extinguished. A small portable engine and pump were hastily brought and set to work, but without effect. To make bad worse, the anchorage proved insufficient, and the dock swung round on the sloping muddy bank on which it had sunk, with every change of tide, and thus worked itself deeper and deeper still in the mud, in which it now lies imbedded about eight feet deep. Endeavours have been made without ceasing to get it up again, but without success. In these attempts considerable damage has been done to the dock, several large holes having been torn in the plating by the injudicious mode of attaching the chains employed, and competent authorities on the spot are of opinion that the dock will never be brought up again. It would be difficult to say exactly what is the real cause of the disaster.

The unfortunate shareholders who have lost their property make comparisons with a similar dock that is being built for the Dutch Government for Batavia. We find that it exceeds the dock at Sourabaya in weight of material about 50 per cent. That the Sourabaya dock was also very badly put together seems to us beyond doubt; the bottom was the only part at all well done, which accounts for the dock making little water while floating about two feet deep; but in the sides, rivets that could, we understand, be shaken by the fingers, might be counted by hundreds, and gaping seams filled with wooden wedges were plentiful.

## CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents to the Editor of THE ARTIZAN.

SIR,—It is sometimes desirable to transmit a motion or power from the place where it is generated to a distant one, and having to do so now, I should be obliged to your inviting a discussion of the subject, as follows:—

A water power is at the distance of 600 yards from the mill, with no means of bringing it nearer. It is proposed to erect a turbine of the effective force of 100 horses, which will drive a drum or rigger of 12 feet in diameter, carrying a wire rope sustained at certain distances to a drum or rigger at the mill. It is proposed that the speed of the rope shall be about 30 feet per second; therefore, the constant strain on it will be about 1800 pounds.

The following are desiderata:—Which would be better, a steel or iron rope? Its diameter, and weight per yard, and size of wire? Should it be kept greased or dry? What would be its probable duration? What would be the probable proportions of power absorbed by this method of transmission? What better or less costly method can be devised?—I am, Sir, yours obediently, G.

To the Editor of THE ARTIZAN.

SIR,—In your Journal for July, 1863, at page 159, is an article on "The Manufacture of Duplicate Machines," by Mr. John Fernie, Assoc. Inst., C.E., in which the writer appears to think that "until lately, little or nothing had been done in its application to the manufacture of machines or engines on a large scale," "until within the last five years, with the sanction of Mr. Kirtley, the Locomotive Superintendent, he had established the system in the workshops of the Midland Railway, at Derby, which has proved most beneficial, not only in reducing the cost of the work, but in greatly improving it."

Now although Mr. Fernie may not be aware of the circumstance, it is nevertheless a fact, that the late firm of Sharp, Roberts and Co., made ten engines for the Grand Junction Railway Company, before the opening of that line, about 25 years ago, all the parts of which were duplicates of each other, in confirmation of which I would refer Mr. Fernie to the then Locomotive Superintendent, Mr. Thomas Melling, Rain Hill Iron Works, who frequently sent to Sharp, Roberts and Co. for parts of engines out of their stock, and always had the satisfaction to find they fitted in every respect: so completely was the system carried out that every part of the boiler, the fire-box, and smoke-box would interchange. It is well known that the same firm (Sharp, Roberts and Co.) made all their smaller machines in duplicate, and provided for the users of the "self-acting mule" a book of plates, showing all the parts of the headstock, with the name and number of each, to enable parties to order duplicates for repairs.

RICHARD ROBERTS. C.E.

BOOKS RECEIVED.—On the *Bhore Ghaut Incline of the Great Indian Peninsula Railway*. Reprint of a paper read at the Bombay Mechanics' Institute, by the late J. J. Berkley, Esq., M.I.C.E., F.G.S., with an Appendix by A. A. West, C.E. Bombay: The Education Society's Press, Byculla, 1863.—*Portefeuille des Machines, de l'outillage et du Matériel relatifs à la construction, &c.*; Dirigé par. C. A. Oppermann, Ingénieur, Constructeur. Paris: Dunod, 49, Quai, des Augustins.

## NOTICES TO CORRESPONDENTS.

J. A. G.—Received and inserted. We shall be glad to hear from you from time to time. The Journal has been sent to you.

W. J. C.—Want of space prevents our giving insertion to the plan this month, but will give it in our next; meantime, you may send us further details.

EISEN.—The results of Mr. D. Kirkaldy's Experiments on Wrought Iron and Steel, the subject to which you refer, was discussed some time since at a meeting of the "Institution of Engineers in Scotland," when Dr. Macquorn Rankine, referring to his remarks upon these experiments at the last meeting, and to the experiments he had himself made upon the fracture of railway axles, exhibited and explained drawings of some of the fractures. There were nine examples, and they might be taken as a fair representation of the character of the other examples. The first five had broken spontaneously, and it was evident from the appearance presented that the iron had invariably been of a fibrous character, excepting a few small crystals about the size of pins' heads. The other four had been broken by the hammer, and were all axles that had only run a short time. Some of these were fibrous, and some of them were crystalline, showing that the same iron would exhibit a fibrous or a crystalline character, according to the manner in which it was broken. The accompanying woodcuts (Figs. 1 and 2) were longitudinal sections of axles, showing different positions of the fibres near the surface. In Fig. 1 the journal had been produced wholly by turning, and the fibres were consequently interrupted; hence there was a tendency for a crack to begin at the shoulder. In Fig. 2 the journal, before being turned, had been forged down nearly to the proper diameter, the fibres were continuous, and there was no tendency to break in the manner before referred to. At the same meeting Mr. Gray exhibited a drawing (shown in the woodcut Fig. 3) of the mandril of a calico-printing machine, and stated that the fracture always took place at the shoulder of the axle where it was  $3\frac{1}{8}$ ths in diameter. The length of the journal was 7in., and the fracture always took place at the outer diameter of the fillet. With reference to your other queries, we are glad to be able to inform you that Mr. Kirkaldy has published a Second Edition of his "Results of an experimental enquiry into the tensile strength and other properties of Wrought Iron and Steel," from a perusal of which we feel assured you will be enabled to arrive at a satisfactory solution of the questions involved. Your bookseller at Leipzig will be able to obtain the work for you.

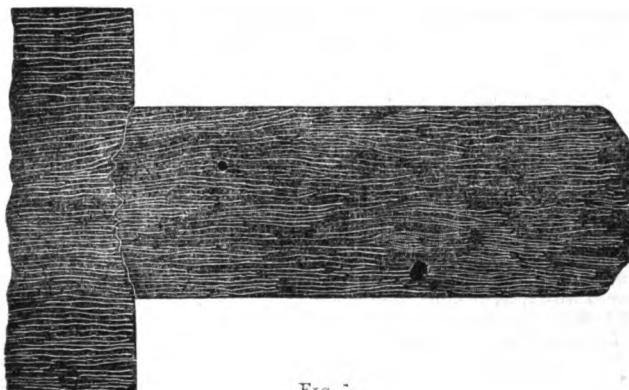


FIG. 1.

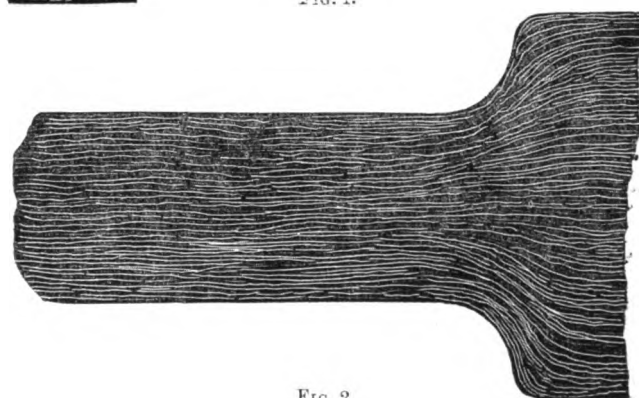


FIG. 2.

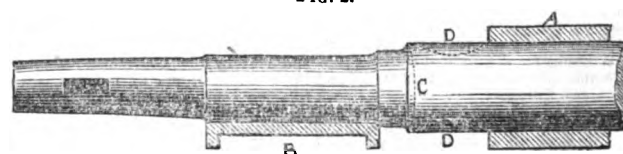


FIG.

# 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.

**SAXBY v. STEVENS.**—This was an action tried in the Court of Queen's Bench on the 8th ult., before Lord Chief Justice Cockburn and a special jury, for the infringement of a patent for the simultaneous working of the points and signals for the prevention of accidents. The question was of a very complicated character, and was expected to have occupied the court the remainder of the sittings, but at twelve o'clock, when the learned counsel for the plaintiff got about half way through his opening statement, the Lord Chief Justice interposed, observing that if ever there was a case that ought to be sent before an arbitrator, instead of being tried by a judge and jury, this was the case. Upon that the learned counsel conferred together and settled the terms of a reference, and a verdict was taken for the plaintiff, subject to that arbitration.

**SOUTHWOOD v. FAIRBAIRN.**—The plaintiff is an engineer now living at Birmingham, but has spent many years in the Australian diggings. On his return home he took out a patent for crushing quartz and all descriptions of ore and stones, not only for extracting gold, but for the purpose of metallurgical roads. In November he entered into a contract with the defendant, an engineer in Southwark, to make and erect on the defendant's premises, and work with 10 or 12-horse power, and make ready for experiments, one of those machines within two months for £95, £40 to be paid during or on the completion of the machine. A dispute subsequently arose, and the defendant refused to complete the contract, although the plaintiff had paid him £20 on account. This refusal the defendant did not now attempt to justify, and paid £40 into court; therefore, the only question was the amount of damages to which the plaintiff was entitled. The plaintiff claimed as damages his inability to exhibit the machine or to execute various contingent orders which would each have realised a profit, or to carry out arrangements he had made for going out to Australia to push the patent under the auspices of a company. The defendant contended that such damages were rather conjectural than substantial. The learned Baron said the difficulty was to lay any fixed rule as to what were direct and proximate damages, and that it was one of those matters which lawyers, when puzzled, put upon the jury, but that annoyance or vexation arising from unpunctuality was not a subject for damage. The jury found a verdict for £30 more than the sum paid into Court.

## 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.

**NEW METHOD OF RAISING A STEAMER.**—M. Bauer, an engineer, has, after long preparatory labours, succeeded in raising the Bavarian steamer *Ludwig*, which sank two years ago in the Lake of Constance, in consequence of coming into collision with a Swiss steamer. The engineer, in order to raise the vessel, which was lying at a depth of 70ft., made use of an apparatus of his own invention. By means of divers he attached to her, one on each side, two large balloons made of water proof linen, which he filled with air. When the expansion had become sufficient, a movement was observed in the water, which look as if boiling, and the vessel gradually came to the surface.

**METROPOLITAN ZINC ROLLING COMPANY.**—A prospectus has been issued of the Metropolitan Zinc Rolling Company, with a capital of £100,000 (of which one-half is to be first put forth), in shares of £10. The object is to establish in London, upon an efficient scale, rolling works for the production of sheet zinc and copper, the demand for which is steadily increasing. Arrangements have been made for the rental of premises adjoining the City-road basin and also for the purchase of the whole of the machinery of the Mines Royal Copper Company.

**COST OF LONDON STREETS.**—New Oxford-street and Cranbourne-street, constructed between 1841 and 1847 by the Commissioners of Woods and Forests from the London Bridge Approaches Fund, cost—the former, £330,074, and the latter, £206,093. Victoria-street, Westminster, constructed between 1845 and 1851 by the Westminster Improvement Commissioners, from the Coal Duties and improved rates, and by money raised on mortgage, cost £215,000.

**OUR SHIPPING.**—At the close of the year 1862 there belonged to the ports of the United Kingdom 28,440 vessels of 4,934,400 tons, usually navigated by 228,139 men and boys—an increase in the course of the year of 402 vessels, 127,574 tons, and 3315 men and boys. The vessels belonging to the British plantations were 10,967, of 1,107,696 tons, and manned by 75,934 persons.

**PAPER MATERIAL.**—In searching for fibre suited for the manufacture of paper, the following hints may be found useful to residents in tropical and other regions. Any fibre capable of cohesion when precipitated on a draining surface from mechanical suspension in water, after having been reduced to a pure state of capillary subdivision by mechanical action, is fit for the manufacture of paper. For all practical purposes it may be accepted as a rule, that for the manufacture of white paper all fibres require bleaching. Raw fibre may be divided into four classes:—1. That which is easily reduced and easily bleached. 2. That which is easily reduced, but difficult to bleach. 3. That which is difficult to reduce, but easily bleached. 4. That wherein perfect bleaching involves the integrity of the fibre. The most profitable shape in which to send fibre to the English market is that of half-stuff (or pulp). Well prepared bleached half-stuff would fetch £25 per ton in the market. The best machine for reducing fibre to half-stuff is the ordinary rag-engine, costing about £150, carrying about 2 cwt. of stuff, and requiring a maximum of seven-horse power for driving. The half stuff would require to be pressed, dried, and packed in bales. For experimental purposes in reducing the fibre, anything smaller than the ordinary sized rag engine is useless, as the weight of the triturating roll—about 15 cwt.—cannot be dispensed with, so that laboratory experiments are necessarily confined to rough separation and bleaching. Moreover, laboratory experiments, unless conducted with the utmost care and skill, furnish no reliable data for commercial operations. As a preliminary, the character of the fibre ought to be determined in the laboratory:—1st. In relation to its structure, having in view ease in fibrous separation. 2nd. In relation to its chemical construction, having in view ease in bleaching. Bleached half-stuff would realise a larger profit than unbleached, always supposing that the process of bleaching, owing to the accident of geographical position or otherwise, did not entail expenses extra to that properly belonging to the operation under the most favourable circumstances. Fibre could be sent into the market as half-stuff unbleached whenever its characteristics were reliably established.

**DISCOVERY OF NATURALLY-FORMED CARBONATE OF SODA.**—Dr. Haines, of Grant College, Bombay, describes the occurrence in vast quantities of naturally-formed carbonate of soda in the neighbourhood of Aden. The substance as found contains 50 per cent. of natural carbonate, and occurs along the coast, for ten miles at least to the east of Aden, in hollows behind high-water mark, to which the sea has access by percolation. Its formation is attributed to the percolation of the sea-water through the fragments, and pebbles of limestone constituting the shingle of the shore, probably by the partial interchange of elements between the salt or chloride of sodium and the carbonate of lime giving rise to the production of chloride of calcium and carbonate of soda. It is surmised that the formation of carbonate of soda may go on along the whole thousand miles of the south-east Arabian coast.

**LAMP FOR BURNING COAL OIL.**—Mr. N. B. Vidal, of Philadelphia, U.S., has brought forward an improved coal oil lamp, the wick tube of which, above the base of the burner, assumes a fan shape, so that as the wick is raised the upper edge of the same is spread out to nearly double its former width. By this method the oil carried up by the wick is distributed over so extended a surface that it is entirely consumed, and no portion can remain to clog the wick, or run down the outside of the tube, to be evaporated and discharged into the air of the room, as is the case where a large supply of oil is constantly brought to a small burning surface. No chimney is needed with this lamp, which burns without smoke, and with a clear flame.

**THE GOODWIN SANDS.**—A public company is being formed for the embankment and reclamation of the Goodwin Sands, and to convert these sands into an island, whereon to build a new township, fortifications, docks, wharves, &c.; also to reclaim the land for agricultural purposes, &c. By the accumulation of the sand from the north, the gulf stream has been shifted to the southward, the great increase of the sand coming from the north having formed a shoal, called the fork, opposite Trinity Bay. By the proposed embankment, the whole of the Channel, between the Goodwins and the Break, will become entirely clear. The company contemplated taking a grant of the Goodwin Sands for the objects they have in view, to recover the sunken ships and treasures, which it is thought will pay all expenses. The land to be reclaimed will consist of about 20,000 acres. The first work to be accomplished is the entrance of the intended lock, which will be made by caisson gates. This lock will be of sufficient capacity to admit the largest class of vessels, being 360 feet long, 100 feet wide, and 40 feet water at the lowest ebb from the sill, adjoining which will be the tidal dock, containing 287 acres, with 40 feet water. When that is completed the embankment will be commenced, as well as the docks, which are to cover about 626 acres. In case of stress of weather, ships in the Downs are to take refuge on payment of a small tonnage. Capacious docks are intended to adjoin, for repairing or examining ships of any class without unloading.

**IRON SHIPBUILDING ON THE TYNE.**—Messrs. T. M. Smith, builders, at North Shields, are rapidly completing one of the first iron sailing ships built on the Tyne. She will be full rigged, will be 1116 tons burthen, and is intended for the cotton trade. Her dimensions are 202ft. long between perpendiculars; extreme breadth 34ft.; depth of hold 23ft. This firm is also about to commence to build an iron East Indianman to be added to their Calcutta line. She will be 1200 tons, 190ft. long, 37ft. 6in. beam, and 22ft. depth of hold.

**MATERIALS USED IN THE 1863 EXHIBITION BUILDING.**—Bricks, 17,250,000; lime, 5611 cubic yards; sand, 18,352 cubic yards; ballast, 8632 cubic yards; cement and plaster, 47,105 bushels; cast iron, 4653 tons; wrought iron, 2269 tons; timber, 439,178 cubic feet; 2,238,722 lineal feet 9in. by 3in. battens, deals, and planks; stone, 62,831 superficial feet, 6in. thick and under; ditto, 6877 cubic feet; zinc, 225,964 superficial feet; lead, 74 tons 14 cwt.; felt, 623,000 superficial feet; slating, 71,200 superficial feet; glass, 216,808 panes, containing 667,542 superficial feet; putty, 95 tons 16 cwt.; nails, 193 tons 12 cwt.; cash paid in labour, £138,348.

**IRON SHIPS.—PREVENTION OF FOULING.**—The iron clipper ship *Chili*, which was coated with Messrs. Peacock and Buchanan's composition, for the prevention of fouling, has recently returned from New Zealand, having been twelve months out of dock, and upon her being examined in Mr. Langley's dock, her bottom was found to be perfectly clean. It is stated that there is not a particle of copper in this composition.

**BOILER RIVETING IN THE UNITED STATES.**—By W. H. KING, U.S.N.—In the United States there are three mechanical modes of uniting plates together; namely, machine-riveted by the two first-named methods, in both of which the rivets are put in hot. West of the Alleghenies, all riveting is done by hand, and at Pittsburgh, Louisville, and other places, the rivets are driven cold in all places accessible for the purpose. For the cold process, a superiority is claimed consequent upon the holes being well filled with the body of the rivets; that is, there is no contraction—hence reduction in the strength and in the rivets' diameters after the workmen cease hammering on the heads. The reverse must be the case when driven hot; for, in cooling, the diameters are reduced by contraction. Moreover, none but the best quality of iron can be used in rivets driven cold; because, if the iron be inferior, it is sure to crack or split through the head, each one being tested by the heading. For hot riveting, it is claimed that, in cooling, the rivets contract in length, drawing the sheets more closely together, thereby creating adhesion sufficient to add to the strength of the joint. Mr. Clarke, resident engineer of the Britannia-bridge, made some experiments to determine the value of this. Three plates were riveted together by a machine, maintaining a temperature of 900 degrees in the rivets; each outside plate had a circular hole in which the rivets fitted exactly; but in the centre one the hole

was oval, or  $2\frac{1}{2}$  in. long for a  $\frac{1}{2}$  rivet, and the rivet was not allowed to touch either end of this hole. A strain was then put on the centre plate till it began to slide, which it did abruptly. Several trials were made, and the least result was an adhesion equal to  $\frac{1}{2}$  tons with  $\frac{1}{2}$  rivets. Mr. Clarke infers from this experiment that, by judicious riveting, the adhesion may in many cases be nearly sufficient to counterbalance the weakening of the plates from punching the holes. In this particular we regard his opinion as an error; for if he had continued the strain on the plate until it parted, or the rivets broke, he would doubtless have found that the total pressure, or breaking-strain, would have been 56 per cent. if single-riveted, and 75 per cent. if double-riveted, of the sheet, as fully tested by other experiments. Theoretically, there is a gain from adhesion in hot-riveted joints, but practically this seems to be lost by the contraction of the rivets' diameter, thus making the total or breaking pressure the same. In western river boilers, where the pressure of steam used is higher than in any other part of the world, no difficulty has ever been experienced from the cold riveted joints not being closely united and perfected tight; and as regards strength compared with the hot-riveted, superiority is claimed by those having cold-riveted boilers in charge. In either mode of hand-riveting the rivets can be seriously injured by too much hammering, and in any case by overheating. Due regard should be had to the temperature, and the blows of the hammer should be hard and quick, and not continued longer than necessary to form the head. Machine riveting has the advantage of forming the head at a single blow, and the rapidity with which the work can be performed must always give it preference over all other methods where it can be employed. It is to be regretted that no extended set of experiments have ever been made in this country to determine the relative strengths of the different modes of riveting and uniting the sheets of steam boilers and other iron structures; also to test the relative value of materials used in this country at the present day; for it must be evident that although the results of the European experiments on iron and steel are of value to us, yet they cannot be regarded as entirely applicable to American constructions, because our iron ores, the temperature of blast of smelting furnaces, and manner of working the metal through the different processes, and the fuel used, all differ in a large degree from those abroad.

**MAGNETO-ELECTRIC MACHINES.**—The following is extracted from a French scientific paper:—One of the principal obstacles encountered in the practical application of electricity as a motive power, is found in the small amplitude of the elementary movements of electro-magnets, since their powers of attraction do not commence till they are almost in contact—the limit of distance varying from 1 to 3 millimetres at most. Thus, all inventors who have proposed their use as a means of producing motive power, have sought to overcome the difficulty by causing the attraction to exert its powers at an angle, or by following the surface of a cone so as to augment the amplitude of the movements, with, however, a proportionate decrease of power. We now propose the adoption to be called *contracteur électrique*, which shall imitate the play of the muscles in the organized body, and which will permit the transformation of the trifling direct motion of a series of electro-magnets, into a movement, ten, twenty, or a hundred times as great. If we take discs of soft iron, and convert them into very deeply-grooved pulleys, in order that they may receive some thousands of turns of insulated copper wire, we can thus transform them into magnets, by the passage of an electric current through the wire. If we superimpose a number of these discs, separated by small rings of india rubber, one millimetre thick, on the passage of a current, all the discs will approach each other, compressing the india rubber; and thus the pile of discs, if composed of 200 elements, for example, will shorten or contract on itself one decimetre, although each disc moves through but one half millimetre. This is the first idea of contractors or electric muscles. It is easy to understand that by fitting one end of such a pile to the connecting rod and crank of a fly-wheel, and the other extremity to a fixed support, we can obtain as great a number of revolutions as we desire, with a force depending on the power of the pile. By combining this idea with that of tubular electrical piles producing electricity in quantity, shall we not find the solution of the problem of applying electricity to the economical production of motive power?

**PROTECTION OF IRON HULLS.**—The following was found to be the result on scraping down the sides and bottom of the iron screw steam storeship *Industry*, in dock at Woolwich. The *Industry* had been coated on the port side with a composition produced in the dockyard, on the starboard side with Peacock's composition, and in the hold with Day's marine cement for resisting the influence of moisture, and the effects of bilge water on the rivets. Day's cement has been pronounced superior to anything yet tested for the purpose. It adheres so well that its removal can only be accomplished by means of hammer and chisel. Peacock's composition is also reported to be highly effective.

**CHANGE IN MEASURES FOR COALS.**—As great inconvenience has long been felt at the measures for coals, a movement has been inaugurated among the principal merchants, shipowners, and others engaged in the trade, for the purpose of abolishing the measure per "keel," and substituting that of per "ton." The parties interested have signed the following document in reference to the subject:—"We, the undersigned merchants, shipbrokers, and shipowners of Newcastle-upon-Tyne, recognising that the keel has long been obsolete, and does not now in reality exist as a standard measure; that it bears no relation to foreign weights and measures, but is one that is most difficult and tedious to establish (the reduction having first to be made in tons and hundredweights, and subsequently into keels); and furthermore, that coals and coke are now sold by the ton, and not by keels and chaldrons, hereby pledge ourselves, and agree to commence at an early date, to conduct all our chartering operations, whenever and for wherever practicable, on the basis of the established and legitimate weight of the realm, by the ton, in order to simplify calculations which, as hitherto conducted, cannot have failed to be a source of great inconvenience to foreigners having business with this port. Newcastle-upon-Tyne, July 6, 1863." The document is signed by the largest mercantile and shipping firms in Newcastle, as well as by several of the colliery owners.

**STEAM PLOUGHS IN ANTIGUA.**—The two steam ploughs (Fowler's and Savory's patents) recently introduced were doing their work well. They were found to be of the utmost service on heavy soils, many fields that had been lying almost useless for upwards of 20 years being now upturned and pulverised.

**LUMLEY'S RUDDER.**—Since the *Columbine* left Sheerness, on particular service, Lumley's new patent rudder, with which the vessel is fitted, has been thoroughly tested at sea, and is declared by the authorities to be a complete success, at least 50 per cent. being gained over the old rudder, both in time of turning and in the diameter of the circle.

### NAVAL ENGINEERING.

**THE LORDS OF THE ADMIRALTY** have abandoned the intention—at least for the present—of converting any of the wooden vessels standing on the stocks at Chatham dockyard into iron-clad ships of war, and the armour-cased frigate, the frame for which is now being prepared at Chatham, will be an entirely new vessel, and will be the first of the squadron of armour-clad ships which are to be constructed from the designs of Mr. E. J. Reed. The new frigate is intended to be a superior ship, both in point of speed, offensive and defensive power, and sea-going qualities, to any of the armour-clads lately constructed, and the Admiralty have decided on naming her the *Lord Warden*, in compliment to Lord Palmerston. The blocks for the *Lord Warden* have been laid on No. 7 slip, and every effort is to be made to have her completed and afloat within 18 months from the present time.

**THE "CONSTANCE."**—The Admiralty, acting upon a suggestion originally made by us, and their attention having been directed to the success of several vessels fitted by the firm of Handolph, Elder, and Company, of Glasgow, determined upon instituting trials to ascertain the applicability of the modern innovations introduced by this firm, to our ships of war. In order as far as possible to put all the competitors on equal terms, the Lords of the Admiralty selected three frigates of the same model, built at Pembroke, as nearly as possible from the same lines as those of Sir W. Symonds, with similar midship sections, and having about an equal draught of water. The *Archæus*, 3141 tons, has been supplied with engines by Messrs. John Penn and Son, the *Octavia*, 3161 tons, has received hers from Messrs. Maudslay; and the *Constance*, 3213 tons, is fitted by Messrs. Randolph, Elder, and Co., of Glasgow. The engines of the *Constance* are the first engines supplied by this firm for the Royal Navy, and it speaks pretty plainly as to the opinion formed of their success in the vessels of the Pacific Steam Navigation Company, that the Admiralty should allow them to contract for engines of such a size. One feature in the engines of the *Constance* makes them somewhat different from others previously constructed by Messrs. Randolph, Elder, and Company, they are adapted for screw propulsion instead of the paddle wheel, and owing to the requirements of ships of war, the entire machinery has to be kept below the water-line. The three ships are not the best adapted for steam vessels, from the fact, that like all Sir W. Symonds' designs, they are very sharp in the floor. The average consumption of coal in the Royal Navy is estimated at the present time as between 3 to 4lb. per indicated horse power; and one of the main objects of the competitive trials is to endeavour to prove the possibility of reducing the consumption to a little over 2lb. To gain this saving of fuel it was necessary to make the engines of the *Constance* heavier, larger, and consequently more expensive than those of corresponding power on board other ships. It is, however, but justice to the manufacturers to state that much of the weight is to be attributed to a desire to retain the means of reverting to the present mode of working, should the new mode be found unsuccessful. In consequence of this desire the boilers fitted to this ship are much larger than are requisite for her new engines. The dimensions of the *Constance* now are—Length, 252ft., over all, 286ft.; extreme breadth, 52ft.; tonnage, 3142 tons. The masts were not yet stepped. Her draught, with 40 tons of coal, and 70 tons of water, is 17ft. forward, and 20ft. 9in. aft. The builders of the engine have supplied her with a pair of what are termed double cylinders, or compound engines of 500 horse power combined, which are bedded in a block of solid cast-iron weighing 50 tons. Well up on each side of the engine-room she is fitted with three cylinders, the pistons from which work directly on the crank shaft. There are three cranks, each of which receives two connecting rods. The middle cylinders are high pressure, the other four are low pressure expanding cylinders. The diameter of the middle cylinder is 60in., and the other 78in. The cylinders are jacketed throughout, in addition to a casing of felt and mahogany. There are three cranks—one to each pair of opposite cylinders, the motion being by ordinary connecting rods. Stroke, 39in. The eccentrics, four in number, are placed immediately at the back of the foremost crank, the pin of which overhangs. The eccentrics are loose upon the shaft, and are worked by means of two pinions moving in interior arcs cut in the bodies of the eccentrics. The spindles of these pinions pass through the overhanging crank pin, and are worked by means of a series of wheels and pinions attached to two starting donkeys. On the side of the foremost eccentric are two strong pins, which are brought by means of these starting donkeys to catches on the crank itself, as may be required for ahead or astern. The engines are thus very easily started or reversed, and as the eccentrics and the whole of the gearing is made of wrought-iron and is of great strength, there is no reason to expect accident from fracture, or undue wear in the number of wheels. Along the fronts of each set of cylinders are two sets of shafts for working the slides. There are three sets of slide valves to each engine—the slides for the admission of steam to the high pressure cylinder, and the slides for the regulation of the steam from the centre to the two outer cylinders. The gab lever on the shaft for working the high pressure slide valve is so constructed as to admit of its being lengthened or shortened, and thereby increasing or decreasing the travel of the valve, thus varying within certain limits the cut off of the steam, or in other words varying the degree of expansion which can be used in the smaller cylinder. The condensers are on the system patented in this country by Mr. Davison, a modification of the system known as Sewells, in which the steam is condensed by contact with the outer surface of the tubes, the water passing through them. The condensing water is drawn through the tubes by circulating pumps, and by means of a series of plates or partitions at each end, the water is made to traverse the whole length of the condenser three times before passing through the pumps to the discharge pipe. The action of the surface condensers can, if required, be changed while the engines are in motion, and the engines can be worked in the ordinary way by sea-injection. When all are in action, the steam is expanded partially in the high pressure cylinders, and from them still further into the low pressure cylinders, down to a pressure of about 10lb. below the atmosphere before it escapes into the condensers. Such a degree of expansion is difficult to obtain practically with any other class of engines in consequence of the unequal action of the steam in the cylinders. Each condenser contains 1308 tubes, or 2616 in the two condensers, the external surface of which, for condensation, is 5948 square feet, being rather more than 11.5 square feet per nominal horse power. The tubes of the condensers are packed so that when they require cleaning they can be easily removed and replaced; each tube is 11ft. 5in. long. The total length of the 2616 tubes is over five and a half miles. The *Constance* has four boilers, partially superheating, with six furnaces to each boiler. The firegrate surface is about 55 square feet per nominal horse-power. The diameter of the propeller shaft is 14in., its length from the sternmost coupling to the thrust block 86ft., and from the thrust block to the engine, 13ft. 11in. The length of the boss of the screw, one of Griffith's double-bladed, is 4ft. 6in.; diameter of screw, 18ft.; and pitch, 27ft. The weight of the engines is 180 tons, of the boilers 100 tons, and of the water in the boilers 70 tons. The stowage for coal is 280 tons; the consumption of coal by ordinary engines would be from 70 to 80 tons per day; by the new engines it is expected that about 50 tons daily will be sufficient. On the 6th ult. the *Constance* left the Hamoaze. In consequence of the strength of the easterly wind, from 4 to 6, and partly on account of heated bearings, it was deemed inexpedient to test the engines formally at the measured mile, and she went accordingly round the Eddystone. On this trip her speed was twice tested by log line, when no special efforts were used for her propulsion, and a rate of over 10 knots was indicated. The revolutions varied from 45 to 52 per minute; steam pressure about 30lb., barometer pressure vacuum 29in., condenser 25in. The action of the screw did not create much trembling motion. The hot bearings consisted of the heating of some of the collars of the journals, which have all been fitted with great nicety.

**AN IRON-PLATED STEAM RAM**, said to be constructed for the Chinese Government, was launched from the yard of Messrs. Laird Brothers, Birkenhead, on the 4th ult. This vessel, which is about 1900 tons burthen, and nearly 250ft. in length, has a peculiar appearance. She has an unusually great beam, the plates, deck beams, and ribs being of immense strength. The inside shell of the vessel, and the shell below the water mark is covered by planking 6in. thick, this planking being again covered by iron plates  $2\frac{1}{2}$ in. in thickness. The vessel has a singular appearance in the water, being more circular than conical. The whole of the stem is composed of forging of such thickness that penetration seems nearly out of the question. The engines by which the vessel will be propelled are upwards of 350-horse power. The whole of the upper deck is plated with iron. The funnel of the vessel can be lowered at pleasure, and the masts are composed of iron, and form tubes on the deck. The vessel will have two of Captains Cole's revolving cupolas.

THE "PHEASANT" SCREW GUNBOAT, 60-horse power, with condensing engines, on the 14th ult. made a trial of her machinery on the completion of her outfit. The vessel drew 8ft. 6in. forward, and 8ft. 8in. aft. Six runs were made at the mile, and a speed obtained, as a mean of the six, of 7.544 knots. The screw of the vessel is of the common pattern, with a diameter of 8ft. and a pitch of 8ft., a length of 11in., and an immersion of the upper edge of 2in.

TRIAL TRIP OF THE "MESSAGGIERE."—A trial trip of a new despatch steamer or *aviso*, built by Messrs. Money Wigram and Penn, for the Italian Government, took place on the 20th ult. The new boat, which is constructed on similar lines to one built by the same firm for the King of Italy a few months since, is 250ft. in length between perpendiculars, 30ft. in breadth, and carries engines of 350-horse power. They are of 5ft. stroke, and their cylinders are 71in. in diameter. The paddle-wheels are over 23ft. in diameter, and are fitted with feathering floats. The engines are oscillating, and the boilers are on the tubular system. The trip extended from Tilbury Fort to a little beyond Sea Reach, and the speed attained in running the measured mile was at the rate of 17 knots, or 19.6 miles an hour. The *Messaggiere* had taken on board over 180 tons of coal, besides nearly the same amount of stores and spare gear, which caused her to draw almost a foot more water than she would have done under ordinary circumstances. With a normal load there appears to be little doubt of her running at a speed of 17½ or even 17½ knots an hour.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—J. J. Greathead, Chief Engineer, to the *Cumberland*, from the *Mar*; T. Duncanson, Chief Engineer, to the *Cumberland*, from the *Conqueror*; S. T. Wallis, Assistant Engineer, to the *Asia*, for hospital treatment; T. Cross, Assistant Engineer, to the *Defence*; W. G. Warren and W. Maxwell, Engineers, to the *Flagard* and *Asia*, as Supernumeraries; W. Wynd, Engineer, to the *Cumberland*, from the *Shearers*; W. Robinson, Engineer, to the *Wye*; M. J. Shannon, Assistant Engineer, to the *Asia*, for hospital treatment; C. S. Uffindell, Assistant Engineer, to the *Flagard*, as Supernumerary; H. F. Strugnell, Assistant Engineer, to the *Asia*, as Supernumerary; J. M. Brankston, of the *Operry*, promoted to Acting 1st class Assistant Engineer; P. Hutchison, of the *Himalaya*; W. H. Banbury, of the *Dart*; J. Rice, of the *Asia*, as Supernumerary; H. Benbow, of the *Cornwallis*; W. Inglis, (a) of the *Operry*, and J. Jessop, of the *Black Prince*, promoted to the rank of Engineers; W. Ross, of the *Foxhound*, promoted to Acting Engineer; J. West, of the *Columbine*, promoted to Engineer; V. C. Friend, Assistant Engineer, to the *Indus* for hospital treatment; T. Vickery, Assistant Engineer, to the *Resistance*; J. D. Chater, Assistant Engineer, to the *Cumberland*, as Supernumerary; W. H. Bennet, Assistant Engineer, to the *Indus*, as Supernumerary; M. Barker, Supernumerary in the *Indus*, promoted to Engineer; T. Young and R. Spiers, Assistant Engineers, to the *Indus* and *Flagard* respectively, for hospital treatment; J. P. Lloyd, Engineer to the *Indus*, for the *Ripple*; E. Taylor, Engineer, to the *Indus*, as Supernumerary; R. Biddle, Engineer, to the *Himalaya*; and W. R. Leeson, Acting Engineer, to the *Flagard*, as Supernumerary.

### MILITARY ENGINEERING

EXPERIMENTS AT SHORBURNES.—On the 7th ult., another of a series of armour plate experiments took place. The target was invented by Mr. George Clark, and consisted of seven plates of various thicknesses, from three to five and half inches of iron; each plate, except the third or fourth towards the centre, having a different backing as regards thickness of angle iron, &c.; but all being formed upon the general principle that the best method of meeting the concussion of the shot beneath the armour-plate is, according to Mr. Clark's theory, by a cellular system of wrought iron webs, either vertical or horizontal, the cells in every case being filled in either with pitch, pine, teak, or millboard packing. The ordeal to which this target was intended to be submitted was the same as that by which the Warrior and all other targets are tried, and which may be summarized by stating that it begins with heavy shells filled with sand and fired at low velocities, gradually increasing to live shells, then to solid shot with small charges and low velocities, and, lastly, to salvos of shot with full charges. Shells, whether empty or filled with sand, have no perceptible effect on any iron target; so that this portion of the programme was abandoned, and firing commenced at once with 68-pounder live shell. After the first three with live shell, all the succeeding rounds until the firing in salvo commenced were with the smooth-bore 68-pounder gun, with cast-iron shot and the full service charge of 16lb. of powder. The effects these produced may be summed up in the few words that though the target stood better than was expected, it from the first showed signs of giving way. The rivets at the back went fast and early, and the bolt-heads, the main fastenings of the plates, gave way also with a rapidity much greater than is usual. Six had gone before the salvos commenced; the plates were deeply indented and buckling up, and one or two ribs at the back of all were bending outwards. The plates, which were rolled at the Millwall Ironworks, were of admirable quality, and, though dented and bent, showed no signs of cracking, nor did they give any marks of yielding where the deep slots had been cut in them at the back to hold the bolt-bars. The last of the 68-pounders fired struck on plate No. 7, and broke through it. This plate, however, was only three inches in thickness. A salvo of three 110-pounders with 14lb. of powder, and two 68's with 16lb. of powder, was then fired simultaneously, but only four of the guns went off. The united blows of these four, however, shook the whole target most seriously, and cracked its largest plate almost completely across. The Armstrong 300 or 150-pounder, according as it is used with spherical or elongated projectiles, was loaded and laid. This most formidable piece—which no target has ever yet entirely resisted—was loaded with 50lb. of powder and a round shot of 150lb. weight. The effect of this was instant. With a terrific crash it smashed through the thickest (5½in.) plate of the target, through cells and backing and inner skin—shivering into matchwood one after the other two of the massive beams which shored up the target from behind, and ploughing into the earth beyond. Beams, bolts, and plate had all alike been scattered into fragments before the passage of this missile. It was the general opinion, judging from the smashing the shot had inflicted after its passage through the target, and the prolonged flight its sound showed it had made through the air afterwards, that had a second target of the same kind been behind the first it would in all probability have gone through both. In other words, had a ship been constructed on the principle of this target, it would have gone in at one side and out at the other, making the same ruin of both. One more shot was fired from the same gun with a reduced charge of 35lb. of powder, but with a steel shell of 300lb. weight, loaded with a 15lb. bursting charge of powder. This, notwithstanding the reduction of firing charge, went as clean through another plate of 4in. as its predecessor had done through the 5½in., the explosion of the shell shaking all the rest of the fabric.

