RECENT SPEZIA TRIALS AND HARD ARMOUR.

IN our impression of October 24th we gave some account of the experiments carried on at Spezia on October 1st last. Foreign visitors were excluded from these trials on account of the presence of cholera at Spezia; nevertheless, reports of the results have appeared in different publications. One in "Annales Industrielles," of November 2nd, contains what appear to be very good sketches of the effects, showing not only the front effects and sections of the targets, but also the effects seen from the back. Nevertheless, we are anxious to see photographs and Government reports before coming to final conclusions.

The experiment was peculiar, especially in one respect namely, in the fact that the blow was out of all proportion to the resisting power of the shields. The plates were about 19in. thick. The projectile weighed 835 kilogrammes, or 1841 lb. The striking velocities on Cammell's, Brown's, and Schneider's targets were 570, 567, and 567 metres, that is, the average was 1864ft. per second. The average striking energy, therefore, was 44,340 foot-tons, which, with a projectile fired from the 17in. breech-loading 100 ton Elswick gun—which projectile has a diameter of 16·93in. about—should perforate about 30in. of iron. The plates measured about 10ft. by 8ft. 6in. by 19in. Taking the weight as 29 tons, the energy per ton of plate would be about 1529 foot-tons. In 1882 the Spezia steel and steel-faced plates were all broken up by blows equal to 1046 foot-tons per ton of plate. We regard both these ways of measuring the relation of the blow to the resisting power of the plate as untrustworthy, but they deal with it from opposite points of view, and show sufficiently clearly that on any system the blow here enormously outmatched the plate, and under these conditions it is very difficult to compare the behaviour of the plates attacked. To learn much it is necessary to know data that are hardly to be gathered from the accounts that have hitherto appeared. From all of them it is apparent that the steel-faced plates were more broken up than the steel. This might arise from the former being inferior, and so suffering more from the same amount of work. This would be bad. It might, however, equally arise from their having absorbed more of the shot's energy. This would be good. Which of the two is the case may be best seen from the condition and behaviour of the projectile after impact. On this our information is scant. The account we published states that the projectile was more broken up against the steel-faced plates than against the steel, and that while the shot's point after perforating the steel entered a sand hill 15 metres in rear of the targets to a depth of 1400 millimetres, or 4ft. 7in., that of the shot which had perforated Cammell's plate penetrated to a depth of 400 millimetres, that is, 1ft. 4in., while that which had passed through Brown's lay on the ground. These few inches in penetration in earth amount to nothing in themselves, but applied to a fragment they may imply a distinct difference in the condition and energy of the shot after impact. The fragments of the projectile are much more instructive, and information on them may tell us something. An extract from *La Rassegna*, quoted in the *Admiralty and Horse Guards' Gazette*, states that the entire head of the projectile which perforated the Schneider plate has been found intact deeply buried in the earth. This reminds us that we have no measure of the quality of Krupp's projectiles as yet. Excellent, no doubt, they are, but we have no means of judging of them in the data before us. One other point deserves notice. The plates were supported by a backing of 20in. of timber. This is much too soft, and probably tells more against the steel-faced plates than the steel one, as concluded by the Italian officers, and as endorsed by the extraordinary behaviour of the steel-faced plate when fixed on granite at Shoeburyness in September, 1883.

Whatever may be learned, however, from this experiment, as applied to the exact conditions of trial, we are quite at sea when we endeavour to apply the lesson to other cases. This is the great evil connected with all our trials on hard armour. Experiments are supposed to be on foot in this country framed with a view to the investigation of a formula for calculating results against hard armour. If anything valuable is to be elicited we must fire a great number of rounds under conditions varying slowly on fixed principles. A few rounds establish no law. We should suggest the following as perhaps as good a way of approaching the subject as is likely to be arrived at; at the same time the investigation is very difficult, and one which, under any circumstances, may entail much labour and disappointment. Suppose a projectile be fired, bearing the same relation as to stored-up work, and if it be desired as to power of perforation also, that existed in some known case when the plate was fractured with but little work to spare. Several rounds must be fired to establish, as a first starting point, a blow that just fractures a plate across. Then slightly alter one condition in plate, leaving all the others the same, and matching the shot by increasing the powder in one respect, to obtain a relation between one element in plate and one in shot. For example, increase the breadth of the plate and also increase the velocity of the shot, till it becomes a match for the wider plate. This process must be continued till relations are established between varying width and varying striking energy in the form of varying velocity. A similar process is necessary as to thickness of plate and other elements, backing, &c. Now, it is obvious that the expense involved in such an investigation would be out of the question if conducted on a large scale. It might, however, very easily and cheaply be carried out by Nordenfelt bullets fired from machine guns. These might not prove wholly representative of what occurs on a larger scale, but they would probably be sufficiently nearly so to serve as a guide such as might enable a very limited number of experiments on a large scale to decide a good deal, and a system might be suggested that would assist in tabulating and comparing results obtained. It is probably remembered by few that before any considerable number of experiments were made with soft armour, Sir W. Fairbairn investigated the subject by statical tests, and actually then arrived at a formula which is now probably as good as any extant. Perforation was a much simpler matter than the destruction of hard plates, and surely the latter should be studied by every possible means, to prevent waste of money in isolated trials, which can hardly lead to much. The test of perforation is more misleading than many are aware when misapplied to hard armour. A pile-driving machine was exhibited this year at the United Service Institution and Iron and Steel Institute with a falling weight, into which were inserted steel punches, shaped like projectiles, of 1in., ½in. and ¼in. diameter. The fall of the weight drove these punches through thick millboard slabs or fractured slabs of hard brick. The stored-up or striking energy was here proportioned to the height of fall, the weight being constant. Hence the energy required for punching being inversely proportional to size of hole, it follows that the ¼in. bullet punch, with 10in. fall, has nearly the same perforation as the ½in. at 20in. and the 1in. at 40in. On the other hand, the three bullets driven with the same weight have about equal smashing power when falling from the same height. In short, the ¼in. punch falling 10in. is, as regards perforation, on an equality with the 1in. punch at 40in.; while to obtain the same smashing power as the latter it must fall not 10in. but 40in. This shows how entirely misleading is the test of perforation for hard armour, and how necessary it is to arrive at something better. Let us hope that this may be successfully achieved. In the meantime we are smashing gigantic shields with results which establish little beyond the fact that a particular shot with a certain velocity will break some individual shield, and with little idea of how to apply the results to cases with other conditions.

We can hardly conclude without a tribute of admiration to the 100-ton B.L. gun, which delivers a blow so far in excess of anything extant. In 1876 the first Elswick 100-ton M.L. gun performed against plates at Spezia. Up to the present date no other makers have produced as powerful a gun, yet Elswick has made many more, and in 1882 fired this much more powerful B.L. 100-ton gun. In actual power magnitude, then, Elswick has long held an unrivalled lead.

THE VICTORIA ELECTRIC LIGHT STATION.

No. II.

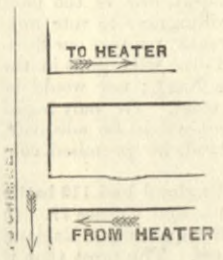
Boilers.—The steam generators for an electric light plant have to fulfil some very special conditions. They must be very economical, occupy little space, require no complicated foundation which would make the removal of one boiler out of a set, or the addition of one to a set, a trouble—some operation involving, perhaps, the stoppage of the entire set for a certain time; they must be capable of being pressed hard for a few hours without too great a decrease of economy; and in order to meet the exigencies of the service, they should be so designed that the stoker can vary almost without notice the rate at which steam is generated. After duly considering all these requirements, Mr. Crompton has come to the conclusion that for this particular class of work the locomotive type of boiler is most suitable, and he entrusted the design of the boilers for Victoria to Mr. W. H. Maw. Messrs. Hick, Hargrave, and Co., of Bolton, were the makers. We illustrate these boilers fully in Figs. 11, 12, 13, and 14. Their dimensions are:—

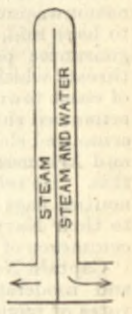
Extreme outside length	20ft. 0in.
Outside diameter of barrel	4ft. 9in.
Centre of barrel to floor	5ft. 5in.
Outside width of fire-box	4ft. 9½in.
Outside length of ditto	5ft. 10in.
Internal height of fire-box—level of grate to crown	6ft. 1½in.
Grate, 4ft. 1½in. wide by 5ft. 1½in. long	20·5 sq. ft.
Length of tubes between plates	11ft. 10½in.
Number of tubes, No. 8 b.w.g.	74
External diameter of tubes	0ft. 3½in.
Area through tubes	4·1 sq. ft.
Heating surface: Fire-box, copper	111 sq. ft.
,, ,, Tubes	732 sq. ft.
Indicated horse-power	300 I.H.P.

The steam generated in the boiler is carried through a 7in. short pipe into a steam collector, 1ft. 6in. diameter and 5ft. long, provided inside with baffle plates for the retention of any water carried over. A small drain pipe, clearly shown in our illustration, Fig. 13, conducts the water thus collected back into the boiler. The end of the steam collector is provided with a 4in. Dennis straight-through valve, by which the steam passes into the main steam pipe, which is 6in. internal diameter. Each boiler is provided with two distinct sets of safety valves—one group of five Cowburn's patent dead-weight safety valves, of 8·3 square inches collective area, loaded to 143 lb. per square inch, and one pair of 2½in. lever safety valves, loaded to 140 lb. per square inch. The three boilers are fed by two Blake's steam pumps. Steam cylinder, 6in. diameter; water cylinder, 4in. diameter; stroke of both, 12in. Inlet to pumps, 2½in.; outlet, 2in.; feed pipe to each boiler, 1½in. Valves are inserted at suitable places into the system of feed pipes, so that either boiler or either pump can be disconnected at pleasure.

The products of combustion pass from the smoke-box downwards into the horizontal underground flue already mentioned. A cast iron throttle valve, 1ft. 6in. by 3ft., inserted between the smoke-box and flue, serves to regulate the draught of each boiler. In addition to this there is also the usual damper in front of the ash-pan, so that the fire is under perfect control. To protect the front tube plate, and to insure perfect combustion and a thorough mixing of the gases, a firebrick arch is built within the fire-box. The system of carrying the main flue underground has many advantages. It simplifies the foundation, since the vertical down-take serves as a support for the smoke-box end of the boiler; it permits the flue to be easily inspected and cleaned, and it prevents radiation of heat in the engine and boiler room, which, in the case of overhead iron flues, would be simply intolerable. To prevent radiation of heat from the boilers and steam-pipes they have all been coated with Haake's fossil meal to the thickness of 1½in.

Feed-water heater.—The exhaust steam from the engines is carried into an exhaust tank, shown in Fig. 1 and Fig. 3, the bottom of which is 10ft. above the floor of the engine room. Here a certain amount of condensation takes place, and the condensed water is drained off into a pit, which also receives the drainage from the heaters, exhaust pipes leading to chimney, and from the steam chests and cylinders of the engines. An ejector placed in this pit then raises the water to another overhead tank, from whence it is led to the feed pumps. The greater part of the exhaust steam is, however, not condensed in the exhaust tank, and must therefore be disposed of in some other manner. To admit the steam direct into the bottom of the chimney would be a fatal mistake, since, on account of its low temperature, it would have the effect of cooling the hot gases within the chimney, and thereby diminishing the draught. The exhaust is therefore carried to the chimney and up within it by two 12in. cast iron pipes, as will be seen by our illustrations, Figs. 8 and 10. These pipes enter the exhaust tank at the bottom, but are prolonged within the tank to nearly the top side, so that no condensed water can enter into them; they are carried vertically downwards then, with bends of large radius, Fig. 9, into the chimney, where they rise in two diametrically opposite corners to within a few feet of the top, where they are joined by a breeches piece into a simple exhaust nozzle. One of these pipes is plain right through, without any valves or restrictions which might impede the flow of the exhaust steam. The other, however, is provided with a throttle valve, placed between branch pipes leading to the heater, as shown in the annexed sketch. By means of this throttle valve part of the exhaust steam can be sent through the heater before it is allowed to enter the chimney. To do this does not set up any appreciable back pressure, since the exhaust steam in passing through the heater is partly condensed, and forms a slight vacuum on the inlet side. A glance at the annexed sketch will make this clear. The heater employed at Victoria is made by Messrs. Stearn and Co., of Glasgow, under Strong's patent, and we illustrate it in Figs. 15, 16, 17, 19, and 20. It consists of a lower vessel, an upper vessel, and a set of filters. The lower vessel—Fig. 15—is not under pressure, and contains a number of vertical tubes, closed at the top and open at the bottom. In each tube there is a diaphragm reaching to within a short distance from the top and dividing the pipe into two parts, one connected with the inlet where the steam rises, the other connected with the outlet where the steam descends. It is claimed that the weight of the condensed water on the descending side produces a slight vacuum on the inlet or ascending side—each pipe, in fact, acting like a syphon, and so relieving the exhaust from the engine from all back-pressure. The mixture of steam and condensed water issuing from the lower vessel is led into a 12in. pipe provided with a drain pocket and copper grating, and there separates. This pipe is shown in our illustration of the heater—Fig. 16—in elevation. The water falling through the grating into the pocket is drained away into the pit mentioned above, and the steam is led back to the exhaust pipe, joining it below the throttle valve. The cold feed-water is admitted into the lower vessel, where it comes into contact with the outer surface of the vertical tubes, and is thereby heated sufficiently to give off most of the carbonic acid gas and air, and to precipitate part of the solid matter held in solution. From this vessel the water is drawn to the pump, and discharged from the pump into the upper vessel—Fig. 15—which is consequently under pressure. Here the water is further heated by a system of coils containing live steam to nearly the temperature of the steam in the boiler, and the rest of solid matter yet contained in the water is precipitated. The actual depositing of this matter takes place in the filters—one of which we show separately in Fig. 17—through which the water is forced on its way to the boilers. It was originally intended to use sand in the filters, but coke has been substituted, since after it has served for retaining the solid matter precipitated out of the feed-water, it can still be used as fuel. To facilitate the charging of the filters, a traveller having two motions and hoisting tackle is provided, of which we give detail illustrations in Fig. 18. The exhaust tank and pipes, the heater and the filters, are all coated with Haake's fossil meal to the thickness of 1in.





THE IMPROVEMENT OF THE NAVY.

ON the 26th ult. Sir E. J. Reed read a paper before the United Service Institution, a report of which will be found on page 413. We now give a summary of the discussion.

The chairman, Admiral Fanshaw, read a letter from Admiral Sir T. Symonds, endorsing Sir E. Reed's condemnation. He considered that the Collingwood, and similar ships, must lose in any engagement with ships of the Duperré type; also he observes that Sir E. Reed's classification takes no account of several French ships falling just below the limit—as the Charles Martel, the Tonnant, Friedland, Colbert, and Trident. He recommended that England should copy the French types, and simply make two ships to each French ship, otherwise he foresaw a naval Sedan in the future. It must be remembered that England must keep the sea always; the French might come out when it suited them.

Admiral Sir George Elliott condemned the citadel type of ship, which he regarded as the necessary consequence of turrets. Sir T. Brassey's summary he regarded as most unsound. He was very glad to see that Sir E. Reed thought it possible to defend ships against torpedoes. It was a secondary matter

whether by Sir E. Reed's plates or by his own crinoline. Torpedo destroyers, however, were needed. Vessels of this class might replace many of our obsolete smaller vessels. Coal protection he had always laughed at. He recommended our naval expenditure to be doubled.

Sir John Hay, M.P., concurred in the necessity of doubling the expenditure. The question of coaling stations ought not to be reckoned as naval expenditure. He considered that ships, rather than forts, were needed for the protection of England. Liverpool or Brighton at this time might be ruined by a few French men-of-war. France had now 45 ironclads against our 39. Our fleet was only half the size it ought to be. He would not recommend putting too many eggs in one basket, however, and would prefer two ships like the Riachuelo to one Duperré. In addition to the ships proposed by Sir E. Reed, every available slip—twelve in all, he believed—ought to be occupied. Our present naval expenditure was disgracefully small; it ought to be £13,000,000 annually. In 1878 we had one of £12,400,000 spent in ready-made shops in "hand-me-downs." He would notice our disgraceful deficiency in guns. We required for our fleet 2245 guns; for merchant ships, 560; and a reserve; in all, 3605 guns. To meet this 387 pieces are ready.

Sir Spencer Robinson regretted that it would be impossible for the meeting to petition Parliament. All felt the great necessity of a Navy now. He urged that this should be pressed strongly now.

Lord Henry Lennox agreed with Sir E. Reed's paper. He had long pressed the necessity of increasing our fleet. He condemned the delay in building, and referred to the Agamemnon and her shortcomings in steering, &c. Neither political party had the courage to ask for the required money; yet he hoped that, if fairly put to the country, no real difficulty would arise as to the necessary money. Mr. Broadhurst, one of the most peace-loving men, recently declared his willingness to vote anything necessary, to secure a Navy that would protect our floating wealth all over the world. He would deal with guns in the House in the coming discussion on the Navy; nor would he touch upon torpedoes, for they did not exist. He only hoped that the coming proposals of Government would be adequate, but if instead of bread a stone was offered, he promised consistent opposition.

Admiral Hamilton stated that in 1793 England had 113 battle ships and France 80; England 133 frigates, and France 77. In 1801, the French had only 39 ships and 38 frigates, and England had 202 line-of-battle ships and 277 frigates. The most that is now claimed is that England is equal to France. In 1863 England had 21 ironclads and 44 screw line-of-battle ships to 16 ironclads and 29 line-of-battle ships possessed by France. A combination was much to be feared. The late French Emperor was reported to have said, "If you do not keep up a strong Navy, I cannot guarantee peace." Then Admiral Hamilton referred to the threats which prompted the volunteer movement, the exposure of coast towns, warlike or peaceful, to attack, the fact that unarmoured ships are unfit to take part, except as auxiliaries to armoured ships. The parts played by the Tennesse, Albemarle, and Arkansas, in the American war, were quoted in support of this. He referred to the proposal to transfer our commerce to neutral flags as ruinous, to the great power the Dutch had owed to their Navy, and said that when a navy ceased to protect the commerce of the country it failed in its mission.

Captain Noel joined in thanking the lecturer for his powerful and moderate lecture. He considered sudden and irregular votes of money led to waste. The Navy had been starved now for fourteen years, though naval officers are apt to be misjudged in representing this. An extraordinary vote was now doubtless required, but followed by an increase to the annual estimates. Points, not referred to in Sir E. Reed's paper, were equally important, *i.e.*, the increase of the *personnel* of the Navy, the repair of the Navy, and the construction of colonial docks, and protection of coaling stations. Experiments had also been cut down, and the guns delayed in consequence. He specially concurred in the following points: the necessity of promptly completing ships now building, and the necessity of auxiliaries as tenders of line-of-battle ships. He referred to the three means of protection against torpedo attack—strengthening the bottom, employing nets, and employing special vessels. Without the last he could not conceive how a fleet could stand at all. He did not altogether agree with Sir E. Reed in his condemnation of compound vessels, and regarded the Inflexible as an excellent ship, and that it was not right to take away half of her tonnage in comparing her with the Admiral Baudin. He would take the proportion of the armour to the tonnage of the ship—such as vessels with one-tenth their tonnage—as armoured vessels. Nevertheless he preferred the Dreadnought type to citadel vessels, and side armour to deck armour. He did not see the necessity for unarmoured cruisers being large. He also referred to a mistake made by Sir T. Brassey, in counting the Agamemnon, Ajax, Conqueror, and Polyphemus twice.

Mr. White heartily endorsed most of Sir E. Reed's recommendations, but dissented from many of his arguments. He reminded the meeting that the French reconstructed their Navy since 1872. England had on any system of reckoning gone five battle-ships to the bad. He endorsed Sir E. Reed's recommendations, and he thought the unarmoured cruisers or protected ships certainly had been put at a minimum figure, speaking in the interests of the country, and not as one interested in private shipbuilding. The English Navy had been worked on too little money, and the attempt had now broken down. He also agreed with the lecturer as to torpedo boats, but he must add that justice had not been done to the English fleet. On this point he, of course, spoke as one who had a personal responsibility in the designs condemned, but would point out that there must be something radically wrong in a system which reckoned the Italia and Lepanto, with their 100-ton guns and 19in. of armour, besides a strong armoured deck, as possessing no armoured tonnage. If this is so, then armoured tonnage and fighting efficiency are not interchangeable terms. Mr. White considered that protection of guns by thick armour would be a special feature in future armour clads. The Italians had preferred a thick armoured deck to side armour with all their knowledge of the most powerful guns. He thought actual experiment desirable—still he asked, was it reasonable to treat the Italia and Lepanto as non-existing battle ships? He further observed that the Collingwood had been designed with a view to money, available speed, armament to be carried, and protection to vital parts. Foreign officers do not adopt Sir E. Reed's view. Artillerists know what mischief is done behind weak armour by projectiles. He did not at all advocate the abolition of armour, and if he might speak for Sir W. Armstrong, he would add that he did not advocate that either, though he considered at present that attention specially needed to be turned to the augmentation of protected ships. The Esmeralda, he begged to say, was not to be regarded as the typical protected ship. Better protected ships were building.