GUN EXPERIMENTS.—The superintendent of the gun factories, Mr. Anderson, has received orders for the construction of a few powerful muzzle-loading guns for the naval service; they are proposed to be rifled and fired with very heavy charges. The security of the breech of the gun, on which the principal strain falls, is to be much increased by an improved method of construction lately proposed by Mr. Anderson. This alteration consists in having a solid block of steel bored out for the interior tube, and then a solid forcing shrunk over it, which enables the breech screw to be dispensed with, and gives much more solidity than heretofore to the structure of large ordnance. Mr. Anderson has also proposed to make the smaller guns of much greater strength, for it has been found necessary to shorten the 12-pounders by cutting off 1½in. from their muzzles, and to fire them with the reduced charge of powder and shot issued for the 9-pounders supplied to the Horse Artillery. There will, however, by this change be the great advantage of having only one charge of powder and the same shot for both Horse Artillery and Foot Artillery field-pieces.

KRUPP'S CAST-STEEL GUNS.—In a recent number of a Turin journal, a notice on the manufacture of cast-steel ordnance, by Signor Piccolo Pelati, mining engineer, appeared from which we extract the following table on the proportions and process of Krupp's guns, all the figures denote the English weights, measures, and coinage.

| Diameter of Bore. | Thickness of metal at the breech. | Length of Bore. | Approximate weight.   |                                    | Price.                |                                    |
|-------------------|-----------------------------------|-----------------|-----------------------|------------------------------------|-----------------------|------------------------------------|
|                   |                                   |                 | Of the rough Casting. | Of the finished piece of Ordnance. | Of the rough Casting. | Of the finished piece of Ordnance. |
| Inch.             | Inch.                             | Ft. In.         | Lbs.                  | Lbs.                               | £ s. d.               | £ s. d.                            |
| 2.56              | 1.77                              | 4 3 12          | 405                   | 340                                | 33 15 7               | 60 0 0                             |
| 2.56              | 2.56                              | 4 3 12          | 718                   | 530                                | 48 15 7               | 76 9 7                             |
| 3.07              | 2.20                              | 4 8 28 5 11 64  | 577 1047              | 577 743                            | 55 10 10              | 86 4 10                            |
| 3.07              | 3.07                              | 4 8 28 5 11 64  | 1102 1433             | 842 1073                           | 97 17 7               | 135 0 0                            |
| 3.31              | 2.36                              | 4 3 12 4 8 28   | 828 908               | 607 676                            | 55 16 10              | 86 6 5                             |
| 3.31              | 2.75                              | 4 3 12 4 8 28   | 992 1102              | 740 831                            | to                    | to                                 |
| 3.31              | 3.31                              | 4 3 12 4 8 28   | 1157 1294             | 882 985                            | 80 4 10               | 120 0 0                            |
| 3.53              | 2.56                              | 5 6 48 5 11 64  | 1344 1426             | 908 963                            | 91 10 5               | 129 15 7                           |
| 3.53              | 3.53                              | 5 6 48 5 11 64  | 1790 1928             | 1322 1432                          | 131 4 10              | 174 0 0                            |
| 3.82              | 2.75                              | 6 9 84 7 3 00   | 1917 2050             | 1366 1477                          | 127 9 7               | 174 15 7                           |
| 3.82              | 3.82                              | 6 9 84 7 3 00   | 2590 2726             | 1884 2010                          | 140 16 0              | 217 9 7                            |
| 4.60              | 2.75                              | 7 8 04 8 1 20   | 2424 2535             | 1569 1653                          | 150 0 0               | 210 0 0                            |
| 4.60              | 3.07                              | 7 8 04 8 1 20   | 2733 2965             | 1840 1928                          | to                    | to                                 |
| 4.60              | 4.60                              | 7 8 04 8 1 20   | 4159 4408             | 3001 3196                          | 275 9 7               | 347 9 7                            |
| 5.12              | 3.46                              | 8 6 24          | 3747                  | 2424                               | 240 0 0               | 311 5 7                            |
| 5.12              | 5.12                              | 8 6 24          | 5730                  | 4214                               | 367 9 7               | 441 0 0                            |
| 5.96              | 3.66                              | 8 6 24 8 11 40  | 4608 4765             | 2975 3045                          | 292 9 7               | 382 9 7                            |
| 5.96              | 3.94                              | 8 6 24 8 11 40  | 5160 5400             | 3553 3682                          | to                    | to                                 |
| 5.96              | 5.96                              | 8 6 24 8 11 40  | 7604 8045             | 5392 5951                          | 525 0 0               | 623 5 7                            |
| 8.19              | 6.14                              | 9 4 56          | 12453                 | 8916                               | 810 0 0               | 975 0 0                            |

ARMOUR PLATES.—A code of regulations for the guidance of the officials and others engaged in bending and preparing the slabs of iron used in armour plating the iron frigate *Achilles*, 50, and the other vessels under construction at Chatham dockyard, has been promulgated by order of the Lords of the Admiralty, and is to be strictly adhered to. The regulations are drawn up from the report of the Armour Plate Committee appointed by the Admiralty, of which Captain Sir John C. D. Hay was the chairman. The committee included a number of scientific officers belonging to both branches of the service. The Committee, in their report to the Admiralty, state that they have examined the various processes adopted in bending the iron plates, and are of opinion that the plates need not suffer deterioration in quality from any reasonable degree of bending, provided the process is properly performed. It is the nature of wrought iron to admit of such changes of shape without injury. The most essential preparation for the process of bending is that the plate should be sufficiently heated, for it is only under this condition that it will acquire the ductility and softness and freedom from elasticity necessary to admit freely the change of shape. The committee consider that a good red heat is probably the minimum that will suffice; "blooded" or "cherry red" is hardly sufficient. The committee, however, deem it necessary that certain precautions should be taken in the process of heating the plates—1st. That the heat be not carried to such an extent as to injure the iron; 2nd. That the heating be done gradually, so as to heat the large mass uniformly throughout its substance; and 3rd. To have the heating surface so arranged as to prevent fierce fire currents from impinging on the edges or sharp arrisures of the plates, by which damage would be done. Probably from good red to brightest red are the safest limits; and, provided the proper precautions be taken, there is reason to believe that the quality of the plate will be rather improved by the heating than otherwise, as, if the iron happens to be hard, the process will be equivalent to annealing, and will render the metal softer. The process of heating adopted at Portsmouth in the presence of the committee appears to comply with the required conditions, and the committee believe the quality of the plates so bent to be well retained. The mode of bending the heated plates is a matter which the committee conceive may be safely left to the mechanical advisers of the Admiralty. The wedge and tap process, as adopted at Portsmouth, has the advantage of simplicity; but the committee think it would be better if the change of shape could be effected by dead pressure—hydraulic, for example—instead of by blows. The committee consider it highly inexpedient to bend thick plates cold, or only slightly heated, as there are very few kinds of iron sufficiently ductile to bend cold, even in small bars, without injury to the structure of the metal, and in large masses this attempt must be injurious, for even if the external surface should escape injury the process will inevitably produce undue internal strains, very detrimental to the powers of resistance under the blows of shot.

RIFLED ORDNANCE.—A new code of regulations, to be adopted in all future trials of rifled ordnance, has been received at the Ordnance Department, Chatham, from the War Department, and is to be strictly adhered to. The regulations hitherto in force are abolished, and in future all rifled guns are to be proved by firing two rounds with the service charge of powder and a cylinder, equal in weight to two service shots; and three rounds with a service shot, and a charge of one-sixth the weight of the service projectile, as at present, for those guns the service charge for which is one-eighth, and in the same proportion for guns having a larger charge. The following alteration in the system of proof of brass ordnance, which has been recently approved in India, has been ordered to be adopted in this country:—The piece to be proved when .08 inch below the true calibre, and afterwards finished. This alteration has been adopted in consequence of its having been observed that the effect of the proof charge upon brass ordnance, when fired with the usual windage, is in almost all cases to leave serious indentations near the seat of the shot. Indentations so caused will, by this system, be removed in finishing the gun.

TRIAL OF ARMOUR PLATES AT PORTSMOUTH.—A trial took place on the 2nd ult. of armour plates at the practice range in Porchester-creek. The plates on trial consisted of one from Messrs. John Brown and Co., of Sheffield, for the iron-cased ship *Ocean*, 16ft.

**RAILWAY EXTENSION.—LONDON, CHATHAM, AND DOVER RAILWAY.**—This line is now for the first time in possession of the through line running over their own property between the two terminus stations, London and Dover. The Bulwark station of this line is situated about a mile from Herne-hill, and about 12 miles from the latter place, but is the temporary dépot for the Crystal Palace, and which will be used until the opening of the Crystal Palace and South London Railway in the beginning of 1885. One account of the treacherous nature of the London clay through which it is driven it has been found necessary to arch it in several places with 12 layers of brick, eight layers being the minimum in any part. The total number of bricks used in its construction is 32,000,000, or 10,000,000 more than are contained in the whole Exhibition building. At its southern end the nine main lines of the Brighton and South-Eastern are crossed, but during the whole of the work no interruption of their traffic took place. Just beyond this spot is

Penge station, and about a mile further on the junction with the main line to Dover is reached. The distance from Victoria station to Beckenham by the new line will be 8½ miles instead of 11½ by the present route, and from Beckenham to the Elephant and Castle the distance will be 7½ miles. Although there will be a saving of three miles on the whole distance, and the gradients are much easier than those on the West-end and Crystal Palace Railway, the company will not lessen the time in which trains run from London to Dover until the new line is perfectly consolidated. Herne-hill will be the junction station for all the London, Chatham, and Dover through trains. Those coming from Victoria and from the Elephant and Castle will be united, and the up trains will be separated at this station.

**FRENCH NEW RAILWAY SYSTEM.**—An inquiry is open at the present moment in the departments of the Seine and Seine-et-Oise, relative to a proposed railway which is to be laid down in a direct line, traversing all the inequalities of the surface of the country, from Paris to Marly-de-Roi. The concession for the proposed line has been made to M. le Baron Séquier, represented by M. Duméril, C.E., and is the result of demonstrations made at the Palace of the Tuileries of the advantages of a system laid before the Academy of Sciences, on the 15th of December, 1843, by M. le Baron Séquier. M. Séquier thus explains an invention which has remained for twenty years as a little model:—"We supply the cause of movement to locomotives by the pressure by springs of their wheels against rails and not in the simple adherence of the wheels to the rails by the weight alone of the machine. An ordinary railway, with simply a third rail of wood or iron laid down between the other two; locomotives nearly the same as those we have at present, only their driving wheels changing their places, and our problem is solved. Let us explain:—We propose that the two driving wheels, placed horizontally and acted on by very powerful springs, shall grasp the central rail—firmly fixed to the sleepers—between them, as a train of rails does a bar of iron. The adhesion of the wheels then due to the pressure of the springs secures the fulcrum necessary for the propulsion of the engine and train. The power of the springs, then, which force the wheels horizontally against the rails, becomes the measure of the capabilities of the machine, instead of its weight. All attempts at producing a light locomotive have hitherto failed, because weight is necessary to adhesion. Here we see this difficulty at once overcome. A simple enlargement of the central rail, acted on, on inclines by smaller wheels on the same axle, suffice to augment the power of the locomotive. Thus, in a moment speed can be converted into tractive power or the reverse."

**RAILWAY TRAVELLING IN INDIA.**—The striking feature in the passenger traffic in India still continues to be the enormous preponderance of third-class passengers. In the year ending June 30, 1862, there were 61,917 first-class passengers, and 299,820 second-class, but no less than 6,147,055 third-class, to whom may be added 342,953 who travelled fourth-class while carriage so that that class were run.

### RAILWAY ACCIDENTS.

**RAILWAY ACCIDENT AT WOLVERHAMPTON.**—On the 6th ult. an accident happened on the London and North Western Railway, at Wolverhampton, which occasioned personal injuries to a great number of persons. The third-class train which leaves Liverpool at 7:15 a.m. was a quarter-of-an-hour late on arriving at Stafford. On account of this delay an engine that usually leaves the shed of this company near to the Bushbury Junction, at Wolverhampton, to take up a train at the passenger station, was not allowed to pass the Bushbury Junction at the customary hour. At 12:45 the Liverpool train had duly arrived at the ticket platform of the Wolverhampton station, and the officers had scarcely commenced to collect the tickets when an alarm was raised that a collision was about to happen. The collectors left the carriages, closed the doors, and the engine and tender that had been kept waiting at the Bushbury Junction came up at a speed of about eight or ten miles an hour, and ran into the rear of the train, which was a very long one. The force of the collision shattered the end and sides of the guard's break van, materially damaging two third-class carriages which were next to it.

**EXTRAORDINARY RAILWAY DISASTER.**—On June 28th, a train which had left Sighthill goods station, near Glasgow, for the north, was approaching Larbert station, when the engine got off the rails, dragging after it a greater portion of the train, and blocking up both lines of rails. The concussion caused by the sudden stoppage having smashed some of the leading trucks, the *driver* of these caught fire from the engine, communicating the fire to other trucks, said to be loaded with petroleum, paraffin oil, and other inflammable material—and before it was extinguished no fewer than twelve trucks, with their contents, were consumed. The line was got cleared by mid-day. Fortunately no one was injured.

**ACCIDENT ON THE MONMOUTHSHIRE RAILWAY.**—An accident happened on the 5th ult to a passenger train of the West Midland Railway, travelling on the Monmouthshire line, by which one person was killed and several seriously injured. The trains of the West Midland Company run over the Monmouthshire Railway from Pontypool-road to Newport, and on this occasion the 11.5 train from Worcester, due at Newport at 1.60, travelled safely down to Pontypool-road. This train does not stop between Pontypool-road and Newport (8 miles), and had got about half-way between the two stations, when as it passed a small local station, called Cwmbran, and while travelling at a speed of about 30 miles an hour, the engine and train suddenly left the line, and dashed against the platform of the station. The collision threw the train bodily to the other side of the line, causing the carriages to be thrown upon the platform.

### BOILER EXPLOSIONS.

**MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.**—At the ordinary monthly meeting of this association, held on June 30th, 1863, the chief engineer presented his monthly report, of which the following is an abstract:—During the past month, there have been examined 340 engines—2 specially; 524 boilers—15 specially, 12 internally, 101 thoroughly, and 402 externally, in which the following defects have been found:—Fracture, 8 (2 dangerous); corrosion, 34 (3 dangerous); safety-valves out of order, 9; water gauges ditto, 21; pressure gauges ditto, 9; feed apparatus ditto, 2; blow-out apparatus ditto, 35; fusible plugs ditto, 13; furnaces out of shape, 4 (2 dangerous); over pressure, 2 (both dangerous); blistered plates, 3; Total, 140 (9 dangerous). Boilers without glass water gauges, 8; without pressure gauges, 2; without blow-out apparatus, 13; without back pressure valves, 39. Explosions.—"No 10 explosion. The fact of this explosion having occurred, was stated in last month's report, but no detailed particulars had then been received. It has been since ascertained that the boiler was a plain cylindrical egg-ended one, externally fired, and that the explosion was caused by rents commencing at the seams over the furnace, which has so frequently been found to be the case in this class of boiler, and called attention to in these reports. Two other explosions of a very similar character have happened during this month, particulars of which are given. Nine explosions have occurred during the last month, by which eleven persons have been killed, and twenty-one others injured. One of these explosions, which resulted from collapse of the flue, and by which no injury was done either to persons or surrounding property, occurred to a boiler under the inspection of this association; while in the eight remaining cases, not one of the boilers was under its care. No. 11 explosion occurred to the boiler of a locomotive engine while running with a passenger train. Between fifty and sixty persons were injured and four killed. This result was not occasioned, however, by the explosion only, but principally by the

train running off the line. Whether the engine leaving the rails was the cause or the effect of the explosion, is an interesting question, and one now undergoing strict investigation. No. 12 explosion, from which five persons were killed and twelve others injured, took place at an ironworks. The boiler in question, which was not under the care of this association, was personally examined shortly after the explosion happened, and found to be of cylindrical egg-ended construction, having an internal flue of horse-shoe shape, both the inlet and outlet of which passed through the further end of the boiler, the remainder of the flue being quite independent of the shell, and thus not forming any longitudinal tie from front to back. The boiler was externally fired, the flame first passing underneath the shell, and then entering the flue at one leg of the horse-shoe, and escaping to the chimney through the other. The length of the shell was twenty-eight feet, the diameter eight feet six inches, and the thickness of the plate seven-sixteenths, while the blowing off pressure was about 40lb. The boiler had rent completely into two parts at the fourth transverse seam from the front end, the larger portion of the shell flying forwards in a straight line from its seat, turning a summersault in its course, and landing in a position quite the reverse of its original one; the egg-end pointing to the brickwork seating and the open one from it. The smaller portion had flown to a much greater distance than the other, and not, as is usually the case, in a direction immediately opposite, but at right angles to it. A sister boiler working alongside, and connected to the one in question, was moved laterally, sufficiently so to disturb the brickwork seating and break the steampipes, though not to unsettle it altogether. With regard to the cause of the explosion. The boiler was fifteen years old, the plates over the furnace had already been repaired, and it was stated that the seams at that part had been observed to be leaking only a quarter of an hour before the explosion took place; while in addition, the shell was found to be patched in several places, and the plates cracked from the rivet holes to the edge. It is concluded, therefore, on consideration of all the circumstances, that the boiler could not have been in good condition, the correctness of which it is thought derives some corroboration from the fact, that the boiler alongside was found at the time of making this examination to be also leaking at the seams over the furnace, and that considerably, although not under pressure. An examination of the fractures, as well as a consideration of the direction in which the parts had flown, led to the conclusion that the rent had commenced at a longitudinal seam of rivets, extending for some two or three plates over the furnace. The rent ran along as far as this longitudinal seam extended, and when met by a plate crossing it, or breaking joint, as it is termed, then developed into a transverse rent, and completely severed the shell in two. It is thought that the fact of this longitudinal rent in the furnace end of the shell, being situated on one side of the centre or keel line, accounts for that portion having been blown laterally, and that the upward direction which it had evidently taken, had caused the summersault of the remaining and larger portion. The explosion, therefore, is attributed to the imperfect condition of the boiler, and although such defects would not be dangerous in a suitably constructed, double-flued, or "Lancashire" boiler, which is always internally fired, they are generally found to be fatal in those boilers which are fired externally; while in the present case the effect was aggravated by the fact of the seams of rivets over the fire being in line, and the diameter of the shell being as much as 8ft. 6in. No. 13 explosion, by which no one was injured or the surrounding property damaged, occurred to a boiler under the inspection of this association, the particulars of which are as follows:—The boiler was an upright furnace one, working in connection with two others of similar construction to itself. It was heated by the flames passing off from a furnace employed in preparing heavy forgings; the flames passing through an internal tube in the centre of the boiler, which ran directly from the top to the bottom. The extreme height of this internal flue was 26ft. 2in., but it was not of one diameter throughout. In order to admit of a brickwork lining to guard the flue above water line, the upper part was made of a larger diameter than the remainder, and attached to it by a flanged plate which formed a set-off or shelf on which the brickwork rested; again, the lower portion of the tube had a bell-mouth at the bottom, to afford an easy entrance for the flame. The length of the upper part was 11ft. 4in., and the diameter 3ft. 3in.; the length of the intermediate portion was 10ft. 4in., and the diameter 2ft. 6in.; while the length of the bell-mouth was 4ft. 6in., and the diameter at the base, 3ft., the thickness of the plates being three-eighths of an inch throughout, and the blowing-off pressure 55lb. The explosion, which did not in any way disturb the original position of the boiler, resulted from collapse of the internal flue tube, the collapse being confined to the intermediate portion just described, which it rent at about the middle of its length. A tube of such small dimensions as those given, namely, only 10ft. 6in. in length, and 2ft. 6in. in diameter, made of plate three-eighths in thickness, if of good material and workmanship as this one was, would be amply sufficient for a pressure of 55lb., if working under ordinary circumstances. This would suggest the conclusion that the water supply had been allowed to run short, but no positive indications of the plates having been over heated appeared upon examination, though this may, however, have taken place on previous occasions without its being known. On account of the height of these upright furnace boilers, the glass gauges become inaccessible, and the one in question was fitted with two gauge taps only, carried down by means of syphon pipes to within reach from the floor. Thus the water could sink below the proper level without affording any external indication, and would consequently pass unknown, should the gauge taps be neglected. This may have happened without any immediate collapse of the tube taking place, although the flue would be materially weakened by it, and rendered liable to give way some time after in consequence. It is impossible to say whether the flue tube was getting out of shape or not, since the boiler had been in such constant work that no opportunity was afforded the association of making an internal and thorough examination for upwards of three years. This may not therefore be an improper time for calling attention to the importance generally, of having spare boilers, so that a suitable opportunity may be afforded for examination, as well as for cleaning and repair. The boiler was found to be heavily incrustated with hard scale, which must considerably have tended to the overheating and weakening of the flue, to which these vertical boilers are always prone, from the tendency of the ascending steam to cling around the tube and prevent the contact of the water. The inaccessibility of the gauges, and fittings of these vertical boilers, on account of their height, is another disadvantage connected with them, and indeed a very thoroughly good and safe furnace boiler must still be considered as a desideratum. No. 16 explosion happened at an ironworks, to an externally-fired boiler 40ft. long, 8ft. in diameter, made of plates seven-sixteenths of an inch thick. The shell of the boiler gave way immediately over the furnace, the fireman being scalded to death from the stream of hot water issuing from the rent. The boiler had been repaired at this part, by putting on a new plate two months previous to the explosion, and it was at this plate that the rent occurred. This boiler, which was not under the charge of this association, was not personally examined on the occurrence of the explosion, but an engineer who inspected it shortly after has kindly furnished the following particulars:—The plate ripped open through the solid metal in two places, the rents being about fifteen inches long and one inch wide; while the parts surrounding it were a good deal cracked and the seams patched, so that the bottom of the boiler was evidently in a very defective state. The ruptured plate was about seven-sixteenths of an inch thick, and did not appear of very good quality, as if not thoroughly welded in rolling; but the fractures were not, properly speaking, "blisters," since the whole thickness of the plate had come down at once. In addition to the inferior character of the plate, the boiler was heavily coated with incrustation, and this had accumulated at the bottom for a depth of 3in. just over the fracture, and extended for a space of 4ft. by 2ft. This mud had hardened so much that the water and steam ploughed but a small hole through it in rushing out. There can be little question

that this coating of mud had kept the water away from the plate, and thus led to its becoming overheated, from which it gave way. There was plenty of water in the boiler at the time of the rupture.

**BOILER EXPLOSION NEAR DEWSBURY.**—On June 27th a boiler explosion causing the death of several workmen took place at a mill situate near Dewsbury, on the Leeds, Bradford, and Halifax Railway. The works are let to five persons, or firms, the main building being a five-storied factory, some four yards long by ten broad, and within its walls processes incident to the manufacture of cloth have been carried on for about two years. Within the building, but at the east end, was a low-pressure engine, and at the gable end was a boiler-house of two stories, containing a double-flued Cornish boiler. It was this boiler which exploded. The boiler-house was levelled to the ground, the engine-house shared a similar fate; the engine-beam being broken, and other portions of the machinery twisted and torn, and the gable end of the factory is knocked down to the lowest storey. The engine chimney, which is 36 yards high, was cracked from top to bottom.

#### ACCIDENTS TO MINES, MACHINERY, &c.

**EXPLOSION OF FIREDAMP IN GLAMORGANSHIRE.**—On June 27th an explosion of firedamp, accompanied with loss of life to several men, and much injury to persons and property, occurred at the Park Colliery, Glamorganshire. The mine in question, which is situated at a place called Baglan, Britonferry, is worked by Messrs. Thomas and Co., and gives employment to about 150 workmen. At the time the explosion took place the greater part of these were above ground.

**COLLIERY EXPLOSION AT RUABON.**—Two men were killed by an explosion of fire damp, at midnight on the 16th ult., at the Wynnstay Colliery, Ruabon. They had gone to their work as usual, about 700 yards from the pit's mouth, and before their descent their safety lamps were carefully locked by the man appointed. About 40 persons were at work in other parts of the pit. An explosion was heard, when the managers descended and found the men dead, an accumulation of fire damp had taken place, and it was manifest that both men had broken open their lamps.

#### WATER SUPPLY.

**DUBLIN WATERWORKS.—TURNING THE COURSE OF THE RIVER VARTY.**—The ceremony of diverting the course of the River Varty, for the purpose of constructing a water-tight dam at the principal storage reservoir of the intended Dublin Waterworks, near the village of Roundwood, in the county of Wicklow, recently took place. There is to be a water-tight dam across the valley of the Varty, half a mile long, and nearly 70ft. high in the centre. It will be about 330ft. wide at the base, and so broad at the top that an ordinary country road will be constructed on its summit level. The embankment may be said to consist of three parts—a central core of about ten or twelve feet thick, and two sloping sides, which taper from a base of, say 150 to 180ft. to a summit of about 15 or 20ft. This core, which passes along the whole length of the bank, consists of a water-tight material, called "puddle," but which is, in fact, brick clay, made into a substance like putty, by carefully mixing with water. This "puddle-wall," or "puddle-trench," must be based on a water-tight foundation and be impacted against a water-tight connection with the natural strata wherever it is placed; and for that purpose the water-tight foundation must be reached at every point, as on that chiefly depends the safety of the bank. In some banks in England the foundation had to be sunk one hundred feet to reach the sound stratum and cut off leakages. At Roundwood, an average cut of ten or twelve feet below the level bed of the river has been sufficient. To reach this under the bed of the river, the river must be diverted—and to procure a water-tight passage for the pipes through the embankment—a special structure had to be made that will be in effect a tunnel through the artificial bank. For a time the water will be allowed to flow freely through the new cut, which is about 14ft. by 10ft. Hereafter, when the bank will be completed, pipes with valves will be laid in this cut—the cut plugged up, the valves closed, and the water accumulated in the storage reservoir, to be let down through the valves as required. In order to enable the diversion to be effected without the risk of injury to the bank, the driest season has been chosen, and that in which the water may be expected to be very low. Thus, the old river bed may be excavated and the water-tight bank constructed on its site, before the advent of any serious flood.

#### GAS SUPPLY.

**IMPERIAL GAS COMPANY.**—The directors of this company have recommenced a dividend of 10 per cent. per annum, free of income tax: they have also been authorized to borrow £50,000 by mortgage, for the extension of mains and works.

**THE KILSO GAS COMPANY** have declared a dividend of 10 per cent.

**THE WISBRACK GAS COMPANY.**—The prosperous condition of this Company has enabled the directors to increase the rate of dividend, and to lower the price of gas to 4s. 6d. per 1000 cubic feet.

**THE SALISBURY GAS COMPANY** have reduced their price of gas to 4s. 6d.

**THE BRISTOL GAS COMPANY,** in reply to a committee of the Bristol Gas Consumers' Association, have declined to reduce the price of gas to 3s. per 1000ft. The committee announce that they are in a position to justify their making application to Parliament in the next Session for a Bill to incorporate a rival company.

**THE PETERBOROUGH GAS COMPANY** recommend a dividend of 8½ per cent. A lowering of meter rents has increased the number of their consumers.

**THE WORCESTER GAS COMPANY** announce a reduction in price to 4s. 6d.

**THE HALESWORTH GASLIGHT COMPANY** have declared a dividend of 7½ per cent.

**THE GALASHIELS GAS COMPANY** announced a dividend of 7½ per cent., and a reduction in their charge from 6s. 5½d. to 5s. 10d.

**THE BRECHIN GAS COMPANY'S** declared dividend is 10 per cent.

**THE CAMBRIDGE GAS COMPANY** have declared a dividend at the rate of 10 per cent. per annum.

**THE BOSTON GAS COMPANY** report prosperously of their affairs, and declare a dividend of 8½ per cent.

#### SEWERAGE WORKS.

**METROPOLITAN MAIN DRAINAGE.**—A visit has been paid by members of both Houses of Parliament to the outfall of the southern system of Main Drainage; Mr. Bazeletto explaining to them the nature of the works. As will be remembered, on each side of the river there are three main tunnels or sewers, which divide underground London into three districts, known respectively as the High, the Low, and the Middle Level. These in their course intercept all existing sewers flowing into the Thames, and carry their contents to Barking Creek on the north side, and to Crossness Point in the Erith marshes on the south side. The High Level, on the north side, is about eight miles in length, and runs from Hampstead to Bow, being at its rise 4ft. 6in. in diameter, and thence increasing in circumference as the waters of the sewers it intercepts require a wider course, to 5ft., 6ft., 7ft., 10ft., 8in., 11ft. 6in., and at its termination, near Lea river, to 12ft. 6in. in diameter. Its minimum fall is 2ft. in the mile; its maximum, at the beginning, nearly 50ft. in the mile. It is laid at a depth of from 20ft. to 26ft. below the ground, and drains

an area of fourteen square miles. The Middle Level, as being lower in the valley of the slope of which London is built, is laid at a greater depth, varying from 30ft. to 38ft., and even more, below the surface. This is nearly complete, and extends from Kensal Green to Bow. The Low Level will extend from Cromer to Abbey Mills, on the marshes near Stratford, and one portion of it will pass through the Thames embankment. At Bow, the Low Level waters of the sewer will be raised by engines at a pumping station to the junction of the High and Middle Level ducts, thence descending by their own gravity through these tunnels to the main reservoir and final fall at Barking. On the south side of the Thames the three great sewer arteries are constructed on similar plans,—the High Level from Dulwich to Deptford; the middle from Clapham to Deptford; and the low level from Putney to Deptford. At this point is a pumping station, which raises the water from the low to the high level, whence it flows away through a 10 feet tunnel to Crossness Point. One part of this tunnel, passing under Woolwich, is a mile and a half in length, without a break, and driven at a depth of 80 feet from the surface. At the outfall will be another pumping station, to lift the water to the reservoir. The southern reservoir is only five acres in extent; that on the north is fourteen. In the reservoir it will be deodorized. The two culverts which carry the sewage to the east and west pumping stations are as large almost as railway tunnels. Before the entrance to the pumps are massive iron strainers, which keep out all the coarse refuse brought down the sewer, and which is afterwards dredged up by the filth hoist into the filth chamber, which is flushed into the river at low water. The pumping-house is nearly finished, and the ironwork of the engines begun. The pumping stations will each consist of an engine house, containing ten boilers calculated to work up to 500 horse power nominal. This power working through eight pumps of 7 feet diameter and 3 feet stroke will daily raise 19,000,000 cubic feet of sewage from 19 feet below low water to the level of the outfall; but, in case of necessity, the pumps can raise 25,000,000 cubic feet per day. The reservoir into which it will flow is not yet finished, but when roofed in with brick will hold 20,000,000 gallons of sewage.

#### DOCKS, HARBOURS, BRIDGES, &c.

**PROPOSED PIER AT ALDBOROUGH.**—A project is on foot for erecting a wrought iron pier at Aldborough, Suffolk. It is proposed to run it out 500ft., that is to the outer edge of the inner shore, so as to command 10ft. of water at the lowest spring tides. The cost of construction is estimated at £5000.

#### MINES, METALLURGY, &c.

**METALLIC ALLOY.**—Mr. A. L. Woolf, of Birmingham, proposes the use of an alloy as a substitute for gold, consisting of copper from 20 to 100 parts; aluminium, 5 to 7½ parts; and gold, 2½ parts. The alloy formed is described as very closely resembling fine gold.

#### APPLIED CHEMISTRY.

**ON THE SUBSTITUTION OF SOLUBLE GLASS FOR THE RESINOUS SOAP USED IN THE MANUFACTURE OF ORDINARY SOAP, BY MR. F. L. STORER.**—The idea of employing soluble glass is by no means new. Its application to this purpose was long ago proposed and patented by M. Wilson, followed by MM. Sheridan, Gossage, and others. It seems to have been recently taken up anew in England. But the American process differs notably from those previously in use, by making use of a product rich in silica, capable of forming a hard and comparatively neutral soap, instead of the extremely alkaline mixtures of the above-mentioned inventors. This constitutes another example of the rapidity with which one industrial process displaces another, previously preferred, but whose further development is impeded by circumstances. The American process commences in preparing by the dry way a silicate of soda containing five equivalents of silica and two of soda, which is dissolved by prolonged boiling in water. The solution is sometimes hastened by pressure. The limpid solution, freed from all insoluble impurities, is decanted and concentrated to about 35° B., 1.32 specific gravity being the state in which it is sold. After preparing by the usual process a certain quantity of pure soap with tallow, oil, or other kind of grease, and when the boiling is just finished, it is poured, while still hot and in a fluid state, into forms or moulds, and the desired quantity of concentrated solution of silicate of soda, either cold or heated, is added at the same instant. To incorporate the silicate thoroughly, the mass is stirred, until the cooling renders this operation difficult. It is then left to harden. By this process the silicate of soda becomes so perfectly incorporated with the soap that as much as 60 per cent. of this solution at 35° B. may be added, and yet yield a soap of adequate consistency. But generally not more than from 25 to 40 per cent. of silicate is added to the soap. It is this power of adding so large a proportion of alkaline silicate thoroughly saturated with silica which forms one of the great advantages of the American process. According to M. Steeber's experiments it is possible to mix only small quantities of the more alkaline silicates, such as were formerly used, with hard tallow or oil soaps, for when more is added the excess separates. The experience of some American soapmakers who have recently tried to introduce 32 per cent. silicate of soda into their soaps, confirms M. Steeber's opinion. Soap prepared by the American process differs materially from ordinary rosin soap neither in appearance nor action. It has passed satisfactorily through the trial of a great demand during the past year, and appears to serve perfectly well for all the uses to which ordinary soap is applied. The American Government has already bought large quantities of it for the use of the army at a much lower price than was formerly given for resins soaps, and it has undergone all the tests exacted by the agents of the Federal Government. We may remark that a mixture of silicate of soda and ordinary soap has been preferentially used for some time in washing woollen fabrics in one of the largest establishments of the United States. Silicate of soda is useful to soapmakers for several qualities not possessed by rosin; for instance, the addition of a large quantity of silicate of soda imparts to the soap neither that disagreeable odour nor the glueiness which too great a proportion of rosin communicates. It may be introduced into soap in much larger proportions than rosin without in any way injuring the sale of the product. It is not probable that rosin will ever resume its former importance to the soapmaker. It will still be used conjointly with the silicate of soda, since a little rosin serves to correct the nauseating odours of inferior fats, and because, according to some makers, it augments the detergent action of the soap. The use of soluble glass in hard soaps should not be confounded with the use as detergents of simple solutions of silicate of soda. The latter are simply alkaline solutions, similar to those of alkaline carbonates. They act chiefly, if not wholly, by their chemical nature, for they do not lather, and in that and other respects are unlike real soaps; while the silicate of soda soap, owing to the portion of fatty acid it contains, lathers abundantly, and behaves like ordinary soap, the mechanical and chemical conditions required by a good soap being fulfilled. It should be borne in mind that silicate of soda soap is distinct from siliciferous soaps formerly prepared by the mechanical addition of silica or of some insoluble silicate, such as silicate of alumina, which is simply a useless adulteration, while in soaps containing soluble glass a portion of fatty acid, so to speak, is replaced by a weak mineral acid, equally efficacious in modifying the causticity of the alkali.

**ANTIDOTE FOR HYDROFLUORIC ACID.**—In case of burns from this liquid, Mr. Kessler recommends the application of lint wetted with acetate of ammonia, and the injection of the same solution into the blisters, if any have formed. If, however, the acid has got into places difficult to moisten, under the nails, for instance, he recommends caustic ammonia to be used instead of the acetate, and remarks that the patient should not trouble himself about the pain, sometimes very acute but transient, which follows the application.

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 JUNE 23rd, 1863.

- 1575 J. Murray—Chains or chain cables and rings.  
1576 A. R. Stocker—Preparing and fashioning iron applicable to the manufacture of boot heels, tips, and horse shoes.  
1577 J. Ellison & A. Rogerson—Slubbing, intermediate and roving frames, in throates and winding machines used for the manufacture of cotton or other fibrous materials.  
1578 W. W. Sleight—Semi-navigatory motive power engine.  
1579 S. Robinson, J. Priestley, & J. Foulds—Looms for weaving.  
1580 T. F. Parsons—Preparing plates, bars, or other objects of iron for being coated with metals or alloys.  
1581 R. A. Brooman—Breech-loading arms.  
1582 W. L. & T. Wiggins—Steam boilers.  
1583 W. L. & T. Wiggins—Lessening the friction of the rubbing surfaces of the slide valves of engines and of the journals of shafts.  
1584 W. L. & T. Wiggins—Superheating steam in steam boilers.  
1585 E. Brooks—Breech-loading fire arms.  
1586 A. Mein—Generating steam.  
1587 F. Feichtinger—Paper applicable for hemorrhoidal complaints.  
1588 W. Toovey—Photolithography, photoincography, and photographic engraving on copper or steel plates.

DATED JUNE 24th, 1863.

- 1589 S. Knowles & R. Hayward—Plaiting and measuring woven fabrics.  
1590 T. Redwood—Straining or mixing and straining liquid and solid substances.  
1591 P. R. Hodge—Ejecting hydrostatic machinery adapted to press, dry docks, slips, or the moving or lifting of heavy masses.  
1592 E. Myers & W. R. Williams—Gas meters for measuring the flow of gas.  
1593 S. Smith—Liquorice.  
1594 J. L. Hughes—Ornamenting porcelain.  
1595 T. Skinner—Ornamentation of silver, German silver, Britannia metal, electro-plated or other plated goods.  
1596 A. E. Brace—Actuating domestic bells and other signals by the electric current.

DATED JUNE 25th, 1863.

- 1597 A. Ripley—Packing, chiefly applicable to piston rods and pumps, and for forming the joints of gas, steam, or water pipes.  
1598 C. A. Court de Goddes de Liancourt—Saving life from drowning.  
1599 D. J. Hussey—Hobbins, and the winding of roving or yarn skeins.  
1600 T. Page—Horse shoes and their fastenings.  
1601 J. O. Mathieu—Twisting machines.  
1602 R. Musbet—Iron and steel.  
1603 W. Kirrage—Using Apoc elasticon hyphasma as a new and improved cloth for floors, roofs, walls, tanks, and other linings, being impervious to damp and of great strength and durability.  
1604 H. G. Craig—Preparing iron and other metal plates for shipbuilding and other purposes.  
1605 H. G. Lee—Sewing machines.  
1606 A. Watson—Fastening.  
1607 J. Head & H. Brinsford—Thrashing machines and cutting and bruising straw.

DATED JUNE 26th, 1863.

- 1608 A. Tulpin—Stretching and dyeing fabrics.  
1609 W. Clark—Aerating liquids.  
1610 G. Buocini—Composition suitable for the manufacture of candles and other like articles, and pomatum, and an improved wick for burning with such composition.  
1611 W. R. Gedge—Placing tyres on wheels or hooping or ferruling generally while the metal is hot.  
1612 J. Griffiths—Puddling iron and steel.  
1613 R. Musbet—Iron and steel.

DATED JUNE 27th, 1863.

- 1614 T. Dunn—Construction and maintenance of the permanent way of railways.  
1615 G. Clark—Guns and projectiles, and carriages, platforms, and slides for working and protecting guns.  
1616 W. & J. Bradshaw—Looms for weaving.  
1617 E. T. Hughes—Couplings for hose pipes, and also connecting axles to the nave of wheels or wheels.  
1618 J. Chatterton—Lining iron and other tubes and hollow vessels, and manufacturing corrugated tubes of plastic materials.

DATED JUNE 29th, 1863.

- 1619 G. Davies—Cork cutting machine.  
1620 W. Andrews—Insulating electric telegraph wires.  
1621 C. Avery—Rotary engines.  
1622 L. E. Hicks—Inkstands.