Mr. W. H. Smith, M.P., would not follow Mr. White in speaking of the technical points he had raised, but rather with the general question. He thought few people doubted that a permanent increase to the Navy had become necessary. He preferred to lay himself open to the charge of changing his views to shrinking from expressing this as his conviction. Waste of money was not the only evil in delay. Vessels were relied on which could not be ready for a long time, and war would come suddenly. The question was, what vessels would be ready in three weeks' time? As Sir E. Reed had pointed out, armour-clads were required especially when regard is paid to the abnormal development of foreign navies. Then had we any cruisers capable of dealing with those who might prey on our commerce? The only course to be taken was to strengthen the country as far as possible against any combination. He did not want to discuss the merits of particular types of ships, but thought all should combine to show the real necessity for augmentation.

Admiral Boys spoke of the great importance of action, comparing our position in past times to our present one. Ships should be launched and available as quickly as possible. He observed that the Cunard ship Umbria was launched only a very few weeks ago, and that day she was reported as arriving within six days and a few hours from New York. As to the Inflexible, he had been called upon to give an opinion, and had said that it was impossible on service for her ends to be demolished in the manner suggested by Sir E. Reed; though opposed to the regular breaching operations of a fixed battery, such a result might be effected. He thought the term "protected tonnage" a curious one, which he did not profess to understand. He was not clear that he could take part of the ship as protected tonnage and part as unprotected. Classification was, however, a difficult matter. So with maximum thickness of armour, which may only exist in a few plates in the ship. Compound armour further complicates the question. He thought Sir E. Reed's estimate low, and observed that gunboats, each carrying one heavy gun, for protection of our ports, were omitted.

Mr. Norwood, M.P., spoke of the Admiralty Committee, of which he was a member, having condemned the delay in completing work; also in having condemned the system of the Admiralty depending on the War-office for guns. They found that as good work could be done in private as Government yards, and thought that within certain limits contract work had much to recommend it. He doubted the powers on service of our war vessels; on the other hand, he thought the mercantile marine might be relied on for carrying purposes. He felt the recent 41 per cent. increase in steam tonnage was a proof of the need of a larger Navy. He had estimated the sum required within one or two hundred thousand pounds of the amount recommended by Sir E. Reed.

Captain Orde Browne observed that the whole stress laid on the complete belt was based on the supposition that the vessel actually sank from shot leaks in action. If she remained afloat she retained her whole fighting powers, guns, engines, &c., being all armoured. As a fact, no vessel had been sunk in the manner contemplated in action. The Huascar's guns, steering gear, &c., were all crushed; but the question of sinking never arose. An Esmeralda was riddled, but she only sank after she had twice been rammed. He maintained that some class was wanted to provide for the vessels protected by horizontal armour. The whole strength of navies was here based on a classification which ignores the existence of such ships as the Italia and Lepanto.

Captain P. H. Colomb thought Sir E. Reed's proposals very moderate. He wished to avoid disputes over details, but rather to press for money for ships of any approved type. He thought that those who sail the ships should be brought into closer connection with those who design them. He preferred the Dreadnought type himself; but without following Sir E. Reed into the intricacies of the armour question, he desired to see questions tried practically. He objected much to gun detachments bring unprotected from machine guns. He thought with Sir E. Reed that torpedo catchers were necessary. He doubted about the armoured cruiser. He believed that our fully armoured ships would be sent anywhere if necessity arose, just as the Agamemnon has now been sent to China. He recommended a settled plan of action, corrected by experiment, to put a backbone into our naval construction.

Captain J. C. R. Colomb regarded Sir E. Reed's proposals as inadequate, though he welcomed them. The proper excess of strength of the British Navy over that of France depended on the circumstances. In the South Pacific, for example, England had a hundred millions annual trade, and France not two and a-half. England had not the ships necessary to hold her position against France for a week. Mr. Barnaby, in 1877, had, among ten functions of the Navy, enumerated the "locking up of your enemy's fleet." This, our traditional war policy, could not be carried out without double the fleet of France.

Admiral Sir Leopold McClintock said that the lecturer had shown that our Navy was utterly incomplete. He observed that our small craft were very bad. Two hundred torpedo boats were building in France; of these a great number are needed. A million of money added to Sir E. Reed's estimate for torpedo boats alone would be well spent.

Captain Fitzgerald spoke of the loss of service of unfinished ships, which, as long as they lay on the stocks, were no more useful than an unlaid egg. He asked whether the Inflexible had not some advantage, as compared with the Duperré, to compensate for her short belt. He thought that torpedo catchers could replace our present miserable small craft. He, however, laughed at the suggestion that young naval officers should find fault with the ships allotted to them.

Admiral Sir J. C. Wilson spoke of the necessity of our fleet being ready, and measuring our strength by our ships that were ready. As to type, he preferred the Thunderer. He spoke of the absurdity of counting a batch of armour-clad ships, without cruisers, torpedo boats, &c., as a "fleet." Then, again, had we any settled fleet manœuvres, or were we not rather living on Trafalgar, and assuming that all must turn out well; while the French, remembering their past failures, were straining every nerve to construct a powerful fleet. He further spoke of the paucity of trained fighting men and the need for barracks.

Mr. Arnold Forster thought that now the country was roused it would be much wiser to put forward a maximum estimate of our needs than a minimum one. The country had no conception, however, of what war involved, especially to those living on the coast. It was wise for speakers to confine themselves to the broad facts of the case, which should be put, if not offensively, at all events aggressively before the public.

Sir C. Nugent thought that Sir E. Reed had under-estimated our wants. For example, one armed cruiser was not enough for each naval station. He thought also that torpedo catchers ought to have more than one gun. He thought our delay in guns was due to the recent revolution in them; other nations were much in the same condition, a condition which he hoped would not long continue.

Admiral Gore Jones specially pressed the need of docks to repair our ships and enable them to maintain their speed.

Commander May said that junior officers specially needed opportunities of learning torpedo work and other necessary parts of their duty, and hoped steps would be taken to disseminate information.

The Chairman then said that he concurred in Sir E. Reed's recommendations as far as they went, but a more complete statement of the whole wants of the Navy was needed. New ironclads should replace our old ones. Sir E. Reed had shown that it was a fallacy to derive satisfaction from the fact that France is replacing old wooden ironclads by new, for we have numbers quite obsolete from other reasons. He agreed with Sir E. Reed as to armoured cruisers being sent to distant seas. He would give the Warrior, Minotaur, &c., new engines, and render them available as cruisers.

Sir E. Reed explained that his summary was based upon the title given him, "the most urgent measures," and he based his recommendations, therefore, on a total expenditure of £6,350,000 on ships and torpedo boats, which would involve £8,000,000, including expenses connected with the subject. He had not wished to revive the question of the fighting powers of citadel ships. He maintained that naval officers generally were against them. He had avoided the subject of coast defences purposely. He would not meet what had been said as to minor details, but he called attention to the fact that had been noticed, that while every shot tells on unarmoured ships, a great part of those that strike steel armour glance off. He considered that it was open to any ship to destroy the sides of the Italia and Lepanto, above the water-line, and turn them topsy-turvey. The Duilio and Dandolo took their shape owing to difficulties arising from miscalculation, which had to be met by diminution of armour. He was glad to hear the praise accorded to the Dreadnought and Thunderer. Captain Colomb had said he preferred not to build vessels so questionable as armed cruisers, but as a fact, no objection had been made to armed cruisers by anyone. He hoped that it would now be noted that, leaving the first-class armour-clads on one side, he provided for a very high rate of speed in all his other vessels. With regard to torpedoes, he did not believe in a water-cushion acting with much effect against a torpedo.

Finally Sir E. Reed referred to the fact that he was performing a painful task, in bringing up a question on which his own party were individually desirous to act, yet year after year inadequate estimates were brought forward and voted for. He much regretted to have to say that a man increased his weight and authority by leading the nation to the brink of the precipice rather than warning them. A vote of thanks was then passed to Sir E. J. Reed for coming forward in the patriotic way he had done at this grave crisis.

THE OCCURRENCE OF BRINE SPRINGS IN COAL MEASURES.

An interesting paper on the above subject was read by Mr. C. E. De Rance, Assoc. Inst. C.E., F.G.S., at the meeting of the Manchester Geological Society on Tuesday last. The subject, Mr. De Rance said, was one of interest beyond the mere question of the occurrence of brine springs, from the fact that the sandstone of the coal measures in many districts were valuable water-bearing rocks for waterworks purposes, and should it appear that brine springs commonly occurred throughout the coal measures, it would render this class of works open to suspicion. Mr. De Rance compared a number of analyses with reference to the brine from the coal measures, special reference being made to the brine from the Rose Bridge Collieries, near Wigan, which was found to contain 3514 grains of chlorides to the gallon, of which no less than 602 grains were chlorides of potash. As regards general results, the analysis was very similar to a brine spring from a fissure in Dukinfield Colliery, and the brine met with in the Dallam-lane Forge boring in the new red sandstone, which was believed to be derived from the coal measures. These coal measure brines appeared to average about 4000 grains to the gallon of the total saline contents, or about two and a-half times as much as the water at high tide at Liverpool analysed by Mr. Norman Tate, F.C.S., for Mr. S. Roberts, F.G.S., which contained a total solid impurity of 1558·08 grains to the gallon, of which 1295·50 were chloride of sodium. The analyses of a number of saline springs, chiefly from the secondary rocks of England and the Continent, were given, the average saline contents of which were about 1100 grains to the gallon, or less than the moderateiy salt sea water at Liverpool. Brine from the Keuper Marls, on the other hand, contained a quarter of its weight of chloride of sodium, as well as other salts, or about 17,500 grains to the gallon, which was about eleven times salter than the sea at Liverpool. The coal measure brine springs consequently occupied an intermediate place between the mineral springs, somewhat less salt than the sea and the Keuper brine, which was an important solution. The brine springs occasionally met with in the Triassic sandstone were believed by Mr. De Rance to be derived from the coal measures beneath, and he was of opinion that the presence of brine of coal measure origin had only affected wells and pumping stations made for that purpose in very few instances; yet they were sufficiently numerous to render great care necessary in the selection of pumping stations in these rocks, where nothing was already known of the character of the water which would be yielded. Allusion was made to the investigations of Mr. William Ripley Nichols, member of the Boston, U.S., Society of Engineers, which proved that the particles of sand, whether in filter beds or when cemented together and forming sandstones, had no power, as had been imagined, of removing and holding a certain portion of the salts of saline solution filtering through them. Mr. De Rance also described the "Revolver" suggested by Sir Frederick Abel, C.B., F.R.S., which had been erected at the Antwerp Waterworks, and in which two million gallons of heavily-polluted water was daily dealt with at an expenditure of only 20 lb. weight iron and a very small amount of power. This was a result of great importance to many works in this country, and experimental trials were already being made.

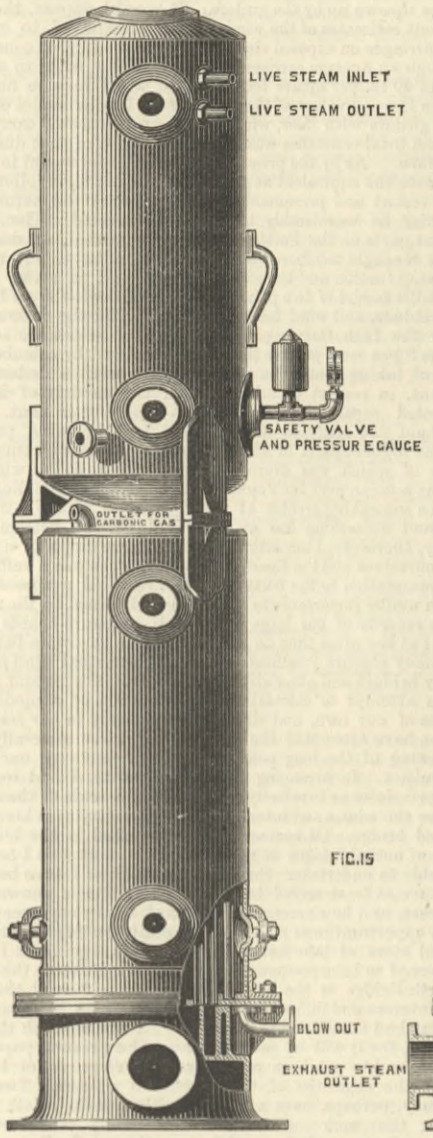
South Kensington Museum.—Visitors during the week ending Nov. 29th, 1884:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 9903; mercantile marine, Indian section, and other collections, 2726. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1595; mercantile marine, Indian section, and other collections, 531. Total, 14,755. Average of corresponding week in former years, 12,984. Total from the opening of the Museum, 23,554,174.

A Fleet of Steamboats in the Market.—On Wednesday Messrs. Fuller, Horsey, and Co. offered for sale the whole of the old fleet of the river steamers which for several years past have been employed in the passenger traffic on the Thames. The London Steamboat Company was recently reconstituted, and it was announced at the sale that the vessels were being disposed of in consequence of their being about to be replaced by new steamers of an improved type. The vessels offered were twelve in number, described as paddle steamers, varying from 37 tons to 58 tons each, and offered with all their machinery and gearing. A stipulation in connection with the sale was that purchasers were required to enter into a covenant not to use the vessels for carrying purposes on any part of the river Thames between Hampton Court and Gravesend. Some of the vessels were offered at the company's works at Woolwich, and the remaining portion at the Battersea dockyards. The bidding showed that there is not at present much demand for this class of property, and ultimately all the vessels were withdrawn.

THE VICTORIA ELECTRIC LIGHTING INSTALLATION—SITE, PLAN, AND DETAILS.

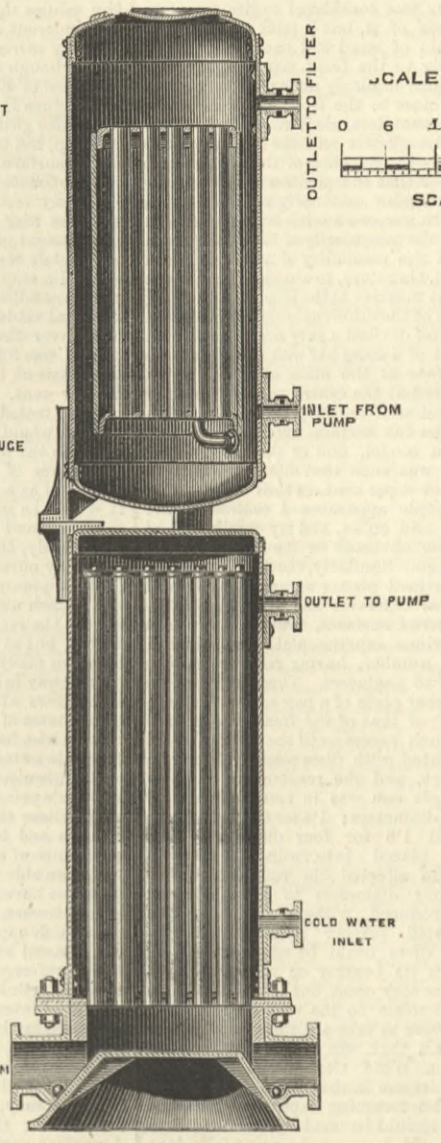
MESSRS. R. E. CROMPTON AND CO., ENGINEERS.

(*For description see page* 419.)



ELEVATION

FIG. 15



SECTION

SCALE FOR HEATERS AND FILTERS

0 6 1 2 3 4

SCALE OF FEET

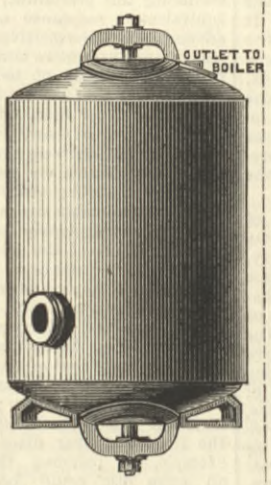
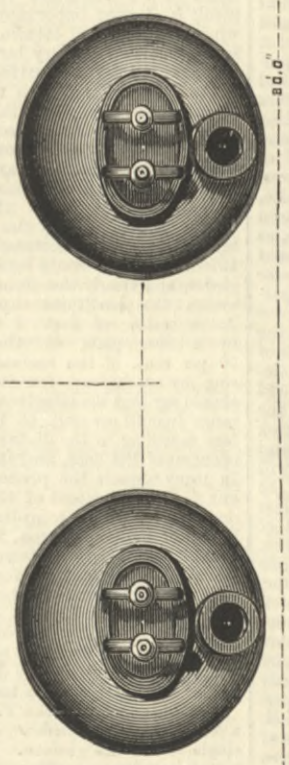
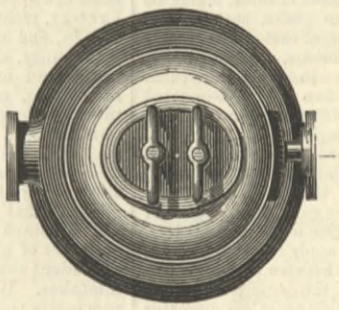


FIG. 17





SCALE FOR SHAFT

0 5 10 15 20

SCALE OF FEET

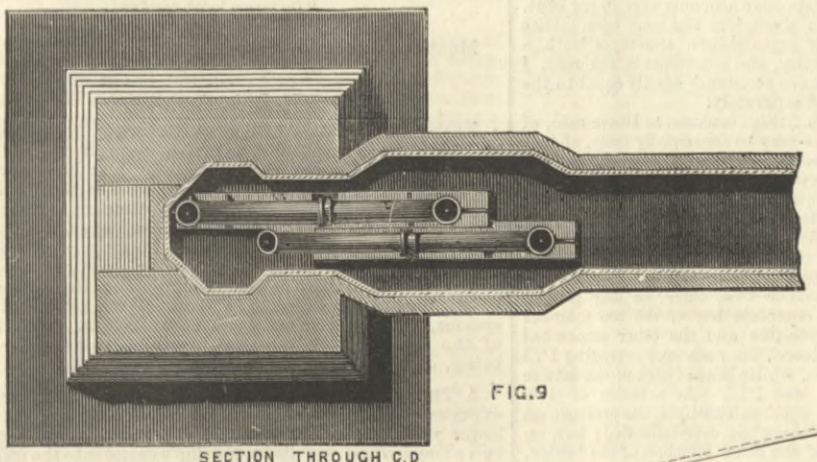
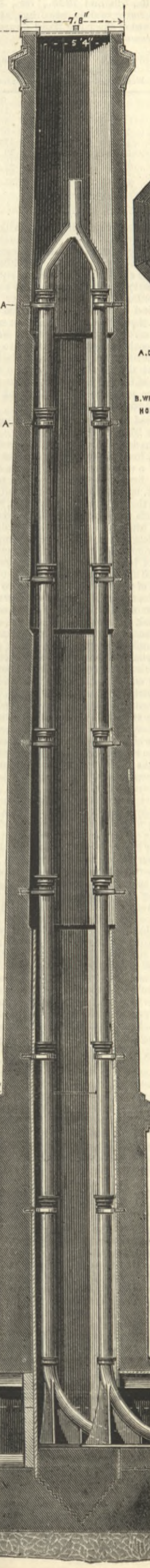
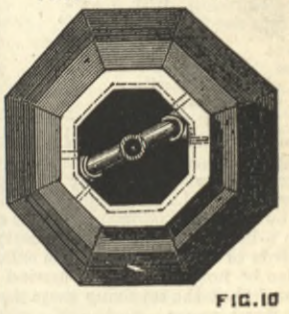


FIG. 9

SECTION THROUGH C.D



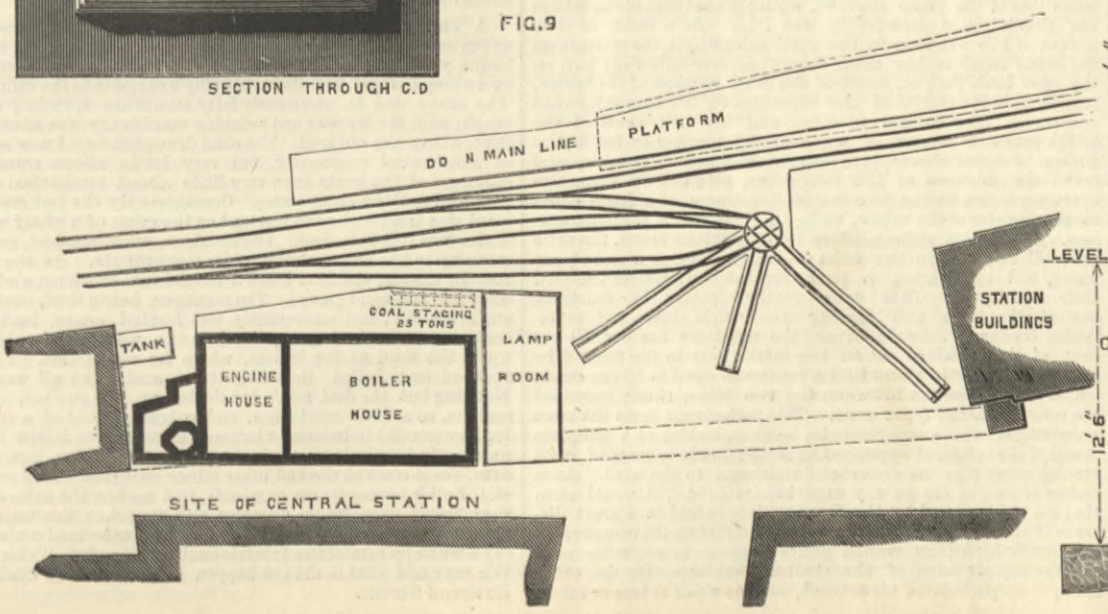


PLAN OF TOP OF CHIMNEY

FIG. 10

A. CAST IRON BRICKS TO BE BUILT INTO CHIMNEY

B. WROUGHT IRON STRAP FOR HOLDING UP PIPES



SITE OF CENTRAL STATION

FIG. 8

THE FORTH BRIDGE.*

By B. Baker, M.I.C.E.