DATED JUNE 30th, 1863.

- 1623 F. J. Duggan—Connecting lamp chimneys and other glasses or shades with the burners of lamps.

- 1624 L. E. A. B. Maralez—Combs.  
1625 J. G. Jennings & M. L. J. Lavater—Stoppers and lids or covers for jars, bottles, and other vessels, also closing and fastening other articles, and constructing and fixing packing and other rims and discs and diaphragms of vulcanized india rubber.  
1626 J. Simpson—Iron hurdles and fencing.  
1627 J. H. Johnson—Moulding or shaping potteryware.  
1628 A. K. Richards—Ordnance and fire arms, and projectiles to be used therewith.  
1629 C. H. Gardner—Lithographic and zincographic presses.  
1630 A. Silverster—Apparatus to be used in the exhibition of dramatic and other performances.  
1631 S. Cole—Clamps or fastenings for securing brochures, solitaires, and other dress ornaments.

DATED JULY 1st, 1863.

- 1632 T. Williams—Effecting or aiding in effecting the locomotion of land carriages or vehicles and floating vessels by manual power or other primary motive agency.  
1633 J. Blake—Reducing and regulating the pressure or quantity of steam, and discharging the water of condensed steam from cylinders, pipes, and other vessels.  
1634 T. Alliston & R. Swift—Metallic joints for bedsteads, and the application of such joints to certain parts of bedsteads.  
1635 W. Snell—Waterproof material.  
1636 T. Boyle—Promoting ventilation in every description of dwelling place and building.  
1637 C. F. Coles—Working guns in vessels and forts, and discharging them under water.  
1638 R. C. Clapham—Hyposulphite of soda, sulphite of soda, and sulphite of lime.  
1639 J. H. Johnson—Coating or covering metal sheets with metals or alloys.  
1640 J. & J. S. Harry—Cutting tobacco into cakes suitable for the press.  
1641 T. Taylor—Railway breaks.  
1642 H. Hutchinson—Boots and shoes.  
1643 G. T. Bonfield—Preparing cotton, wool, or other fibrous material.  
1644 J. & J. Cole, jun.—Looms for weaving.

DATED JULY 2nd, 1863.

- 1645 J. J. Shedlock—Wet gas meters.  
1646 R. A. Brooman—Protecting metals and metallic articles from oxidation, and coating zinc, brass, copper, and other metals.  
1647 A. A. Croll—Purification of gas for illumination.  
1648 K. Lloyd—Waterproofing, softening, and preserving all kinds of wearing leather, rendering old hard leather soft and pliable and impervious to wet, particularly boots and shoes, carriage harnesses, gig aprons, carriage heads, and mill bands.  
1649 W. Miller—Evaporating through the combined agencies of heat and centrifugal force.  
1650 F. Mansome—Containing or preserving iron ships or vessels, or iron used for other purposes.  
1651 J. King—Fencing land and hanging gates.

DATED JULY 3rd, 1863.

- 1652 C. Martin—Treatment and preparation of materials for the manufacture of paper.  
1653 H. Broadhead & G. Murdoch—Breech loading ordnance, gun carriages, and concussion shells.  
1654 W. R. Newton—Treatment and preservation of skins of all kinds.  
1655 R. Dawson—Decorating and cleaning corn and other grain.  
1656 C. Birch—Boots and shoes.  
1657 H. B. Ryth—Rotative engine.  
1658 H. Thomas—Candlesticks.  
1659 H. S. Warner—Treating or preparing megas and other substances to be used as fuel.  
1660 E. Le Loe—Churning.

DATED JULY 4th, 1863.

- 1661 J. C. MacDonald & J. Calverley—Printing apparatus.  
1662 M. E. Ryth—Rotative engine.  
1663 J. MacDonald—Jacquard looms.  
1664 R. Flude & J. Farndon—Looms for weaving narrow fabrics.  
1665 J. Grimston—Shuttles for weaving narrow fabrics and mousting and fitting them to the looms.  
1666 H. A. Bonneville—Steam engines.  
1667 H. A. Bonneville—Obtaining motive power.  
1668 H. A. Bonneville—Telegraph wires.  
1669 A. Norman—Apparatus for fanning or for agitating air.  
1670 J. Oxley—Filtering apparatus.  
1671 G. A. Barrett, W. Ewell, C. J. Andrews, A. Barrett, & J. L. Bowhay—Thrashing machines.

DATED JULY 6th, 1863.

- 1672 A. & B. S. Gower—Sowing and harrowing machine.  
1673 J. Samu—I—Gas for lighting and heating purposes.  
1674 W. B. Adams—Wheels and their tires, axles, and axle boxes.  
1675 T. W. Coudrey—Attaching boxes to hold soap, black lead, or similar household articles to the sides of wash tubs, pails, or house buckets.  
1676 J. McCaffrey—Propellers for propelling ships.  
1677 S. J. Cooke—Supplying carbonic acid gas to casks or other vessels containing beer or other fermented liquid.  
1678 H. Cauter—Lubricating matter or composition.  
1679 B. Bonfield—Stoppers for bottles.  
1680 G. C. Collier—Treatment of cut tobacco for its better preservation.  
1681 C. Schiele—Turbines.  
1682 L. J. Guichard & G. F. J. Lefebvre—Lamps for burning mineral oils.  
1683 W. S. Bruce—Lucifer matches, fuses, and other similar lights.

DATED JULY 7th, 1863.

- 1684 E. Edwards—Glass finger plates and other articles made of glass, and kilns for annealing articles made of glass.  
1685 T. Bartholomew—Shoes for the feet of horses and other animals, and the means of connecting them.  
1686 J. Orr—Weaving piled and other fabrics.  
1687 W. E. Gedge—Seats, chairs, sofas, lounges, and other similar articles of furniture.  
1688 W. E. Gedge—Apparatus for milking.  
1689 S. Robinson—Spring hinges for swing doors.  
1690 G. P. P. Reed—Watches or timekeepers.

DATED JULY 8th, 1863.

- 1691 E. Myers & H. Forbes—Propelling and steering ships.  
1692 G. Haselmeier—Brick machines.  
1693 W. Basford—Generating and purifying gas.  
1694 F. Kly—Composition applicable to corn plasters.  
1695 H. Armstrong—Alum.  
1696 J. Giboux, S. R., & W. Trulock—Breech-loading fire-arms.  
1697 P. A. L. de Fontainebleau—Roofing houses.  
1698 T. Freeman—Corn and seed drill.  
1699 A. G. Southey—Horse lamps.  
1700 R. & L. A. Tallerman—Waterproofing and ventilating boots, shoes, and slippers.  
1701 G. Haselmeier—Lever horse-power machines.  
1702 W. E. Newton—Locks and fastenings.  
1703 H. D. Cunningham—Working guns.  
1704 J. Thomas—Treating ores and certain containing iron.

DATED JULY 9th, 1863.

- 1705 S. Davis—Anatomical bit for horses or other animals.  
1706 J. Smith & S. A. Cheese—Hydraulic engine.  
1707 W. Williams—Shirt collars and boys' and ladies' collars.  
1708 R. Phillips & W. Bond—Temples for looms.  
1709 G. A. Brooman—Ships and propelling the same.  
1710 P. G. B. Westmacott—Cranes and dock-gate and other crabs.  
1711 J. P. Delany & J. C. R. Oke—Pistons of steam engines.  
1712 P. G. B. Westmacott—Hydraulic engines.  
1713 W. V. Wilson—Red colouring matter.  
1714 R. Agate—Roofs and other lights for railway stations, conservatories, and other structures.  
1715 W. E. Newton—Barometers or gauges for measuring the pressure of fluids.  
1716 W. Teut—Plus or hooks for suspending fabrics.  
1717 G. Gouland—Nautical and surveying instruments.  
1718 W. Teaker—Thrashing machines.

DATED JULY 10th, 1863.

- 1719 P. A. Godefroy—Purifying oils.  
1720 A. R. Johnston—Portable fence.  
1721 M. F. Mennesson—Protecting the silvring of mirrors.  
1722 J. J. Shedlock—Soil pits.  
1723 C. de Bierge—Piles for foundations and piers.  
1724 W. Clark—Gravel-laying machine.  
1725 T. Legg & R. Griffith—Sewing machines.  
1726 R. Houshy, jun., J. Bonnal, & W. Astbury—Traction engines and apparatus for ploughing and tilling land.  
1727 W. E. Jones—Permanent way of railways.  
1728 W. Henderson—Treating ores and other substances containing iron.  
1729 J. P. Bourquy—Rolling press.  
1730 J. Campbell—Permanent way of railways.  
1731 K. & W. Hawthorn—Working of railways.  
1732 L. Stille—Galvanic batteries.

DATED JULY 11th, 1863.

- 1733 E. D. Chatterway—Railway signals.  
1734 M. W. Ruthven—Steering vessels.  
1735 A. Dixon & J. Pamprey—Cot flower clip.  
1736 J. Orr, J. Hinton, & J. Lewis—Chenille.  
1737 J. Barnes—Clipping off connecting threads of lace.  
1738 R. A. Brooman—Cartridges.  
1739 H. Grenave—Railways and tramways.

DATED JULY 13th, 1863.

- 1740 J. Mortimer—Dwelling houses.  
1741 R. D. Dwyer—Casks and other vessels.  
1742 H. Coulter—Burners for hydro-carbon and other fluid burning lamps.  
1743 R. D. Dwyer—Letter copying presses.  
1744 H. N. King—Apparatus for producing spectral illusions on the stage.  
1745 J. Barton—Gund for coal and other pits.  
1746 R. S. Walker—Coating iron ships.  
1747 G. H. Barber—Calendar or date denoting apparatus.  
1748 J. Luong—Dyeing and printing.  
1749 R. A. Brooman—Suspending chandeliers, gasoliers, and other weights.  
1750 R. A. Brooman—Sizing warp and weft threads.  
1751 P. C. A. Locodius—Fishing.  
1752 H. A. Bonneville—Breech-loading fire-arms.

DATED JULY 14th, 1863.

- 1753 L. M. Bourrique & J. B. Vidard—Railway carriages.  
1754 L. M. Bourrique & J. B. Vidard—Waggons for railways.  
1755 J. K. Cooper—Sights for rifles and other fire-arms.  
1756 C. Opperman—Connecting and disconnecting horses and other animals with carriages.  
1757 J. T. Cooke—Battens.  
1758 J. T. & F. R. Holmes—Thrashing and dressing machines.  
1759 G. Saxon—Metallic pistons.  
1760 J. Davison—Furaces.  
1761 R. Hornsby & J. E. Phillips—Reaping and mowing machines.  
1762 W. Wood—Covering land, bog, or peat, with earth or soil.  
1763 E. Somers—Sodium.  
1764 W. Roberts—Ploughs.  
1765 J. L. Todd—Rollers employed for spinning fibrous materials whilst in a wet state.  
1766 J. Slater—Compressing bricks, tiles, and other plastic materials.

DATED JULY 15th, 1863.

- 1767 E. Funnell—Self-acting electro-magnetic clock work signal for railway purposes.  
1768 T. Wimpenny—Roving and spinning wool, cotton, and other fibrous substances.  
1769 D. P. Wright—Attaching the burners of paraffin and other lamps to the founts or oil containers.  
1770 W. T. Cheetham—Obtaining hydraulic motive power.  
1771 W. Clark—Making paper transparent and transferring designs.  
1772 P. A. J. Dujardin—Electric telegraphs.  
1773 M. Henry—Figuring, ornamenting, and colouring fabrics.  
1774 R. A. Brooman—Reducing charcoal and other friable substances to fine or impalpable powder.  
1775 R. A. Brooman—Telegraphing by electricity.  
1776 D. C. Clemm—Employment of magnesia and its combinations in manufactures.  
1777 D. Tannet—Breakwaters.

DATED JULY 16th, 1863.

- 1778 H. Meze—Treating fatty matters.  
1779 A. Watson—Cooking ranges.  
1780 S. A. Couper—Packing case to contain bottled beer, wine, or any other liquid in bottle.  
1781 J. N. Taylor & W. Austin—Ships.  
1782 H. Elliott—Breech-loading fire-arms.  
1783 L. Priestley & J. L. Todd—Elastic boots and leggings.  
1784 L. R. Bodmer—Manufacture of a new product from peat and peat tar.  
1785 C. Stokes—Expanding and contracting horse collar.  
1786 G. Rand—Apparatus for boiling and cooking.  
1787 J. Lamb & S. Tovey—Looms for weaving carpets.  
1788 A. Montclair & W. Tent—Attaching hooks to furniture and fabrics.  
1789 B. Lumbert—Preparation of waste paper in order its being again used in the manufacture of paper.  
1790 O. Wakefield—Cooks or taps.  
1791 N. Thompson—Boat building.  
1792 K. Maw—Pillars, posts, columns, mouldings, and building, when corrugated metal is employed.

DATED JULY 17th, 1863.

- 1793 A. J. Scelley—Canopies of bedsteads.  
1794 A. C. D. Will—Producing raised patterns on felt hats, caps, and bonnets.  
1795 J. Darrieux—Powder for cleaning metals.  
1796 F. Lepoutre—Mechanical sector.  
1797 T. Johnson—Washing and cleansing casings.  
1798 E. Alcou—Gas burners.  
1799 K. A. Brooman—Varnish.  
1800 G. F. Wilson and G. Payne—Soap.  
1801 R. Coenen—Winding, measuring, and string silk.  
1802 J. H. Johnson—Machine knitting needles.

DATED JULY 18th, 1863.

- 1803 A. Clark—Revolving shutters and blinds.  
1804 W. C. Page—Preventing and removing the incrustations in marine and land steam boilers.  
1805 E. Hulborow and I. Parker—Sights for fire-arms.  
1806 G. Murdoch—Steam and vacuum gauges.  
1807 E. J. Mayor—Horse shoes.

DATED JULY 20th, 1863.

- 1808 W. Simpson and J. Hutton—Hollow cutting tools.  
1809 F. A. Culvert—Opening, cleaning, and preparing fibrous substances.  
1810 R. B. Brinsley and J. Hargreaves—Sizing and drying yarns and fabric.  
1811 R. Knowles—Cleaning cotton.  
1812 J. and W. H. Bailey—Preventing boiler explosions.  
1813 A. Smith—Drugging bristler.  
1814 W. H. Gedge—Lamp navigation.  
1815 A. A. Pelas—Printing plates.  
1816 F. Ayckbourn—Air and water beds.  
1817 J. Lyman—Micrometer draughting scales.  
1818 H. Gourd—Water closets.  
1819 J. Weare—Ink.

DATED JULY 21st, 1863.

- 1820 F. L. H. Dacchell—Purifying water.  
1821 C. H. Rosacker—Reducing wood to a fibrous condition.  
1822 W. Clarke—Manufacture of fabrics in twist lace machinery.  
1823 W. L. Auerdin—Softening and preparing flax.  
1824 C. S. Ducauc—Apparatus for heating, melting, boiling, and evaporating.  
1825 R. T. Bainbridge—Ventilation.  
1826 J. E. Varmer—Umbrellas and parasols.  
1827 G. Haselmeier—Harrowing and smoothing land.  
1828 R. A. Brooman—Vatches.  
1829 E. Alcou—Condensing steam.  
1830 W. Naylor—Safety valves.  
1831 W. E. Newton—Mats, straps, bands and ropes.

DATED JULY 22nd, 1863.

- 1832 P. R. Jackson—Rolling hocks and tyres.  
1833 J. Hould—Preparing and spinning hemp and flax.  
1834 C. Senior—Closing, punching, and rivetting horse pits.  
1835 J. White—Pyramid and other cans for oil.  
1836 C. Beslay—Making furcive waterproof.  
1837 B. B. Bertram—Advertising medium.  
1838 L. Ferrin—Danger signals.  
1839 S. Timmons—Ploughs.

DATED JULY 23rd, 1863.

- 1840 W. Cole—Safety of window cleaners.  
1841 A. T. Holden—Springs.  
1842 L. J. Filtou—Extinguishing chimney fires.  
1843 M. A. Soul—Expelling refuse matter from steam and sailing ships below the water line.  
1844 G. Davies—Revolving fire-arms.  
1845 W. and J. Garforth—Preparing textile fabrics.  
1846 M. Meisel—Regulating the speed of trains.  
1847 W. Horton—Fire arms.  
1848 W. Clark—Saw.  
1849 T. Perkins—Horse and hand rakes.

# LOCOMOTIVE ENGINEERING

SHARP, STEWART & CO'S EXPRESS ENGINE.

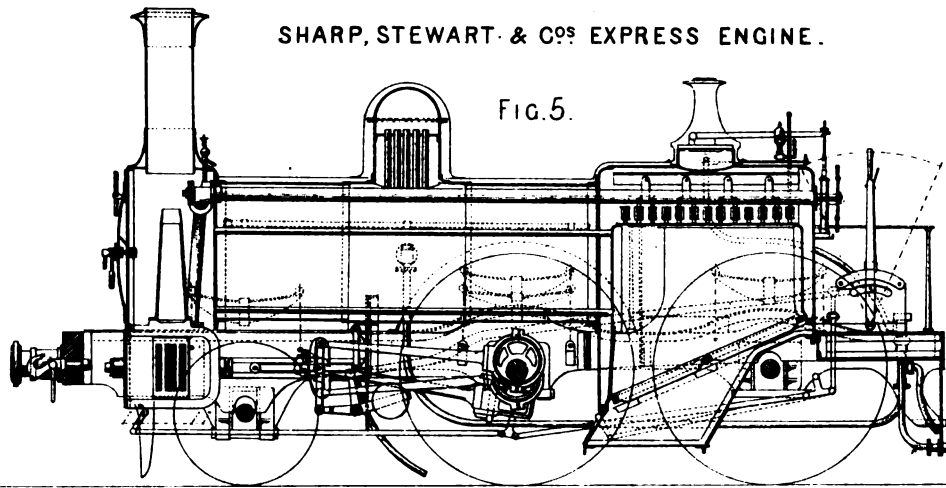
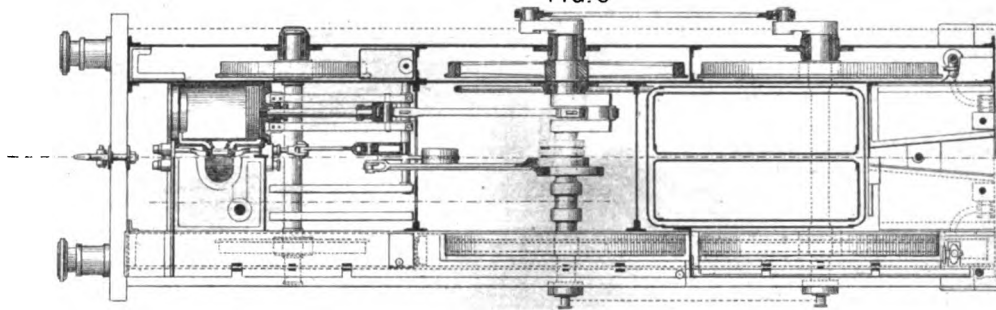


FIG. 6



RAMSBOTTOMS STANDARD EXPRESS ENGINE.

FIG. 1.

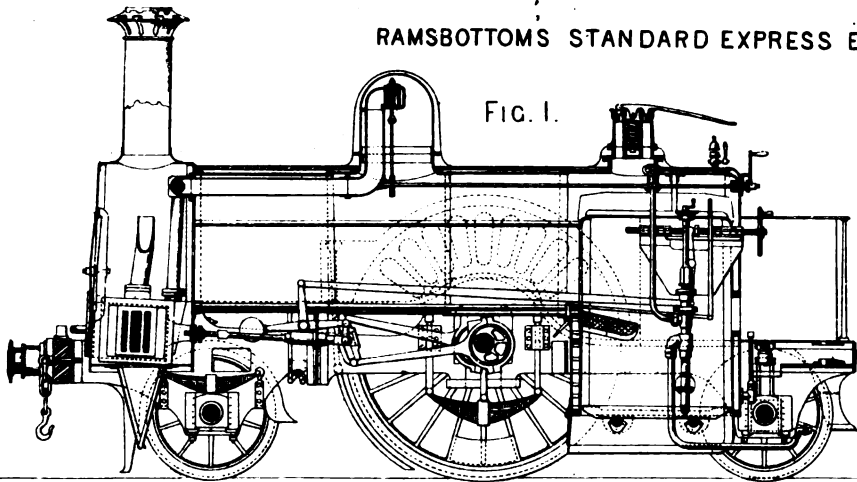


FIG. 3.

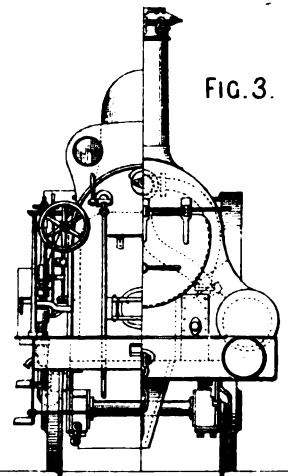


FIG. 2.

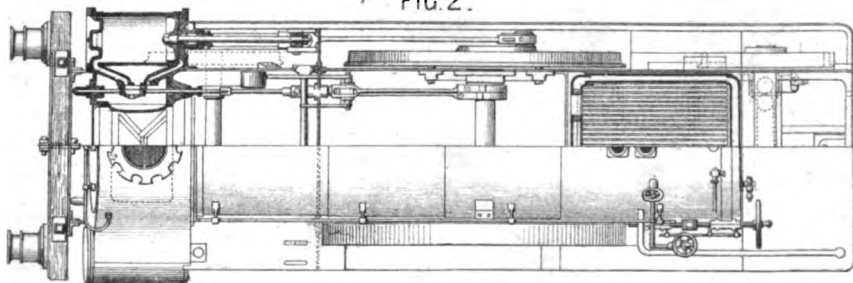
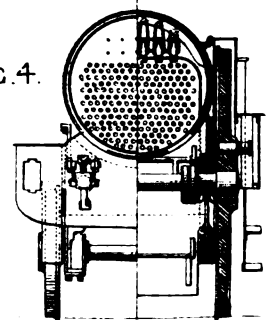


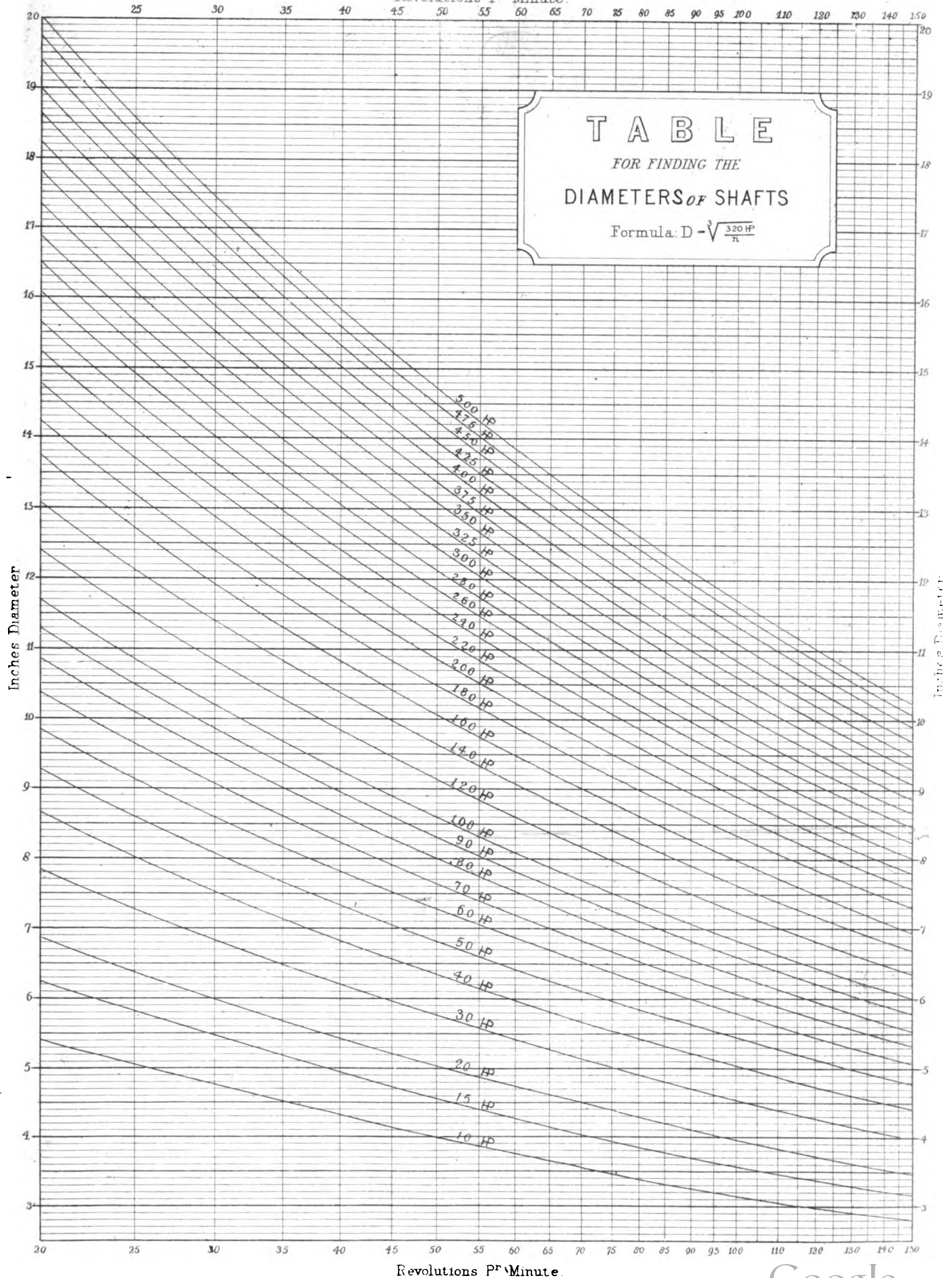
FIG. 4.



0 1 2 3 4 5 10 15 20  
Scale of Feet



Revolutions Per Minute.





# THE ARTIZAN.

No. 9.—VOL. 1.—THIRD SERIES.

SEPTEMBER 1st, 1863.

## A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. BIRCKEL.

(Continued from page 148.—Illustrated by Plate 247.)

With a view more especially to establish a contrast between the ideas of different Locomotive Engineers, as embodied in their respective productions, we have prepared a series of copper-plate engravings, including illustrations of types of such locomotive engines, taken from the practice of various makers and locomotive superintendents as have obtained deserved repute for efficiency and durability, and which at the same time possess very distinctive characteristics. In the accompanying plate 247, the first of our series devoted to the illustration of the several types, Figures 1, 2, 3, and 4 represent Mr. Ramsbottom's standard express engine, as constructed under his superintendence at the works of the London and North-Western Railway Company, at Crewe.

This class of engines we believe, has generally to carry the Irish mail, upon that portion of the road between Stafford and Holyhead, the train consisting, on an average, of eleven carriages and a break van, which, with the engine and tender, make a gross load of about 90 tons, at a mean speed of 45 miles per hour; this duty is performed with an average consumption of 26½ lbs. of coal per mile, the road between Chester and Holyhead being very heavy.

Their main dimensions and leading features are as follows:—

**BOILER BARREL.**—10ft. 5in. long × 3ft. 11in. diameter, made of  $\frac{7}{8}$ in. plates, single rivetted; height from rails to centre of barrel, 6ft. 6in.

**FIRE-BOX SHELL.**—Flush at the crown with the barrel, 4ft. 9in. long × 4ft. wide, made of  $\frac{7}{8}$ in. plates; two  $\frac{1}{2}$ in. safety-valves, placed on the crown of the shell, and constructed on Mr. Ramsbottom's principle.

**FIRE-BOX.**—4ft. 2in. long × 3ft. 6in. wide × 5ft. 7in. deep, made of  $\frac{1}{2}$ in. copper plates, the tube plate excepted, which is  $\frac{3}{4}$ in. thick; provided with the smoke burning apparatus, described in our paper treating of the boiler. (In THE ARTIZAN of January, 1863.)

**HEATING SURFACE.**—192 brass tubes, 2in. diameter × 10ft. 9in. long = 1080 square feet; fire-box, 2in. diameter × 10ft. 9in. long = 95 square feet; total 1175 square feet.

**FIRE GRATE.**—4ft. 2in. long × 3ft. 6in. wide = 14·7 square feet; fire bars, 26 in number, 1in. thick at the top, with a space of  $\frac{1}{2}$ in. between them; the fire bar frame consists of two round bars of iron, 3in. diameter, resting at each end in a V seat, bolted against the ash pan side, with  $\frac{1}{2}$ in. iron pegs screwed into them, at such distances as to provide an inch clear space for the fire bars. By this arrangement it is found that the latter do not solder together, as is frequently the case with the frames commonly used.

**SMOKE-BOX.**—2ft. 8in. long × 2ft. 11in. radius, partly enclosing the cylinders; provided at the bottom with a funnel, having an aperture of 6in. length and 1½in. width, to relieve the smoke-box of the cinders which would accumulate rapidly during the combustion of coal. By causing the front lip of the aperture to project slightly below the backlip, which is bent backwards with an easy curve, it is found that the vacuum is not impaired, while, by this very simple contrivance, the smoke-box is greatly protected against the destructive action of red hot cinders.

**CHIMNEY.**—16in. diameter × 13 feet 1in. high, measured from the rails.

**CYLINDERS.**—Outside, 16in. diameter × 24in. stroke, fitted with internal back cover, and with Mr. Ramsbottom's patent piston. Steam pipes, 3½in. bore; steam ports, 13½in. long × 1½in. wide; exhaust port, 3½in. wide; lap of valve,  $\frac{1}{2}$ in.; blast orifice, 4½in.

**LINK MOTION,** with screw reversing gear, illustrated and described in detail in our paper on the link motion, given in THE ARTIZAN, of March, 1863; length of link 16in., throw of eccentrics, 5½in.

**FEEDING APPARATUS.**—Two medium sized Giffard's injectors placed on each side of the fire-box.

**REGULATOR.**—Double-beat valve regulator, to suit main steam pipe, 5½in. diameter.

**CONNECTING ROD.**—6ft. 3in. long, with short fork at the cylinder end; cross head pins, 2½in. diameter × 2½in. long; crank pin bearing, 4in. diameter × 4½in. long.

**FRAMES.**—Single inside plate frames, 4ft. 1in. apart; 13in. deep over driving fork, and 1in. thick.

**WHEELS AND AXLES.**—Wheels, six in number, of solid wrought iron; driving wheels, 7ft. 6in. diameter; leading and trailing wheels, 3ft. 7½in. diameter; tyres, 5in. wide × 2½in. thick; driving axles, 7in. diameter × 7in. long in bearings, and 6½in. diameter in body; leading and trailing axles, 6in. diameter × 9½in. long in journals, and 5½in. diameter in body.

**WHEEL BASE.**—Between leading and driving wheels, 7ft. 7in.; between driving and trailing wheels, 7ft. 11in.; total, 15ft. 6in.

**SPRINGS.**—Leading springs, 2ft. 8in. span, made of 14 plates,  $\frac{1}{2}$ in. thick by 4½in. wide; driving springs, 3ft. span, made of 18 plates,  $\frac{1}{2}$ in. thick × 4in. wide; trailing springs made of two volutes, on each side of the engine 5½in. diameter, resting in wrought iron cross frame, and butting against the foot plate by the medium of this frame.

**WEIGHT OF ENGINE IN WORKING ORDER.**—On leading wheels, 9 tons 8 cwt.; on driving wheels, 11 tons 10 cwt.; on trailing wheels, 6 tons 8 cwt.; total, 27 tons 6 cwt.

Width of engine measured over all, 7ft. 9in.; length of engine measured over all, 24ft.

Figs. 5 and 6 represent an express engine as supplied to the London, Chatham, and Dover Railway Company, by Messrs. Sharp, Stewart and Co. This class of engines will take a load of 220 tons on a level road at the rate of 45 miles per hour. Their main dimensions and leading features are as follows:—

**BOILER BARREL.**—10ft. 6in. long × 3ft. 10in. diameter, made of  $\frac{7}{8}$ in. plates, single rivetted; distance from centre of barrel to rails, 6ft. 7in.

**FIRE-BOX SHELL** 6ft. long × 4ft. wide, made of  $\frac{1}{2}$ in. plates, the crown projecting 6½in. above the top of the barrel; mounted with two common 3½in. safety valves, screwed down with spring balance.

**FIRE-BOX.**—5ft. 3½in. long × 3ft. 6½in. wide × 5ft. 3in. deep at front, and 2ft. 9½in. at back. Contains a longitudinal mid-feather; the whole made of  $\frac{1}{2}$ in. copper plates, excepting the tube plate, which is  $\frac{3}{4}$ in. thick.

**HEATING SURFACE.**—181 brass tubes, 2in. diameter × 10ft. 10in. long = 1026 square feet; fire-box, = 106 square feet; total, 1132 square feet.

**AREA OF FIRE GRATE.**—19·8 square feet; fire bars and frame placed at an angle, with the object of preventing smoke.

**SMOKE-BOX.**—2ft. 3in. long × 2ft. 4½in. radius; made of  $\frac{1}{2}$ in. plates.

**CHIMNEY.**—15½in. diameter × 13ft. 3in. high, measured from the level of the rails.

**CYLINDERS.**—Inside, 17in. diameter × 22in. stroke, fitted with piston somewhat similar to Ramsbottom's; steam ports, 15½in. long × 1½in. wide; exhaust port, 3½in. wide; lap of valve, 1in.; steam pipe, 3in. diameter.

**LINK MOTION.**—Shifting link, 16½in. long; eccentrics, 5½in. throw.

**CONNECTING ROD,** 5ft. 10in. long; bearing in cross head, 3in. diameter × 3in. long; bearing at crank, 7in. diameter × 4½in. long; bearings of outside coupling rods, 3in. diameter × 3½in. long.

**FEEDING APPARATUS.**—Two injectors placed on each side of the fire-box.

**REGULATOR.**—Common horizontal slide valve regulator placed inside smoke-box.

**FRAMES.**—Inside and outside plate frames, 11in. deep over driving fork outside frames,  $\frac{1}{2}$ in. thick; inside frames,  $\frac{1}{2}$ in. thick, and 4ft. 1in. apart.

**WHEELS AND AXLES.**—Wheels, six in number, made of solid wrought iron; driving and trailing wheels, 6ft. 6in. diameter; tyres, 5½in. broad × 2½in. thick, dovetailed on the wheel rim; leading wheels, 4ft. diameter, with tyres 5in. broad × 2½in. thick; outside bearings of driving and trailing axles, 6in. diameter × 9in. long; inside bearings of driving axle, 6½in. diameter × 4½in. long; bearings of leading axle, 5in. diameter × 9in. long.

**WHEEL BASE.**—Between leading and driving axle, 7ft. 6in.; between driving and trailing axle, 7ft.; total, 14ft. 6in.

**SPRINGS.**—All 3ft. span; leading and trailing springs, 19 plates,  $\frac{1}{2}$ in. thick × 4in. wide; inside driving springs, 11 plates,  $\frac{1}{2}$ in. thick × 4in. wide, and outside driving springs, 16 plates,  $\frac{1}{2}$ in. thick and 4in. wide.

**WEIGHT OF ENGINE IN WORKING ORDER.**—On front wheels, 9 tons 11 cwt 1 qr.; on driving wheels, 11 tons 1 qr.; on trailing wheels, 9 tons 16 cwt.; total, 30 tons 7 cwt. 2 qrs.; width of engine over all, 8ft. 4in.; length over all, 25ft. 10in.

(To be continued.)

## ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." EIGHTH VOYAGE FROM LIVERPOOL TO NEW YORK, JUNE AND JULY, 1863.

| Date each day, ending at Noon. | PADDE ENGINE.                         |                                                             |                                |                                       | SCREW ENGINES.                                              |                                |                                       |                                                             | Latitude. | Longitude. | Course.       | Barometer. | Observations on Rolling of Ship. |                         |                         | GENERAL REMARKS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------|---------------------------------------|-------------------------------------------------------------|--------------------------------|---------------------------------------|-------------------------------------------------------------|--------------------------------|---------------------------------------|-------------------------------------------------------------|-----------|------------|---------------|------------|----------------------------------|-------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                | Revolutions of En-<br>gines each day. | Average Pressure of<br>Steam in Engine-room.<br>per minute. | Tons of Coal used each<br>day. | Revolutions of En-<br>gines each day. | Average Pressure of<br>Steam in Engine-room.<br>per minute. | Tons of Coal used each<br>day. | Revolutions of En-<br>gines each day. | Average Pressure of<br>Steam in Engine-room.<br>per minute. |           |            |               |            | Inclination to windw.            | Inclination to leeward. | No. of oscill. per min. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| June 30 ...                    | 10,623                                | 9.32                                                        | 21                             | 1,120                                 | 35.25                                                       | 171                            | 257                                   | 290                                                         | 250       | 250        | Various.      | 29.06      | ...                              | ...                     | ...                     | June 30, at 9.25 a.m., started paddle and screw engines ahead full speed; at 11.30, stopped engines off Bell Buoy to discharge pilot, and waiting to take cargo on board; light N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                        |
| July 1 ...                     | 8,957                                 | 9.0                                                         | 21                             | 1,080                                 | 35.5                                                        | 171                            | 257                                   | 290                                                         | 110       | 110        | Various.      | 30.01      | ...                              | ...                     | ...                     | July 1, at 4.55 p.m., started engines ahead slow; at 5.5 p.m., full speed; fresh N.W. to S.S.W. breeze and cloudy; heavy sea running.                                                                                                                                                                                                                                                                                                                                                                           |
| July 2 ...                     | 14,603                                | 10.46                                                       | 21                             | 1,111                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 30.03      | ...                              | ...                     | ...                     | July 2, at 12 noon, paddle and screw engines working very easy; at 6.15 p.m., stopped engines, and came to anchor in Queenstown harbour; at 8.50 p.m., started engines ahead slow; at 9.45 p.m., full speed; fresh S.W. W. S.W., and W. breeze; heavy swell.                                                                                                                                                                                                                                                    |
| July 3 ...                     | 15,496                                | 10.15                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 3, light N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| July 4 ...                     | 13,506                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 4, light S.W. to N.W. breeze; sea smooth; fore and aft sails set.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| July 5 ...                     | 15,772                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 5, fresh W.N.W. breeze; heavy sea running.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| July 6 ...                     | 15,496                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 6, dense fog; engines standing by paddle and screw engines; light W.N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                               |
| July 7 ...                     | 15,496                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 7, dense fog; engines standing by paddle and screw engines; light W.N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                               |
| July 8 ...                     | 15,496                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 8, dense fog; engines standing by paddle and screw engines; light W.N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                               |
| July 9 ...                     | 15,496                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 9, dense fog; engines standing by paddle and screw engines; light W.N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                               |
| July 10 ...                    | 15,496                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 10, dense fog; engines standing by paddle and screw engines; light W.N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                              |
| July 11 ...                    | 15,496                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 11, dense fog; engines standing by paddle and screw engines; light W.N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                              |
| July 12 ...                    | 15,496                                | 10.21                                                       | 21                             | 1,066                                 | 35.0                                                        | 171                            | 257                                   | 290                                                         | 321       | 321        | S. 82° 18' W. | 29.06      | ...                              | ...                     | ...                     | July 12, dense fog; engines standing by paddle and screw engines; light W.N.W. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Total .....                    | 162,001                               | 10.22                                                       | 21                             | 1,251                                 | 35.16                                                       | 17                             | 1852                                  | 3203                                                        | 3883      | 4046       | Various.      | 29.08      | ...                              | ...                     | ...                     | July 12, light W.N.W. breeze, and heavy swell; at 5.30 p.m., stopped engines off Montauk Point, to take pilot on board; 5.50 p.m., full speed; at 10.40 p.m., stopped paddle and screw engines, and reversed full speed; at 10.50 p.m., stopped engines, came in collision with schooner <i>Trimmer</i> ; in passing came foul of port paddle wheel, damaging arms and several floats; engines working occasionally from 1.30 a.m. until 5.45 a.m.; dropped anchor; distance, about 13 miles from Flushing Bay. |

## ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." EIGHTH VOYAGE FROM NEW YORK TO LIVERPOOL, JULY AND AUGUST, 1863.

| Date each day, ending at Noon. | PADDE ENGINE.                         |                                                             |                                |                                       | SCREW ENGINES.                                              |                                |                                       |                                                             | Latitude. | Longitude. | Course.       | Barometer. | Observations on Rolling of Ship. |                         |                         | GENERAL REMARKS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------|---------------------------------------|-------------------------------------------------------------|--------------------------------|---------------------------------------|-------------------------------------------------------------|--------------------------------|---------------------------------------|-------------------------------------------------------------|-----------|------------|---------------|------------|----------------------------------|-------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                | Revolutions of En-<br>gines each day. | Average Pressure of<br>Steam in Engine-room.<br>per minute. | Tons of Coal used each<br>day. | Revolutions of En-<br>gines each day. | Average Pressure of<br>Steam in Engine-room.<br>per minute. | Tons of Coal used each<br>day. | Revolutions of En-<br>gines each day. | Average Pressure of<br>Steam in Engine-room.<br>per minute. |           |            |               |            | Inclination to windw.            | Inclination to leeward. | No. of oscill. per min. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| July 21 ...                    | 10,702                                | 8.6                                                         | 21                             | 1,066                                 | 33.8                                                        | 15                             | 151                                   | 217                                                         | 270       | 270        | S. 71° 23' E. | ...        | ...                              | ...                     | ...                     | July 21, at 12.15 noon, started engines ahead slow; 2.45 p.m., full speed; 10.45 p.m., stopped engines off Montauk Point, to discharge pilot; 11.10 p.m., full speed; light N.N.E. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| July 22 ...                    | 12,250                                | 8.68                                                        | 21                             | 1,080                                 | 34.0                                                        | 15                             | 161                                   | 220                                                         | 302       | 302        | S. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 22, light N.N.E. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| July 23 ...                    | 12,421                                | 8.5                                                         | 21                             | 1,080                                 | 34.0                                                        | 15                             | 161                                   | 220                                                         | 302       | 302        | S. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 23, light N.N.E. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| July 24 ...                    | 12,553                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 24, light E.S.E. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| July 25 ...                    | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 25, light E.S.E. breeze; sea smooth.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| July 26 ...                    | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 26, dense fog; standing by engines; fresh E. breeze, and heavy sea running.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| July 27 ...                    | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 27, strong S.W. and W. gale; heavy sea running; fore topsail set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| July 28 ...                    | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 28, fresh S.W. breeze; heavy sea running; ship rolling heavily; screw engines racing; fore topsail set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| July 29 ...                    | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 29, fresh S.W. breeze, and heavy sea running.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| July 30 ...                    | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 30, fresh S.S.E. breeze, and heavy sea running.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| July 31 ...                    | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | July 31, fresh S.S.E. breeze, and heavy swell.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Aug. 1 ...                     | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | August 1, fresh S.S.E. breeze, and heavy swell.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Aug. 2 ...                     | 12,655                                | 8.5                                                         | 21                             | 1,114                                 | 34.0                                                        | 15                             | 173                                   | 268                                                         | 321       | 321        | N. 76° 3' E.  | ...        | ...                              | ...                     | ...                     | August 2, at 3.20 p.m., stopped engines, to take pilot on board; 3.35, full speed; at 6 p.m., stopped engines off Bell Buoy, to wait for tide.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Total .....                    | 138,175                               | 8.5                                                         | 21                             | 1,218                                 | 33.37                                                       | 16                             | 1902                                  | 3120                                                        | 3699      | 3801       | Various.      | ...        | ...                              | ...                     | ...                     | Actual time of steaming from New York to Montauk, 8 hours. From Montauk to Bell Buoy, 10 days 15 hours 30 minutes. Total, 10 days 23 hours 30 minutes. Density of water in boilers, 14; vacuum in paddle engines, 26.5; vacuum in screw engines, 25.5; extreme diameter of paddle wheel, 60ft.; effective diameter 46.83ft. = 163.5ft. each revolution; pitch of screw, 4ft.; distance run per hour, 11.45 knots; immersion on leaving New York, 25ft. 8in. forward—aft. 26ft.; ditto on arrival at Liverpool, 23ft. 8in. aft.; slip of paddle wheels, 13.8 per cent.; slip of screw, 23.6 per cent.; average daily consumption of coals by paddle engines, 110.72 tons; ditto by screw engines, 173 tons; total daily consumption of coals, 283.72 tons. * For coaling furnace bars and getting up steam. |

TABLE SHOWING THE QUANTITY OF HYPOCHLORITE OF LIME OR BLEACHING POWDER REQUIRED TO PRODUCE SOLUTIONS OF DIFFERENT DENSITIES, &c.

COMPILED BY

MR. T. W. KEATES, F.C.S.

The following Table shows the approximate quantity of Hypochlorite of Lime or Bleaching Powder per cent. or in lbs., &c., per gallon, required to make a clear bleaching liquid of a given strength.

The numbers in the two first columns are the mean of a great many actual weighings made upon the clear solution after the insoluble matter had completely subsided.

The numbers in the fifth column are obtained upon the assumption that 33.3 per cent. of chlorine represents the value of good commercial bleaching powder.

| Bleaching Powder per Cent. by Weight. | Specific Gravity of the Solution. | Equivalent in Degrees of Twaddell. | Bleaching Powder in lbs., &c., per Gallon. |     |       | Chlorine per Cent. by Weight. |
|---------------------------------------|-----------------------------------|------------------------------------|--------------------------------------------|-----|-------|-------------------------------|
|                                       |                                   |                                    | lbs.                                       | oz. | drms. |                               |
| 20.0                                  | 1114.0                            | 22.8                               | 2                                          | 4   | 5     | 6.66                          |
| 19.5                                  | 1111.1                            | 22.2                               | 2                                          | 2   | 11    | 6.50                          |
| 19.0                                  | 1108.3                            | 21.6                               | 2                                          | 1   | 14    | 6.33                          |
| 18.5                                  | 1105.4                            | 21.0                               | 2                                          | 1   | 8     | 6.16                          |
| 18.0                                  | 1102.6                            | 20.5                               | 2                                          | 0   | 0     | 6.00                          |
| 17.5                                  | 1099.7                            | 19.9                               | 1                                          | 14  | 11    | 5.83                          |
| 17.0                                  | 1096.9                            | 19.3                               | 1                                          | 13  | 15    | 5.66                          |
| 16.5                                  | 1094.0                            | 18.8                               | 1                                          | 12  | 12    | 5.50                          |
| 16.0                                  | 1091.2                            | 18.2                               | 1                                          | 12  | 0     | 5.33                          |
| 15.5                                  | 1088.3                            | 17.6                               | 1                                          | 11  | 3     | 5.16                          |
| 15.0                                  | 1085.5                            | 17.1                               | 1                                          | 10  | 4     | 5.00                          |
| 14.5                                  | 1082.6                            | 16.5                               | 1                                          | 9   | 2     | 4.83                          |
| 14.0                                  | 1079.8                            | 15.9                               | 1                                          | 8   | 5     | 4.66                          |
| 13.5                                  | 1076.9                            | 15.3                               | 1                                          | 7   | 8     | 4.50                          |
| 13.0                                  | 1074.1                            | 14.8                               | 1                                          | 6   | 6     | 4.33                          |
| 12.5                                  | 1071.2                            | 14.2                               | 1                                          | 5   | 7     | 4.16                          |
| 12.0                                  | 1068.4                            | 13.6                               | 1                                          | 4   | 5     | 4.00                          |
| 11.5                                  | 1065.5                            | 13.1                               | 1                                          | 3   | 8     | 3.83                          |
| 11.0                                  | 1062.7                            | 12.5                               | 1                                          | 2   | 13    | 3.66                          |
| 10.5                                  | 1059.8                            | 11.9                               | 1                                          | 1   | 12    | 3.50                          |
| 10.0                                  | 1057.0                            | 11.4                               | 1                                          | 0   | 15    | 3.33                          |
| 9.5                                   | 1054.1                            | 10.8                               | 1                                          | 0   | 4     | 3.16                          |
| 9.0                                   | 1051.3                            | 10.2                               | 0                                          | 15  | 8     | 3.00                          |
| 8.5                                   | 1048.4                            | 9.6                                | 0                                          | 14  | 6     | 2.83                          |
| 8.0                                   | 1045.6                            | 9.1                                | 0                                          | 13  | 5     | 2.66                          |
| 7.5                                   | 1042.7                            | 8.5                                | 0                                          | 12  | 13    | 2.50                          |
| 7.0                                   | 1039.9                            | 7.9                                | 0                                          | 11  | 8     | 2.33                          |
| 6.5                                   | 1037.0                            | 7.4                                | 0                                          | 11  | 0     | 2.16                          |
| 6.0                                   | 1034.2                            | 6.8                                | 0                                          | 10  | 5     | 2.00                          |
| 5.5                                   | 1031.3                            | 6.2                                | 0                                          | 9   | 2     | 1.83                          |
| 5.0                                   | 1028.5                            | 5.7                                | 0                                          | 8   | 3     | 1.66                          |
| 4.5                                   | 1025.6                            | 5.1                                | 0                                          | 7   | 7     | 1.50                          |
| 4.0                                   | 1022.8                            | 4.5                                | 0                                          | 6   | 9     | 1.33                          |
| 3.5                                   | 1019.9                            | 3.9                                | 0                                          | 5   | 13    | 1.16                          |
| 3.0                                   | 1017.1                            | 3.4                                | 0                                          | 4   | 14    | 1.00                          |
| 2.5                                   | 1014.2                            | 2.8                                | 0                                          | 4   | 0     | 0.83                          |
| 2.0                                   | 1011.4                            | 2.2                                | 0                                          | 3   | 3     | 0.66                          |
| 1.5                                   | 1008.5                            | 1.7                                | 0                                          | 2   | 6     | 0.50                          |
| 1.0                                   | 1005.7                            | 1.1                                | 0                                          | 1   | 9     | 0.33                          |

TABLE FOR FINDING THE DIAMETERS OF SHAFTS OF  
WROUGHT IRON.

(Illustrated by Plate No. 248.)

The want felt in the drawing offices of engineers and machinists, of a ready means of determining the diameter of shafts suitable for transmitting a given power, has often been stated to us; and having been recently requested to furnish information on this subject to several correspondents, we have much pleasure in being able to present our subscribers with the accompanying table, which has been obligingly furnished to us by Mr. W. Jackson, of the firm of Jackson and Watkins, of the Canal Iron Works, Millwall.

This table exhibits a set of curves giving the diameter of shafts, in inches, for engines of from 10 to 500 horse-power, the revolutions varying from 20 to 150. This table was computed from the formula—

$$D = \sqrt[3]{\frac{320 \text{ H.P.}}{n}}$$

D being the diameter of the shaft,  
H.P. the horse-power,  
n the number of revolutions per minute.

Example.—Required, the diameter for the driving shaft of an engine of 260 horse-power, making 30 revolutions per minute. By the table,  $D = 14$  in. Intermediate powers or speeds may be ascertained by interpolation, for example, 250 H.P. at 30 revolutions = 13·8 in.; or 260 H.P. at 32 revolutions = 13·8 in.

## INTERNATIONAL EXHIBITION, 1862.

*Report by the Committee appointed at a General Meeting (held on the 18th day of June, 1863,) of the Medal-holders and Gentlemen interested in the awards of the International Exhibition, 1862, ALDERMAN COPELAND, M.P., Chairman.*

A meeting of gentlemen to whom prize medals and certificates of honourable mention were awarded by the Commissioners of the Exhibition of 1862, was held at the rooms of the Society of Arts (by the kind permission of the Council of that body), on the 18th of June last; when a committee was appointed for the purpose of obtaining protection for the prize medallists against the unauthorised assumption of the medals and honourable mentions by persons to whom they had not been granted.

The meeting was called in consequence of a recent case, in which an application was made to the Court of Chancery for an injunction to restrain the piracy of the prize medals by a manufacturer who had not obtained any prize medal, nor exhibited at the Exhibition, but which application had failed, the Vice-Chancellor having decided that, in the existing law, the grant of a prize medal to one manufacturer or exhibitor created no right on his part to restrain any statement (fraudulent or otherwise) by another manufacturer of a similar article, to the effect that he had obtained a medal.

Your committee, after conferring with some members of the Society of Arts, obtained the necessary professional assistance, and caused a bill to be prepared, for the purpose of giving effect to the views of the meeting by whom they were appointed. This bill was drawn with the utmost possible care, with the assistance of gentlemen who had been professionally connected with the "Merchandise Marks Act" of last year, and was settled by two counsel who have made the Trade Marks and Copyright Acts a special study, and who are the authors of the most recent legal works on those subjects; and was afterwards submitted for the consideration and correction of a learned judge, who most kindly afforded to your committee the benefit of his great experience.

The Draft Bill so prepared was laid before the President of the Board of Trade, who, while expressing his desire to assist in promoting the object in view, hesitated to introduce any measure of the description contemplated, into the House of Commons, at so late a period of the Session.

It became necessary to apply to the Earl Granville for aid in this difficulty. Some discussion took place, and very earnest representations were made to his lordship of the great importance of the question involved, and the absolute necessity, if any benefit at all were to be derived from any legislative enactment, that the requisite measure should be passed in the Session which has just terminated. Earl Granville received the representatives of your body with the utmost kindness and urbanity, and expressed his desire to assist the committee in the objects they had in view; but, after consultation with some other members of the Government, a doubt was expressed whether the bill, as prepared by your committee, was not likely to lead to a too lengthened discussion for so late a period of the Session.

The result was that a gentleman, officially connected with one of the departments of the Government, was instructed to prepare a short Government Bill, in lieu of that prepared by your committee, who were however consulted, and through their legal advisers made various suggestions on that bill, as at first framed. Some of these were adopted; as respects others, your committee were less fortunate.

The measure as introduced may have been deemed imperfect, but it was apparent that your committee's clearest possible duty was to aid, by every means in their power, the passing of that measure, even if needing amendment in a future Session, rather than allow Parliament to dissolve and the measure to pass, without any legislative enactment being obtained, the result of which would have been that, before Parliament re-assembled, the continued piracies of Exhibition awards would have deprived them of value, in the hands of the real holders.

The measure so introduced has, with some trifling alterations, become law. Your committee feel confident that the evils complained of will be thereby checked, and that the holders of the awards have the strongest grounds for congratulation.

The measure was introduced, and read a first time, on the 20th July; read a second time, and committee dispensed with, on the 21st; amended, read a third time, and passed in the Lords; reprinted and introduced in the Commons, and read a first time there, on the 23rd; read a second time, passed through Committee, and reported, on the 24th; read a third time and passed, after a long debate, on the 27th; and received the Royal assent on the 28th, under the title, "The Exhibitions Medals Act, 1863."

This result was only arrived at by dint of very great exertion on the part of those who took any active part, either in the proceedings of the committee or the carriage of the measure.

The Marquis of Clanricarde kindly undertook, at the shortest possible notice, to take charge of the bill in the House of Lords; and by his clear and admirable statement of the objects and necessity for the measure, secured its unanimous adoption by that House.

A very large number of members, on both sides of the House of Commons, gave their aid towards the passing of the measure, and the thanks of the medal-holders are most justly their due. It is difficult to distinguish where so many are entitled to acknowledgments, but it will probably be felt by all, that the President of the Board of Trade, who took charge of the measure in the House of Commons, has added another to the many grounds on which he was already entitled to the thanks of the mercantile community.

Your committee applied to, and obtained the aid of, "The Mercantile Law Amendment Society," and through their concurrence of the various Chambers of Commerce in the kingdom, and it is in a main degree to the great influence and established position of utility of the Mercantile Law Amendment Society that the success attained may be attributed.

It cannot but be felt that every medal-holder will derive benefit from the act that has been obtained; and that the commercial value of the awards of the Commissioners of the Exhibitions of 1861 and 1862, both at home and abroad, has been greatly enhanced by the legislative protection secured.

Of course the obtaining of an important act (especially when carried through the Legislature with such unexampled speed as in the present case) must be attended with considerable expense. It was necessary, to attain success, that individual members of the committee should take upon themselves not only more than their proportion of the labour, but the whole responsibility for the expenses incurred; and your committee confidently rely on those who have received awards for subscriptions to defray the cost thus incurred in their service.

It is not proposed that the foreign exhibitors should be asked to contribute at all. It is to the defect of the English law, as it existed at the time the Exhibitions were held, that the evils complained of have been attributable. This is a circumstance as to which the English exhibitors might have informed themselves, but for which the foreign exhibitors must have been wholly unprepared; and they cannot properly be asked to aid towards the necessary amendment of a law to which they are strangers.

A large number of the medal-holders have expressed their strong feeling of the importance of the present committee continuing organised for a time, to protect the interests of their fellow-medallists, and probably to promote an Amendment Act in the coming Session, or to watch the Amendment Bill which the President of the Board of Trade has promised to introduce. Your committee are unwilling to abandon the cause which they have once embraced, and have consented to continue their functions.

Your committee would request information of every case that may come to the knowledge of any medal-holder, in which any person falsely represents that he has obtained either a medal or honourable mention; and any suggestion as to measures to be adopted towards giving effect to the act already obtained, and stopping the fraudulent dealings to which it is intended to apply.

Except in so far as any such further proceedings may be concerned, your committee's task has been performed. They have obtained the legislative protection which they were desired to seek; and they trust it will be felt by the whole of those whose interests were confided to their care, not alone that every exertion has been used for obtaining the result desired, but that there is every ground for mutual congratulations, between the committee and their constituents, on the unexampled rapidity with which this result has been arrived at, and the success with which their exertions on your behalf have been crowned.

(By order) EDMUND JOHNSON,  
Hon. Secretary.

London, August 15, 1863.

## COPY OF "THE EXHIBITION MEDALS ACT," 1863.

Whereas it is expedient to prevent false representations with respect to grants of medals and certificates by the Commissioners for the Exhibition of 1861 and the Commissioners for the Exhibition of 1862: Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords spiritual and temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

1. If any trader commits any of the offences following, that is to say,—  
1. Falsely represents that he has obtained a medal or certificate from the Exhibition Commissioners in respect of any article or process for which a medal or certificate has been awarded by the Commissioners; 2. Falsely represents (knowing such representation to be false) that any other trader has

obtained a medal or certificate from the Exhibition Commissioners; 3. Falsely represents (knowing such representation to be false) that any article sold or exposed for sale has been made by, or by any process invented by, a person who has obtained in respect of such article or process a medal or certificate from the Exhibition Commissioners, he shall incur the following penalties; that is to say, 1. For the first offence he shall forfeit to her Majesty a sum not exceeding five pounds. 2. For any subsequent offence he shall forfeit to her Majesty a sum not exceeding twenty pounds, or be imprisoned for a period not exceeding six months.

II. In proceedings under this Act it shall not be necessary to prove that any person has sustained damage by the false representations of the defendant. It shall not be necessary in any proceedings under this Act to set out any copy or fac-simile of any medal or certificate.

III. For the purposes of this Act, "the Exhibition Commissioners" shall mean the Commissioners for the Exhibition of 1851 and the Commissioners for the Exhibition of 1862. The term "defendant" shall mean any person against whom proceedings may be taken under this Act.

IV. Offences under this Act may be prosecuted summarily in England and Ireland before two justices; as to England, in manner directed by an Act passed in the session holden in the eleventh and twelfth years of the reign of her Majesty Queen Victoria, c. 43, intitled "An Act to facilitate the Performance of the Duties of Justices of the Peace out of Sessions within England and Wales with respect to summary Convictions and Orders, or any Act amending the same; as to Ireland, in manner directed by the Act passed in the session holden in the fourteenth and fifteenth years of the reign of her Majesty Queen Victoria, intitled "An Act to Consolidate and amend the Acts regulating the Proceedings in Petty Sessions and the Duties of Justices of the Peace out of Quarter Sessions in Ireland, or any Act amending the same. In Scotland, an offence against this Act may be prosecuted summarily at the instance of the Procurator Fiscal before any sheriff and sheriff substitute, or before any two justices of the county, or before the magistrates or any police magistrate of the burgh in which the offence was committed.

V. No provision of this Act shall take away, diminish, or prejudicially affect any suit, process, proceeding, right, or remedy which any person may be entitled to at law, in equity, or otherwise; nor exempt or excuse any person from answering or making discovery upon examination as a witness, or upon interrogatories or otherwise, in any suit or other civil proceeding: Provided always, that no evidence, statement, or discovery, which any person shall be compelled to give or make, shall be admissible in evidence against such person in support of any indictment for a misdemeanour at common law or otherwise, or of any proceeding under the provisions of this Act.

VI. This Act may be cited for all purposes as "the Exhibition Medals Act, 1863."

### TRIAL OF THE "CONSTANCE."

In THE ARTIZAN of last month we gave some further particulars as to the dimensions of this vessel and her machinery, as also a notice of a trial trip which she made on the 6th July, when it will be remembered from the overheating of the bearings, the result was not very satisfactory. Since that time the necessary adjustments and alterations having been made, the *Constance* went out again on trial on the 10th ult. The chief particulars of her performance under trial are as follows:—Draught of water, forward, 17ft. 1in.; aft, 20ft. 10in.; propeller, diameter 18ft.; pitch, 25ft.; upper edge 4in. out of water. Steam in boilers, 32.5lbs. per square inch; mean pressure in high pressure cylinders, 19.54; ditto in low pressure cylinders, 3.96; indicated horse-power, 2017; mean pressure at half-boiler power in high pressure cylinders, 14.955; in low pressure cylinders, 2.34; indicated horse-power, 1190. Vacuum in condensers, 28in.; barometer, 30.2; maximum temperature in stoke-hole, 104°; minimum in ditto, 86°; maximum temperature in engine-room, 74°; minimum in ditto, 72°; temperature on deck, 68°.

| No. of runs.          | Revolutions of Engines. | Time.  | Speed. | 1st Mean. | 2nd Means. | True Mean. |
|-----------------------|-------------------------|--------|--------|-----------|------------|------------|
| 1                     | 55½                     | 4' 54" | 12.245 |           |            | } 12.301   |
| 2                     | 56½                     | 4 48   | 12.500 | 12.372    |            |            |
| 3                     | 53                      | 4 58   | 12.061 | 12.291    | 12.331     |            |
| 4                     | 55                      | 5 2    | 11.921 | 12.001    | 12.146     |            |
| 5                     | 55½                     | 4 42   | 12.766 | 12.343    | 12.172     |            |
| 6                     | 56                      | 4 43   | 12.766 | 12.766    | 12.555     |            |
| At Half Boiler Power. |                         |        |        |           |            |            |
| 1                     | 43                      | 5' 43" | 10.486 |           |            | } 10.573   |
| 2                     | 47                      | 6 8    | 9.783  | 10.139    |            |            |
| 3                     | 48                      | 5 12   | 11.538 | 10.661    | 10.400     |            |
| 4                     | 47                      | 5 55   | 10.141 | 10.884    | 10.747     |            |

It will be seen from these particulars that the results were much more satisfactory than those obtained on the previous trial, and doubtless still better results may be expected when the various parts of her machinery have been brought into proper working order.

### BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The annual meeting of the British Association commenced at Newcastle-on-Tyne on the 26th ult. The following is an abstract of the address of the President:—

The President, Sir William Armstrong, in opening his address, stated that he deemed it the greatest honour of his life that he was called upon to assume the office of President, and adverted to the gratifying reception which the British Association had met with on their former visit to this region of mining and manufacturing industry. A quarter of a century had elapsed since the Association assembled in this town, and in no former period of equal duration had so great a progress been made in physical knowledge. In mechanical science, and especially in those branches of it which are concerned in the application of steam power to effect interchange between distant communities, the progress made since 1838 has no parallel in history. The railway system was then in its infancy, and the great problem of Transatlantic steam navigation had only received its complete solution in the preceding year. Since that time railways have extended to every continent, and steamships have covered the ocean. The history of railways shows what grand results may have their origin in small beginnings. When coal was first conveyed in this neighbourhood from the pit to the shipping-place on the Tyne, the pack-horse was in use. As soon as roads suitable for wheeled carriages were formed carts were introduced. The next improvement consisted in laying wooden bars or rails for the wheels of the cart to run upon, and this was followed by the substitution of the four-wheeled waggon for the two-wheeled cart. By this further application of mechanical principles the original horseload of 3cwt. was augmented to 42cwt. The next step in the progress of railways was the attachment of slips of iron to the wooden rails. Then came the iron tramways, consisting of cast-iron bars of an angular section; in this arrangement the upright flange of the bar acted as a guide to keep the wheel on the track. The next advance was an important one, and consisted in transferring the guiding flange from the rail to the wheel; this improvement enabled cast-iron edge rails to be used. Finally, in 1820, after a lapse of about 200 years from the first employment of wooden bars, wrought iron rails, rolled in long lengths, and of suitable section, were made in this neighbourhood, and eventually superseded all other forms of railway. Last of all came the locomotive engine, that crowning achievement of mechanical science, which enables us to convey a load of 200 tons at a cost of fuel scarcely exceeding that of the corn and hay which the original packhorse consumed in conveying its load of 3cwt. an equal distance. It was chiefly in this locality that the railway system was thus reared from earliest infancy to full maturity, and among the many names associated with its growth that of George Stephenson stands pre-eminent. As in the vegetable kingdom fit conditions of soil and climate quickly cause the appearance of suitable plants, so in the intellectual world fitness of time and circumstances promptly calls forth appropriate devices. The seeds of invention exist, as it were, in the air, ready to germinate whenever suitable conditions arise, and no legislative interference is needed to insure their growth in proper season. The coalfields of this district, so intimately connected with the railway system, both in its origin and maintenance, will doubtless receive much attention from the Association at their present meeting. After dwelling upon the origin of the coal deposits, the President stated that the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit is sufficient (if used discreetly), to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British islands. These estimates are extremely discordant; but the discrepancies arise, not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked from British mines has been almost trebled during the last 21 years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4000ft. as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than 2ft. in thickness, the entire quantity of available coal existing in these islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but

with a continued yearly increase of  $2\frac{1}{2}$  millions of tons, would only last 212 years. It is clear that long before complete exhaustion takes place England will have ceased to be a coal-producing country on an extensive scale. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal-seams last which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing industry. Were we reaping the full advantage of all the coal we burnt no objection, could be made to the largeness of the quantity; but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam-engine, our present knowledge of the mechanical energy of heat shows that we realise in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height ten times that weight. The average quantity of coal which we expend in realising a given effect, by means of the steam-engine, is about 30 times greater than would be requisite with an absolutely perfect heat-engine. The causes which render the application of heat so un-economic in the steam-engine have been brought to light by the discovery of the dynamical theory of heat; and it now remains for mechanicians, guided by the light they have thus received, to devise improved practical methods of converting the heat of combustion into available power. Engines in which the motive power is excited by the communication of heat to fluids already existing in the aeriform condition, as in those of Stirling, Ericsson, and Siemens, promise to afford results greatly superior to those obtained from the steam-engine. It is a common observation that before coal is exhausted some other motive agent will be discovered to take its place, and electricity is generally cited as the coming power. Electricity, like heat, may be converted into motion, and both theory and practice have demonstrated that its mechanical application does not involve so much waste of power as takes place in a steam-engine; but, whether we use heat or electricity as a motive power, we must equally depend upon chemical affinity as the source of supply. The act of uniting to form a chymical product liberates an energy which assumes the form of heat or electricity, from either of which states it is convertible into mechanical effect. In contemplating, therefore, the application of electricity as a motive power we must bear in mind that we shall still require to effect chymical combinations, and in so doing to consume materials. But where are we to find materials so economical for this purpose as the coal we derive from the earth, and the oxygen we obtain from the air? The latter costs absolutely nothing; and every pound of coal which in the act of combustion enters into chymical combustion renders more than  $2\frac{1}{2}$  lb. of oxygen available for power. We cannot look to water as a practicable source of oxygen, for there it exists in the combined state, requiring expenditure of chymical energy for its separation of hydrogen. It is in the atmosphere alone that it can be found in that free state in which we require it, and there does not appear to be the remotest chance, in an economic point of view, of being able to dispense with the oxygen of the air as a source either of thermodynamic or electrodynamic effect. But to use this oxygen we must consume some oxidisable substance, and coal is the cheapest we can produce. The President, in respect to the use of falling water as a motive power, stated that the hydraulic capabilities of our streams sank into insignificance when compared with those of Alpine and other regions,—referred to Niagara, which expends sufficient power to carry on the whole manufacturing operations of mankind,—and stated that industrial populations had scarcely yet extended to those regions which afford this profusion of motive power; but we may anticipate the time when these natural falls will be brought into useful operation. He stated that coal is also extensively used for the kindred purpose of relaxing those cohesive forces which resist our efforts to give new forms and conditions to solid substances. In these applications, which are generally of a metallurgical nature, the same wasteful expenditure of fuel is everywhere observable. In an ordinary furnace employed to fuse or soften any solid substance, it is the excess of the heat of combustion over that of the body heated which alone is rendered available for the purpose intended; the rest of the heat, which in many instances constitutes by far the greater proportion of the whole, is allowed to escape uselessly into the chimney. The combustion also in common furnaces is so imperfect that clouds of powdered carbon, in the form of smoke, envelope our manufacturing towns, and gases, which ought to be completely oxygenized in the fire, pass into the air with two-thirds of their heating power undeveloped. Some remedy for this state of things we may hope is at hand in the gas regenerating furnaces recently introduced by Mr. Siemens. With regard to smoke, which is at once a

waste and a nuisance, the President stated that he had taken part with Dr. Richardson and Mr. Longridge in a series of experiments made in this neighbourhood in the years 1857-58 for the purpose of testing the practicability of preventing smoke in the combustion of bituminous coal in steam-engine boilers, and stated with perfect confidence that, so far as the raising of steam is concerned, the production of smoke is quite unnecessary and inexcusable. After adverting to the wasteful use of coal for domestic purposes, the President spoke of the danger attending colliery operations, and was of opinion that, though the Davy lamp was a great boon to the miner, it led him into more dangerous workings, and, as far as the miner was concerned, neutralised its effects. The only gleam of amelioration, he remarked, is in the fact that the loss of life in relation to the quantity of coal worked is on the decrease, taken as a percentage on the number of miners employed. The increase of the earth's temperature as we descend below the surface is a subject which has been discussed at previous meetings of the British Association. It possesses great scientific interest as affecting the computed thickness of the crust which covers the molten mass, assumed to constitute the interior portions of the earth, and it is also of great practical importance, as determining the depth at which it would be possible to pursue the working of coal and other minerals. At the last meeting of the British Association in this town the importance of establishing an office for mining records was brought under notice of the Council by Mr. Sopwith, and measures were taken which resulted in the formation of the present Mining Records Office. The British Association may congratulate itself upon having thus been instrumental in establishing an office in which plans of abandoned mines are preserved for the information of those who at a future period may be disposed to incur the expense of again bringing those mines into operation. Before dismissing this subject of coal it may be proper to notice the recent discovery by Berthelot of a new form of carburetted hydrogen possessing twice the illuminating power of ordinary coal-gas. Berthelot succeeded in procuring this gas by passing hydrogen between the carbon electrodes of a powerful battery. Dr. Odling has since shown that the same gas may be produced by mixing carbonic oxide with an equal volume of light carburetted hydrogen and exposing the mixture in a porcelain tube to an intense heat. Still more recently, Mr. Siemens has detected the same gas in the highly-heated regenerators of his furnaces, and there is now every reason to believe that the new gas will become practically available for illuminating purposes. Of all the results which science has produced within the last few years, none has been more unexpected than that by which we are able to test the materials of which the sun is made, and prove their identity, in part at least, with those of our planet. The spectrum experiments of Bunsen and Kirchhoff have not only shown all this, but they have also corroborated previous conjectures as to the luminous envelope of the sun. The President then went into an elaborate elucidation of the theory of the transmission of heat from the sun to the earth, and the dynamical theory of heat, referring to the labours of Naysmith, Mayer, Joule, Dr. Young, Thompson, and Rankine, and the earlier theorists, Lord Bacon and Aristotle. He then referred to the science of gunnery, as being intimately connected with the dynamical theory of heat. When gunpowder is exploded in a cannon, the immediate effect of the affinities by which the materials of the powder are caused to enter into new combinations, is to liberate a force which first appears as heat, and then takes the form of mechanical power communicated in part to the shot and in part to the products of explosion which are also propelled from the gun. The mechanical force of the shot is reconverted into heat when the motion is arrested by striking an object, and this heat is divided between the shot and the object struck, in the proportion of the work done or damage inflicted upon each. While speaking of the subject of gunnery, the President paid a passing tribute of praise to that beautiful instrument invented and perfected by Major Navez, of the Belgian Artillery, for determining, by means of electro-magnetism, the velocity of projectiles. This instrument has been of great value in recent investigations, and there are questions affecting projectiles which we can only hope to solve by its assistance. Experiments are still required to clear up several apparently anomalous effects in gunnery, and to determine the conditions most conducive to efficiency, both as regards attack and defence. It is gratifying to see our Government acting in accordance with the enlightened principles of the age, by carrying on scientific experiments to arrive at knowledge, which, in the arts of war, as well as of those of peace, is proverbially recognised as the true source of human power. Professor Tyndall's recent discoveries respecting the absorption and radiation of heat by vapours and permanent gases, constitute important additions to our knowledge. The extreme delicacy of his experiments and the remarkable distinctness of their results render them beautiful examples of physical research. They are of great value as affording further illustrations of the vibratory actions in matter which constitute heat; but it is in connexion with the science of meteorology that they chiefly command our attention. Few sciences have more practical value than meteorology, and there are few of which we

as yet know so little. Nothing would contribute more to the saving of life and property, and to augmenting the general wealth of the world, than the ability to foresee with certainty impending changes of the weather. At present our means of doing so are exceedingly imperfect, but, such as they are, they have been employed with considerable effect by Admiral Fitzroy, in warning mariners of the probable approach of storms. We hope that so good an object will be effected with more unvarying success when we attain a better knowledge of the causes by which wind and rain, heat and cold are determined. The balloon explorations, conducted with so much intrepidity by Mr. Glaisher, under the auspices of the British Association, may perhaps in some degree assist in enlightening us upon these important subjects. We have learnt from Mr. Glaisher's observations that the decrease of temperature with elevation does not follow the law previously assumed of 1 deg. in 300ft., and that in fact it follows no definite law at all. Mr. Glaisher appears also to have ascertained the interesting fact that rain is only precipitated when cloud exists in a double layer. Raindrops, he has found, diminish in size with elevation, merging into wet mist, and ultimately into dry fog. Mr. Glaisher met with snow for a mile in thickness below rain, which is at variance with our preconceived ideas. He has also rendered good service by testing the efficiency of various instruments at heights which cannot be visited without personal danger. The facility now given to the transmission of intelligence and the interchange of thought is one of the most remarkable features of the present age. Cheap and rapid postage to all parts of the world; paper and printing reduced to the lowest possible cost; electric telegraphs between nation and nation, town and town, and now even (thanks to the beautiful inventions of Professor Wheatstone), between house and house—all contribute to aid that commerce of ideas by which wealth and knowledge are augmented. But while so much facility is given to mental communication by new measures and new inventions, the fundamental art of expressing thought by written symbols remains as imperfect now as it has been for centuries past. It seems strange that while we actually possess a system of shorthand by which words can be recorded as rapidly as they can be spoken, we should persist in writing a slow and laborious longhand. It is intelligible that grown-up persons who have acquired the present conventional art of writing should be reluctant to incur the labour of mastering a better system; but there can be no reason why the rising generation should not be instructed in a method of writing more in accordance with the activity of mind which now prevails. Even without going so far as to adopt for ordinary use a complete system of stenography, which it is not easy to acquire, we might greatly abridge the time and labour of writing by the recognition of a few simple signs to express the syllables which are of most frequent occurrence in our language. Another subject of a social character which demands our consideration is the much-debated question of weights and measures. Whatever difference of opinion there may be as to the comparative merits of decimal and duodecimal division, there can, at all events, be none as to the importance of assimilating the systems of measurement in different countries. Science suffers by want of uniformity, because valuable observations made in one country are in a great measure lost to another from the labour required to convert a series of quantities into new denominations. International commerce is also impeded by the same cause, which is productive of constant inconvenience and frequent mistakes. The President could speak from personal experience of the superiority of decimal measurement in all cases where accuracy is required in mechanical construction. In the Elswick Works, as well as in other large establishments of the same description, the inch is adopted as the unit, and all fractional parts are expressed in decimals. No difficulty has been experienced in habituating the workmen to the use of this method, and it has greatly contributed to precision of workmanship. The inch, however, is too small a unit, and it would be advantageous to substitute the metre, if general concurrence could be obtained. As to our thermometric scale, it was originally founded in error; it is also most inconvenient in division, and ought at once to be abandoned in favour of the Centigrade scale. The recognition of the metric system and of the Centigrade scale by the numerous men of science composing the British Association would be a most important step towards effecting that universal adoption of the French standards in this country which sooner or later will inevitable take place; and the Association, in its collective capacity, might take the lead in this good work, by excluding in future all other standards from their published proceedings. The recent discovery of the source of the Nile by Captains Speke and Grant has solved a problem in geography which has been a subject of speculation from the earliest ages. It is an honour to England that this interesting discovery has been made by two of her sons; and the British Association, which is accustomed to value every addition to knowledge for its own sake, will at once appreciate the importance of the discovery, and the courage and devotion by which it has been accomplished. The science of organic life has of late years been making great and rapid strides, and it is gratifying to observe that researches both in zoology and botany are characterised in the present day by great accuracy and elabora-

tion. Investigations patiently conducted upon true inductive principles cannot fail eventually to elicit the hidden laws which govern the animated world. The remarkable work of Mr. Darwin, promulgating the doctrine of natural selection, has produced a profound sensation. The novelty of this ingenious theory, the eminence of its author, and his masterly treatment of the subject, have, perhaps, combined to excite more enthusiasm in its favour than is consistent with that dispassionate spirit which it is so necessary to preserve in the pursuit of truth. The President said he would not run the risk of wearying the assembly by extending his remarks to other branches of science; and in conclusion expressed a hope that, when the time again comes round to receive the British Association in this town, its members will find the interval to have been as fruitful as the corresponding period on which they now looked back. The tendency of progress is to quicken progress, because every acquisition in science is so much vantage ground for fresh attainment. We may expect, therefore, to increase our speed as we struggle forward; but, however high we climb in the pursuit of knowledge, we shall still see heights above us; and the more we extend our view the more conscious we shall be of the immensity which lies beyond.

At the conclusion of this address, which occupied little more than an hour in its delivery, the applause of the audience broke forth, and continued almost uninterruptedly for some minutes.

#### ABSTRACT OF AN INVESTIGATION ON PLANE WATER-LINES.

By W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S.S., L. & E. &c.

1. This paper contains an abstract of a mathematical investigation, which has been communicated in detail to the Royal Society. By the term "Plane Water-Line" is meant one of those curves which a particle of a liquid describes in flowing past a solid body, when such flow takes place in plane layers. Such curves are suitable for the water-lines of a ship; for during the motion of a well-formed ship, the vertical displacements of the particles of water are small compared with the dimensions of the ship; so that the assumption that the flow takes place in plane layers, though not absolutely true, is sufficiently near the truth for practical purposes.