(*Concluded from page* 388.)

I have summarised the readings of the gauges for the past two years, and find them to fairly bear out my anticipations. In preparing the following table, the mean of all the readings of the revolving gauge between 0 lb. and 5 lb., 5 lb. and 10 lb., &c., have been taken, and the mean of the corresponding readings at the same time of the small fixed gauge and of the large fixed gauge for easterly and westerly winds have been set forth opposite.

Revolving gauge.		Small fixed gauge.		Large fixed gauge.	
Mean pressure.		Easterly.	Westerly.	Easterly.	Westerly.
lb.	lb.	lb.	lb.	lb.	lb.
0 to 5	3·09	3·47	2·92	2·04	1·9
5 to 10	7·58	4·8	7·7	3·54	4·75
10 to 15	12·4	6·27	13·2	4·55	8·26
15 to 20	17·06	7·4	17·9	5·5	12·66
20 to 25	21·0	12·25	22·75	8·6	19
25 to 30	27·0		28·5		18·25
30 to 35	32·5		38·5		21·5
Above	65		41·0		35·25
(One observation only above 32·5.)					

I do not myself, nor does Mr. Fowler, place implicit faith in the registrations of our own or anybody else's anemometers, although we test the working of the gauges in the most careful manner, but at the same time I think it is pretty well established by our two years' experiments that the effective pressure per square foot on a large and comparatively heavy board averages only about two-thirds of that indicated by an ordinary light anemometer. It will also be noticed that the heaviest gales have been from the west, and that the revolving gauge then indicated much the same as the fixed gauge. Some critics were of opinion that our 300ft. gauge would be of little use, as it could not swivel square to the wind; but remembering the experiments made with a fan blast on oblique plates, which showed that the resultant pressure was normal to the surface, I felt sure that having reference to the prevailing winds swivelling was of no practical importance at the Forth, and the results justified my anticipations.

The two heaviest gales occurred in the early morning of December 12th, 1883, and January 26th, 1884, respectively. On the latter occasion much damage was done throughout the country, and there was conclusive evidence, from the extent as well as the intensity of the storm, that it was a very exceptional one in character. At Inch Garvie the small fixed gauge was reported to us as registering 65 lb. per square foot, but on inspection I found the index pointer could not traverse further, or it might, perhaps, have indicated much higher. At Valencia very strong squalls covering short periods were stated to have attained a rate of upwards of 150 miles per hour. At Holyhead lengthened squalls of 120 miles, and short squalls of higher rates, were reported. At Alnwick we were told that several instances of ten miles in five minutes, or 120 miles an hour, and squalls of 150 miles, occurred. Now, if we assume, as is common, the pressure of wind to be equal to $\cdot 005\ V^2$, and accept the velocity of 150 miles as correct, we shall have to believe that pressures of 112 lb. per square foot were reached at Valencia, on the west coast of Ireland, and at Alnwick, on the east coast of England, on the 26th of January last. I confess I find it much easier to believe that the records of anemometers as at present obtained are utterly misleading and valueless for all practical purposes. I entirely mistrusted our own 65 lb. record, even before I knew that the index was at the end of its travel. On finding out the latter fact, however, I experimented with the gauge, and finally, in the presence of the inspecting officers of the Board of Trade, made it register 65 lb. by the sudden application of a pressure not exceeding 20 lb. The momentum of the light index needle, and not that of the pressure plate, which was bridled back, sufficed to cause the error. I look upon the record of 65 lb., therefore, as valueless, so far as regards the specific maximum pressure attained during the great storm, but of considerable value as evidence that the highest pressure, whatever it might have been, partook of the character of a smart jerk of too instantaneous duration to affect a structure of any size or weight. From the records generally, and from my own watching of the movements of the three gauges, I have come to the conclusion that uniform velocity and pressure in a wind, whether it may prevail or not at cloud heights, can never obtain near the surface of the earth or in the neighbourhood of any bridge or other structure capable of causing eddies. Unsteady motion must be the rule in air as in water, and the threads of the currents moving at the highest velocity will strike an obstruction successively rather than simultaneously, so that the mean pressure per square foot on a large area must be less than that on a small surface from that cause alone, irrespective of possible differences in the partial vacuum at the back of the planes. In the spring of this year, when running into Dublin Harbour during a heavy broadside gale, I took occasion, when in still water, but in the full blast of the wind, to measure the heel of the vessel, and from her elements to calculate subsequently the mean pressure required. My pressure board in this case was about 6000 square feet in area, and the deduced mean pressure was 12 lb. per square foot. From other data I estimated the corresponding anemometer pressure at fully double the preceding amount; and this was perfectly rational, because the vessel kept steady at the constant heel, whilst heavy local gusts of very small area struck different parts of her in a distinctly recognisable manner. In short, the large area and heavy mass of the hull equalised the jerky action of the numerous small blasts of high intensity, and a similar action doubtless takes effect in ordinary railway structures, and will to a still greater extent in such a large and heavy structure as the Forth Bridge. Mr. Fowler and I are of opinion, therefore, as a result of our two years' further consideration, that the assumed pressure of 56 lb. per square foot over the whole of the bridge is considerably in excess of anything likely to be realised. It is another question whether the method of estimating the effective area exposed by the bridge—namely, double the plane surface, with a deduction of 50 per cent. in the case of tubes—is right or wrong. We think it is a sufficiently near approximation to the truth, for reasons which I will briefly set forth. As all engineers well know, one of the results of the panic caused by the fall of the Tay Bridge was the appointment by the Board of Trade of a committee to consider the question of wind pressure on railway structures, which committee advised the adoption of certain rules. Shortly stated these were:—(1) That a maximum wind pressure of 56 lb. per square foot should be provided for. (2) That the effective surface upon which the wind takes effect should be assumed at from once to twice the front surface, according to the extent of the openings in the lattice girders. (3) That a factor of safety of four for the ironwork and of two for the whole bridge overturning as a mass when gravity alone comes in, should be adopted. In the case of the Forth Bridge we took, with the approval of the Board of Trade, the highest ratio for the surface, namely, twice; but I must admit that I had not at the time the slightest idea whether the twice ought not to be thrice and even more, and the recommendations of the committee did not assist me, as they were founded on no special experiments, and did not accord with my own experience so far as it then extended. Under these circumstances the necessity of further experiments was clearly indicated, and we have made them. The tension members and the bracing of the Forth Bridge, as already explained, are lattice box girders, and the main compression members are tubes. Thus, in the case of the top tension members near the piers, we have the front surface of the girder with channel bars and projecting flanges, making it essentially different to the flat anemometer plate, and three corresponding surfaces, situated respectively about 7ft., 33ft., and 40ft. to the rear of the front surface. In the case of the tubes we have the tube itself, then a couple of box lattice cross braces, with channel bar members, and finally another tube. No theory exists which could enable us to estimate even approximately the equivalent flat surface of such a network; and I felt until my scheme of experiment by models was realised with satisfactory results, that our calculation of stresses from wind pressure rested on anything but a logical basis. The problem to be solved was how far the eddies caused by the front surfaces affected the surfaces to the rear. In the recommendation of the Wind Committee a front plate girder was considered to give complete shelter to any girders to the rear of it, but I think any one who has walked Indian file in a gale of wind will have noticed that unless he locked up pretty closely to the front man he felt practically the full force of the gale, and similarly unless the rear plate girders of a bridge be relatively close to the front girder the latter will not afford anything like complete shelter. It is obvious, therefore, that the depth of the girders and the distance apart enter into the problem, as well as the question of their being plate or lattice; and I may add further that the position and character of the floor between the girders also materially affect the wind stresses. My original idea was to prepare models and test them in actual wind at Inch Garvie, but the irregularity of the results, even with the flat boards, precluded the possibility of any useful data being so obtained. I determined, therefore, to abandon the attempt to measure actual resistances, but to arrive at the same end by getting the equivalent area in flat surface of the different bridge members and cross bracing, and for this purpose devised a very simple pendulum arrangement, consisting in effect of a cross bar with a model at one end and an adjustable flat surface at the other of exactly equal weight, which bar was suspended at the centre, so that the only resistance to turning was the torsion of the suspending string. On oscillating this pendulum, if the flat surface were not the exact equivalent in resistance of the model, one or the other would advance, and the sensitiveness was such that different observers would rarely vary more than 3 or 4 per cent. in their results. To test the sufficiency of this simple apparatus I contrasted the resistances of thin flat surfaces and cubes, and my results agreed within 2 or 3 per cent. of those obtained in the most elaborate manner by Dubuat many years ago. Similarly, the results obtained with cylindrical surfaces and inclined planes were in strict accord with those obtained by previous observers and other apparatus. When experimenting with sheltered surfaces, however, my results differed considerably from previous experimental ones, which I must say are singularly few in number, having reference to the vast importance of the subject to engineers. Thus, according to Thibault, the resistance of the rear plate of a pair set at a distance apart equal to the diameter is ·7 of that of the front plate, whilst in my experiments I found no such excess until the distance apart was 3½ diameters. I experimented with discs placed at from one diameter to four diameters apart, and the resistance of the two discs in terms of that of the single one was in round number 1·0 for one diameter; 1·25 for 1½ diameters; 1·4 for two diameters; 1·6 for three diameters; and 1·8 for four diameters. An increased number of discs placed intermediately between the front and rear discs little affected the resistance. For example, by reducing the four diameters to 3·6 diameters, an extra disc could be introduced without increasing the resistance of 1·8, and by still further reducing the distance to 3·5 diameters four discs could be employed. This result is of great importance in its bearing on railway bridges where a succession of lattice bars may occur one behind the other, which would offer a very large surface to the wind if the proper way of estimating that surface were to take a slightly angular view of the bridge and measure up all that was visible. It has been already mentioned that in the Wind Committee's report no addition is made for sheltered surfaces in the case of plate girders, whilst it might appear from the foregoing experiments that as much as 80 per cent. allowance should be made where the girders are four depths apart. This would, however, be a very fallacious deduction, for it omits all consideration of the floor of the bridge. Reasoning from the observed resistance of cubes, it may be inferred that the resistance of a tubular girder, such as the Britannia Bridge, would be only 80 per cent. of that of a single flat girder, and clearly the floor of a girder bridge, if close plated, makes the conditions approximate to that of the tube. As a matter of fact I found that two plates connected by a floor plate at the bottom offered no more than 90 per cent. of the resistance of the single plate. Summarising my conclusions—for it is impossible to give details here—I should say that the effective surface of a plate girder bridge would range from 90 per cent. to 180 per cent. of that of the front surface according to the distance apart of the girders, the degree of openness of the floor, and its position relative to the main girders. In many respects the preceding remarks apply to lattice girders, but the varying extent of the open spaces between the bars introduces an additional complication. When the openings were one-fourth of the whole area, I found for a distance of one diameter apart an increased resistance of 8 per cent. from the second disc, whilst with openings of double the size the increase was 30 per cent. At two diameters the respective amounts were 40 per cent. and 66 per cent., whilst at four diameters the more open lattice reached 94 per cent. In other experiments, sometimes with a small flat plate in front of a lattice, and sometimes in the rear, I obtained at four diameters distance resistance exactly equal to the sum of the two specimens tested separately.