2. The author refers to the researches of Professor Stokes (*Cambr. Trans.* 1842), "on the Steady Motion of an Incompressible Fluid," and of Professor William Thomson, (made in 1858, but not yet published,) as containing the demonstration of the general principles of the flow of a liquid past a solid body.

3. Every figure of a solid past which a liquid is capable of flowing smoothly, generates an endless series of water-lines, which become sharper in their forms as they are more distant from the primitive water-line of the solid. The only exact water-lines, whose forms have hitherto been completely investigated, are those generated by the cylinder, in two dimensions, and by the sphere, in three dimensions. In addition to what is already known of those lines, the author points out, that when a cylinder moves through still water, the orbit of each particle of water is one loop of an elastic curve.

4. The profiles of waves have been used with success in practice as water-lines for ships, first by Mr. Scott Russell (for the explanation of whose system the author refers to the *Transactions of the Institution of Naval Architects* for 1860-1-2), and afterwards by others. As to the frictional resistance of vessels having such lines, the author refers to his own papers; one read to the British Association in 1861, and printed in various engineering journals, and another read to the Royal Society in 1863, and printed in the *Philosophical Transactions*.

5. The author proceeds to investigate and explain the properties of a class of water-lines comprising an endless variety of forms and proportions. In each series of such lines, the primitive water-line is a particular sort of oval, characterized by this property; that the ordinate at any point of the oval is proportional to the angle between two lines drawn from that point to two foci. (In the Fig., L B represents a quadrant of such an oval; O being its centre, and A one of the foci. The other focus is at an equal distance to the other side of the centre.) Ovals of this class differ from ellipses, in being considerably fuller at the ends, and flatter at the sides.

6. The length of the oval may bear any proportion to its breadth, from equality (when the oval becomes a circle) to infinity. (In the Fig., the length O L is to the breadth O B, nearly as 17:6).

7. Each oval generates an endless series of water-lines, which become sharper in figure as they are further from the oval. In each of those derived lines, the excess of the ordinate at a given point above a certain minimum value, is proportional to the angle between a pair of lines drawn from that point to the two foci.

8. There is thus an endless series of ovals, each generating an endless series of water-lines; and amongst those figures, a continuous or "fair" curve can always be found, combining any proportion of length to breadth

from equality to infinity, with any degree of fullness or fineness of entrance, from absolute bluntness to a knife-edge.

9. The lines thus obtained present striking likenesses to those at which naval architects have arrived through practical experience; and every successful model in existing vessels can be closely imitated by means of them, from a Dutch galliot to a racing boat.

10. Any series of water-lines, including the primitive oval, are easily and quickly constructed with the ruler and compasses, as follows:—Parallel to the longitudinal axis OX, draw a series of straight lines at equal distances apart. Through the foci draw a series of circular arcs AC<sub>1</sub>, AC<sub>2</sub>, &c., so as to contain a series of angles found by dividing those distances by

$$\frac{OL^2 - OA^2}{2OA}$$

Each of those circular arcs indicates the direction of motion, in still water, of each of the particles that it traverses. Then through the angles of the network formed by the straight lines and circular arcs, draw a series of curves; these will be the required water-lines. The centre of curvature of the oval at L is the focus A.

11. The following curves, traversing certain important points in the water-lines, are exactly similar for all water-lines of this class, and are easily and quickly constructed with the compasses.

LM is a hyperbola, having a pair of asymptotes crossing the axes at O at angles of 45°. It traverses all the points at which the motion of the particles, in still water, is at right angles to the water-lines.

LQN, and LP, are the two branches of a curve of the fourth order, having a pair of asymptotes which traverse O, making angles of 30° with OX. A straight line joining L and P makes an angle of 30° with LO. The two branches cross the axis OX at L, making angles of 45°. The branch LQN traverses a series of points at each of which the velocity of gliding of the particles of water along the water-line is less than at any other

point on the same water-line. The branch LP traverses a series of points, at each of which the velocity of gliding is greater than at any other point on the same water-line.

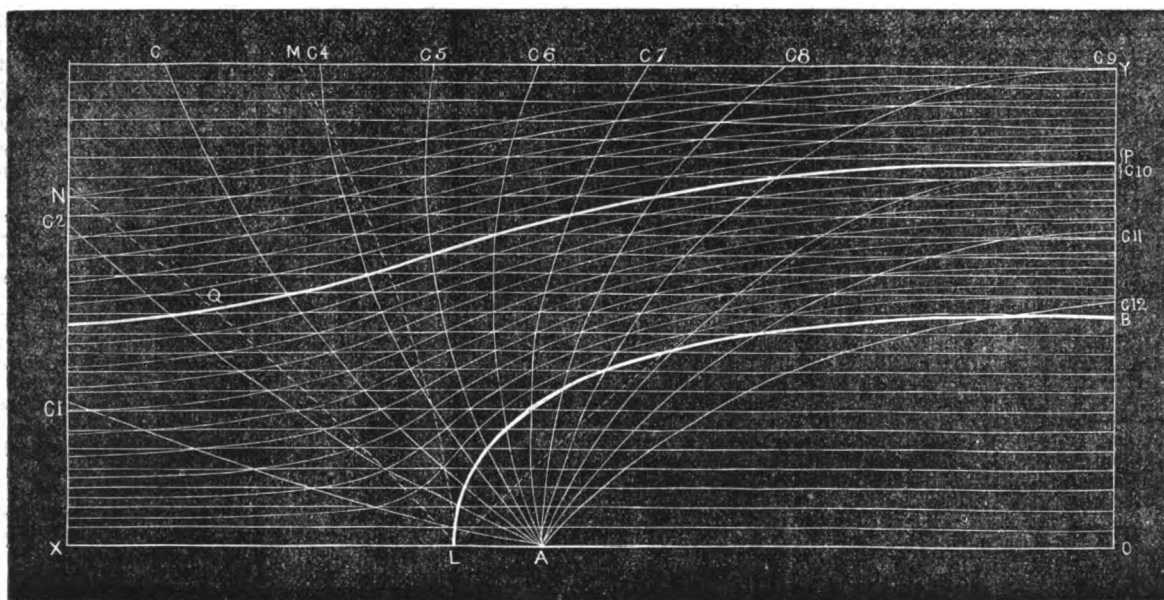
12. The axis OY, from B to P, traverses a series of points of minimum velocity of gliding; from P onwards, it traverses a series of points of maximum velocity of gliding.

13. Every water-line, complete from bow to stern, which passes within the point P, has three points of minimum and two of maximum velocity of gliding; while every water-line which passes through or beyond P, has only two points of minimum and one of maximum velocity of gliding. Hence the latter class of lines cause less commotion in the water than the former.

14. On the water-line PQ, which traverses the point P itself, the velocity of gliding changes more gradually than on any other water-line having the same proportion of length to breadth. Water-lines possessing this character can be constructed, with any proportion of length to breadth, from  $\sqrt{3}$  (which gives an oval through L and P) to infinity. The finer of those lines are found to be nearly approximated to by wave-lines; but are less hollow at the bow than wave-lines are.

15. The author shows how horizontal water-lines at the bow, drawn according to this system, may be combined with vertical plane lines of motion for the water at the stern, if desired by the naval architects.

16. In this, as in every system of water-lines, a certain relation (according to a principle first pointed out by Mr. Scott Russell) must be preserved between the form and dimensions of the bow and the maximum speed of the ship, in order that the appreciable resistance may be wholly frictional, and proportional to the square of the velocity, (as the experimental researches of Mr. W. R. Napier and the author have shown it to be in well-formed ships,) and may not be augmented by terms increasing as the fourth and higher powers of the velocity, through the action of vertical disturbances of the water.



#### ON THE PROPORTIONS OF SHIPS OF LEAST SKIN-RESISTANCE FOR A GIVEN SPEED AND DISPLACEMENT.

By W. J. MACQUORN RANKINE, C.E., LL.D., &c., &c.

The author referred to a previous paper which he had read to the British Association in 1861, in which he had stated the results of a theoretical investigation of the "skin resistance" of ships, and verified those results by a comparison with those of experiment. In the course of that paper he had stated, that the theory gives, for the proportion of length to breadth which produces least skin-resistance with a given displacement and speed, that of *seven to one*, nearly.

This is the case when the figures and proportions of the cross-sections are given, so that the draught of water bears a fixed proportion to the breadth. But when the draught of water has a fixed absolute value, the theory gives a somewhat different result; for the proportion of length to breadth which produces the least skin-resistance is found to increase as the draught of water becomes shallower.

In the following table of examples L denotes the length, B the

extreme breadth, H the draught of water, and the ratio  $\sqrt{LB} \div H$ , which is the argument of the table, is computed as follows:—

$$\frac{\sqrt{LB}}{H} = \sqrt{\left\{ \frac{\text{Displacement in cubic feet}}{H^3 \times \text{co-efficient of fineness}} \right\}}$$

In the vessels to which these calculations are applicable, the cross sections are supposed to be nearly rectangular, and the "co-efficient of fineness" is in general between 0.55 and 0.65.

Example No. I. II. III. IV. V. VI.

|                       |       |     |      |      |      |      |
|-----------------------|-------|-----|------|------|------|------|
| $\frac{\sqrt{LB}}{H}$ | = 5.2 | 9.0 | 15.6 | 22.5 | 30.7 | 40.2 |
| $\frac{L}{B}$         | = 7   | 8   | 9    | 10   | 11   | 12   |
| $\frac{B}{H}$         | = 2   | 3.5 | 5.2  | 7.1  | 9.3  | 11.6 |

The general agreement of those results with successful practice in ship-building is obvious.

## THE ROYAL SOCIETY.

## ON THE MOLECULAR MOBILITY OF GASES.

BY THOMAS GRAHAM, F.R.S., MASTER OF THE MINT.

The molecular mobility of gases is here considered in reference chiefly to the passage of gases, under pressure, through a thin porous plate or septum, and to the partial separation of mixed gases which can be effected, as will be shown, by such means. The investigation arose out of a renewed and somewhat protracted inquiry regarding the diffusion of gases (depending upon the same molecular mobility), and has afforded certain new results which may prove to be of interest in a theoretical as well as in a practical point of view.

In the diffusionmeter, as first constructed, a plain cylindrical glass tube, rather less than an inch in diameter and about ten inches in length, was simply closed at one end by a porous plate of plaster of Paris, about one-third of an inch in thickness, and thus converted into a gas receiver.\* A superior material for the porous plate is now found in the artificially compressed graphite of Mr. Brockedon, of the quality used for making writing-pencils. This material is sold in London in small cubic masses about 2 inches square. A cube may easily be cut into slices of a millimetre or two in thickness by means of a saw of steel spring. By rubbing the surface of the slice without wetting it upon a flat sand-stone, the thickness may be further reduced to about one-half of a millimetre. A circular disk of this graphite, which is like a wafer in thickness, but possesses considerable tenacity, is attached by resinous cement to one end of the glass tube above described, so as to close it and form a diffusionmeter. The tube is filled with hydrogen gas over a mercurial trough, the porosity of the graphite plate being counteracted for the time by covering it tightly with a thin sheet of gutta serena. On afterwards removing the latter, gaseous diffusion immediately takes place through the pores of the graphite. The whole hydrogen will leave the tube in forty minutes or an hour, and is replaced by a much smaller proportion of atmospheric air (about one-fourth), as is to be expected from the law of the diffusion of gases. During the process, the mercury will rise in the tube, if allowed, forming a column of several inches in height—a fact which illustrates strikingly the intensity of the force with which the interpenetration of different gases is effected. The native or mineral graphite is of a lamellar structure, and appears to have little or no porosity. It cannot be substituted for the artificial graphite as a diffusion-septum. Unglazed earthenware comes next in value to graphite for this purpose.

The pores of artificial graphite appear to be really so minute, that a gas *in mass* cannot penetrate the plate at all. It seems to be molecules only which can pass; and these may be supposed to pass wholly unimpeded by friction, for the smallest pores that can be imagined to exist in the graphite must be tunnels in magnitude to the ultimate atoms of a gaseous body. The sole motive agency appears to be that intestine movement of molecules which is now generally recognised as an essential property of the gaseous condition of matter.

According to the physical hypothesis now generally received†, a gas is represented as consisting of solid and perfectly elastic spherical particles or atoms, which move in all directions, and are animated with different degrees of velocity in different gases. Confined in a vessel, the moving particles are constantly impinging against its sides and occasionally against each other, and such collisions take place without any loss of motion, owing to the perfect elasticity of the particles. Now if the containing vessel be porous, like a diffusionmeter, then gas is projected through the open channels, by the atomic motion described, and escapes. Simultaneously the external air or gas, whatever it may be, is carried inwards in the same manner, and takes the place of the gas which leaves the vessel. To the same atomic or molecular motion is due the elastic force, with the power to resist compression, possessed by gases. The molecular movement is accelerated by heat and retarded by cold, the tension of the gas being increased in the first instance and diminished in the second. Even when the gas is present both within and without the vessel, and is therefore in contact with both sides of the porous plate, the movement is sustained without abatement—molecules continuing to enter and leave in equal number, although nothing of the kind is indicated by change of volume or otherwise. If the gases in communication be different but possess sensibly the same specific gravity and molecular velocity, as nitrogen and carbonic oxide do, an interchange of molecules also takes place without any change in volume. With gases opposed of unequal density and molecular velocity, the amount of penetration ceases of course to be equal in both directions.

These observations are preliminary to the consideration of the passage through a graphite plate, in one direction only, of gas under pressure, or under the influence of its own elastic force. It is to be supposed that a vacuum is maintained on one side of the porous septum, and that air or some other gas, under a constant pressure, is in contact with the other side. Now a gas may pass into a vacuum in three different modes, or in two modes besides that immediately before us.

1. The gas may enter the vacuum by passing through a minute aperture in a thin plate, such as a puncture in platinum foil made by a fine steel point. The rate of passage of different gases is then regulated by their specific gravities, according to a pneumatic law which was deduced by Professor John Robison, from Torricelli's well-known theorem of the velocity of efflux of fluids. A gas rushes into a vacuum with the velocity which a heavy body would acquire by falling from the height of an atmosphere composed of the gas in question, and supposed to be of uniform density throughout. The height of the uniform atmosphere will be inversely as the specific gravity of the gas, the atmosphere of

hydrogen, for instance, sixteen times higher than that of oxygen. But as the velocity acquired by a heavy body in falling is not directly as the height, but as the square root of the height, the rate of flow of different gases into a vacuum will be inversely as the square root of their respective densities. The velocity of oxygen being 1, that of hydrogen will be 4, the square root of 16. This law has been experimentally verified\*. The times of the effusion of gases, as I have spoken of it, are similar to those of the law of molecular diffusion; but it is important to observe that the phenomena of effusion and diffusion are distinct and essentially different in their nature. The effusion movement affects masses of gas, the diffusion movement affects molecules; and a gas is usually carried by the former kind of impulse with a velocity many thousand times greater than by the latter. The effusion velocity of air is the same as the velocity of sound.

2. If the aperture of efflux be in a plate of increased thickness, and so becomes a tube, the effusion-rates of gases are disturbed. The rates of flow of different gases, however, assume again a constant ratio to each other when the capillary tube is considerably elongated, when the length exceeds the diameter at least 4000 times. These new proportions of efflux are the rates of the "Capillary Transpiration of Gases."† The rates were found to be the same in a capillary tube composed of copper as they are in a tube of glass, and appear to be independent of the material of the capillary. A film of gas no doubt adheres to the inner surface of the tube, and the friction is really that of gas upon gas, and is consequently unaffected by the nature of tube-substance. The rates of transpiration are not governed by specific gravity, and are indeed singularly unlike the rates of effusion.

The transpiration-velocity of oxygen being 1, that of chlorine is 1.5, that of hydrogen 2.26, of ether vapour at low temperatures the same or nearly the same number as hydrogen, of nitrogen and carbonic oxide half the velocity of hydrogen, of olefiant gas, ammonia, and cyanogen 2 (double or nearly double that of oxygen), of carbonic acid 1.376, and of the gas of marshes 1.815. In the same gas the transpirability of equal volumes increases with density, whether occasioned by cold or pressure. The transpiration-ratios of gases appear to be in constant relation with no other known property of the same gases, and they form a class of phenomena remarkably isolated from all else at present known of gases.

There is one property of transpiration immediately bearing upon the penetration of the graphite plate by gases. The capillary offers to the passage of gas a resistance analogous to that of friction, proportional to the surface, and consequently increasing as the tube or tubes are multiplied in number and diminished in diameter, with the area of discharge preserved constant. The resistance to the passage of a liquid through a capillary was observed by Poiseuille to be nearly as the fourth power of the diameter of the tube. In gases the resistance also rapidly increases; but in what ratio, has not been observed. The consequence, however, is certain, that as the diameter of the capillaries may be diminished beyond any assignable limit, so the flow may be retarded indefinitely, and caused at last to become too small to be sensible. We may therefore have a mass of capillaries of which the passages form a large aggregate, but which are individually too small to permit a sensible flow of gas under pressure. A porous solid mass may possess the same reduced penetrability as the congeries of capillary tubes. Indeed the state of porosity described appears to be more or less closely approached by all loosely aggregated mineral masses, such as lime plaster, stucco, chalk, baked clay, non-crystalline earthy powders like hydrate of lime or magnesia compacted by pressure, and in the highest degree perhaps by artificial graphite.

3. A plate of artificial graphite, although it appears to be practically impenetrable to gas by either of the two modes of passage previously described, is readily penetrated by the agency of the molecular or diffusive movement of gases. This appears on comparing the time required for the passage of equal volumes of different gases under a constant pressure. Of the following three gases, oxygen, hydrogen, and carbonic acid, the time required for the passage of an equal volume of each through a capillary glass tube, in similar circumstances as to pressure and temperature, was formerly observed to be as follows:—

|                     | Time of capillary transpiration. |
|---------------------|----------------------------------|
| Oxygen .....        | 1                                |
| Carbonic acid ..... | 0.72                             |
| Hydrogen .....      | 0.44                             |

Through a plate of graphite, of half a millimetre in thickness, the same gases were now observed to pass, under a constant pressure of a column of mercury of .00 millimetres in height, in times which are as follows:—

|                     | Time of molecular passage. | Square root of density (oxygen 1). |
|---------------------|----------------------------|------------------------------------|
| Oxygen .....        | 1                          | 1                                  |
| Hydrogen .....      | 0.2472                     | 0.2502                             |
| Carbonic acid ..... | 1.1886                     | 1.1760                             |

It appears then that the times of passage through the graphite plate have no relation to the capillary transpiration-times of the same gases first quoted. The new times in question, however, show a close relation to the square roots of the densities of the respective gases, as is seen in the last table; and so far they agree with theoretical times of diffusion usually ascribed to the same gases.

The experiments were varied by causing the gases to pass into a Torricellian vacuum, and consequently under the full pressure of the atmosphere. The times of penetration of equal volume of gases were now—

|                     | Times. | √ Density. |
|---------------------|--------|------------|
| Oxygen .....        | 1      | 1          |
| Air .....           | 0.9501 | 0.9507     |
| Carbonic acid ..... | 1.1860 | 1.1760     |
| Hydrogen .....      | 0.2505 | 0.2502     |

\* On the Motion of Gases, Phil. Trans. 1846, p. 573.

† Phil. Trans. 1846, p. 591, and 1849, p. 340.

\* "On the Law of the Diffusion of Gases," *Transactions of the Royal Society of Edinburgh*, vol. xii. p. 222; or *Philosophical Magazine*, 1834, vol. ii. pp. 175, 289, 351.

† D. Bernoulli, J. Herapath, Joule, Krönig, Clausius, Clerk, Maxwell, and Caquin. The merit of reviving this hypothesis and first applying it to the facts of gaseous diffusion, is fairly due to Mr. Herapath. See *Mathematical Physics*, in two volumes, by John Herapath, Esq. (1847).

This penetration of the graphite plate by gases appears to be entirely due to their own proper molecular motion, quite unaided by transpiration. It seems to offer the simplest possible exhibition of the molecular or diffusive movement. This pure result is to be ascribed to the wonderfully fine porosity of the graphite. The interstitial spaces, or channels, appear to be sufficiently small to extinguish transpiration, or the passage of masses, entirely. The graphite becomes a molecular sieve, allowing molecules only to pass through.

With a plate of stucco, the penetration of gases under pressure is very rapid, and the volumes of air and hydrogen passing in equal times are as 1 to 2·891, which is a number for hydrogen intermediate between its transpiration-volume 2·04 and diffusive-volume 3·8, showing that the passage through stucco is a mixed result.

With a plate of biscuit ware, 2·3 millimetres in thickness, the volume of hydrogen rose to 3·754 (air = 1), approaching closely to 3·8, the molecular ratio.

The rate of passage of a gas through graphite appeared also to be closely proportional to the pressure.

Further, hydrogen was found to penetrate through a graphite plate into a vacuum, with sensibly the same absolute velocity as it diffused into air, establishing the important fact that the impelling force is the same in both movements. The molecular mobility may therefore be spoken of as the diffusive movement of gases; the passage of gas through a porous plate into vacuum, as diffusion in one direction or single diffusion; and ordinary diffusion, or the passage of two gases in opposite directions, as double, compound, or reciprocal diffusion.

*Atmolysis.*—A partial separation of mixed gases and vapours of unequal diffusibility can be effected by allowing the mixture to permeate through a graphite plate into a vacuum, as was to be expected from the preceding views. As this method of analysis has a practical character and admits of wide application, it may be convenient to distinguish it by a peculiar name. The amount of the separation is in proportion to the pressure, and attains its maximum when the gases pass into a nearly perfect vacuum. A variety of experiments were made on this subject, of which perhaps the most interesting were those upon the concentration of the oxygen in atmospheric air. When a portion of air confined in a jar is allowed to penetrate into a vacuum through graphite or unglazed earthenware, the nitrogen should pass more rapidly than the oxygen in the proportion of 1·0668 to 1, and the proportion of oxygen be proportionally increased in the air left behind in the jar. The increase in the oxygen actually observed when the air in the jar was reduced from 1 volume

To 0·5 volume, was 0·48 per cent.

|        |   |   |      |   |
|--------|---|---|------|---|
| 0·25   | " | " | 0·98 | " |
| 0·125  | " | " | 1·54 | " |
| 0·0625 | " | " | 2·02 | " |

Or, the oxygen increased from 21 to 23·02 per cent. in the last sixteenth part of air left behind in the jar.

The most remarkable effects of separation are produced by means of the *tube atmolyser*. This is simply a narrow tube of unglazed earthenware, such as a tobacco-pipe stem two feet in length, which is placed within a shorter tube of glass and secured in its position by corks, so as to appear like a Liebig's condenser. The glass tube is placed in communication with an air-pump, and the annular space between the two tubes is maintained as nearly vacuum as possible. Air or any other mixed gas is then allowed to flow in a stream along the clay tube, and collected as it issues. The gas so atmolysered is of course reduced in volume, much gas penetrating through the pores of the clay tube into the air-pump vacuum; and the slower the gas is collected the greater the proportional loss. In the gas collected, the denser constituent of the mixture is thus concentrated in an arithmetical ratio, while the volume of the gas is reduced in a geometrical ratio. In one experiment the proportion of oxygen in the air after traversing the atmolyser was increased to 24·5 per cent., or 16·7 upon 103 oxygen originally present in the air. With gases differing so much in density and diffusibility as oxygen and hydrogen, the separation is of course much more considerable. The explosive mixture of two volumes of hydrogen and one volume of oxygen, gave oxygen containing only 9·3 per cent. of hydrogen, in which a taper burned without explosion; and with equal volumes of oxygen and hydrogen, the proportion of the latter was easily reduced from 50 to 5 per cent.

*Interdiffusion of Gases—Double Diffusion.*—The diffusiometer was much improved in construction by Prof. Bunsen, from the application of a lever arrangement to raise and depress the tube in the mercurial trough. But the mass of stucco forming the porous plate in his instrument was too voluminous, in my opinion, and, from being dried by heat, had probably detached itself from the walls of the glass tube. The result obtained of 3·4 for hydrogen, air being 1, is, I understand, no longer insisted upon by that illustrious physicist. It is indeed curious that my old experiments generally rather exceeded than fell short of the theoretical number for hydrogen:—

$$\sqrt{\frac{1}{0.06926}} = 3.7997.$$

With stucco as the material, the cavities in the porous plate form about one-fourth of its bulk, and affect sensibly the ratio in question, according as they are or are not included in the capacity of the instrument. Beginning the diffusion always with these cavities filled with hydrogen, the numbers now obtained with a stucco plate of 12 millimetres in thickness, dried without heat, were 3·783, 3·8, and 3·739 when the volume of the cavities of stucco is added to the air and hydrogen, and 3·931, 3·940, and 3·883 when such addition is not made to these volumes. The graphite plate, on the other hand, being thin, and the volume of its pores too minute to require to be taken into account, its action is not attended with the same uncertainty. With a graphite plate of 2 millimetres in thickness, the number for hydrogen into air was 3·876, and of hydrogen into oxygen 4·124, instead of 4. With a graphite of 1 millimetre in thickness, hydrogen gave 3·993 to air 1. With a graphite plate of 0·5 millimetre in thickness, the proportional number for hydrogen to air rose to 3·984,

4·068, and 4·067. A similar departure from the theoretical number was observed when hydrogen was diffused into oxygen or carbonic acid, instead of air. All these experiments were made over mercury and with dried gases. It appears that the numbers are most in accordance with theory when the graphite plate is thick, and the diffusion slow in consequence. If the diffusion be very rapid, as it is with the plates, something like a current is possibly formed in the channels of the graphite, taking the direction of the hydrogen and carrying back in mass a little air, or the slower gas, whatever it may be. I cannot account otherwise for the slight predominance which the lighter and faster gas appears always to acquire in diffusing through the porous septum.

*Speculative Ideas respecting the Constitution of Matter.*—It is conceivable that the various kinds of matter, now recognised as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of gravity upon all bodies. We know the anxiety with which this point was investigated by Newton, and the care he took to ascertain that every kind of substance, "metals, stones, woods, grain, salts, animal substances," &c., are similarly accelerated in falling, and are therefore equally heavy.

In the condition of gas, matter is deprived of numerous and varying properties with which it appears invested when in the form of a liquid or solid. The gas exhibits only a few grand and simple features. These again may all be dependent upon atomic and molecular mobility. Let us imagine one kind of substance only to exist, ponderable matter; and further, that matter is divisible into ultimate atoms, uniform in size and weight. We shall have one substance and a common atom. With the atom at rest the uniformity of matter would be perfect. But the atom possesses always more or less motion, due, it must be assumed, to a primordial impulse. This motion gives rise to volume. The more rapid the movement the greater the space occupied by the atom, somewhat as the orbit of a planet widens with the degree of projectile velocity. Matter is thus made to differ only in being lighter or denser matter. The specific motion of an atom being inalienable, light matter is no longer convertible into heavy matter. In short, matter of different density forms different substances—different inconvertible elements as they have been considered.

What has already been said is not meant to apply to the gaseous volumes which we have occasion to measure and practically deal with, but to a lower order of molecules or atoms. The combining atoms hitherto spoken of are therefore not the molecules of which the movement is sensibly affected by heat, with gaseous expansion as the result. The gaseous molecule must itself be viewed as composed of a group or system of the preceding inferior atoms, following, as a unit, laws similar to those which regulate its constituent atoms. We have indeed carried one step backward and applied to the lower order of atoms ideas suggested by the gaseous molecule, as views derived from the solar system are extended to the subordinate system of a planet and its satellites. The advance of science may further require an indefinite repetition of such steps of molecular division. The gaseous molecule is then a reproduction of the inferior atom on a higher scale. The molecule or system is reached which is affected by heat, the diffusive molecule, of which the movement is the subject of observation and measurement. The diffusive molecules are also to be supposed uniform in weight, but to vary in velocity of movement, in correspondence with their constituent atoms. Accordingly the molecular volumes of different elementary substances have the same relation to each other as the subordinate atomic volumes of the same substances.

But further, these more and less mobile or light and heavy forms of matter have a singular relation connected with equality of volume. Equal volumes of two of them can coalesce together, unite their movement, and form a new atomic group, retaining the whole, the half, or some simple proportion of the original movement and consequent volume. This is chemical combination. It is directly an affair of volume, and only indirectly connected with weight. Combining weights are different, because the densities, atomic and molecular, are different. The volume of combination is uniform, but the fluids measured vary in density. This fixed combining measure—the *metron* of simple substances—weighs 1 for hydrogen, 16 for oxygen, and so on with the other "elements."

To the preceding statements respecting atomic and molecular mobility, it remains to be added that the hypothesis admits of another expression. As in the theory of light we have the alternative hypotheses of emission and undulation, so in molecular mobility the motion may be assumed to reside either in separate atoms and molecules, or in a fluid medium caused to undulate. A special rate of vibration or pulsation originally imparted to a portion of the fluid medium enlivens that portion of matter with an individual existence, and constitutes it a distinct substance or element.

With respect to the different states of gas, liquid, and solid, it may be observed that there is no real incompatibility with each other in these physical conditions. They are often found together in the same substance. The liquid and the solid conditions supervene upon the gaseous condition rather than supersede it. Gay-Lussac made the remarkable observation that the vapours emitted by ice and water, both at 0° C., are of exactly equal tension. The passage from the liquid to the solid state is not made apparent in the volatility of water. The liquid and solid conditions do not appear as the extinction or suppression of the gaseous condition, but something superadded to that condition. The three conditions (or constitutions) probably always co-exist in every liquid or solid substance, but one predominates over the others. In the general properties of matter we have, indeed, to include still further (1) the remarkable loss of elasticity in vapours under great pressure, which is distinguished by Mr. Faraday as the Caignard-Latour state, after the name of its discoverer, and is now undergoing an investigation by Dr. Andrews, which may be expected to throw much light upon its nature; (2) the colloidal condition or constitution, which intervenes between the liquid and crystalline states, extending into both and affecting probably all kinds of solid and liquid matter in a greater or less degree. The predominance of a certain physical state in a substance appears to be a distinction of a kind with

these distinctions recognised in natural history as being produced in unequal development. Liquefaction or solidification may therefore not involve the suppression of either the atomic or the molecular movement, but only the restriction of its range. The hypothesis of atomic movement has been elsewhere assumed, irrespective of the gaseous condition, and is applied by Dr. Williamson to the elucidation of a remarkable class of chemical reactions which have their seat in a mixed liquid.

Lastly, molecular or diffusive mobility has an obvious bearing upon the communication of heat to gases by contact with liquid or solid surfaces. The impact of the gaseous molecule, upon a surface possessing a different temperature, appears to be the condition for the transference of heat, or the heat movement, from one to the other. The more rapid the molecular movement of the gas the more frequent the contact, with consequent communication of heat. Hence, probably, the great cooling power of hydrogen gas as compared with air or oxygen. The gases named have the same specific heat for equal volumes; but a hot object placed in hydrogen is really *touched* 3·8 times more frequently than it would be if placed in air, and four times more frequently than it would be if placed in an atmosphere of oxygen gas. Dalton had already ascribed this peculiarity of hydrogen to the high "mobility" of that gas. The same molecular property of hydrogen recommends the application of that gas in the air-engine, where the object is to alternately heat and cool a confined volume of gas with rapidity.

#### RESULTS OF THE MAGNETIC OBSERVATIONS AT THE KEW OBSERVATORY, FROM 1858 TO 1882, INCLUSIVE.

By MAJOR-GENERAL EDWARD SABINE, F.R.S.

The first three sections of this paper are occupied by a discussion of the Laws of the Disturbances of the Magnetic Declination at Kew, derived from the photographic records of the Kew Observatory between January 1, 1858, and December 31, 1882. In the first section a synoptical table is given, showing the direction and amount of the easterly and of the westerly deflections of the declination magnet at 24 equidistant epochs on each of 95 days of principal disturbance occurring in the years 1858 to 1882 inclusive. The deflections are measured from the normals of the same month and hour, computed from the undisturbed positions at the same epochs on the 1825 days comprised in the five years since the commencement of the photographic records. The phenomenal laws of the disturbances on the 95 days are then investigated, and are compared with the corresponding laws derived from a far larger number of observations in the same years, taken out by the well-known process employed by the author in the reduction of the observations of the colonial magnetic observatories. The result is shown to be that, so far as the laws of disturbances are concerned, the two processes furnish mutual confirmation—the laws being approximately the same whether they are derived from the whole body of the hourly positions, or from that portion only which includes 95 days (or on an average 19 days in each year) which were specially affected by disturbance,—but that, for the purpose of eliminating the effects of the disturbances in the subsequent investigation of the secular, periodical, and other minor magnetic variations, the process of elimination introduced by the author and employed by him for several years past in the reduction of the colonial observations has the advantage of separating from the whole body of the observations a far greater portion of the disturbing influence than would be gained by the simple omission of the observations on the 95 days. The laws of the *disturbance-diurnal* variation, thus found to be approximately the same whether obtained from the narrower or from the wider basis of investigation, are then stated, and are compared with the results of similar investigations recorded in the author's previous publications—the points of accordance or of difference being severally discussed in the third section.

The fourth section contains Tables of the "Diurnal Inequality," and of the "Solar-diurnal Variation" at Kew, showing the mean values at each hour and in each month. The "Diurnal Inequality" is explained as consisting of two principal constituents, viz. the "Disturbance-diurnal Variation," and the "Solar-diurnal Variation." It is obtained for each month by taking the differences between the mean positions of the magnet at each of the 24 hours, in the month, and the mean position in the month itself (viz. the mean of all the days and all the hours)—no omission whatsoever being made of disturbed observations.

The "Solar-diurnal Variation" is obtained by a similar process, after the separation and omission of all the observations which differed by a certain small and constant value from the normals of the same month and hour. By this process the effects of the "Casual and Transitory changes" are in a very great degree eliminated, and a very close approximation is obtained to the systematic diurnal action of the sun upon the direction of the horizontal magnet, apart from the effects of disturbances. The solar-diurnal variation thus obtained at Kew is compared with results similarly obtained at six other stations, viz. three stations in the interior of the two great northern continents, one equatorial station, and two stations in the middle latitudes of the southern hemisphere—thus generalizing upon a very extensive scale the action of the sun in producing the phenomena under notice.

The fifth section is occupied by a similar generalization of the facts which placed in evidence the existence of a semi-annual inequality in the solar-diurnal variation, having its epochs coincident, or very nearly so, with the sun's passage of the equator, and dependent consequently on the earth's position in its orbit. The sun's action in producing this semi-annual inequality is shown to be characteristically different from that which is manifested in the solar-diurnal variation itself, pointing apparently to a difference in the mode of the sun's action in the two cases.

The sixth section contains a tabular view of the "Lunar-diurnal Variation" at Kew, in each of the five years during which the photographic record has been maintained there; this is followed by a comparison with similar results at other stations on the globe, and a statement of the principal points of agreement or of difference which are shown thereby.

This paper is a continuation of the preceding one. It consists two of sections, the seventh and eighth. In the seventh section the author discusses the secular change and annual variation of the declination; and in the eighth section, the annual variation or semi-annual inequality of the inclination and of the horizontal and total magnetic force.

**Seventh Section.**—The position of the horizontal magnet at 24 equidistant epochs in the day, tabulated from the photographs of the Kew declinometer, with the omission of the disturbed observations, as described in the former paper, are grouped in weekly means, forming 52 mean values, corresponding to the number of weeks in the year. A table is given of these weekly values, comprehending, in five columns, the five years from January 1858 to December 1882, inclusive, and from these a sixth column is formed, representing the mean declination in each of the 52 weeks of a mean or typical year, corresponding in this instance to the year 1860. The mean declination obtained from all the weekly results in the five years, and corresponding to its middle epoch July 1, 1860, is  $21^{\circ} 39' 18\frac{1}{2}''$ ; and from a comparison of the mean declinations corresponding to July 1 in the columns which severally present the weekly values in the years from 1858 to 1882 inclusive, the mean value of the secular change corresponding to the period comprised in the table is deduced. A proportional part of the secular change is then applied with its appropriate sign to each of the weekly values in the mean or typical year. These should all correspond with the mean declination of the whole Table ( $viz. 21^{\circ} 39' 18\frac{1}{2}''$ ), or should exhibit only such small and unsystematic differences as might reasonably be ascribed to casual errors. The final column of the Table contains these differences, in which it is at once seen that they divide themselves into two distinct categories, distinguished by the minus sign in the semi-annual period from March 21 to September 21, and by the + sign from Sept. 21 to March 21. Hence the author infers the existence of a variation in the declination at Kew having an annual period, and consisting of a semiannual inequality with epochs coincident, or nearly so, with the sun's passage of the equator—the magnet being deflected towards the east when the sun is north, and towards the west when he is south of the equator. The amount of the semiannual inequality, as shown by the table, averages —  $28\cdot95''$  in the weeks from March 21 to September 21, and +  $29\cdot9''$  in those from September to March. The whole amount of the variation at Kew is therefore  $58\frac{1}{2}''85$ .

The result thus obtained from the observations at Kew is compared with the result of an investigation of the corresponding phenomena at Hobarton in the Southern hemisphere, obtained from hourly observations of the declination during five years, commencing in October 1843, and terminating in September 1848. The observations themselves are published in the 2nd and 3rd volumes of the Hobarton Observations, and are treated, for the purposes of this paper, precisely in the same way as those of the Kew Observatory, forming a table strictly analogous to the one, previously described, at Kew. The final column of the Hobarton Table exhibits the differences, in each of the 52 weeks of the typical year, from the mean declination derived from the whole of the observations in the five years. The + and — signs in this column attest in as striking a manner as do those at Kew, the existence at Hobarton of a semi-annual inequality of which the epochs coincide, or very nearly so, with the sun's passage of the equator: the direction of the deflection is the same as at Kew, viz., of the north end of the magnet towards the east when the sun is north of the equator, and to the west when he is south of the equator. The amount of the deflection in the first-named semiannual period is, on the average,  $19\frac{1}{2}''$  in each week; and in the opposite semiannual period  $18''$ ; making together an annual variation of  $38\frac{1}{2}''$ .

The author then refers to the result of a similar investigation of the phenomena at St. Helena in the equatorial zone, the particulars of which have been already published in the 2nd volume of the St. Helena Observations. The result, derived from eight years of observation, of which five years were hourly, evidences at that station, also the existence of a semi-annual inequality with epochs coinciding, or nearly so, with the equinoxes—the deflections being also in the same directions as those at Kew and Hobarton, viz., to the east when the sun is north, and to the west when he is south, of the equator. The amount of the annual variation thus produced is less at St. Helena than at either Kew or Hobarton—the semiannual difference being about  $7''$ , and the annual variation  $14''$ .

The author remarks that the difference in the amount of deflection at the three stations may, in part at least, be occasioned by the difference in amount of the antagonistic force of the earth's magnetism, tending to retain the magnet in its mean position in opposition to all disturbing causes. The antagonistic force, viz. the horizontal component of the earth's magnetic force, is approximately  $5\frac{1}{2}$  (in British units) at St. Helena,  $4\frac{1}{2}$  at Hobarton, and  $3\frac{1}{2}$  at Kew.

In a note appended subsequently to the delivery of this paper, viz. on June 19, 1883, the author refers to a similar investigation of the phenomena at the Cape of Good Hope, published in 1851, in the 1st volume of the magnetical observations at that station. The volume contains the fortnightly means of the declination from July 1842 to July 1846, corrected for secular change, and collected in Table III., page 5, of that volume. The differences of the declination in each fortnight, so corrected, for the mean declination of the whole period, are shown in its final column. The mean of the thirteen fortnights (in the four years) between March 26 and Sept. 23, is  $0\cdot4''$  more easterly, and of the thirteen fortnights between Sept. 24 and March 25,  $0\cdot4''$  more westerly than the mean value—showing an annual variation of  $0\cdot8''$  (or  $48''$ ), or a semiannual inequality averaging  $24''$  to the east in the thirteen fortnights from March 26 to Sept. 23, and  $24''$  to the west in the thirteen fortnights from Sept. 24 to March 25. This is in accordance with the conclusions at all the other stations at which the phenomena have been subjected to a suitable investigation. The antagonistic horizontal component of the earth's magnetism is approximately  $4\frac{1}{2}$ .

**Eighth Section.**—In the eighth section the author examines the evidence which the monthly determinations of the dip and of the horizontal component of the magnetic force at Kew afford of the existence of a semi-annual inequality in the absolute values of the dip and of the total magnetic force. The results of the

monthly determinations from April 1857 to March 1863 are exhibited in two tables, one appropriated to the dip, and the other to the horizontal force. The whole series of the determinations of the horizontal force were made with the same unifilar magnetometer and the same collimator magnet throughout, and also by the same observer, Mr. Chambers, one of the assistants at the Kew Observatory. In the monthly determinations of the dip from April 1857 to September 1860, twelve different circles, and their twenty-four needles, were occasionally employed, the mean of all the observations in each month being taken as the mean result in that month. There were also several observers in this part of the series, chiefly four. In the months from October 1860 to March 1863, one circle with its two needles were the sole instruments, and Mr. Chambers the sole observer. The probable error of a single monthly determination of the dip in the first part of the series, when several instruments and several observers were employed, is stated to be  $\pm 0^{\circ}69$ ; and in the second part of the series, obtained by a single circle and the same observer throughout, the probable error is  $\pm 0^{\circ}75$ ; whence it is inferred that the greater number of partial results which contributed to produce the monthly mean in the earlier period more than counterbalanced the diversities which might have been occasioned by the peculiarities of the different observers and of the different instruments. The probable error of a single monthly determination of the dip, after the application of the corrections for secular change and annual variation, is stated to be  $\pm 0^{\circ}71$ , and of a single monthly determination of the horizontal force derived from the 72 monthly determinations  $\pm 0^{\circ}024$ .

The results of the monthly determination at Kew, as bearing upon the question of annual variation, may be briefly stated as follows:—1st. The dip is subject to an annual variation, which, on the average of the six years, amounts to  $1^{\circ}35$ ; consisting of a semi-annual inequality with epochs coinciding, or very nearly so, with the equinoxes; the mean dip being on the average  $0^{\circ}65$  lower than its annual mean value in the six months from April to September, and  $0^{\circ}7$  higher than its annual mean value in the six months from October to March. 2nd. That the horizontal force is subject to a semi-annual inequality having the same epochs—being on the average  $0^{\circ}013$  higher than its annual mean in each of the six months from April to September, and  $0^{\circ}013$  lower than its annual mean in each of the months from October to March. 3rd. That, combining the results of the dip and horizontal force, the total terrestrial magnetic force is expressed in British units by  $10^{\circ}3002$  as its mean value in the months from April to September, and by  $10^{\circ}3047$  in the months from October to March,—there being thus a difference of  $0^{\circ}0327$ , by which the intensity of the magnetic force of the earth is greater in the months when the sun is south of the equator than in the months when he is north of the equator.

This conclusion is compared with the results obtained in a corresponding manner from the published observations of the Hobarton Observatory, viz., with the monthly determinations of the horizontal force in the five years from January 1846 to December 1850 inclusive, and with those of the dip in the ten years from January 1841 to December 1850 inclusive. From these data the conclusions are drawn, 1st, that at Hobarton the dip is subject to an annual variation amounting to  $1^{\circ}18$ , consisting of a semiannual inequality with epochs coinciding or nearly so with the equinoxes—the (south) dip being on the average  $0^{\circ}59$  less in the months from April to September, and  $0^{\circ}59$  greater in the months from October to March than the mean annual value; and 2nd, that the horizontal force is subject to a similar semi-annual inequality, being  $0^{\circ}007$  less than its mean value in the months from April to September, and  $0^{\circ}005$  greater in the months from October to March; and combining these two results, that the total force at Hobarton is expressed in British units by  $13^{\circ}50882$  in the months from October to March, and by  $13^{\circ}55195$  in the months from April to September; the difference,  $0^{\circ}1687$ , expresses the measure of the greater intensity of the earth's magnetic force when the sun is south than when he is north of the equator.

The author concludes this section of his investigations by drawing the attention of the Royal Society to this concurrent evidence, from the observations of the three observatories situated in parts of the globe so distant from each other, of a semi-annual inequality having such strong features of resemblance in both hemispheres, and remarks that it seems difficult to assign such effects to any other than a cosmical cause. The "inequalities" may in themselves seem to be small; but judged of *scientifically*, i. e., in the proportion they bear to their respective probable errors, they are large.

#### EXPERIMENTS MADE AT WATFORD ON THE VIBRATIONS OCCASIONED BY RAILWAY TRAINS PASSING THROUGH A TUNNEL.

By SIR JAMES SOUTH, LL.D., F.R.S., MEMBER OF THE BOARD OF VISITORS OF THE ROYAL OBSERVATORY, GREENWICH.

These experiments were made in consequence of an attempt in 1846 to run a line of railway through Greenwich Park, in what seemed to several competent judges a dangerous proximity to the Royal Observatory.

It was abandoned, but (as Sir James South was informed) only for a time; and he thought it right to make some examination of the probable effects of such a vicinity, especially as to the power of a tunnel in deadening the vibrations.

The Watford tunnel was chosen as the observing station, being, on the high authority of Mr. Warburton, in ground very analogous to that on which the Royal Observatory stands; and every facility for making observations was afforded by the late Earl of Essex, through whose park and preserves this tunnel passes.

As the chief inconvenience to be feared from the proposed railway was the disturbance of the observations by reflection in mercury, it seemed best to take a series of these under circumstances as nearly as possible resembling those which might be expected at Greenwich. An Observatory was therefore erected, in which a large and powerful transit-instrument was mounted, with all the attention to stability that could be given in a first-class Observatory; and it had

sufficient azimuthal motion to enable the observer to follow the Pole-star in its whole course; so that night or day (if clear), he could have the reflected image of the star in the mercurial vessel, ready to testify against the tremors caused by any train.

The distance of the vessel from the nearest part of the tunnel was 302 yards, that proposed for Greenwich being 286 yards. The length of the tunnel is 1812 yards; its southern or London end is 643 yards from where the mercury was placed, its northern or Tring end 1281 yards; and about 64 feet of chalk and gravel lie above the brickwork of its crown. The author's preparations were not complete till December 1846, and then a continuance of cloudy weather interfered with observation till January the 11th, 1847, when and on the following nights he obtained results so decisive that he felt it his duty to communicate them at once to the then first Lord of the Admiralty, the late Lord Auckland, who was so satisfied with them that in a letter to Sir James, dated "Admiralty, Jan. 26, 1847," he recorded the impression they had made on his mind in the following terms:—"They would be quite conclusive if the question of carrying a tunnel through Greenwich Park were again to be agitated." Sir James, however, continued the work to the end of March.

With the ordinary disturbance to which an Observatory is liable (as wind, carriages, or persons moving near it) the reflected image of a star breaks up into a line of stars, perpendicular to the longest side of the mercury vessel. With increased agitation, another line of stars perpendicular to the first appears, making a cross. With still more the cross becomes a series of parallel lines of stars; still more makes the image oscillate; and at last all becomes a confused mass of nebulous light. The first of these (the line) is not injurious to one class of observations; but the others are, and therefore the second (the cross) was taken as a measure of the beginning and end of injurious disturbance. Signal shots were fired when a train passed the southern entrance of the tunnel, and a shaft 1162 yards from it. Hence the train's velocity was obtained, and thence its position at any given time.

Upwards of 230 observations are given in detail, and their most important results are shown in a table, which contains the date, the distances at which the cross of stars begins and ceases to be visible, those at which the series of parallel lines is seen, the velocity in miles per hour, the weight of each engine, and also the length and weight of each train (when it could be identified).

This table proves that in *all cases* but one (which in fact is scarcely an exception) there is sufficient vibration to excite the cross at 670 yards, and that in 24 per cent. of the number it is seen beyond 1000, its maximum being 1176. At the southern end such disturbances reach far beyond the tunnel, while at the north they fall within it. From comparing them in the two cases, the author infers that the train's agitation extends laterally as far when it is in the tunnel as when in the open cutting. The amount of disturbance does not depend solely on the velocity and weight of the train, but also on other circumstances, of which prolonged action and length of train are the chief. In one instance, with only a velocity of 11.4 miles, the cross was seen at 1110 yards—a proof that no regulation of the speed in passing an Observatory at a distance of 300 or 400 yards would be of any avail.

The system of parallel lines is only seen between lines making angles of  $45^{\circ}$  with the perpendicular to the rails, that is, at distances under 427 yards; it scarcely ever is produced unless the cross be visible beyond 1000 yards.

These forms are also produced by the reports of cannon of twelve ounces calibre, at distances from 300 to 3000 yards; in the last case there is but a faint trace of the cross. In all, the appearance is momentary, not lasting in any case more than a second and a half. They are not produced by the roar of a two-pound rocket fired 82 feet from the mercury, though very loud. When the cannon were fired *in the tunnel*, where the perpendicular meets it, two sets of tremors were seen—one, he believes, propagated through the ground, the other through the air about a second later, the sound escaping probably through the shafts. Attempts were made to substantiate or refute this hypothesis; but the difficulties of rapidly shifting and unshifting the coverings prepared for the purpose were such as to compel him to relinquish them.

These observations were reduced in 1847; but conceiving all danger to the Royal Observatory was past, the author did not think it necessary then to proceed with them. As, however, no Observatory can now be considered secure from railway injury, he wishes to make them public, in hopes that they may be useful, not only to practical astronomy, but to some other departments of science.

#### INSTITUTION OF CIVIL ENGINEERS.

The Council of the Institution of Civil Engineers have awarded the following premiums for the session 1862-63:—

1. A Telford Medal, and a Telford Premium, in books, to John Brunton, M. Inst. C.E., for his "Description of the Line of Works of the Scinde Railway."
2. A Telford Medal, and a Telford Premium, in books, to James Robert Mosse, M. Inst. C.E., for his paper on "American Timber Bridges."
3. A Telford Medal, and a Telford Premium, in books, to Zerah Colburn, for his paper on "American Iron Bridges."
4. A Telford Medal, and a Telford Premium, in books, to Harrison Hayter, M. Inst. C.E., for his paper on "The Charing Cross Bridge."
5. A Telford Premium, in books, to William Michael Peniston, M. Inst. C.E., for his paper on "Public Works in Pernambuco, in the Empire of Brazil."
6. A Telford Premium, in books, to William Henry Preece, Assoc. Inst. C.E., for his paper "On Railway Telegraphs, and the Application of Electricity to the Signalling and Working of Trains."

7. A Telford Premium, in books, to Alexander Woodlands Makinson, M. Inst. C.E., for his paper "On some of the Internal Disturbing Forces of Locomotive Engines."

8. A Telford Premium, in books, to Daniel Miller, for his paper on "Structures in the Sea, without Cofferdams,—with a Description of the Works of the New Albert Harbour at Greerock."

9. A Telford Premium, in books, to Robert Crawford, Assoc. Inst. C.E., for his paper on "The Railway System of Germany."

10. A Telford Premium, in books, to William Cudworth, M. Inst. C.E., for his paper on "The Hownes Gill Viaduct, on the Stockton and Darlington Railway."

11. A Telford Premium, in books, to James Grant Fraser, M. Inst. C.E., for his paper "Description of the Lydgate and of the Buckhorn Weston Railway Tunnels."

12. A Watt Medal, and the Manby Premium, in books, to John Fernie, Assoc. Inst. C.E., for his paper "On the Manufacture of Duplicate Machines and Engines."

The following are the subjects for premiums for the session 1863-64:—

1. On the Decay of Materials in Tropical Climates, and the methods employed for arresting and preventing it.

2. On the Theory of Metal and Timber Arches.

3. On the Theory and Details of Construction of Wrought Iron Girder Bridges.

4. On Land-slips, with the best means of preventing or arresting them, with examples.

5. On the Pressure of Earth on Tunnels, and the conditions which limit its amount.

6. On the Theory and Practice of Artesian Well-boring, and of sinking large shafts, as now practised on the Continent.

7. On the result of contrivances for facilitating the Driving of Tunnels, or Drifts in Rock.

8. On the Principles to be observed in Laying-out lines of Railway through mountainous countries, with examples of their application in the Alps, the Pyrenees, the Indian Ghats, the Rocky Mountains of America, and similar cases.

9. On the best means of preserving Railways in Alpine countries from interruptions from snow.

10. On the result of recent experience in Iron Permanent Way.

11. On the Principles to be observed in the designing and arrangement of Terminal and other Railway Stations, Repairing Shops, Engine Sheds, &c., with reference to the traffic and the rolling stock.

12. On Railway Ferries, or the Transmission of Railway Trains entire across Rivers, Estuaries, &c.

13. On Locomotive Engines for ascending Steep Inclines, specially when in combination with sharp curves, on Railways.

14. On the Working of Locomotive Engines in Long Tunnels, with frequent Stations.

15. On the Results of the Application of Giffard's Injector to the Boilers of Locomotive and other Engines.

16. On the Working Expenses of Railways, and the influence on these of the original design and construction.

17. On the Results of a series of observations on the Flow of Water from the Ground, in any large district; with accurately recorded Rain-Gauge Registries, in the same locality for a period of not less than twelve months.

18. On the Construction of Catch-water Reservoirs in Mountain Districts, for the supply of Towns, or for Manufacturing purposes.

19. Accounts of existing Water-works; including the source of supply, a description of the different modes of collecting and filtering, the distribution throughout the streets of Towns, and the general practical results.

20. On the Best Means of Improving the Water Supply of the Metropolis.

21. On the Structural Details, and the Results in Use, of Apparatus for the Filtration of large volumes of Water.

22. On the Drainage and Sewerage of large Towns; exemplified by accounts of the systems at present pursued, with regard to the level and position of the outfall, the form, dimensions, and materials of the sewers, the prevention of emanations from them, the arrangements for connecting the house drains with the public sewers, the best means of limiting the contamination of river from the sewage discharged into them, and the disposal of the sewage, whether in a liquid form, as irrigation, or in a fluid form, as deodorisation.

23. On the Results of the Employment of Steam Power on Canals, and of other measures for the Improvement of Canals as a means of conveyance for heavy traffic.

24. On Iron Paving, and a comparison of the Results attained by it, and by stone block paving, &c.

25. A History of any Fresh Water Channel, Tidal River, or Estuary,—accompanied by plans and longitudinal and cross sections,—including notices of any works which may have been executed upon it, and of the

effects of the works; particularly of the relative value of Tidal and Fresh Water, and of the effect of Enclosures from the Tidal Area upon the general regime, of Sluicing where applied to the improvement of the entrance or the removal of a Bar, and of Groynes, or Parallel Training Walls. Also of Dredging, with a description of the Machinery employed, and the cost of raising and depositing the material.

26. On the Results of a Series of Observations, illustrative of the modifications which the tidal wave undergoes in its passage up and down a river, or estuary.

27. On the Construction of Tidal, or other Dams, in a constant, or variable depth of water; and on the use of wrought iron in their construction.

29. On Graving Docks and mechanical arrangements having similar objects, with the conditions determining their relative applicability in particular cases, as dependent on the rise of tide, the depth of water, and other circumstances.

30. On the Arrangement and Construction of Floating Landing Stages, for passenger and other traffic, with existing examples.

31. On the different systems of Swing, Lifting, and other opening Bridges, with existing examples.

32. On the Construction of Lighthouses, their Machinery, and Lighting Apparatus; with notices of methods in use for distinguishing the different Lights.

33. On the Measure of Resistance to Steam Vessels at high Velocities.

34. On the results of the use of Tubular Boilers, and of Steam at an increased pressure, with or without superheating, for Marine Engines, noticing particularly the difference in weight and in speed, in proportion to the Horse-power and the Tonnage.

35. On the relative advantages of the Principle of Expansion, as applied in the Single long-stroke Cylinder Engine, in the Double Cylinder Engine, and in the three Cylinder Engine; and on the adaptation of the two latter to marine purposes.

36. On the Principles and Varieties of Construction of Blast Engines, with British and Foreign examples.

37. On the best description of Steam Fire Engines, and their power and efficiency, as compared with ordinary hand Fire Engines.

38. On the construction of, and the comparative duty performed by, modern Pumping Engines for raising Water, for the supply of Towns, or for the Drainage of Mines; noticing, in the latter case, the depth and length of the underground workings, the height of the surface above the sea, the geological formation, the contiguity of streams, &c.

39. On Turbines and other Water Motors of a similar character; and their construction and performance, in comparison with Water-wheels.

40. On the present systems of Smelting Iron Ores; and on the conversion of cast-iron into the malleable state, and of the manufacture of iron generally, comprising the distribution and management of Iron Works.

41. On the Manufacture of Iron for Rails and Wheel Tyres, having special reference to the increased capability of resisting lamination and abrasion; and accounts of the Machinery required for rolling heavy Rails, Shafts, and bars of Iron of large sectional area.

42. On the Manufacture of large Masses of Iron for the purpose of Warfare, as Armour Plates, etc.

43. On the construction of Rifled and Breech-loading Artillery; and on Initial Velocity, Range and Penetration of Rifled Projectiles, and the influence of Atmospheric Resistance.

44. On the use of Steel Bars and Plates in Engine-work, and Machinery for Boilers and for Shipbuilding, as well as for Bridges.

45. On the use of Steel in the Construction of Locomotive Engines, especially with reference to durability and the cost of repairs, in tyres and cranked axles, as compared with Iron of acknowledged good quality.

46. On the Bessemer and other processes of Steel-making; on the present state of the Steel Manufacture on the Continent of Europe; and on the employment of castings in Steel for Railway Wheels and other objects.

47. On the safe working strength of Iron and Steel, including the results of experiments on the Elastic Limit of long bars of Iron, and on the rate of decay by rusting, &c., and under prolonged strains.

48. On the Transmission of Electrical Signals through Submarine Cables.

49. On the present relative position of English and Continental Engineering Manufactories, especially with reference to their comparative positions in respect of the cost, and the character of the work produced.

50. Memoirs and accounts of the Works and Inventions of any of the following Engineers:—Sir Hugh Middleton, Arthur Woolf, Jonathan Hornblower, Richard Trevithick, William Murdoch (of Soho), Alexander Nimmo, and John Rennie.

Original Papers, Reports, or designs, of these, or other eminent individuals, are particularly valuable for the Library of the Institution.

The competition for Premiums is not confined to Members, or Associates of the Institution, but is equally open to all persons, whether natives or foreigners.

The Council will not consider themselves bound to award any Premium, should the communication not be of adequate merit, but they will award more than one Premium, should there be several communications on the same subject deserving the mark of distinction.

The communications must be forwarded, on or before the 1st of January, 1884, to the house of the Institution, No. 25, Great George street, Westminster, S.W., where further information may be obtained.

## THE CHEMICAL SOCIETY.

### ON SOME EFFECTS OF HEAT ON FLUIDS.

By W. R. GROVE, ESQ., Q.C., F.R.S., Etc.

The paper of M. Donny (*Mémoires de l'Académie Royale de Bruxelles*, 1843) makes known the fact that in proportion as water is deprived of air, the character of its ebullition changes, becoming more and more abrupt, and boiling like sulphuric acid with *soubresauts*, and that between each burst of vapour the water reaches a temperature above its boiling point. To effect this, it is necessary that the water be boiled in a tube with a narrow orifice, through which the vapour issues: if it be boiled in an open vessel, it continually re-absorbs air and boils in the ordinary way.

In my experiments on the decomposition of water by heat, I found that with the oxy-hydrogen gas given off from ignited platinum plunged into water, there was always a greater or less quantity of nitrogen mixed; this I could never entirely get rid of, and I was thus led into a more careful examination of the phenomenon of boiling water, and set before myself this problem—what will be the effect of heat on water perfectly deprived of air or gas?

Two copper wires were placed parallel to each other through the neck of a Florence flask, so as nearly to touch the bottom; joining the lower ends of these was a fine platinum wire, about 1½ in. long, and bent horizontally into a curve. Distilled water which had been well boiled, and cooled under the receiver of an air-pump, was poured into this flask so as to fill about one-fourth of its capacity. It was then placed under the receiver of an air-pump, and one of the copper wires brought in contact with a metallic plate covering the receiver, the other bent backwards over the neck of the flask, and its end made to rest on the pump plate. By this means, when the terminal wires from a voltaic battery were made to touch, the one the upper and the other the lower plate, the platinum wire would be heated, and the boiling continued indefinitely in the vacuum of a very excellent air-pump. The effect was very curious; the water did not boil, but at intervals a burst of vapour took place, dashing the water against the sides of the flask, some escaping into the receiver. (There was a projection at the central orifice of the pump plate to prevent this overflow getting into the exhausting tube.)

After each sudden burst of vapour, the water became perfectly tranquil, without a symptom of ebullition until the next burst took place. These sudden bursts occurred at measured intervals, so nearly equal in time that, had it not been for the escape from the flask, at each burst, of a certain portion of water, the apparatus might have served as a timepiece.

I showed this experiment at one of my lectures at the time, as affording an illustration of the action of the geysers, of which it seemed to me to afford a rational explanation. Supposing a source of heat at a certain depth beneath the earth's surface, and subterranean wells whose only communication with the air was a narrow tube, probably formed by the issue of vapour, the air, if any, dissolved in the water of these wells would be expelled, and the boiling would take place at intervals and by sudden bursts instead of in the ordinary way.

This experiment, though instructive, did not definitely answer the question I had proposed, as I could not of course ascertain whether there was some minute residuum of gas which would form the nucleus for each ebullition, and I proceeded with others. A tube of glass, 5 ft. long, and  $\frac{1}{8}$ th inch internal diameter, was bent into a V shape; into one end a loop of platinum wire was hermetically sealed with great care, and the portion of it in the interior of the tube was platinised. When the tube had been well washed, distilled water, which had been purged of air as before, was poured into it to the depth of 8 inches, and the rest of the tube filled with olive oil; when the V was inverted, the open end of the tube was placed in a vessel of olive oil, so that there would be 8 in. of water resting on the platinum wire, separated from the external air by a column of 4 ft. 4 in. of oil. The projecting external ends of the platinum wire were now connected with the terminals of a voltaic battery and the water heated; some air was freed and ascended to the level of the tube—this was made to escape by carefully inverting the tube so as not to let the oil mix with the water, and the experiment continued. After a certain time the boiling assumed a uniform character, not by such sudden bursts as in the Florence flask experiment, but with larger and more distinct bursts of ebullition than in its first boiling.

The object of platinising the wire was to present more points for the ebullition, and to prevent *soubresauts* as much as possible.

The experiment was continued for many hours, and in some repetitions of it for days. After the boiling had assumed a uniform character, the progress of the vapour was carefully watched, and as each burst of vapour condensed in the oil, which was kept cool, it left a minute bead of gas, which ascended through the oil to the bend of the tube: a bubble was formed here which did not seem at all absorbed by the oil. This was analysed by a eudiometer, which I will presently describe, and proved to be nitrogen. The beads of gas, when viewed through a lens and micrometer scale at the same height in the tube, appeared as nearly as may be of the same size. No bubble of vapour was condensed completely, or without leaving this residual bubble. The experiment

was frequently repeated, and continued until the water was so nearly boiled away, that the oil, when disturbed by the boiling, nearly touched the platinum wire; here it was necessarily stopped.

To avoid any question about the boiling being by electrical means, similar experiments were made with a tube, without a platinum wire, closed at its extremity, and the boiling was produced by a spirit lamp. The effects were the same, but the experiment was more difficult and imperfect, as the bursts of vapour were more sudden, and the duration of the intervals more irregular.

The beads of gas were extremely minute, just visible to the naked eye. I cannot find any record of their exact measure.

In these experiments there was no pure boiling of water, *i.e.*, no rupture of cohesion of the molecules of water itself, but the water was boiled, to use M. Donny's expression, by evaporation against a surface of gas.

It is hardly conceivable that air could penetrate through such a column of oil, the more so as the oil did not perceptibly absorb the nitrogen freed by the boiling water and resting in the bend of the tube; but, to meet this conjectural difficulty, the following experiment was made. A tube, 1 ft. long and  $\frac{1}{8}$ th inch internal diameter, bent into a slight angle, had a bulb of  $\frac{1}{4}$  in. diameter blown on it at the angle; this angle was about 3 in. from one end and 9 in. from the other; a loop of platinum wire was sealed into the shorter leg, and the whole tube and bulb filled with and immersed into mercury; water, distilled and purged of air as before, was allowed to fill the short leg, and by carefully adjusting the inclination, the water could be boiled so as to allow bubbles to ascend into the bulb and displace the mercury. The effect was the same as with the oil experiment, no ebullition without leaving a bead of gas; the gas collected in the bulb, and was cut off by what may be termed a valve of mercury, from the boiling water, then allowed to escape, and so on. The experiment was continued for many days, and the bubbles analysed from time to time; they proved, as before, to be nitrogen, and, as before, continued indefinitely.

A similar experiment was made without the platinum wire, and though, from the greater difficulties, the experiment was not so satisfactory, the result was the same.

As the mercury of the common barometer will keep air out of its vacuum for years, if not for centuries, there could be no absorption here from the external atmosphere, and I think I am fairly entitled to conclude from the above experiments,—which I believe went far beyond any that have been recorded,—that no one has yet seen the phenomenon of pure water boiling, *i.e.*, of the disruption of the liquid particles of the oxy-hydrogen compound so as to produce vapour which will, when condensed, become water, leaving no permanent gas. Possibly, in my experiment of the decomposition of water by ignited platinum, it may be that the sudden application of intense heat, and in some quantity, so forces asunder the molecules that, not having sufficient nitrogen dissolved to supply them with a nucleus for evaporation, the integral molecules are severed, and decomposition takes place. If this be so, and it seems to me by no means a far-fetched theory, there is probably no such thing as boiling, properly so called, and the effect of heat on liquids in which there is no dissolved gas may be to decompose them.

Considerations such as these led me to try the effect of boiling on an elementary liquid, and bromine occurred as the most promising one to work upon. As bromine could not be boiled in contact with water, oil, or mercury, the following plan was ultimately devised. A tube, 4 ft. long and  $\frac{1}{8}$ th inch diameter, had a platinum loop sealed into one closed extremity; bromine was poured into the tube to the height of 4 in.; the open end of the tube was then drawn out to a fine point by the blow-pipe, leaving a small orifice; the bromine was then heated by a spirit lamp; and when all the air was expelled, and a jet of bromine vapour issued from the point of the tube, it was sealed by the blow-pipe. There was then, when the bromine vapour had condensed, a vacuum in the tube above the bromine. The platinum loop was now heated by a voltaic battery and the bromine boiled: this was continued for some time, care being taken that the boiling should not be too violent. At the end of a certain period—from half-an-hour to an hour—the platinum loop gave way, being corroded by the bromine: the quantity of this had slightly decreased. On breaking off, under water, the point of the tube, the water mounted and showed a notable quantity of permanent gas, which on analysis proved to be pure oxygen. As much as a quarter of a cubic inch was collected at one experiment. The platinum wire, which had severed at the middle, was covered with a slight black crust, which, suspecting to be carbon, I ignited by a voltaic spark in oxygen in a small tube over lime water; it seemed to give a slight opalescence to the liquid, but the quantity was so small that the experiment was not to be relied on. No definite change was perceptible in the bromine; it seemed to be a little darker in colour and had a few black specks floating in it, which I judged to be minute portions of the same crust which had formed on the platinum wire, and which had become detached.

The experiment was repeated with chloride of iodine, and with the same result, except that the quantity of oxygen was greater; I collected as much as half a cubic inch in some experiments, from an equal quantity of chloride of iodine, the platinum wire, however, was more quickly acted on than with the bromine, and the glass of the tube around it to some extent.

Melted phosphorus was exposed to the heat of the voltaic disruptive discharge by taking this between platinum points in a tube of phosphorus, similarly to an experiment of Davy's, but with better means of experimenting; a considerable quantity of phosphuretted hydrogen was given off, amounting in several experiments to more than a cubic inch.

A similar experiment was made with melted sulphur and sulphuretted hydrogen given off, but not in such quantities as the phosphuretted hydrogen. I tried in vain to carry on these experiments beyond a certain point; the substance became pasty, mixed with platinum from the arc, and from the difficulty of working with the same freedom as when they were fresh, the glass tubes were always broken after a certain time. Had I time for working on the subject now, I should use the discharge from the Ruhmkorff coil, which had not been invented

at the period of these experiments. At a subsequent period, when this discharge was taken in the vacuum receiver of an air-pump from a metallic point to a metallic capsule containing phosphorus, a considerable yellow deposit lined the receiver, which, on testing, turned out to be allotropic phosphorus. No gas is, however, given off. I had an air-pump (described, *Phil. Trans.*, 1852, p. 101) which enabled me to detect very small quantities of gas, but I could get none. It was in making these experiments that I first detected the strise in the electric discharge, which have since become a subject of such interesting observations, which are seen, perhaps, more beautifully in this phosphorus vapour than in any other medium, and which cease, or become very feeble, where the allotropic phosphorus is not produced.

I tried also phosphorus highly heated by a burning glass in an atmosphere of nitrogen, but could eliminate no perceptible quantity of gas, though the phosphorus was changed into the allotropic form.

It is not difficult to understand why gas is not perceptibly eliminated in the last two experiments; the effect is probably similar to that described in my paper on "The Decomposition of Water by Heat," where, when the arc or electric spark is taken in aqueous vapour, a minute bubble of oxyhydrogen gas is freed and disseminated through the vapour, recombination being probably prevented by this dilution; but, however long the experiment may be continued, no increased quantity of the gas is obtained, all beyond this minute quantity being recombined. If, however, the bubble of gas be collected, by allowing the vapour to cool, and then expelled, a fresh portion is decomposed, and so on.

So with the phosphorus in the experiments in the air-pump and with the burning glass, if any gas is liberated it is probably immediately recombined with the phosphorus; possibly a minute residuum might escape recombination, but the circumstances of the experiment did not admit of this being collected, as the gas was with the aqueous vapour.

When, on the other hand, the gas freed is immediately cut off from the source of heat, as when the spark is taken in liquids, an indefinite quantity can be obtained.

Decomposition and the elimination of gas may thus take place by the application of intense heat to a point in a liquid, or also in gas or vapours; but in the latter case it is more likely to be masked by the quantity of gas or vapour through which it is disseminated.

I believe there are very few gases in which some alteration does not take place by the application of the intense heat of the voltaic arc or electric spark. If the arc be taken between platinum points in dry oxygen gas over mercury, the gas diminishes indefinitely, until the mercury rises, and by reaching the point where the arc takes place, puts an end to the experiment. I have caused as much as a cubic inch of oxygen to disappear by this means. I at one time thought this was due to the oxidation of the platinum, but the high heat renders this improbable, and the deposit formed on the interior of the glass tube in which the experiment is made has all the properties of platinum-black; so if the spark from a Ruhmkorff coil be taken in the vapour of water for several days, a portion of gas is formed which is pure hydrogen, the oxygen freed being probably changed into ozone and combined with the mercury or dissolved by the water.

I have alluded to the endiometer by which I analysed the gases obtained in these experiments; it was formed simply of a tube of glass frequently not above 2½ millimetres in diameter, with a loop of wire hermetically sealed into one end, the other having an open bell-mouth. By a platinum wire a small bubble of the gas to be examined could be got up through water or mercury into the closed end of the tube, and by the addition of a bubble of oxygen or hydrogen gas, a very accurate analysis of very minute quantities of gas could be made; I have analysed by this means quantities no larger than a partridge-shot.

I need hardly allude to results on the compound liquids such as oils and hydrocarbons, as the fact that permanent gas is given off in boiling such liquids would not be unexpected; but the above experiments seem to show that boiling is by no means necessarily the phenomenon that has generally been supposed, viz., a separation of cohesion in the molecules of a liquid from distension by heat. I believe, from the close investigation I made into the subject, that (except with the metals, on which there is no evidence) no one has seen the phenomenon of pure boiling without permanent gas being freed, and that what is ordinarily termed boiling arises from the extrication of a bubble of permanent gas either by chemical decomposition of the liquid, or by the separation of some gas associated in minute quantity with the liquid, and from which human means have hitherto failed to purge it. This bubble once extricated, the vapour of the liquid expands it, or, to use the appropriate phrase of M. Donny, the liquid evaporates against the surface of the gas.

My experiments are, in a certain sense, the complement of his. He showed that the temperature of the boiling point was raised in some proportion as water was deprived of air, and that under such circumstances the boiling took place by *soubresauts*. I have, I trust, shown that when the vapour liberated by boiling is allowed to condense, it does not altogether collapse into a liquid, but leaves a residual bubble of permanent gas, and that at a certain point this evolution becomes uniform.

Boiling, then, is not the result of merely raising a liquid to a given temperature; it is something much more complex.

One might suppose that with a compound liquid the initial bubble by which evaporation is enabled to take place might, if all foreign gas were or could be extracted, be formed by decomposition of the liquid, but this could not be the case with an elementary liquid; whence the oxygen from bromine or the hydrogen from phosphorus and sulphur? as with the nitrogen in water, it may be that a minute portion of oxygen, hydrogen, or of water is inseparable from these substances, and that if boiled away to absolute dryness, a minute portion of gas would be left for each ebullition.

With water there seems a point at which the temperature of ebullition and the quantity of nitrogen yielded become uniform, though the latter is excessively minute.

The circumstances of the experiments with bromine, phosphorus, and sulphur did not permit me to push the experiment so far as was done with water; but, as far as it went, the result was similar.

When an intense heat, such as that from the electric spark or voltaic arc, is applied to permanent gas, there are, in the greater number of cases, signs either of chemical decomposition or of molecular change; thus compound gases, such as hydrocarbons, ammonia, the oxides of nitrogen, and many others, are decomposed. Phosphorus is vapour is reduced to allotropic phosphorus, oxygen to ozone, which, according to present experience, may be viewed as allotropic oxygen. There may be many cases where, as with aqueous vapour, a small portion only is decomposed, and this may be so masked by the volume of undecomposed gas as to escape detection, if, for instance, the vapour of water were incompressible, the fact that a portion of it is decomposed by the electric spark or ignited platinum would not have been observed.

All these facts show that the effect of intense heat applied to liquids and gases is far more complex, and presents greater interest to the chemist than has generally been supposed. In far the greater number of cases, possibly in all, it is not mere expansion into vapour which is produced by intense heat, but there is a chemical or molecular change. Had circumstances permitted I should have carried these experiments further and endeavoured to find an *experimentum crucis* on the subject; there are difficulties with such substances as bromine, phosphorus, &c., arising from their action on the substances used to contain and heat them, which are not easy to vanquish, and those who may feel inclined to repeat these experiments will find these difficulties greater than they appear in narration; but I do not think they are insuperable, and hope that, in the hands of those who are fortunate enough to have time at their disposal, they may be overcome.

To completely isolate a substance from the surrounding air, and yet be able to experiment on it, is far more difficult than is generally supposed. The air-pump is but a rude mode for such experiments as are here detailed.

Caoutchouc joints are out of the question; even platinum wires carefully sealed into glass, though, as far as I have been able to observe, forming a joint which will not allow gas to pass, yet it is one through which liquids will effect a passage, at all events when the wires are repeatedly heated.

In some experiments with the ignited platinum wire hermetically sealed into a tube of glass, the end of the tube containing the platinum wire was placed in a larger tube of oil, to lessen the risk of cracking the glass. After some days experimenting, though the sealing remained perfect, a slight portion of carbon was found in the interior liquid. This does not affect the results of my experiments, as I repeated them with glass tubes closed at the end and without platinum wires, and also without the oil-bath; but it shows how difficult it is to exclude sources of error. When water has been deprived of air to the greatest practicable extent it becomes very avid for air. The following experiment is an instance of this: A single pair of the gas-battery, the liquid in which was cut off from the external air by a greased glass stopper, having one tube filled with water, the other with hydrogen, the platinised platinum plates in each of these tubes were connected with a galvanometer, and a deflection took place from the reaction of the hydrogen on the air dissolved in the water. After a time the deflection abated, and the needle returned to zero, all the oxygen of the air having become combined with the hydrogen. If now the stopper were taken out, a deflection of the galvanometric needle immediately took place, showing that the air rapidly enters the water as water would a sponge. Absolute chemical purity in the ingredients is a matter, for refined experiments, almost unattainable. The more delicate the test, the more some minute residual product is detected; it would seem (to put the proposition in a somewhat exaggerated form) that in nature everything is to be found in anything if we carefully look for it.

I have indicated the above sources of error to show the close pursuit that is necessary when looking for these minute residual phenomena. Enough has, I trust, been shown in the above experiments to lead to the conclusion that, hitherto, simple boiling, in the sense of a liquid being expanded by heat into its vapour without being decomposed or having permanent gas eliminated from it, is a thing unknown. Whether such boiling can take place may be regarded as an open question, though I incline to think it cannot; that if water, for instance, could be absolutely deprived of nitrogen, it would not boil until some portion of it was decomposed; that the physical severance of the molecules by heat is also a chemical severance. If there be anything in this theoretic view, there is great promise of important results on elementary liquids, if the difficulties to which I have alluded can be got over.

The constant appearance of nitrogen in water, when boiled off out of contact with the air almost to the last drop, is a matter well worthy of investigation. I will not speculate on what possible chemical connection there may be between air and water; the preponderance of these two substances on the surface of our planet, and the probability that nitrogen is not the inert diluent in respiration that is generally supposed, might give rise to not irrational conjectures on some unknown bond between air and water. But it would be rash to announce any theory on such a subject; better to test any guess one may make, by experiment, than to mislead by theory without sufficient data, or to lessen the value of facts by connecting them with erroneous hypotheses.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—We regret that, owing to the meetings of the Association commencing so late in the month, we have only been able to insert the President's Address,—to which very considerable interest is deservedly attached,—and two papers by Professor Rankine. We purpose, however, giving in our next issue a selection of the most important of the papers read at the meetings of the several sections.

## SCOTTISH SHIPBUILDERS' ASSOCIATION.

## ON INDIAN RIVER STEAMERS.

BY MR. ROBERT LEYS.

In laying before you a few suggestions on Indian river navigation, I will confine my remarks to the river Indus and its tributaries. It is at certain seasons of the year shallow and tortuous, with a current of from  $1\frac{1}{2}$  to 3 knots per hour, according to the season—having, like the Nile, periodical inundations. At one place (Sukkur), where a rocky island divides the stream, the current at the high season is from 8 to 9 knots, but this pass is only about three-fourths of a mile in length. There is another peculiarity of the Indus: its shifting channels. It often happens that where there is 8 or 9 feet water one week, in the following week there will not be as many inches. The banks are also often swept away, taking with them whole native villages, so that any system of buoying off the channel is out of the question.

The navigation is guided by native pilots, who know by the surface of the water the channel to take; and they are often deceived, at times getting into a *cul de sac*, when they must about ship and seek another channel. As to the prospects of trade on the river I do not think there can be a doubt, as a glance at the map of India will show that it runs through a large tract of well-populated country. At about 500 miles from its mouth it is joined by the Chunab and Sutlej, the Chunab being again joined by the Jelum and Ravee, the Indus holding on its course north until it penetrates the Himalaya mountains and enters Tibet. However, it has not been navigated further north than Attock, and this may be said to be the utmost point navigable. The principal towns are Sukkur on the Indus, Moulton on the Chunab, Lahore on the Ravee, and Ferozpoor on the Sutlej, thus forming the Punjab, or country of the five rivers.