The top member of the Forth Bridge consists, as I have said, of a pair of box lattice girders, or as may be said equally truly, of four single-web lattice girders. Models of these single-web girders, tested in pairs, gave 20 per cent. increase from the rear girder when the distance apart was equal to the depth; 50 per cent. for two depths; 70 per cent. for three depths; and 80 per cent. for four depths. When three girders were placed one behind the other, the middle girder gave rise to a further increase of about 4 per cent. for three depths and for four depths; in short, it mattered practically little whether two, three, or four girders were used. Two models of a complete bay of the top member were made, one as light as possible and the other somewhat heavy. The results were in accord, the resistance averaging 1·75 times that of the plane surface, whilst that of each of the lattice box girders tested separately was 1·15. As a factor of two instead of 1·75 was used in the wind calculations, the pressure on the lattice members has been somewhat over-estimated; but, on the other hand, that on some of the other members of the bridge, judging from the results of the experiments, has been somewhat underrated. The bottom member and the main struts of the bridge consist of a pair of tubes braced together by box lattice girders. I tested a complete bay of the bottom member, and found the resistance of the two tubes, placed seven diameters apart, together with the two box lattice braces, of a depth equal to the diameter of the tubes, to be 1·1 times that of the plane surface. Substituting plate girders for the lattice braces, the ratio was still only 1·24, so the tube evidently acted as a sort of cut water, and by clearing a path for the flat surfaces lessened their resistance. This was further proved by removing one of the tubes and testing the single tube and cross-lattice bracing. Tube in front, the resistance was but 80 per cent. of that obtained when the lattice was to the fore. The lattice bracing tested alone had a resistance equal to 60 per cent., whilst when in position between the two tubes, it only increased the resistance about 5 per cent. This perhaps was to me the most reassuring of all the experiments, because, looking at a complete model of the bridge, it appeared as if the intricate mass of cross bracing must offer an enormous resistance to the wind. As a matter of fact, so far as my experiments extend, it would seem that the eddies caused by the front surface extend to a great distance in all directions, and in a complex structure the innumerable and conflicting eddies would almost appear to neutralise each other as regards some of the sheltered surfaces. On the other hand, in simple isolated structures, such as a pair of bars or tubes the shelter is practically *nil* at distances equal to about six diameters, and the members might as well be abreast. This was well demonstrated in the experiments by arranging the models on the skew, so as to imitate the effect of a wind blowing at an angle to the horizon, when constant results were obtained with widely-different angles. In the approach viaduct at the Forth the lattice girders are under the rails, and there is a wind fence on each side. Testing a model of this class of construction, I found that the resistance of the parapet and of the railway carriages was only two-thirds of the corresponding plane surface, a result due no doubt to the eddies thrown up by the girders. It would appear, therefore, that current estimates of the wind pressure required to overturn railway carriages on exposed viaducts should be further considered, for although an average carriage might overturn with an uniform pressure of 40 lb. per square foot, a 60 lb. wind may be necessary to produce the equivalent of that pressure. In our model of a pair of lattice girders with floor, wind fence, and railway carriage on the top, the total resistance was but 93 per cent. of that due to the plane surface. As by the present rules engineers would in such a case estimate the equivalent at about 150 per cent., it follows that in many recent and presumably future bridges the actual wind stresses may be considerably less than estimated. The leading constituent parts of the Forth Bridge were tested, as described, by models of single members and of complete bays, but we proceeded a step further and tested both in air and in water a complete metallic model of two pairs of cantilevers with cross bracing, internal viaduct, and wind fence, together with the intermediate part over the Inch Garvie piers. The total resistance so ascertained was 9 per cent. greater than that obtained by calculation on the basis of taking double the plane surface with a deduction of 50 per cent. in respect of tubes. With the models of different parts, tested separately, the excess was 4 per cent. This excess would not apply to the moment of the wind pressure, because the highest parts of the bridge are lattice structures, the resistance of which was over-estimated. If a 56 lb. wind ever occurred as a mean over such an area as that we are dealing with, it would be something greater at the high level of the lattice top member and something less at the level of the bottom tubes. Personally, therefore, I am satisfied that the assumption originally made by ourselves and the Board of Trade officers was a sufficiently close approximation to the truth for all practical purposes. I do not attach undue importance to the results obtained by the models, nor to the records of our large and small pressure boards at the Forth, but at the same time to me they have thrown a little daylight on many obscure questions respecting the actual wind pressure on railway bridges and other structures. Mr. Stewart and I would sometimes attempt to calculate the resistance of a model upon hypotheses of our own, and differ most widely in our results, as others who have attempted the same thing have generally done. A single swing of the long pendulum would solve all our doubts and difficulties. In arranging the experiments, I had regard to Froude's principles as to velocity relative to the scale of the models, and believe the eddies and interferences to be similar in kind in the models and bridge. Of course what is wanted is the measured resistance of actual bridges in actual storms, but this I have not yet been able to undertake. Such experiments as I have been able to make have at least served to show how little is known about wind stresses, and how necessary it is that every engineer should seize such opportunities as may offer for contributing something to the general store of information. Two years ago I said I should have preferred to have postponed any communication on the subject of the Forth Bridge to the British Association "until the many points of interest and difficulties inseparable from so gigantic an undertaking had manifested themselves." I am in much the same position now, for it will be gathered from the present paper that no real strain has yet been put upon the resources of the contractors or the capacities of the executive officers. Two years hence I may, perhaps, have a more thrilling tale to tell. Much interest in the work has been evidenced by continental and American engineers, and the criticism on the whole has not been unfavourable but appreciative. Occasionally it has been suggested that the appearance will not be as elegant as could be desired, but I retort, mentally, in Lord Bacon's words, "Houses are built to live in, and not to look on; therefore let use be preferred before uniformity, except where both may be had." We aim at getting both, and our granite-faced piers, with their simple but bold mouldings, certainly look better than cluster-columned metallic piers, however scientific. Thus far we have succeeded in satisfying our masters, and very keen critics, the directors of the North-Eastern, the Midland, the Great Northern, and North British Railways, and the officers of the Board of Trade, both as regards the quality and appearance of the executed work. If I were to pretend that the designing and building of the Forth Bridge was not a source of present and future anxiety to all concerned, no engineer of experience would believe me. Necessarily, where no precedent exists, the successful engineer is he who makes the fewest mistakes. We cannot wait for precedents, and therefore as successive points of doubt or difficulty arise, we reason them out on the best data attainable, and then in the land of Burns' we act up to Burns' favourite motto—

"On reason build resolve—
That column of true majesty in man!"

Montreal, September, 1884. B. Baker.

* Paper read before the British Association.

Fresh Discoveries at the Fish River Caves.—These natural subterranean wonders, which more than rival the famous Kentucky Caves, have had their name altered by the New South Wales Government, and will henceforth be known as the Jenolan Caves. The keeper reports that he has made another interesting discovery, having found the entrances to several new caves, the existence of which has hitherto been unknown. Having proceeded a short distance into one of them, he was lowered down over a precipice, at the bottom of which he found a number of fossil bones. Some of the remains are stated to be those of an animal of the tiger species, and the others are at present unknown. The exploration of the interior of the caves was, however, retarded for the time being, owing to their being flooded, by heavy rains.

A True Crane Story.—Cranes, when built by ignorant or inexperienced engineers, are somewhat apt to fail at critical moments. Some years ago, a large crane of a novel design had been built to run along a wharf, and discharge a ship's cargo into the railroad cars. The crane was an enormously lofty structure spanning a line of track, and the hoisting and swinging machinery was situated some 20ft. above the rail level. The chief draughtsman knew something of mechanical engineering, but very little about cranes. The manager of the works knew very little about mechanical engineering, and nothing about cranes. Consequently the first crane of the kind was tried with a full test load on the edge of a wharf where the water was full 25ft. deep. The manager, who was deaf, and a fitter were up in the crane controlling its movements. As the test load rose in the air, the fitter heard a suspicious cracking, and ran for dear life and solid ground. The manager, being deaf, continued to smile blandly, and consequently was hurled, crane, load, chains, crabs, and all mixed up together into the water, and only brought up in the mud at the bottom, where he stuck fast. The water seethed and boiled, the bubbles rose, and then all was silence. Nothing but the deaf man's hat floated on the surface. This was serious, so a diver went down, and catching hold of a stray boot leg, succeeded in inducing a battered manager to follow it. Nine months in hospital were required to mend two broken legs, a broken arm, some cracked ribs and other minor injuries. This gentleman still builds cranes for use on wharfs, but makes the axles on which they travel over 2in. in diameter, and watches the tests from a prudent distance. As the Irish editor of an esteemed contemporary says when he commences to relate another anecdote "This *is* true." We may add that it did not happen in the United States.—*The Railroad Gazette.*

RAILWAY MATTERS.

PROPOSALS have been made to the Midland Railway Company, in connection with its harbour goods traffic at Bristol, that an elevating steam floating raft should be used to convey loaded railway trucks from the quays to the goods stations, similar to those in use on the Firth of Forth.

THE Midland directors have sanctioned the erection, at some cost, at Derby Central Station, of a coffee tavern, where refreshments of all kinds will be supplied to such of their numerous drivers, guards, porters and other workmen, at the lowest possible price; and a limited liability company is being formed among the men themselves to carry on the concern.

THE Eastern railway question seems to occupy a great deal of the time of some of the Servian and Turkish officials. The Servian Government has again made representations to the Porte on the subject of the railway junction, pointing out that the completion of the work would take at least sixteen months. Assym Pasha, in reply, gave a positive assurance that the junction would be made within the time stipulated.

WE have on several occasions suggested that English railway companies should follow the example of one or two of the continental companies and cultivate their slopes. The Midland Company intends awarding £100 annually to the servants who cultivate slopes, but if shareholders were awake to the possibilities in this direction they would secure a dividend from this source alone. A part of the staff of all railway companies should be the gardener and his men, who should make proper and very profitable use of the thousands of acres of slopes, some well sheltered and offering good gardening prospects.

THE original of "Mugby Junction" has long been a bye-word to railway men and also to the travelling public; but now all that is to be changed. The six separate lines, that contribute over a hundred passenger trains daily, have been rearranged; and a handsome new station is nearly completed. The *Contract Journal* says, the main feature will be what is known as an "island" platform, 470 yards long—the longest in England. In the centre, with 35ft. platform space on either side, is the station, with booking, telegraph, and other offices, and also waiting and refreshment rooms. The mason's work is finished, and the internal fitting is so far advanced that it is expected a portion will be ready for use early next year. The station will be covered with a handsome roof partly of glass; and a high-level platform will be of great convenience to passengers entering and leaving the carriages. A new road has been made to approach the station from the town; and the platform will be reached by a subway.