Before describing the kind of vessels I would suggest for its navigation, I will take a review of the vessels that have already been tried. Shortly after the conquest of Scinde by Sir Charles Napier, the East India Company, seeing the advantage of steam, had two small steamers built of light draught. They were 80ft. long and 18ft. beam; their load draught was 4ft., with engines of 50 nominal horse-power. This was a great step from the native boats; but owing to their small power and deep draught of water, they could only take Government stores and a few Government passengers; and, although the distance from Kurrachee to Moulton is only about 800 miles, they generally took five weeks to reach the latter place. The downward passage was accomplished in from seven to ten days. This will even look a long time; but it must be remembered that they can only steam in day-light, laying to at the bank at night, and taking their fuel (wood) for the following day.

They have gradually enlarged the size of the steamers as they built new ones, until the last built, just before India was united to the British Crown, were length 166ft., beam 28ft., depth of hold 8ft., nominal horse-power 120, their load draught 4ft. 6in. Now the great fault of these vessels was their draught of water and the length of time on the passage, twenty days being their average up passage; and at the high season of the river they could not go through Sukkur Pass, their cargo being unshipped below and transported in bullock carts to the upper side of the pass, and then put on board another steamer.

The next move for navigating the Indus was by a joint-stock company, with a patent for navigating shallow rivers. This was a steamer with an articulated train of barges, something like your mud barges on the Clyde, only the bow of each barge was fitted into the stern of the preceding one, which was part of a circle, and tied together with triangular draw-bars working on ball-and-socket joints. The steamer was 200ft. long, 20ft. beam, and 5ft. depth of hold. The first or joining barge was 40ft. long, 18ft. beam, and the same depth as the steamer. This barge was concave at both ends, so as to join the convex stern of the steamer and convex bow of the following barge. To complete the train, other four barges were joined in a similar manner, 100ft. long, 18ft. beam, and 5ft. depth of hold, the whole train being 640ft. long. The last barge was for passengers, having a deck house 60ft. by 16ft. Her stern was spoon shaped, with a rudder attached. The bow of the steamer was also of the spoon pattern. The displacement of the steamer with engines and boilers was 185 tons, and the mean draught was 2ft. 2½in. The joining barge displaced 18 tons, draught of water 10½in.; each of the 100ft. barges displaced 39 tons, draught 10in.; and the passenger barge displaced 63 tons, draught of water 1ft. 4in. This was their displacement without any cargo. The train was fitted with a great number of novelties, among which was a self-acting telegraph, to indicate to the steersmen of the other barges what direction the bow of the steamer was taking, the steamer, as it were, acting as a bow rudder to the rest of the train. On the steamer's bow was placed a frame with thirty lanterns, to throw a blaze of light ahead, to enable them to proceed in the darkest night. The paddle-wheels were 6in. below the keel, that they might be used as crawlers when the train had not water to float in, having supplementary engine, fitted with wheel gearing, to reduce the speed when crawling.

The last barge of the train was fitted with a drop pile. This was to pin the tail of the train if the bow should get aground when going with the stream, and prevent the doubling up of the train. None of these novelties were of much service. Once at Ghizree the steamer was crawled off with six inches less water than her draught, but the bottom was a stiff clay. At another time in Kurrachee harbour, where the bottom was sand, they just dug a hole in the sand without moving the vessel. The drop pile was once tried, but although it was an elm log 14in. square, it snapped across like a carrot.

A number of experimental trials were made at a measured distance of 3850 yards in Kurrachee harbour, the mean results of which were as follows:—With steamer alone, loaded to a mean draught of 3ft., the speed attained, with an indicated horse power of 273·58, was 9·374 English miles. Her immersed midship section was 58 square feet. This was a very poor result, but from her block stern and formation of the bow little else could be expected. The next trial was with the 40ft. and one of the 100ft. barges connected, loaded to 2ft. 10in. With this a speed of 7·19 English miles was attained, the indicated power being 302·79 horse-power, the immersed section of steamer being the same as on the former trial, the length of steamer and barges 340ft. Another 100ft. barge was connected, and the speed was reduced to 5·75 English miles, indicated power 332 horse power. Another 100ft. barge was connected, thus making the length of train 540ft. The speed was reduced to 4·33 English miles. The slip of the wheel on this trial was 51 per cent. I may mention that the engines were high pressure, and the steam carried on these trials was from 90 to 110 lbs.

After these trials, the train of steamer, 40ft. barge, and 100ft. barge, made an attempt to ascend the Indus, but although the patentee was on board, with a crew of thirty-two Europeans and forty-two natives, it was twenty-three days in making 420 miles. It was found quite unmanageable in the currents, oftener in a zig-zag than in a straight line, first on the one bank then on the opposite. A second attempt was made, which was equally unsuccessful.

After this failure, alterations were made in the steering gear, and a number of trials made in the harbour with no better result as to speed,—although the steering was rather improved. The train again started for the river, but before it was well out of the harbour one of the arms of the draw-bar broke, and the barges doubled round on the steamer, breaking in the stern and after compartment, when the steamer filled and sank in twenty-four feet water, the crew getting on to the barges. No lives were lost. Thus ended the train system, for a time at least, although a second train was ready for launching.

The steamer of this second train had now her block stern cut off, and lengthened 20ft., with a pretty fine after run: the barges got bows and sterns put to them to suit them for being lashed alongside the steamer, or towed astern, as might be wanted. This steamer started for Moulton with one barge 140 feet long, going through Sukkur Pass at the height of the inundations, and reached Moulton in twenty-five days. This was a poor result, but it was only making the best of a bad job. Since then she has taken two barges and made the passage pretty regularly.

The next move for navigating the Indus was with steamers and railway combined—the Scinde Railway and Indus Flotilla.

The Scinde railway starts from the Island of Keamaree, which forms the east side of the harbour of Kurrachee, and has its terminus at Kottree, on the banks of the Indus, about 130 miles from its mouth. This line is 110 miles long, and makes a very considerable saving in distance, but much more in time; the shortest water route to Kottree being 230 miles, but can only be used about seven months in the year, the N.W. monsoons causing a heavy surf all along that coast from April to September. The other water passage is by the creeks, which are very tortuous, and the distance to Kottree by them is computed at about 400 miles.

The Indus Flotilla Company had a steamer built on the Thames by a celebrated builder, and tried on that river. Her dimensions were, length 200ft., beam 38ft., and depth of hold 8ft. She was propelled by a condensing three-cylinder oscillating engine, two of the cylinders being below and the third above the deck. At her trial on the Thames she attained a speed of 13 miles per hour, with 688 indicated horse-power; her draught of water was 1ft. 11in., and her immersed midship section 70ft. This was no great result, but it exceeded anything she ever did in India. Whether that her boilers were not suited for wood fuel, or that the heavy teak decks and stringers fitted into her in India, was the cause of her falling off, I do not pretend to say: it might be both combined; but the fact was she did not make over 10 miles an hour in still water when tried in India. She was very unfortunate, breaking one of her piston-rods and smashing a cylinder. There were other six steamers built from this model one, and from the last accounts only one of them had been tried. The results were so unfavourable that not one of them was taken off the contractor's hands after being put up in Kurrachee, the company having purchased some of the boats belonging to the East India Company, and are carrying on their trade with them.

This is pretty nearly what has been done in navigating the Indus. To

know the rocks that others struck on was my reason for dwelling so long on what has been done already. It is a great part of the battle to know the dangers ahead.

I will now lay before you what sort of vessels I think would suit that or similar rivers. Light draught is of the utmost importance, combined with strength and moderate speed. To secure the first two qualities, steel or homogenous metal should be used in the plates, frames, decks, and beams, and from the late improvements in the manufacture of the latter metal, it would not be much more expense, taking into account its smaller scantling for equal strength compared with iron; and further to strengthen the steamer longitudinally, two bulkheads to run from bow to stern about 6ft. from her sides, also to be divided into five compartments by thwart bulkheads above the longitudinal bulkheads, two trusses rising about 8ft. above the deck at midship, with stanchions spaced about 10ft. apart; the trusses to be of the T section, and the stanchions tubes for lightness. For the third qualifications, high-pressure engines and boilers of the locomotive class, using steel for piston-rods, connecting rods, and valve gear, and homogenous metal in the framing, shafts, and cranks, cast iron only being used for the cylinders and valve casing; in fact, wherever the superior metal can be used it should be adopted.

The description of vessels would be a steamer with two barges lashed alongside, or in going through the creeks or narrows to be towed astern. Dimensions for steamers to be, length 240ft., beam 30ft., and depth of hold 5ft., with a co-efficient of fineness at 3ft. draught of .72. This will look full, but it must be remembered that it was nearly all taken from the two ends, the body of the vessel for about two-thirds her length being nearly a square box.

The barges to be, length 150ft., beam 22ft., and depth of hold 5ft., co-efficient of fineness .75, divided into three compartments with thwart bulkheads. The decks to be of the same material as the vessel.

A steamer of the above dimensions would displace at 3ft. draught 432 tons. The hull and fittings I calculate would be 185 tons; engines, boilers, and water, 110 tons; this would leave for cargo and fuel 137 tons, allowing 37 tons for fuel, which would be ample for her longest run between stations. This would leave 100 tons for dead weight cargo of steamer.

Each barge would displace 206 tons at 3ft. draught. Weight of each 56 tons, leaving 150 tons for cargo to each barge. This gives for steamer and two barges 400 tons of cargo, which, at the present rate of freight, 1d. per ton per mile for up freight, and  $\frac{1}{2}$ d. per ton per mile for down freight, should leave a very good return upon the capital laid out, after clearing working expenses.

I am quite aware that fullness increases the weight of the vessel herself, and tends to diminish the speed; but I wish to make her an owner's vessel, to carry a fair load upon the least draught of water. Now, I think you will agree with me that fullness has something to do in this respect, and as I do not think it advisable to make her longer for handiness in working in the river, the only other resource would be giving her more beam. This, I think, would increase the resistance as much as a little fullness in the vessel herself. Further, she is finer than any of the steamers on the river when I left. I believe the Oriental Inland Steam Navigation Company got one or two boats on the model of your Clyde river steamers; but what was the consequence? they drew 4ft. 6in., and were therefore useless for a part of the year. Light draught and to carry a fair cargo is indispensable. Speed, such as your Rothesay boats, is not wanted; 11 or 12 miles an hour would be ample, and with 600 indicated horse power, I think would be realised easily, even taking into account the fullness.

The boats of the Government, with very bluff bows, and 1 $\frac{1}{2}$ ft. more draught of water, the midships immersed area being 126ft. for steamer and barge, made 8 miles an hour with about 400 indicated horse power. I am taking the indicated horse-power at 2 $\frac{1}{2}$  times the nominal, and I am sure they did not exceed, if they came up to that; and again the *Sutlej*, the altered train steamer, with one barge, went through Sukkur Pass at the height of the inundation, the current at the time said to be 8 miles, and the speed of the vessel 1 $\frac{1}{2}$  miles per hour. Now, I have uniformly found that a steamer will go in still water more than the current and speed of ship added together. Some allowance must be made for shallow water; but the Indus is neither a shallow nor a narrow river generally: in some parts it is both, though not at the same place, and of course you must have vessels to pass these parts.

The expense of such a class of steamers would be about £450 per voyage for fuel, wages, and stores. The fuel is the heavy item, and as the demand for wood increases, there is no doubt the price will also rise; but as coal has been found in Scinde and also in the Punjab, that will soon become the fuel to be used. English coal might be used for the lower stations of the river, but to transport it to the upper stations would be very expensive, at least £7 per ton for the upper stations before being put on board the steamers. You must not understand that I think that one steamer and barges would be a profitable investment. The expense of management, agencies, and fuel stations would be too heavy; these would be the same

whether there was one or a dozen of steamers sailing from each end weekly, or at least once in ten days; for this, four or six steamers and barges would be wanted.

The trade of the river is in a transition state, increasing every year to a large extent. The principal up freight is general merchandise, piece goods, beer, and metals; the down freight is raw and manufactured silks, wool, indigo, and various kinds of oil seeds, to which I hope soon will be added cotton.

The passenger traffic is mostly native, and though not yet so numerous as on the Clyde in the summer time, it has increased greatly, and will continue to increase as facilities are afforded them, for they are a very migratory race. Cabin accommodation is not required to any large extent: the natives are all deck passengers, and even the few Europeans that travel prefer what is called a first-class deck passage. This simply means to be victualled in the cabin and sleep on deck.

No bulwarks are required for the steamers or barges, but a light rail and netting, with awning stanchions fitted for double awnings, with a space between the awnings of about 18in.; the lower awning to have hanging curtains all round.

The engines, as I formerly stated, should be high-pressure of the simplest construction. I think diagonal cylinders of about 26in. diameter and 5ft. stroke, working steam at 100lbs. per square inch, and cutting off at half-stroke, with a piston speed of 350ft. per minute, would be a suitable size; and although they take up a large space in the vessel, they distribute the strain to an equal extent. As the water of the Indus is very muddy, a filter is indispensable for the feed water. One placed in the bilge of the vessel, with a steam-pipe attached to reverse the current at pleasure, and clean it out, would be suitable.

The boilers to be of the locomotive class, suitable for wood fuel; the furnace doors large, Scinde wood being in crooked billets, generally supplied in from 3 to 4ft. lengths. The funnel to have a spark catcher similar to those on the American locomotives; the ash pans to be used as feed heaters, with safety escape valve connected to each.

#### REVIEWS AND NOTICES OF NEW BOOKS.

*A Course of Geometrical Drawing.*—Part I., revised edition, containing Practical Geometry, including the use of Drawing instruments, the Construction and use of Scales, Orthographic Projection and elementary descriptive Geometry. Part II., containing Orthographic, Geometric, and Perspective Projection, including the principles of shading and the practice of making finished drawings, designed as a text-book for the use of candidates preparing in Geometrical Drawing for the different Public Examinations, and to meet the wants of the Engineer, the Architect, and the Builder, &c. By W. S. BINNS, M.C.P. London: John Weale.

Mr. Binns has published, in a single volume, the two little treatises issued by him as aids to the student in Geometrical Drawing. The result is highly satisfactory, for the author has succeeded thoroughly in producing a text-book, which, for practical utility and simplicity, is not excelled by any work of the kind, either in the English or French languages, addressed to the classes for whom the present volume is intended.

The first part is written and arranged in a style suited to beginners, the second part to the more advanced students. The collection of problems is large, and the selection excellent. Mr. Binns's book deserves to be extensively known and patronised.

*Book-keeping, its Use and Necessity; with Hints for the Tyro in the Government in Public Official Life.* By J. T. WARD. 8vo., 1s.: London: the Author.

We confess to knowing but little of the science of commercial book-keeping; but Mr. Ward has strung together eleven short essays in the form of "letters on book-keeping," containing some admirable hints, which would, if read and attended to by book-keepers and others engaged in counting house duties, result in advantage to themselves and their employers.

*A Record of the Progress of Modern Engineering;* comprising Civil, Mechanical, Marine, Hydraulic, Railway, Bridge, and other Engineering works. Edited by WM. HUMBER, Assoc. Inst. C.E., and Member Inst. M.E. Imperial 4to. Plates. London: E. and F. N. Spon. Parts 6, 7, and 8.

We must confess our satisfaction at the great improvement effected by Mr. Humber, during the progress through the press of this important work. As a *portefeuille* of examples of works of railway engineering construction its practical value is now becoming more perfectly developed.

Thus far Mr. Humber has chiefly, if not entirely, confined himself to recording the progress of that branch of modern engineering which is connected with the construction of railways, at home and abroad; and some really admirable illustrations have been given, more particularly in the later parts. As the publication of the work progresses—like good wine—it improves. The plates are all of large size, and the illustrations are drawn to scales sufficiently extensive for reproduction by the practical man who may require to adapt to his own use any of those public works which have been selected for publication by Mr. Humber.

## CORRESPONDENCE.

*We cannot hold ourselves responsible for the opinions of our Correspondents.*

To the Editor of THE ARTIZAN.

SIR,—I read with interest the remarks of your correspondent Mr. Grier;\* and feel that his experiment on the said law of motion, though bringing no result, is still useful to a teacher, or learner, as another illustration of the general truth. I take the liberty of forwarding the accompanying short paper, not as containing anything new, but as expressing, in a simpler form than I have seen it elsewhere put, this important truth of science. With respect to the cube theory, a principle so useful and so true in practice, saying nothing of its recognition by such respectable authority, cannot be summarily disposed of as a clumsy approximation to the imperfection of mechanical appliances, but must be met by careful enquiry and examination, the only certain way to improvement.

By the said law of motion, let P be a pressure exerted on a body whose mass is M, and P' another pressure on the same body, then,

$$\text{moving force of } \frac{P}{M} : \text{moving force of } \frac{P'}{M} :: P : P'.$$

Now, if P' equal any multiple of P, say 2 P, and the law is expressed in the way your correspondent states it, we get something like following:—

To move a body mass, M, through a given space, if we wish to double the velocity, we must double the pressure.

But the given space will be passed over in half the time as before, and, therefore, if the motion be continued as long as at first, double the space will have to be passed over. And taking the case of resistance to motion in a fluid, double the number of particles will have to be displaced, thus requiring double the power while each particle also requires twice as much power to move it as before, whence, the ratio of the resistances will be as  $1^2 : 2^2$ . And for any value as P of P', the ratio will be as  $1^2 : 2^2$ .

I am, Sir, your obedient servant,

H. W. G.

Portsea, August 23, 1863.

## Obituary.

## THE LATE MR. JOSHUA FIELD, F.R.S.

It is with great regret we have to announce the death of Mr. Joshua Field, of the firm of Messrs. Maudslay, Sons, and Field.

This eminent engineer was born in the year 1787, and died after a few weeks' illness at his residence, Balham Hill House, Surrey, on Monday, 11th ult. It has fallen to the lot of few men to have been engaged for so many years in the active pursuit of mechanical engineering, or to have attained to so distinguished a position as Mr. Field occupied in his profession, which he may be said to have reached by the momentum of natural talent, multiplied by untiring industry.

He was selected when still a young man by the late Henry Maudslay, to co-operate in bringing mechanical tools to the precision which laid the foundation of that excellence of workmanship, which is now so distinguished a characteristic of English engineering. In marine engines and boilers he was especially successful. The impetus given to steam navigation in 1838, by attention to detail in design and high standard of workmanship in execution of the machinery of the Great Western steamship, was surprising, and laid the foundation of the high reputation enjoyed by his firm in that important department of engineering. In nearly all other branches he was equally successful, and was consulted as a safe authority by many eminent men.

His public character, however, was eclipsed by the virtues of his private life, of which we will only remark that kindness and modesty of deportment, open-hearted liberality, a cheerful and happy disposition, were combined with a sincere but unobtrusive piety.

His remains were accompanied to Norwood Cemetery, on the 18th ult., by a large concourse of private and professional friends, including a large number of workmen from the manufactory at Lambeth.

Mr. Field has left a widow, one daughter, and four sons, two of whom were in partnership with him and Messrs. Maudslays.

\* [Mr. Grier's communication, though given in the body of THE ARTIZAN of last month, should have appeared in its proper place under the head of Correspondence.—ED. ARTIZAN.]

## NOTICES TO CORRESPONDENTS.

D. B. (Govan).—We believe the model in question was produced by the method of development suggested by Mr. Thomas Moy at a meeting of the British Association for the Advancement of Science in 1856 or 1857. If you refer to the volumes of THE ARTIZAN for the years 1856 to 1860 you will find the information you require, and much that is highly interesting. See a diagram at page 286 (vol. 15, for 1857), and others.

G. H. (Newcastle-on-Tyne).—There is nothing new in the idea. The trunks of steam engine pistons have been made both elliptic and of parallelogram form in section. You had better stick to the cylindrical form.

ENGINE-TESTER.—The cylinder might have been injured through the presence of grit and hard dirty matter. The course suggested by you is most improbable, as, if you looked after your engine ever so superficially, you must have observed the wearing away of the piston rod gland, and the constant leakage which would occur.

WORKMAN.—Calculate working load at one-eighth of breaking strain. Your question is incomplete. Send a sketch of what you propose, state the purpose for which the engine is intended to be used, and the greatest speed at which it is intended to work, and we will give the exact information. Get Professor Rankine's work on Engineering, published by Griffin and Co., Paternoster-row. Mr. Weale, of Holborn, has published several books which it is evident you would find useful.

BETA.—The "multi-puncher," to which no doubt you refer, was designed and patented by Mr. R. Roberts, of Manchester, and was erected at the Canada Works, Birkenhead, where, by its use, it has, we believe, repaid its cost very many times. The other machine is manufactured by Messrs. Collier and Co., of Salford.

M. DE BRITTO.—The engines were constructed by Messrs. Humphrys, Tennant, and Co., of Deptford. The frigate was, we think, built by Messrs. Wigram and Co., Blackwall.

R. R.—Clifford's boat lowering apparatus is the one we recommend, in the most perfect belief as to its great superiority.

S. (Calcutta).—The locomotives were designed by Mr. John Kershaw, C.E., of Duke-street, Westminster, London; and built by Messrs. Sharp, Stewart, and Co., of Manchester.

"120° IN THE ENGINE-ROOM."—Cover your cylinders, steam pipes, and other hot surfaces, with Spencer's patent composition for preventing the radiation of heat; it is far better than the felt and wood usually employed, and much cheaper, too; "it sticks like wax." Mr. James Spence, of Portsmouth Dockyard, is the patentee.

D. (Dundee).—Messrs. Rennie have sent out to Spain such a floating dock for the Spanish Government.

PHILLIP "N. W."—If your measurement of the fine steel music wire is accurate, the strength, according to our calculation, is equal to about 182 or 184 tons per square inch. How was it hardened and drawn? Send some pieces for our inspection and experiment, as we have by us the apparatus we employed in making the experiments in connection with the great music wire patent cause, Horsfall v. Smith, tried at Guildhall, London, about five years ago.

FERRO-CARBILL.—Repeat your first inquiry more distinctly. The Bessemer process is in successful working, and the Bessemer steel is being extensively used in rolling rails for railways. The greatly increased wear and tear, and the comparative badness of the iron rails rolled within the last few years in Wales, combined to render the employment of steel necessary. We do not know anything of the firm named by you, and do not desire to do so.

X. X.—Mr. Fairbairn's experiments are the most recent. For a report of the very complete set of experiments on the strengths of iron and steel by Mr. D. Kirkaldy, of Glasgow, refer to THE ARTIZAN for 1861; but he has since published the two series of experiments, &c., in a volume, the second edition of which was noticed in THE ARTIZAN for July, 1863.

J. G. (Edinburgh).—We should like to know what heat you employed when the prussiate of potash was applied, as a proper treatment with prussiate of potash should certainly harden the metal.

## RECENT LEGAL DECISIONS

## AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &amp;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.

BOVILL v. THE BRIGHTON AND UCKFIELD RAILWAY COMPANY.—Mr. Lush, Q.C., and Mr. Watkin Williams were for the plaintiff; Mr. Hawkins, Q.C., Mr. Waller, of the equity bar (specially retained), and Sir G. Honeyman, were for the defendants. The plaintiff in this case is the well-known engineer. He sued the defendants upon an agreement by which he was engaged to negotiate and conclude a contract for them with Sir Morton Peto and Mr. Betts for the construction of the defendant's line for £215,000, for concluding which he was to be paid a commission of £500, and the breach of contract complained of was that, after he had concluded the contract with Messrs. Peto and Betts, the defendants repudiated his authority to enter into it for them, and refused to complete, and thus prevented him from earning his commission. After the pleadings had been opened by Mr. Watkin Williams, the counsel on each side entered into a negotiation, the result of which was that the defendants submitted to a verdict for £500.

# 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.

**AERIAL LOCOMOTION.**—On the subject of such movement by means of screw propellers, M. Babinet expresses himself as follows:—"MM. Nadar and de la Landelle have constructed a little apparatus which receives its propulsion by means of springs, and which rises in the air, springs and all, without any other action. These little engines are therefore perfectly automotive, and find a fulcrum in the air. The form of the screw-propellers remains to be studied, as well as the nature of the steam-engine which is to provide the force of locomotion; but, as a large model is always, in a mechanical point of view, more advantageous than a small apparatus, we may here boldly say that if a mouse has been carried up into the air, it will be much more easy to transport an elephant. That is a question of money and technology. Hence we may warrant the success of aerial navigation within the limits of possibility; that is, we shall never be able to go against violent winds which the strongest birds cannot resist. As to the exclusion of air-balloons, which MM. Nadar and de la Landelle proscribe, natural philosophers have long considered the directing of balloons lighter than air as a problem which is not only insoluble, but absurd. As to screw-propellers, they should be possessed of great velocity, but a great many may be applied so as to work together. A spring will give the propellers a regular motion, and the steam-engine, made of thin metal, is only to keep the spring constantly tight. This spring will act as a fly for the motive power. As to the necessary velocity, I may say that on the Seine, a screw steamer, the screw of which had a distance of a metre between the threads, and which might have performed a kilometre in 800 revolutions, only went 200 metres when it turned slowly, whereas it went 800 metres when turned fast. The advantageous effect of rapidity consists in this, that the air, obliged to yield to the impulse, has not time to escape from under the screw, and is strongly compressed. For this same reason a parachute descends slowly, because, to escape from under it, the air must fetch a considerable compass, which is effected at the expense of the descent."

**NEW COATING FOR IRON-PLATED VESSELS.**—Some experiments with a new method for coating the iron plates of vessels, to preserve them from oxidation and fouling, have been so satisfactory that the Admiralty has ordered the whole of the armour-plates of the cupola ship *Royal Sovereign* to be thus covered. The material, which has been introduced by Messrs. H. J. Hall and Co., is termed "Brown's vitreous sheathing," and consists of a mass of glass fused upon small plates of iron, sufficiently to be to a certain extent flexible which are applied to the ship by a new adhesive process, and which have been ascertained to be capable of resisting all ordinary contingencies from pressure or abrasion. Compared with other metallic coating substances, this sheathing is economical, the cost being 1s. 6d. per square foot. The Peninsular and Oriental Company have tested the invention, and a trial of it has been ordered by the French Emperor at Cherbourg.

**APPLICATION OF STEEL.**—Experiments have been made in Prussia to ascertain the capabilities and advantages of cast-steel steam boilers. Two cylindrical egg-end boilers, one of steel, the other of wrought-iron, were compared, and after working six months were examined. They were 30ft. long, and 4ft. in diameter; the steel boiler plate was 3/16 in. thick. It was tried by the hydraulic test, to a pressure of 195lbs. per square inch, without altering in shape or showing leakage. After working six months, the cast-steel plates were found quite unaffected, and had a remarkably small amount of incrustation as compared with the other boiler. The former generated 25 per cent. more steam than the latter. Another examination has recently been made, the boiler having been in use for a year and a half. The steel boiler was found in excellent condition. It appeared that it evaporated 11'66 cubic feet per hour, against 9'37 by the common boiler, with about the same expenditure of fuel.

**TELEGRAPHIC WIRE.**—Telegraphic wire has become rather an important article of commerce. During the last ten years it has been exported to the following values:—1873, £73,584; 1874, £81,566; 1875, £163,737; 1876, £90,076; 1877, £202,346; 1878, £234,708; 1879, £242,300; 1880, £251,712; 1881, £214,441; 1882, £231,044. We have thus in the ten years an aggregate export of the value of £2,474,410.

## NAVAL ENGINEERING.

**THE "WYE,"** iron screw storeship, 700 tons, 100 horse-power, which has recently received extensive repairs, and been fitted with new boilers built by Messrs. Denney Brothers, at the hands of the operatives of Sheerness Dockyard, has undergone her trial at the measured mile off Maplin Sands. The average speed attained was 9'591 knots, vacuum 27in.; revolutions, maximum 71, mean 70'16 per minute; pressure of steam, 15lb.; draught of water—forward, 10ft. 4in.; aft, 12ft. 6in. The vessel is fitted with Griffith's screw, pitch 18ft., diameter, 12ft. 6in.; and the indicated horse-power of her engines is 540. The trial was considered very successful, and the vessel will shortly leave for the west coast of Africa as a storeship.

**ADMIRALTY PILOT BOAT.**—A new pilot lifeboat 22ft. in length, built by the shipwright department of Woolwich Dockyard, by order of the Board of Admiralty, from designs furnished by Mr. Turner, the master shipwright of the yard, has recently arrived at Devonport. The boat, which is self-righting, cannot sink by reason of its buoyancy effected by

air cases and open tubes through the bottom. If turned over and filled with water it will right itself in about 15 seconds. The air cases are movable, so as to be easily taken out for painting and inspection, with the exception of the long middle trunk, through which the open tubes pass, and which is fastened to the boat for the purpose of strengthening her lengthways. Should any water penetrate into the trunk by any unforeseen mishap it can be cleared out readily by the removal of some metal screws in the lower part of the sides of the trunk. But should the boat by any possibility ship a sea, filling her entirely, it would run out in 15 seconds. If a small quantity of water should find its way into the joints of the cases they can be emptied by taking up the short piece of mid-ship bottom board and the case under each side. The sailing qualities of the lifeboat were tested at various times in the river, preparatory to her being despatched from Woolwich yard. On one occasion during a high wind, when all her sails were set she continued her course buoyantly with her gunwale 12in. under water.

**THE "ONONDAGA,"** AMERICAN IRON-CLAD STEAMER, has been recently launched from the Continental works, Greenpoint, U.S. The *Onondaga* is 230ft. long, 52ft. beam, and 15ft. deep. She is unlike the Monitors afloat in some respects, having side armour, consisting of 1 1/4 in. in thickness, of rolled plate iron, to which is bolted a hammered iron plate 4 1/4 in. thick; to this is fastened solid locust timbers, 13in. deep, and over this a guard of plate iron, 1in. thick, is securely bolted. The deck is of iron, 2in. thick, rivetted to iron beams, and to have an ash planking on this deck 5in. thick. There will be two turrets, each 21ft. in diameter, 9ft. high, made of 6in. rivetted plate iron, and over this a hammered iron plate is fastened, making altogether 12 1/4 in. of iron in thickness. A pilot house, 6ft. diameter, inside, is placed over the forward turret, made in the same general manner as the turrets. Her motive power consists of two propeller wheels, one under each counter, both driven by a pair of engines, 30in. bore, and 18in. stroke of piston, supplied with steam from four tubular boilers.

**IRON FRIGATE ON MR. REED'S PRINCIPLE.**—The first of a new description of iron frigates to be constructed according to Mr. Reed's plan is to be laid down at Chatham as soon as the resources of that establishment will permit. The new frigate is to be named the *Bellerophon*, and although somewhat smaller than the iron ships of the *Achilles* class, is intended to be superior, both for offensive and defensive purposes, to any of the iron steamers now afloat, while, from the several improvements already effected in iron shipbuilding, she is expected to be a first-rate sea-going ship. The *Bellerophon* will be a little over 200ft. in length, or about 80ft. less than the *Achilles*, and with a breadth of beam of 50ft. She is only intended to mount 12 guns, but these will be of the most powerful description used in the service. The vessel will be incased in iron armour-plate of 5 1/4 in. in thickness in her most exposed parts, and 4 1/4 in. in other portions of the vessel. She will be fitted with engines of 1200 horse-power, in order to enable her to steam 15 knots an hour.

**TRIAL TRIP OF THE "RECRUIT."**—The iron paddlewheel steamer *Recruit*, 6, 150-horse power, fitted at Chatham for the coast of Africa, was taken to the Maplin Sands on the 19th ult. for the purpose of making an official trial of her speed at her sea-going trim, with all her Armstrong and other guns, stores, &c., on board. On the occasion of her former trial, on the 9th ult., the *Recruit*, after one break down, attained an average speed of 10'508 knots per hour in six runs at full boiler power. In four runs, with half of the boilers cut off, the average speed was 8'853 knots, the paddlewheels making 31 revolutions per minute. Her mean draught was eight feet. Since her former trial all her guns, stores, &c., have been put on board. With all her stores on board the *Recruit* lies like a log in the water, and at times during the trial she washed over her spousons in a manner which was rather alarming. Only two runs were made at the measured mile, when the speed attained was only about five knots an hour. After steaming twice over the Maplins, the performance of the vessel was found to be in the highest degree unsatisfactory. Captain Hall consequently determined on abandoning the trial, and the vessel was brought back to harbour, a very strong report of the unfavourable result of the trial being at once forwarded to the Admiralty.

**A NEW WAR VESSEL.**—A new war vessel is in course of construction at Cincinnati, U.S. This strange craft is known as *Elliott's War Turtle*. It is shaped like a large punch-bowl, with the propeller in the form of a turbine wheel, placed at the bottom, and so arranged as to take water in through eight radial tubes, which may be opened or closed by valves; the said tubes connecting with the propeller and outer edge or hull of the vessel. The propeller passes the water downward from its cylinder and revolves always in the same direction, and when the vessel is to be moved forward in any direction, one or more of the valves is opened, thereby relieving the pressure on that side, while the pressure still remains on the opposite side to propel the vessel. The turret is very similar in appearance to those on the Monitors, but is built fixedly and firmly on the top of the vessel, and lined inside with heavy timber. It revolves with the boat by the action of the water upon the rudders placed in the mouth of the radial tubes. It mounts four guns.

**THE TRIAL TRIP OF THE "ORONTES"** troopship, Cap. W. H. Hire, took place on the 12th ult. at the measured mile in Stokes Bay, under the supervision of Captain H. Broadhead. Mr. Langdon, who represented the firm of Messrs. J. Watt and Co., the makers of the engines, was also on board. She made six runs at full speed, with steam pressure at 22lb., vacuum 22in., and 60 revolutions of engines, giving an average of 12'352 knots; and at half-boiler power, with steam pressure at 25lb., vacuum 26in., and 46'5 revolutions of engines, giving an average speed of 9'755 knots. She then made the circle, with helm a-port, at full power, in 9min. 24sec., and at half-power, with helm a-port, in 11min. 1sec.; and with helm a-starboard at full power, the circle was made in 9min., and at half-power in 9min. 23sec. The half circle was made, at full power and helm a-port 9min. 26sec., and at half-power 4min. 46sec.; and with helm a-starboard, full power, 9min. 17sec.; half-power, 4min. 41sec. Her draught of water was—forward, 21ft. 6in.; aft, 22ft. 6in. The trial was considered very satisfactory.

**THE "LORD WARREN."**—This armour clad frigate, like the *Royal Oak*, the last vessel built on the same ship, will be constructed almost entirely of foreign oak. In the construction of the *Lord Warren* several important improvements will be effected by Mr. Reed, from whose designs she is to be built. The plan of lessening the thickness of the armour plating on the bow and the stern, hitherto adopted in this class of vessel, is to be discarded in the case of the *Lord Warren*, and the Admiralty have decided on encasing her in one uniform thickness of armour-plates; so that she will have the same description of plates on her stem as on her broadsides, the use to which it is intended to apply her rendering it most important that her bow should be carefully protected and of enormous strength. Another important feature in the *Lord Warren* will be the placing of a powerful battery of guns at her bow, in which she will differ from all other vessels of war now afloat. This battery will be so placed as to enable the guns to be fired straight ahead, while the solid, iron-plated bow will be carried up sufficiently high to form a sort of tower, in which the guns will be placed. As the *Lord Warren* is designed to steam at least 13 knots an hour, this powerful bow battery will prove of the utmost value when chasing a hostile vessel. In order to support this additional weight thrown on the bow, the body of the frigate will be built out into a long projecting prow, several feet below the water, and this will serve a twofold advantage—that of giving increased buoyancy to the frigate, and at the same time furnishing her with a most powerful means of destruction, the *Lord Warren* being, in this respect, different to every other vessel afloat. The extremity of the prow will be furnished with a huge steel stem, shaped somewhat like a

cleaver, and this formidable weapon will, it is anticipated, cut completely through a howitzer ship when used as a ram, as from the enormous size and momentum of a vessel of the *Lord Warden's* dimensions, one or at the most, two blows would be sufficient to sink the largest vessel afloat. The ports in the new frigate will be more elevated above the water line, and the armour-plating carried lower down than in any other vessel of the class, notwithstanding which provision is made for a high rate of speed.

THE RUSSIAN IRON-CLAD BATTERY "PERVENITZ" left Gravesend on the 8th ult., for Cronstadt, under steam. On arriving off the Maplin Sands she was tried at the measured mile, and realised a mean speed of eight knots, with 80 revolutions of her engines, the maximum number of revolutions being 110. She completed a full circle in five minutes fifteen seconds, and was found to be under the most perfect command of the helm.

THE PADDLE-WHEEL STEAMER "SALAMIS," 250-horse power, was taken out of Chatham harbour on the 1st ult., for the purpose of making her first trial of speed on the completion of the fitting of her engines. The engines were in charge of Mr. Ravenhill, of the firm of Ravenhill, Salkeld and Co., by whom they have been manufactured. With 180 tons of coal on board, the *Salamis* drew 9ft. 11in. aft, and 9ft. 6in. forward; or, in other words, she was on a nearly even keel. She is fitted with Morgans's patent feathering floats, and her engines are fitted with all the modern improvements. The diameter of the cylinders is 61in., and the length of stroke 4ft. 6in. She has four boilers in which the steam is generated, and 12 furnaces, in addition to which she is fitted with superheated steam apparatus. The vessel was taken considerably past the Mouse light, as far as the entrance to the Downs, when with full boiler power the speed of the vessel was very satisfactory. Two runs were made at the measured mile, Maplin sands, at about three-quarter speed, and, notwithstanding that the paddlewheels were only making an average of 34 revolutions per minute, the vessel attained an average speed of close upon 16 knots per hour. With an improved trim and with 38 revolutions of the paddlewheels there is little doubt that she will attain an average of 16 knots per hour, which is exceedingly satisfactory. During the trial her engines worked with remarkable smoothness, and, notwithstanding that it was the first occasion of their being tried, there was no priming and no occasion to stop the machinery on account of hot bearings. The second official trial of the *Salamis* took place on the 21st ult., at the measured mile, off the Maplin Sands. The wind at the time of the trial was blowing from the westward with a force of three, and there was a moderate sea on. Six runs were taken at full boiler power, with the following results:—In the first run the time was 4m. 34s., the speed in knots 13.139, the pressure of steam 26lb., and the number of revolutions of engines 38; in the second run the time was 3m. 36s., the speed in knots 16.667, the pressure of steam 26lb., and the number of revolutions of engines 39; in the third run the time was 4m. 36s., the speed in knots 13.043, the pressure of steam 26lb., and the number of revolutions 38½; in the fourth run the time was 3m. 35s., the speed in knots 16.744, the pressure of steam 26lb., and the number of revolutions of engines 37½; in the fifth run the speed was 4m. 36s., the speed in knots 12.95, the pressure of steam 26lb., and the number of revolutions of engines 38; in the last run the time was 3m. 40s., the speed in knots 16.364, the pressure of steam 26lb., and the number of revolutions of engines 37. The average speed of the six runs was 14.643 knots, equal to 17½ statute miles per hour. This result was in the highest degree satisfactory. The *Salamis* afterwards made four runs at half-boat power, with the following results:—In the first run the time was 5m. 12s., the speed in knots 11.538, the number of revolutions 38, the pressure of steam 26lb.; in the second run the time was 4m. 22s., the speed in knots 13.74, the number of revolutions 30, and the pressure of steam 26lb.; in the third run the time was 5m. 8s., the speed in knots 11.65, the number of revolutions 30½, and the pressure of steam 26lb.; in the fourth run the time was 4m. 23s., the speed in knots 13.688, the number of revolutions 30, and the pressure of steam 26lb. The mean average speed of the four runs was 12.648 knots. At the close of the official runs some experiments were made in making the circle. At full speed the complete circle was made in 5m. 10s., the rudder being brought over to an angle of 35 deg. by three men with three and a half turns of the wheel. At half speed the complete circle was made in 5m. 29s. With the helm hard a-port, the half circle was made in 2m. 39s., and with the helm hard a-starboard the half circle was accomplished in 2m. 23s., the rudder in each case being over at an angle of 30 deg., and the diameter of the circle being about three times the vessel's length. At half speed, with the helm at port, the half circle was made in 2m. 40s., and with the helm at starboard in 2m. 53s., with three men at the wheel, the rudder, which was at an angle of 30½ deg., being brought over in three turns. The engines from full speed were stopped dead in 13 sec. from the word being given from the bridge, and when going astern the engines were stopped in 3 sec., and turned ahead in 3 sec. From full speed ahead the engines were stopped and started astern in 40 sec. The boilers generated a full supply of steam, and not the slightest appearance of hot bearings was indicated. The engines worked with the greatest smoothness and regularity, and the diagrams of the expansion cards were exceedingly favourable. During the trials the average temperature was 82 deg. in the engine-room, 92 deg. in the after stokehole, and 94 deg. in the forward stokehole.

THE TRIAL TRIP OF THE "AURORA," TWIN SCREW STEAMER, took place on the 25th ult. The *Aurora*, built and engined by Messrs. J. and W. Dudgeon, of Millwall, is an iron vessel, 165ft. in length, with a beam of 23ft., a depth of 13ft. 6in., an area of midship section of 150 square feet, and a displacement of 400 tons. Her engines have a collective nominal power of 120 horse, and drive two three-bladed screws, each independently of the other, 7ft. in diameter, and with a pitch of 14ft. 6in. The cylinders have a diameter of 26in., and a 21in. stroke. The *Aurora* is a smart-looking vessel, with much finer lines forward and aft than were possessed by either of her predecessors. She carries two short masts, rigged for fore and aft canvass, and altogether has the appearance of a thorough steam clipper. Her draught of water at starting was 7ft. 3in. aft, and 5ft. 3in. forward. The following are the particulars of the trial.—In running past the measured mile in the Lower Hope, with the engines going 103 to 105 revolutions, she was timed and found to go over the ground in 4 min. 8 sec., giving the vessel a speed of 14.516 knots. At 1.30 p.m., the *Aurora* was approaching the Nore Light vessel, the engines averaging 120 revolutions, with 27lb. of steam and a vacuum of 25in., and every part working with the greatest possible smoothness. At 1.37 the Nore was passed, the distance from Tilbury, 20 nautical miles, having been done in 1 hour and 17 minutes. From the Nore to the Mouse Light the vessel continued her course, the wind still fresh from the same quarter, and the movement of the water which necessarily accompanied it giving the vessel, from her light draught and hold upon the water, sufficient "roll" to detract from the efficient action of her only submerged screws. Notwithstanding this disadvantage, however, she ran past the "mile" on the Maplin Sands in 4 min. 10 sec., giving a speed of 14.4 knots, it being now slack water, and the tide of little moment either way, and accomplished the distance to the Mouse Light in 2 hours, 5 min., 22 sec., having been 23 min. 23 sec. from the Nore—8 nautical miles. During the latter part of the run down, a small jib had been set to steady the vessel, but no other help was given by the vessel's canvass to her engines in attaining this somewhat extraordinary rate of speed. From the Mouse the *Aurora* was run out between the Maplin and the Barrow as far as the Swin Light. On reaching the Swin the vessel's head was brought round and laid homeward, it having been decided not to lengthen the trial by making circles, &c. From the Mouse to the Nore in the teeth of a strong gale, the run was made in 33 min. 15 sec., the time being at the measured mile 4 min. 25 sec. Southward was passed at 4 hours 15 min., and about two miles a head was seen the *Sea Scallow*, one of the fastest paddle steamers on the Thames, plying between London, Southend, and Sheerness, and a hot chase ensued, the *Aurora* eventually passing the *Sea Scallow* at 4 hours 40m., in the midst of a heavy squall of wind and rain, and subsequently during the run up to Blackwall passing everything under

steam she came across. Gravesend was passed at 5 hours 15 min., the engines making on an average 127 revolutions, and Blackwall pier, the closing point of the *Aurora's* day's work, being reached in 1 hour 7 min., the distance being 29 miles. The principle of the adaptation of twin screws to ships of war has been so far acknowledged in its importance by the Admiralty that their lordships have given Messrs. Dudgeon an order to construct a small vessel, which shall combine in their most efficient form the double-screw principle.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—W. Stacey, engineer, and W. Crow and J. Glaysher, assistant-engineers, to the *Reeruit*; W. Hardie, engineer to the *Figard*, as supernumerary; A. Atken, supernumerary in the *Asia*, promoted to Engineers; J. Elwess and J. Rogers, supernumeraries in the *Asia*, promoted to first-class Assistant-Engineers; E. Brown, Engineer to the *Asia*, for the *Albacore*; W. Herd and J. Davies, Assistant-Engineers to the *Hawke*; G. R. Bissaker, R. Ditchburn, J. Barr, G. Murray, S. Scott (B), J. Hughesden, T. S. Blyth, F. M. C. Richards, Assistant-Engineers to the *Mariborough*, as supernumeraries for disposal; J. M. Page, first-class Assistant-Engineers to the *Orontes*; T. Scott (A), confirmed as first-class Assistant-Engineer in the *Pembroke*; W. Rumble, first-class Assistant-Engineer to the *Cumberland*, for the *Wizard*; A. Brown, promoted to Acting First-class Assistant-Engineer in the *Galatea*; R. Jago, Second-class Assistant-Engineer, to the *Jago*; J. Spinks, Acting Engineer, A. Smart, First-class Assistant Engineers, and J. W. Smart, Second-class Assistant Engineer, to the *Snipe*; W. H. Brimfield, Acting First-class Assistant Engineer, to the *Wye*; D. Wilson, R. McCaskill, A. Kennedy, M. Baird, D. Sharp, J. M'Arthur, P. Foulis, J. Muir, E. Bennett, J. Crichton, J. Galbraith, S. M'Dougall, E. M'Leish, and J. Fraser, promoted to Assistant Engineers of the first-class; R. Crosswaite, Engineer, to the *Liverpool*; E. N. Cockrell, First-class Assistant Engineer, to the *Mariborough*; D. Wishart, in the *Briak*, promoted to Acting First-class Assistant Engineer; H. Cook, promoted to Acting Chief Engineer; J. T. Kelly, promoted to Acting First-class Assistant Engineer.

#### MILITARY ENGINEERING.

BROADWELL'S BREACH-LOADING GUN.—The officers composing the Ordnance Select Committee of Woolwich Arsenal have recently been engaged at the proof butt, in order to test the Broadwell breech-loading principle, which they have had under consideration for some months past. This system consists of a peculiarly shaped self-acting gas ring or valve, which in previous trials was placed in the wedge or breech block of the gun, the position and shape of which Mr. Broadwell has since changed. The chief object of this trial was to test the advantages of the alteration. The gas ring is now fitted behind the bore, and acts against a bearing in the face of the breech block. The intention of the inventor in making this alteration appears to be to improve the facility of its application to guns not constructed expressly for its use. The issue of the trials is pronounced exceedingly satisfactory, and, according to the opinion freely given at their termination, the merits of the system were fully established, in so far, at least, as it is applicable to guns of a calibre equal to an 18-pounder, with which it had been tested. The method is now to be tested in a similar manner with the 110-pounder or larger guns. An important feature in the invention is in the case of a common steam valve, that the greater the pressure the tighter the breech becomes closed against the escape of gas.

TESTING OF ENGLISH AND FRENCH ARMOUR PLATES.—Some interesting testing of English and French manufactured armour-plates took place at Portsmouth on the 4th and 5th ult., the practice against the plates being carried on in the usual manner, with a solid cast-iron shot, fired with 16lb. of powder, from a 95cwt. 68-pounder, at 200 yards' distance, the plates being bolted on the sides of the *Thunderer* target-ship. The plates were four in number, and comprised two manufactured by Messrs. Petin, Gaudet, and Co., of France; one of 5½in. thickness of metal, 15ft. 7in. in length, and 3ft. 4in. in breadth, and the other of 4½in. of metal, and of the same length and breadth as the 5½in. plate. The third plate was a 5½in., from the Millwall Iron Works, for the *Agincourt*, 15ft. 7in. in length, and 3ft. 5½in. in breadth; and the fourth was a 5½in. bent plate for the *Royal Sovereign's* turrets, from Messrs. Beale's, of the Parkgate Works, Yorkshire. Messrs. Beale's plate, the Millwall, and the French 4½in. were tested on the 4th ult., the French 5½in. being reserved for trial on the following day. The Millwall plate received 11 shots, and was very severely tried by overlapping shots at either end, but stood the test splendidly, and was considered a plate of superior quality. Messrs. Beale's plate was not quite so good. It showed a number of small cracks and an inclination to open from the back. Messrs. Petin Gaudet's 4½in. turned out, from its evident carelessness of manufacture, very unsatisfactory, and failed in all the conditions of contract as relating to its short-resisting powers. The metal was allowed to be good, but its manufacture was very indifferent. When examined at the close of the firing, its welding was found to be most imperfect. It had the appearance of being a rolled plate, and rolled 4½in. plates are generally finished by placing four 2½in. layers of iron, carefully cleaned from all dirt or oxide, together, and then rolling the 10in. mass down to the required 4½in. The separation of these four layers in the French plates disclosed the fact that no care had been taken in cleaning the surfaces of the four layers of iron, and consequently perfect adhesion under the rolls was impossible. Compared with the 4½in. plate supplied to the Admiralty by Petin Gaudet and Co., the one tested on this occasion was of a vastly inferior character. The result placed the three plates tested in the following order.—No. 1, Millwall Company, for *Agincourt*, 5½in.; No. 2, Beale, for *Royal Sovereign*, 5½in.; No. 3, Messrs. Petin Gaudet and Co., 4½in., a full allowance being made in this classification for the extra inch of metal in Nos. 1 and 2 plates. No. 3 received in all 15 shots, pretty well distributed, three being edge blows, and in two spots overlapping. No. 1 had a diameter of 9in., an indent of 2.1-19in., and a crack 6in. across the indent. No. 2 had an indent of 2in. and a crack 8in. long. No. 3 and 7 just impinged in the circumference of their indents upon each other, and opened cracks 12in. and 6in. long. No. 5 overlapped No. 2 4in., and drove the plate's fractured part in a circular form within the indents into the ship's side 4.6-10in., or beyond the plate's back. No. 10 overlapped upon 2 and 5 (the last mentioned), and broke the plate further into the ship's side, the area of the fracture being 16in. by 10in., measuring from centre of each blow, in a triangular form, 9in. at the base by 6in. each way. No. 13 was also attended with bad results for the plate's reputation, the shot striking full on the plate in its centre, near its upper edge, and breaking the metal away considerably to the upper edge. Messrs. Petin Gaudet's 5½in. plate on the 5th ult. was tested slowly and carefully, and came out of the trial in a most triumphant manner—in a manner which placed it on full terms of equality with the Millwall plate tried the day previous. It received 17 shots in all. The laminations showed the same faulty welding that the 4½in. of the previous day exhibited; and the success of the plates was undoubtedly owing to the superior quality of the iron, and not to its manufacture.

A SECOND TRIAL OF FRENCH ARMOUR-PLATES supplied by Messrs. Petin, Gaudet, and Co. to our Board of Admiralty, took place at Portsmouth on the 19th ult., and the results then obtained, together with a subsequent inspection of plates, prove the two tried on this occasion to be inferior in their short-resisting powers to the two previously tried in company with the Millwall plate. Messrs. John Brown and Co. sent a plate 15ft. 6in. in length by 3ft. 7½in. in width, and 5½in. in thickness, for trial with the French plates, but not to compete with them. It was built up in a peculiar manner of cold blast and charcoal iron, according to a plan laid before the firm. Notwithstanding its failure, however, as a merely experimental plate, it has received a higher official classification than either of the French manufactured plates. Messrs. Petin and Gaudet's two plates were of the following dimensions:—The first was 15ft. 7in. in length by 3ft. 4in. in width

and 5½ in. in thickness; and the second 15 ft. 7 in. in length by 3 ft. 4 in. in width and 4½ in. in thickness. The main conditions of the contract between Messrs. Petin and Gaudet and our Admiralty are—that the 4½ in. plates shall withstand three shots planted as nearly as possible in the same place without penetration being effected, and that the 5½ in. plates shall resist four shots in the same manner. The 5½ in. plate received in all 10 shots fairly distributed over its surface. Only in three instances were the shots overlapping, or "planted as nearly as possible in the same place," but in all three instances was the plate broken through, and penetration effected by two shots, instead of five, as per contract. Nos. 2 and 4 shots just impinged upon each other's circumference, with No. 3 in close proximity, all at the right hand end of the plate, but with no other shots near, and Nos. 3 and 4 were connected by a wide deep crack extending upwards of 15 inches. Petin and Gaudet's 4½ in. plate received only six shots, which, however, sufficiently decided its character. The first shot on the lower left edge exhibited a crack 7 in. in length in the indent. No. 2 on the right lower edge, upon a bolt, opened the layer of metal and cracked two layers across. No. 3 shot, to the left of No. 2, opened wide fissures in the plate and drove the broken metal into the ship's side, with a large crack to the right. No. 5, in the centre of the plate, above and clear of No. 2 and 3, drove the plate into the ship's side four inches, with deep fissures in the metal. The last shot did no particular damage in the circumference of its own impact, but opened up a deep crack across a previous shot-mark 13 in. in length. Penetration, it will be seen, was effected in this plate with single shots.

#### STEAM SHIPPING.

**THE QUICKEST PASSAGE ACROSS THE ATLANTIC.**—The *Scotia*, belonging to the British and North American Royal Mail Ship Company, on her recent voyage to New York, made the most extraordinarily fast run on record. She left Liverpool on the 18th of July, and made the passage to New York in nine days, two hours, and 15 minutes, beating the fastest passage before made by nine hours and 45 minutes. The two quickest passages previously made were by the *Persia*, in nine days 12 hours and 10 minutes, from Liverpool to New York; and the *Baltic*, in nine days 12 hours.

**IRON SHIPBUILDING ON THE TYNE.**—Recently several new iron vessels have been launched, the most conspicuous of which has been the *Atlantic*, one of a fleet of large iron tank ships building by Messrs. John Rogerson and Co., of St. Peter's, on the Tyne, to be employed in bringing petroleum from America to this country. The *Atlantic* is a sailing vessel. Her length over all is 145 ft.; breadth of beam, 28 ft.; and depth, 16 ft. 9 in. Her hold consists of a series of iron cisterns, of a depth from deck to keel, each depth to hold a stated quantity of oil. She belongs to the Petroleum Trading Company. With the present ship the directors calculate they will make four voyages in the year, and by employing tank ships, like the *Atlantic*, they anticipate saving a considerable sum in the year. It was calculated that one ton of oil in barrels would occupy 63 cubic feet, so that a vessel that would only carry 500 tons in barrels would carry in bulk nearly 700 tons. A large screw steamer, the first built for the White Star line of Australian packets, and named the *Royal Standard*, has also been launched from the building yard of Messrs. Palmer, Brothers, and Co., of Howdon on the Tyne, during the high tides. She is 236 ft. long, 40 ft. beam, 27 ft. deep, her measurement is 2000 tons, and the height between decks is 7½ ft. clear. The vessel is fitted up with due regard to the comfort of the passengers, special attention having been paid to ventilation. Her screw will be auxiliary, and her engines will be of 140-horse power nominal, constructed on the high-pressure surface condensing principle.

**TRIAL TRIP OF THE "RANGOON."**—The new screw steamship *Rangoon*, built for the Peninsular and Oriental Company, by Messrs. Samuda, of London, and commanded by Captain J. M. Rogers, had her official trial on the 4th ult., at the measured mile in Stokes Bay. She is 201½ tons burden, and her engines, which were constructed by Messrs. Humphrys and Tennant, of Deptford, are of 400 horse-power. The result of four runs on the mile were as follows:—

| Run.         | Time.    | Knots per Hour. | Vacuum. | Revolutions. | Steam. |
|--------------|----------|-----------------|---------|--------------|--------|
| 1            | 4m. 47s. | 12.543          | 20      | 65           | 25     |
| 2            | 4m. 41s. | 12.811          | 25      | 68           | 27½    |
| 3            | 5m.      | 11.728          | 25      | 68½          | 27½    |
| 4            | 4m. 26s. | 13.533          | 26      | 68           | 27     |
| Mean of runs |          | 12.400          | 25½     | 68           | 26½    |

Indicated horse-power, 1970; nominal ditto, 400. Draught of water, 17 ft. 11 in. forward, and 18 ft. 9 in. aft. Coals on board, 561 tons; water, 50; stores, 80; ballast, 100; total weight on board, 791 tons.

#### LAUNCHES.

**LAUNCH OF THE "SYRIA."**—A fine new paddle-wheel steamer, called the *Syria*, built for the Peninsular and Oriental Company, by Messrs. Day and Company, of the Northern Iron Works, Southampton, was launched on the 15th ult. She is built of iron, and upwards of 1300 tons of this metal has been used in her construction. The following are her principal dimensions—Length between perpendiculars, 312 ft.; length over all, 340 ft. 6 in.; breadth, 36 ft. 2 in.; depth from base line, 29 ft.; tonnage, builders' measurement, 2000. The *Syria* will be propelled by a pair of oscillating paddle engines of 450 horse-power nominal, which will be fitted with surface condensers, and other recent improvements.

**THE LAUNCH OF THE "RESEARCH."** 4, 1250 tons, iron-cased frigate, the first of the vessels constructed on Mr. Reed's plan, took place at Pembroke, on the 15th ult. She is intended to carry only four heavy guns, but will be entirely encased with from 4 to 4½ in. armour plates.

**THE LAUNCH OF THE SEA KING,** from the new shipbuilding shed of Messrs. Stephens and Son, at Kelvinhaugh, recently took place. The *Sea King* is built on Messrs. Stephens' principle, of a combination of wood and iron. She has been specially constructed for the China trade, and is of 1200 tons burthen.

**THE LAUNCH OF FOUR STEAMERS AT THE SAME INSTANT,** on the Tyne, took place on the 15th ult. The launches were from the building yards of Messrs. Palmer Bros., at Jarrow and Howdon, which are nearly opposite each other. The vessels were the *Latona*, being the sixth of a line of steamships built for a company trading between London and Italy; the *John McIntyre*, a large screw collier, the property of Messrs. Cory and Co., of London; the *No. 1*, built for a Rotterdam firm, and the *Europa*, intended to be employed in the passenger and goods trade between Genoa and the island of Sardinia. Their aggregate tonnage is about 4300.

#### TELEGRAPHIC ENGINEERING.

**THE MEDITERRANEAN EXTENSION TELEGRAPH COMPANY.**—At the half-yearly meeting of this company, the following was reported:—The improvement in the past half year had been such as to render it unnecessary for the company to apply to Government for assistance under the guarantee. The directors expected that the interruption in the communication on the Malta and Alexandria line would soon be restored. The receipts for the past half year amounted to £5494 1s. 3d., as compared with £5100 for the corresponding period of last year. The time occupied in the transmission of messages between Malta and London had been considerably reduced. The report was adopted. A dividend of 8 per cent. on the preference shares, and 3 per cent. on the original shares, was agreed to, £543 being carried to the reserve fund.

**THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.**—The half-yearly ordinary meeting of this company has been held. The report stated that during the past half-year a considerable extension of the company's system, amounting to 754 miles of line and 2066 miles of wire, had taken place. The reduction of the tariff since June 1882, had retarded the progressive advance of the company's income. From the continental traffic a steady enlargement of business continued. The revenue of the company, from all sources, amounted to £117,210 4s. 8d., showing an increase of £14,843 4s. 8d. on the corresponding period of 1882. After making provision for the working expenses, and interest, the net surplus and profit on the six months amounted to £29,061 17s. 6d. The directors recommended a dividend of £3 10s. per cent. for the half year.

#### RAILWAYS.

**DISTRIBUTION OF RAILWAYS.**—A paper has recently been submitted to the French Academy of Sciences by M. Lalanne, showing that the apparently fortuitous distribution of railways over the surface of a large country is in reality subject to certain laws, which may be stated as follows:—1. The meshes of a network of railways, as their number increases, tend to assume a triangular form. 2. These triangles have a tendency to form groups of six each round a certain point, which, therefore, is the nucleus of a hexagon. 3. When a pentagon happens to replace the hexagon there generally is a heptagon somewhere which makes up the deficiency, so that the number six really represents the average number of lines starting from each point. 4. There are certain exceptional points, such as the capital of the country, towards which more than six lines converge; in this case the number of lines does not exceed 12. 5. In those districts where the network is still incomplete there are centres from which only three lines diverge instead of six; in that case they make equal angles with each other, thus leaving space for the three remaining lines. This strange regularity, now observable in the networks of France, England, and North America, depends upon a primordial law which Buffon calls the reason of reciprocal obstacles. Rivers, mountains, forests, or even the mere inequality in the productive force of different soils, have contributed towards the formation of these regular meshes. Among the consequences which M. Lalanne deduces from this theory of his there is this—that the distance between two agglomerations of population of the same order and near each other must be an extra multiple of the distance between the two agglomerations of an inferior order. Thus, the average distance between two capitals of departments in France is 87 kilometres; that between two contiguous *chefs-lieux d'arrondissements* is 43½ kilometres; and between two contiguous cantons, 14½ kilometres; so that the distance between two prefectures is equal to twice the distance between two sub-prefectures, six times that between two cantons, and 24 times the average distance between two communes.

**RAILWAY WORK FOR THE YEAR 1882.**—In the year 1882 the enormous number of 190,420,071 passengers travelled on the railways of the United Kingdom, besides 56,656 season-ticket holders, who of course all travelled very many times; and besides, also, 232,334 horses, 388,864 dogs, 3,094,183 cattle, 7,800,923 sheep, and 1,999,892 pigs. The passengers were more than in 1881 by about 7,000,000. They paid £12,298,373 for their fares. The first-class passengers paid £3,332,330; the second-class, £4,019,321; the third-class, £4,839,250. 12 90 in every hundred went first-class, 28 75 second-class, 58 45 third-class. The proportion of third-class passengers is rather increasing, and of second-class rather diminishing. Thirty-five passengers were killed (nine of them owing to their own misconduct or want of caution), and 536 were injured. This is less than half the number who lost their lives in 1881 by railway accidents. The passenger trains travelled 57,542,831 miles, and the goods trains nearly as many more. The passenger traffic supplied 47.76 per cent. of the total receipts of the companies, and the goods traffic the larger half, 52.24 per cent. The receipts from all the traffic amounted to £29,123,553, being nearly £3,000,000 more than the interest of the National Debt, and an increase of £563,000 over the receipts of 1881; but the length of line open increased from 10,965 miles at the end of 1881 to 11,551 miles at the end of 1882. The working expenditure amounted to 40 per cent., and left the net receipts £14,820,601, nearly £130,000 more than in 1881. In the year 1882 the companies paid £29,370, for law and Parliamentary expenses, £158,169 as compensation for personal injuries, £38,540 for damage and loss of goods, £275,087 for Government duty, and £598,410 for rates and taxes. It took £2,708,683 to maintain the way and works, and £1,242,714 to maintain the carriages and waggon, £3,966,005 to provide locomotive power, and £2,987,637 to conduct the traffic. The total sum raised by shares and loans reached £385,218,438 at the close of the year 1882.

**RAILWAY BETWEEN MOSCOW AND SEBASTOPOL.**—An ukase has been signed by the Emperor of Russia, for the construction of a railway from Moscow to Sebastopol. The line is to be 953 miles in length, the nominal capital will be £22,500,000, and the period allowed for the completion of the work is six years from the date of commencement. Sebastopol is to be made a free port.

#### RAILWAY ACCIDENTS

**RAILWAY ACCIDENTS IN 1882.**—A Parliamentary return states that during the year ending December 31, 1882, there were 216 persons killed and 600 injured in consequence of railway accidents, of which 24 deaths occurred in Ireland, 42 in Scotland, and 150 in England and Wales; the number of miles of railway open in each division respectively being 1593, 1777, and 8176. During 1881, when the total number of miles of railway open in the United Kingdom was 10,833, the number of lives lost by accidents was 284, and the number of persons injured 833. Of the 216 deaths in 1882, 26 passengers and 20 servants of contractors or the companies were killed from circumstances over which they had no control, and 9 passengers and 89 servants from want of caution on their part; 49 of the remainder were trespassers, including seven cases of suicide.

**ACCIDENT TO AN EXCURSION TRAIN NEAR LYNN.**—An accident occurred to an excursion train that was running from Hunstanton to Lynn, about 8 45, on the evening of the 3rd ult. As the train was proceeding at a rapid rate the engine came in contact with a bullock, which had got upon the rails. A first class and two other carriages were thrown off the line, causing the death of five of the passengers. The accident took place at Gaywood, about three miles from Lynn.

**NARROW ESCAPE ON THE GREAT WESTERN RAILWAY.**—The train on the Great Western line from London, due at Warwick on the 15th ult., at 6 18 p.m., did not arrive until 7. The cause of the delay was, that a few minutes after the train left Warwick; it had not proceeded more than three-quarters of a mile when the ashpun of the engine dropped out and lay across the line: the train, of course, came to a stand, and most of the passengers alighted; it was then seen that the iron composing the upper part of the pan was literally worn through, and was in almost as bad a state as it could be. Had the train got on two or three miles further, and acquired a greater velocity, the consequences of this casualty must have been very serious.

**ACCIDENT ON THE GREAT WESTERN RAILWAY.**—On the 24th ult. an accident happened on the Great Western Railway to the 7 15 a.m. express from Birmingham to Paddington. Whilst running at full speed between Hinton and Warwick the hind axle of the engine snapped, and one of the wheels flew off. The driver feeling the jerk applied the brake, but was unable to bring the train up until it had run two miles, when the engine left the metal. The carriages, however, fortunately kept on the line. The whole of the passengers escaped without the slightest injury. The escape of the train is attributable to the remaining wheel of the broken axle gliding along the longitudinal sleepers upon which the metal is laid.

### BOILER EXPLOSIONS.

**MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.**—At the ordinary monthly meeting of this association held July 26th, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 324 engines and 460 boilers. Of the latter, 17 have been examined specially, 11 internally, 55 thoroughly, and 387 externally; in addition to which three of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture 8 (2 dangerous); corrosion, 16; safety-valves out of order, 9 (2 dangerous); water gauges ditto, 21; pressure gauges ditto, 8; blow-out apparatus ditto, 37; fusible plugs ditto, 2; furnaces out of shape, 4; over pressure, 1 (dangerous); deficiency of water, 1 (dangerous); blistered plates, 3; total, 110 (6 dangerous). Boilers without glass water gauges, 2; without blow-out taps, 38; without back pressure valve, 41. One explosion has occurred during the last month, of a very fatal character, particulars of which are given below. No. 20 explosion, by which ten persons were killed and four others injured, occurred to an ordinary mill boiler of the two-fueled 'Lancashire' class. This boiler was not under the inspection of this association. The dimensions were as follows:—Length 30ft., diameter of the shell nearly 7ft. 6in., and that of the furnace tubes—which were parallel throughout, and not strengthened by any hoops or flanges—2ft. 6in.; the thickness of the plates in the shell and tubes, seven-sixteenths, in the flat end plates half an inch, each of them being strengthened with three gusset stays, secured with double angle irons. The longitudinal seams in the shell were not laid in line, but disposed so as to break joint. The age of the boiler was about two years. It had not been tested by hydraulic pressure. The boiler had been fitted with a single lever safety-valve, the valve being enclosed in a box connected over, from which the waste steam escaped through a discharge pipe, carried through the wall of the boiler house. It had also been fitted with a glass water gauge—a feed-check and back-pressure valve combined, fixed to the front end plate, a little below water level—a blow-out or mud tap, and a steam pressure-gauge, of the dial class; but the boiler had no tap for fixing an indicator, so as to check the accuracy of the gauge, and ascertain the actual working pressure with the steam up. The boiler was rent into so many fragments by the explosion that it was completely destroyed, while considerable damage was also done to the surrounding property. Both the furnace tubes were torn away from the end plates, as well as separated into two pieces, dividing at one of the transverse seams at the middle of their length. Three of these lengths, weighing upwards of a ton each, were blown over a row of cottages, one alighting on the first floor of a dwelling beyond, having broken through the roof in its fall, the other two lengths falling at intermediate distances between these two rows of buildings; while the fourth flew in a direction nearly at right angles with the other, and also fell upon a cottage carrying in the roof. The safety-valve weight, which was a ball of about eight inches diameter, was shot upwards, and, on its fall, broke through a third cottage. The shell of the boiler had been torn up into so many pieces that it was difficult to trace the course of the rents, and to determine where they first commenced; but it may be remarked that one of them ran through the manhole, which was not strengthened as it should have been by a substantial month-piece. These fragments of the shell had not flown so far as the flue-tubes had done, but many of them lay scattered near the original seat of the boiler, while some were buried under the ruins. The end wall of the mill was blown down, and the various floors laid open, while the engine was completely buried in the debris. The chimney was gashed by a large rent, running up it for half its height, and stood tottering over the old seat of the boiler, so that approach was dangerous; while the ground surrounding was covered with bricks, and the ruins of the injured buildings; the windows in every direction, as well as many of the roofs being riddled. But it is difficult to convey an adequate idea of the ruin that had been produced. With regard to the explosion having arisen from shortness of water, it was given in evidence at the inquest that the gauge-glass was blown through, and plenty of water observed shortly before the explosion happened; the correctness of which was borne out by subsequent examination, since the flues were found to be coated with incrustation which overheating, had it occurred, would have disturbed; while, in addition, the furnace-crowns could not have retained their shape as they did, had the water been low. As to the explosion being due to excessive pressure consequent upon the defect of the safety-valve, it is true that the spindle of the valve was bent, but it is a matter of opinion whether this did not become so subsequently to the explosion, and was its consequence rather than its cause. At the time of making my own examination, which was done immediately on the explosion being reported, there was no opportunity of seeing the safety-valve, since it was in the hands of the jury who were then engaged upon the inquest—but I am informed, on good authority, that the injury was such as could not have occurred to the valve in regular work, while it was known to have been previously in good order. But, apart from the condition of the safety-valve, there are other considerations affecting the view that the pressure exceeded 60lb. per square inch, and neither that nor twice the amount would have rent the shell had the material and the workmanship been good; while from the fact that the flue-tubes were not collapsed, and the shell was rent into fragments—although the latter should have resisted twice the strain of the former—it is clear that the explosion did not result from simple over pressure. It cannot be doubted that the plates were of very bad quality, one of them in the shell, situated at the top of the external flue, had fractured through the solid when the boiler was at work a few months since, while it is reported that one of the scientific witnesses who gave evidence at the inquest stated—that merely with the blow of a brick he had broken off a piece of plate about 15 or 16 square inches in area, and seven-sixteenths in thickness. Also another engineer who had an opportunity of fully examining the plates after the inquest was closed, has informed me that he found them to be very inferior, while a specimen kindly forwarded to me, at my request, by the owners of the boiler, shows a short and crystalline fracture, is little better than cast-iron, and quite unfit for use. The cast-iron nature of the plates rendered them less adapted to withstand the tensile strain of the shell than the compressive one of the furnace tubes, which therefore accounts for the shell having been broken up into pieces, while the furnace tubes were uninjured, except by the effects of the explosion itself.

At the ordinary monthly meeting of this Association, held August 26th, the chief engineer presented his monthly report, of which the following is an abstract:—

"During the past month there have been examined 313 engines and 401 boilers. Of the latter, 6 have been examined specially, 9 internally, 45 thoroughly, and 341 externally, in addition to which 2 of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 5 (1 dangerous); corrosion, 14; safety valves out of order, 7; water gauges ditto, 9 (1 dangerous); pressure gauges ditto, 15; feed apparatus ditto, 2; blow-out apparatus ditto, 27; fusible plugs ditto, 1; furnaces out of shape, 4 (1 dangerous); over pressure, 3; deficiency of water 1 (dangerous). Total, 88 (4 dangerous). Boilers without glass water gauges, 3; without blow-out apparatus, 16; without back pressure valves, 25.

Nine explosions have occurred during the past month, from which five persons have been killed and three others injured. Not one of the boilers in question was under the inspection of this Association. No. 25 explosion occurred to a boiler not under the inspection of this Association, working at a dye-works. But little damage was done to the surrounding property, and the boiler only slightly moved from its seat. The boiler was one of a series of four, ranged side by side, and connected together, all of them being set upon mid-feathers. It was of the internally-fired class, the length of the shell being 28ft., and the diameter, 8ft., the thickness of the plates three-eighths of an inch, and the blowing-off pressure, 40lb. The cause of the explosion was the dilapidated condition of the boiler; it had repeatedly been found to leak at the back end, both at the last plate at

the bottom, as well as at the flat end one, and had, in consequence, been temporarily repaired, from time to time, with bolted patches. At the time of the explosion there were three of these patches on the boiler, within 12in. of one another. The surrounding plate at length became so eaten away by continual leakage, that it was reduced in places to one-eighth of an inch in thickness, and in others to that of a sheet of brown paper, from which rupture ensued underneath the boiler, at the back end, immediately over the mid-feather.

#### MODE OF SETTING AN INTERNALLY-FIRED BOILER OF 7FT. DIAMETER.

"The boiler to be carried on two continuous side walls, spaced 4ft. apart in the clear between them. The top course of these walls on which the boiler rests to consist of fire-brick blocks, which can be obtained of any desired pattern, and should, in the present instance, be of the following dimensions:—Height on the vertical space, 12in.; width on the base, 12in.; width of bearing surface on which the boiler beds, 6in. The angle of this surface, in order to fit the circle of the boiler, should be 38 deg. above the horizontal: this will be best obtained by striking it out full size in accordance with the foregoing dimensions, which can readily be done by any competent bricksetter. The back of the blocks should slope down to a thickness of 4in., so as to form an abutment against the brickwork at the bottom of the side flues, to prevent the weight of the boiler thrusting the blocks apart. The top of the side flues to be on a level with the furnace crowns, and the bottom on a level with the underside of the boiler. Their width at the top to be 6in., thus making a distance of 8ft. in the clear between the face of the side flues, which should not follow the sweep of the boiler, as is frequently the case, but should run vertically from top to bottom, in order to form a pocket for deposit to lie in without covering any of the heating surface of the boiler, and at the same time to leave room for a man to pass along and examine the plates. The flue beneath the boiler will be formed by the side walls already referred to, spaced 4ft. apart; the height may be about 2ft. The course of the flame immediately after leaving the furnace tubes, to pass under the bottom of the boiler; to split at the front end and return to the chimney through the two side flues. Generally two dampers are introduced, one to each side flue. It is important in boilers with two plain internal tubes, that the course of the flame should pass under the bottom before entering the side flues, in order to promote circulation of the water, and to prevent straining the boiler at the transverse seams of rivets on its under side, and causing what is familiarly known as 'seam rending.' It is not equally necessary, though still advisable, to pass the flames under the bottom before entering the side flues of those boilers which are fitted with tubes or pockets for quickening the circulation of the water. In cases where the angle iron at the front end plate is external, the face of the brickwork should be set back some inches, so that the angle iron may be exposed to view, or leakage may take place without detection. The front cross wall underneath the boiler need not be more than 4in. thick; otherwise it is frequently found to harbour corrosion. This wall should be recessed so as to leave the blow-out pipe entirely free, in order that it may be accessible to examination, not liable to be strained by settlement of the boiler, nor corrosion of the plates accelerated by contact with the brickwork should leakage occur.

#### "MODE OF SETTING INTERNALLY-FIRED BOILERS OF SIX FEET AND FIVE FEET DIAMETER.

"For a boiler 6ft. in diameter, the side walls should be spaced 3ft. apart in the clear. The fire-brick blocks should be 12in. high on the vertical face, 12in. wide on the base, and 4in. upon the bearing surface upon which the boiler beds, the angle of this surface above the horizontal being 33 deg., the other dimensions of these blocks remaining as before. The side flues to be carried down 3in. below the level of the bottom of the boiler, and at the top to be on a level with the furnace crowns, this latter, as well as the remaining particulars being the same as those for the boiler of 7ft. diameter. For a boiler 5ft. in diameter, the side walls should be 2ft. 6in. apart in the clear, the fire-brick blocks 14in. high on the vertical face, 12in. wide at the base, and 3in. wide upon the bearing surface upon which the boiler beds, the angle of this surface above the horizontal being 33 deg. The other dimensions of these blocks remain unaltered from those given above. The side flues to be carried down 6in. below the level of the bottom of the boiler, and at the top to be on a level with the furnace crowns, the remaining particulars being the same as those for the boiler of 7ft. diameter. For boilers of still smaller diameter if a mid-feather be unavoidable, it should be faced with fire-brick blocks for the boiler to rest on, and the blocks bevelled off to a narrow bearing surface, since one of the causes of injury from mid-feather walls is their width. For a boiler of 4ft. diameter, the width upon the top edge need not exceed 3in. The flues under all circumstances must be sufficiently large to admit of a man's passing right through them for the purpose of examination."

**EXPLOSION AT SOUTHAMPTON.**—A boiler explosion took place at some saw mills in Southampton on the 27th ult. The boiler and engine-house were blown to pieces, and portions of the building were scattered over the neighbourhood. Owing to the explosion taking place in the morning, before the workmen were assembled, no personal injuries occurred.

**BOILER EXPLOSION AT ST. HELEN'S.**—On the 13th ult. a boiler explosion, attended by personal injuries, occurred on the premises of Doulton Brothers, potters, St. Helen's. At a few minutes before eight o'clock in the evening the engine was at work, grinding clay, and suddenly, without the slightest warning, one of three boilers, that are used on the premises, burst with a terrific explosion. The shock was felt in distant parts of the town. The boiler was about 30ft. long and 6ft. diameter. It was riveted into several pieces, and one of them, the largest, was carried into the air, passing over the pottery wall.

**EXPLOSION NEAR IPSWICH.**—On the 20th ult., the boiler of a steam thrashing machine, which had been at work all day at a farm in the village of Charsfield, about ten miles from Ipswich, exploded. Two men and a boy were killed, the corn which was being thrashed became ignited, and the produce of 15 acres was consumed.

### GAS SUPPLY.

**METROPOLIS.**—A parliamentary return has just been issued, showing the actual state and condition of each company, and the dividends for the year 1892. It appears that the following dividends were paid:—The Chartered paid dividends at the rate of 9 and 10 per cent., including back dividends at 1 per cent. per annum for the half-year to Christmas, 1892; the City of London dividends at 9 and 4 per cent., with a balance of £866; the Commercial £30,513, on a capital stock of £332,195 (less sums remaining outstanding). The capital account is said to "include calls in course of payment," but the rate of dividend is not stated. The Equitable paid dividends at the rate of 11, 14, 14, and 10 per cent. (less sums remaining outstanding), with a balance of £398; the Great Central dividends at the rate of 6 and 8 per cent. (less sums remaining outstanding), with a balance of £18,445; the Imperial at the rate of 10 per cent., with a balance of £28,600; the Independent at the rate of 10 per cent., with one year's back dividend (£1600), and a balance of £3548. The London paid £38,827, on £548,843 (less sums remaining outstanding), but the rate is not stated. The Phoenix was 10 per cent., with £2190 dividend arrears for 1892, with a balance of £930. The Ratcliffe dividend was £3 15s. per cent., without a balance; the South Metropolitan 10 per cent., with a balance of £10,300; the Surrey Consumers, 10 per cent., with a balance of £4047; and the Western, 10 per cent., with £2295 "towards back dividends of less than 10 per cent."

THE WORCESTER GAS COMPANY have announced a dividend of 10 per cent. per annum for the last half year.





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