THE *Railroad Gazette* record of United States train accidents in September gives brief accounts of 46 collisions, 50 derailments, and 4 other accidents; 100 accidents in all, in which 21 persons were killed and 174 injured. The number of accidents was greater than in August, and, indeed, greater than that recorded in any month since February. As compared with September, 1884, there was a decrease of 58 accidents, of 23 in the number killed, and of 9 in that of persons injured. These accidents may be classed as to their nature and causes as follows:—Collisions: Rear, 27; butting, 16; crossing 3. Derailments: Broken rail, 1; broken frog, 2; broken bridge, 2; spreading of rails, 2; broken wheel, 1; broken axle, 4; broken coupling, 1; accidental obstruction, 2; cattle, 6; land slide, 1; wash-out, 1; misplaced switch, 8; open draw, 2; malicious obstruction, 1; unexplained, 16. Other accidents: Broken coupling-rod, 1; oil tank burst, 1; cars burned while running, 2; total, 100. Six collisions were caused by trains breaking in two, three by mistakes in orders or failure to obey them, two by carelessness in putting trains on sidings, two by failure to use signals properly, one each by fog, by cars blown out of a siding, by the wreck of a preceding train, by the breaking of a locomotive throttle valve, and by a misplaced switch.

DOWN to April 1st, 1883, 139,452 servants of the railways in the German Empire had been tested for colour-blindness. Of these 998, or less than ¾ of 1 per cent., were colour-blind. Out of 115,154 persons engaged in the outdoor railway service who were tested, 46 were found wholly and 273 partly colour-blind, or 319 in all, which is 0·277 per cent. of the whole number. The number examined by the several different methods were:—Stilling's, 60,671; Holmgren's, 32,671; Dahl's, Cohn's, Schmitt's, Rimpler's, &c., 1031; coloured glass plates in transmitted and reflected light, 7088; coloured strips of paper and other coloured materials, 5564; signals and the spectrum, 3199; 37,104 were tested by railroad officers; 76,413 were tested by railroad physicians; 754 were tested by oculists. Only one locomotive driver out of 13,616 was found totally and 27 partly colour-blind, in all 0·2 per cent. The greatest proportion was among unsuccessful applicants for appointments in the lowest grade of the service—47 out of 672. There are 19 managements which repeat the tests periodically, 28 which repeat them in special cases after sickness—typhus fever, for example—and 38 test only when entering the service. When men already engaged in the service are found defective, they are put in positions which are not directly connected with the train service, or in the less important positions.

THE *Railroad Gazette* gives the following definitions, some of which refer to railway matters:—"Some genius has been calculating values as related to human energy in various departments of life, and cites the following illustrations:—The British Poet Laureate can take a worthless sheet of paper, and by writing a poem on it can make it worth 65,000 dols.; that's genius. Vanderbilt can write a few words on a sheet of paper and make it worth 5,000,000 dols.; that's capital. The United States can take an ounce and a quarter of gold and stamp on it an 'eagle bird,' and make it worth 20 dols.; that's money. The mechanic can take the material worth 5 dols. and make it into a watch worth 100 dols.; that's skill. The merchant can take an article worth 25c. and sell it for 1 dol.; that's business. The list might be extended. A railroad president can sell you a bond warranted to pay 6 per cent., and then assess you 7 dols.; that's financial ability. A board of directors can bond a road for 100,000 dols. a mile, and then discover the traffic don't amount to a red cent; that's railroad enterprise. A man can get a railroad station for nothing, and then turn it into a dry goods store; that's Jay Gould. A man can pay 10c. for a seat in a car, have to stand all the time on a platform, and then fall off and be cut to bits, and called a drunkard; that's the Elevated. A man can run two cars together, and then find four fingers missing; that's car-coupling."

THE dissatisfacton of the traders caused by the heavy railway rates has been heightened this week by the reply received by the South Staffordshire Railway and Canal Freighters' Association from the three companies serving the Staffordshire district, in response to their application for a reduction of freights made last March. Touching the claim of the traders that the charge on damageable iron of 1s. 6d. should be reduced to 1s. per ton, the companies reply that they have taken hoop iron out of the list. A general revision of local rates was also asked for, and the reply is that a complete list of low special rates can be had on application. Rates for Northamptonshire stone remain unaltered, but reductions are made in rates from the Northampton district for pig iron. The crucial question of the rates to ports has not yet been dealt with. In the new regulations iron ore from the Forest of Dean, coke from Staveley, cinders from Sheffield, Rotherham, and Birkenhead, and pig iron from North Staffordshire will be somewhat favoured, upon paper; and certain of the hardware branches will receive relief. The rates on cut nails are to be reduced to the same as on iron in England and Wales; cast iron sugar pans are reduced 5s. to London, and from 15s. 10d., 17s., 17s. 6d., and 18s. 4d., to 15s. alongside, all in lots of 10 tons; and dished sheets and rice bowls are reduced also by 5s. to London, and by 1s. 8d. to 3s. 2d. to Liverpool; while the old rates for returned empties are to be reverted to. But the much graver addition touching delivery upon owners' sidings is to be adhered to.

NOTES AND MEMORANDA.

THE deaths registered during the week ending November 29th in twenty-eight great towns of England and Wales corresponded to an annual rate of 23·8 per 1000 of their aggregate population, which is estimated at 8,762,354 persons in the middle of this year. The six healthiest places were Plymouth, Derby, Sheffield, Brighton, Portsmouth, and Birkenhead.

DURING the week ending November 1st, 1884, in 24 cities of the United States, having an aggregate population of 5,616,500, there were 2284 deaths, which is equivalent to an annual death rate of 21·1 per 1000. The American *Sanitary Engineer* says:—The death rate in the North Atlantic cities was 21·3, in the Eastern cities 21·3, in the Lake cities 18·6, in the River cities 19·7, and in the Southern cities, for the whites 19·3, and for the coloured 36·4 per 1000.

THERE is something strange, says the *Toronto Globe*, about the cost of electric lighting. In Toronto the cost is 62 cents per light per night. In Winnipeg the cost is 1·25 dols., which is said to be accounted for by the fact that coal is dear. In Rochester the cost is 40 cents a night. This is accounted for by the fact that the dynamos are run by water power. But how is it accounted for, that in Ottawa, where water power is also used, the cost is only 22 cents a light?

THE galvanometer of Deprez d'Arsonval has been applied to the measurement of the current which is necessary for the illumination of a Geissler tube. The galvanometer was regulated to give a scale division for each hundredth-millionth of an ampère. At the moment of illumination the current was 3500 micro-ampères; it was gradually reduced until there was a sudden extinction at 150 micro-ampères. The experiment points to great advantages which may result from the use of the galvanometer in measurements of small intensities.

IN London last week 2587 births and 1716 deaths were registered. Allowing for increase of population, the births were 72 and the deaths 81 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate from all causes, which in the two preceding weeks had been 19·6 and 19·7 per 1000, rose with the cold weather to 22·3, a higher rate than has prevailed in any week since the beginning of August. In Greater London 3327 births and 2142 deaths were registered, equal to annual rates of 34·1 and 21·9 per 1000 of the population.

AT a recent meeting of the Chemical Society Dr. Thorne communicated the substance of a paper by Khan Bahadur Bomanji Sobrabji, on some new paraffins. The reaction used by the author is the one proposed by Wurtz: $2\ Cn\ H_{2n} + I + Na_2 = 2\ Na\ I + Cn\ H_{2n} + Cn\ H_{2n+2}$. The author gives an account of the preparation and properties of the following bodies: Cetane, $C_{16}H_{34}$, boils at 278 deg., melts at 18 deg. to 20 deg.; its vapour density was found by Meyer's apparatus 7·9 to 7·85; theory requires 7·84. Dicetyl, $C_{32}H_{66}$, crystallising in glistening scales, which melt at 70 deg. Ethylcetyl and Diheptyl, boiling-point 245 deg.

AT a recent meeting of the Academy of Sciences, a paper was read on an experimental demonstration of the inversion of the electro-motive force produced by the contact of iron and copper at a high temperature, by M. F. F. Le Roux. From the results of several series of experiments, conducted under varying conditions, the author concludes that at about the temperature of 1000 deg. an electric current passing from the copper to the iron heats the point of contact, while cooling it at the ordinary temperature. *Nature* remarks that "a knowledge of this fact, now for the first time demonstrated, may affect not only the theory of thermo-electricity, but also that of certain chemical phenomena."

THE aluminium cap of the Washington Monument has been completed. A *Standard* correspondent says its weight is 117 ounces. It is a better conductor of electricity than silver when alloyed with 90 per cent. of copper; its strength is, weight for weight, greater than steel; it is lustrous in appearance, and proof against corrosion. "Mr. Frishmuth, who was a pupil of Herr Wohler, the discoverer of aluminium, has, after years' research, discovered a method of substituting some cheap carbon compounds of sodium for the costly metallic sodium which is so dangerous in the process of manufacture. He also announces the discovery of a solder called the Emerson-Foote metal. Merchants are sanguine of the value of this discovery. Mr. Carnegie believes that the process will prove to be the Aladdin's lamp of metallurgy."

MR. W. CROOKES, F.R.S., and Drs. W. Odling and C. Meymott Tidy, reporting on the composition and quality of daily samples of water derived during October from the mains of the seven London water companies taking their supplies from the Thames and Lea, state that "of the 188 samples subjected to examination, three were found to be very slightly turbid. The remaining 185 samples were perfectly clear, bright, and well filtered. As regards degree of freedom from organic matter, the water supplied to the metropolis during the month has more than maintained the character it has now exhibited continuously for a long time past. Thus, while the mean proportion of organic carbon in the water supplied by the Thames Companies during the previous three months was ·128 part in 100,000 parts, the mean proportion in the Thames derived water supply during october was only ·118 part in 100,000 parts, corresponding to about two-tenths of a grain of organic matter per gallon, this excessively low proportion of organic matter being, it must be said, quite unusual for the period of the year."

AT the last meeting of the Royal Microscopical Society a new lantern microscope with the oxy-hydrogen light was exhibited, which, according to the opinions expressed by some of the most eminent microscopists of the day, is destined to be of great service to lecturers who require to exhibit microscopic objects to classes or audiences. A number of anatomical and other objects, mounted by Fellows of the Society, were exhibited on a screen 14ft. square; and Mr. Lewis Wright, and Messrs. Newton and Co., of Fleet-street, the makers of the instrument, received high commendations for the brilliancy and sharpness with which the details of the subjects were shown. The results obtained were, in the opinion of Dr. Dallinger, F.R.S.—president—Dr. Carpenter, Professor Stewart, Mr. Michael, Mr. Crisp—hon. sec.—and others, greatly in advance of anything that has been previously obtained, far exceeding in definition the Giant Electric Microscope exhibited last year. This instrument was also exhibited at the recent meeting of the Quekett Microscopical Society, when the blow-fly's tongue was shown from 6ft. to 14ft. long, and a section of a drone-fly's eye was magnified 2500 diameters.

AT the meeting of the Chemical Society, on the 20th ult., a paper was read "On the Application of Iron Sulphate in Agriculture, and its Value as a Plant Food," by A. B. Griffiths. The paper contains an account of further researches on this subject—Chem. Soc. Trans. 1884, 71. The author has grown duplicate crops of beans, turnips, and wheat under similar conditions, excepting that one set was manured with ½ cwt. of ferrous sulphate per acre, the other having no iron salt added. With the beans, the crop with the iron yielded 44 bushels of grain, without the iron only 28 bushels were produced, the plants and the pods in the first case—with iron—contained more iron and phosphoric acid than in the second—without iron. No difference as regards these constituents was found in the seeds. In the case of wheat no very marked increase in the weight of the crop was observed, but the wheat grown with the iron seemed to be healthier, and completely resisted rust, which attacked the crop grown without iron. With the turnips, the plot manured with ferrous sulphate gave 16½ tons, the unmanured 13 tons of roots. The former contained markedly more iron and phosphoric acid. From some estimations of chlorophyll made by Dr. Russell, it appears that the use of sulphate of iron increases the amount of chlorophyll in the leaves. An excess of sulphate of iron acts as a poison. This paper is of importance to owners of works for separating copper for the wet process.

MISCELLANEA.

ADVICE has been received that the Yarrow stern wheel steamer, which was put together at Alexandria, reached Assouan last Sunday, and passed the cataract easily. The passage from Cairo to Assouan, including stoppages, was the quickest on record, towing 30 tons in two lighters.

THE Thirty-sixth Bingley Hall Fat Stock and Poultry Show came off in Birmingham this week. The space allotted to the individual implement firms was curtailed, compared with previous exhibitions. Still there was an extensive and well-selected selected collection. There were 137 exhibitors.

AN oil mill has lately been established in Hamburg for the extraction of oil from cotton-seed. This is the first establishment of the kind erected in Germany. The oil industry in Hamburg has reached more than 40,000 metric tons of seed nuts, and other oleaginous substances annually used in the oil manufacture.

THE *Kölnishe Zeitung* gives an account of the opening of one of the feed-water purifying apparatus, made by Gebrueder Stolwerck, Cologne, as illustrated in our columns some time since, and speaks very highly of the action of the apparatus, after three and a-half years' use in connection with a 100-horse power boiler.

BELGIUM is making full use of the telephones. Telephonic service is complete between Brussels and Antwerp, the wires being used both for telegraphing and telephoning, and the Government intends establishing telephonic connection between Brussels and Liége, Verviers, Mons, Ghent, Charleroi, and Louvain.

THOSE who are interested in the free use of zinc in modern buildings may see it in the now nearly completed Hotel Metropole, at Northumberland-avenue. Messrs. F. Fraby and Co. are carrying out extensive exterior decorations of the two top stories of the immense pile of buildings, and the louvre or mansard roofs are entirely in that material.

IN the lead production of different countries, Spain holds the first place, the amount reaching some 120,000 tons in one year, or one-sixth more than America, which comes next on the list, while Germany follows with 90,000. Of Spain's total production, some 67,000 tons are derived from one district, that of Linares, in which more than eight hundred mines are registered.

THE council of the Wolverhampton Chamber of Commerce have appointed a sub-committee to draw up a representation to the Board of Trade, asking that, either through the medium of our consuls or otherwise, British manufacturers should be furnished with more exact and early information as to the description of manufactured goods needed by foreigners, with the object of increasing British trade.

ON Tuesday there was launched from the yard of her builders, Messrs. Raylton Dixon and Co., an iron steamship of the following dimensions:—Length over all, 203ft.; breadth, 30ft.; depth moulded, 15ft. 10½in.; with a carrying capacity of 1120 tons on 14ft. 10in. draught. She is built on raised quarter deck rule, and with water ballast in cellular bottom. Her engines, of 95-horse power, are by Messrs. Blair and Co., of Stockton. She was christened the Redistribution, *pro tem.*

THE Society of British Artists has a good collection of pictures in Suffolk-street this year. It is not within our province to criticise those that are of the most interest, and we can only refer to one that illustrates ploughing in Kalaylei. The one-tined dirt scrabber is pulled by a donkey and two free slaves, working like two young Englishmen on pleasure bent, towing a lady-laden boat up the Thames with three miles to go and a heavy storm just commencing, and is guided by an individual in the rear with a sunshade. Probably these people will be soon able to buy a 25s. plough, such as those we recently referred to.

THE Aston Local Board decided, at a special meeting last week, by twelve votes to one, to apply to Parliament for power to purchase and carry on the Aston portion of the Birmingham gas undertaking. It was stated that the site of the proposed new works, together with railway and canal frontages, had been secured at a cheap rate; and Mr. Geo. W. Stevenson, C.E., Westminster, estimated that the profit which could be made by Aston in relief of the rates would be from £7000 to £8000 per annum. The action of the Board will, however, have to be approved by the ratepayers.

IN connection with the new Windsor-street Gasworks of the Birmingham Corporation, an expenditure of £7000 has been authorised in the extension of the railway viaduct, and in the provision of the necessary elevators and motive-power for loading from stock. This portion of the viaduct will be required for the coal supply as the new retort house is brought into operation. The contract for the extension of the viaduct has been given to Messrs. Piggott and Co., engineers, of Birmingham, their tender amounting to £6470. The sales of gas by the Corporation for the quarter ending September amounted to 30,439,209,600 cubic feet, which was an increase of 1 per cent. over the third quarter of last year.

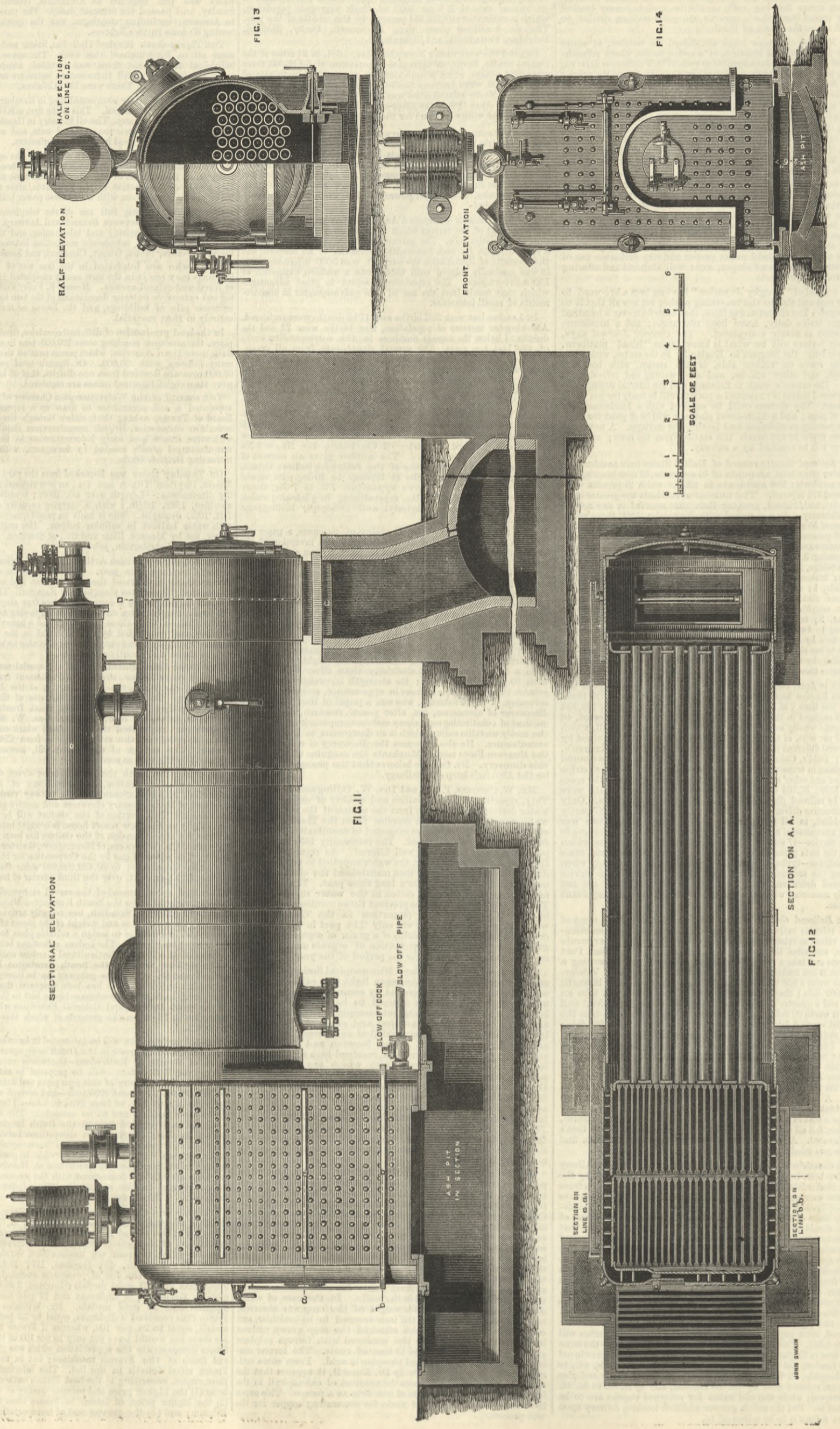
THE final consignment of the carved stonework of the Gwalior gateway, presented to the South Kensington Museum by his Highness the Maharajah Scindiah, has recently arrived in London, but owing to the great size and weight of the pieces of masonry, it has been found impossible to assign a suitable place to it in any part of the present buildings. The Indian collections being located in the galleries of the Royal Horticultural Gardens until the completion of the western wing of the South Kensington Museum, no site can be found on which the gateway can be incorporated with the permanent buildings. It has been proposed that this imposing example of Indian art workmanship be lent to the Commissioners for the great Indian and Colonial Exhibition which is to be held in London in 1886, on the grounds of which there would be space to erect it.

SOME of our readers will be interested in knowing that, in a few days, notices will appear in the Dutch newspapers that the Local Board of Works of Rotterdam—Commissie voor de Plaatselyke Werken van Rotterdam—will be prepared to receive tenders for the supply and delivery of cast iron pipes and fittings of from 24in. to 6in. diameter—about 4000 tons—and several sluice valves and hydrants—about 250, of from 24in. to 3in.—all for the waterworks of the town, which are to be extended. The specification and conditions are printed only in the Dutch language, and though there is in such cases always competition between English and other foreign manufacturers who have agencies in Holland, others will no doubt like to know what is going forward. The tenders must mention the price free at Rotterdam, and all the articles must exactly correspond with the drawings, patterns, and the description in the conditions. The adjoint director of town works is M. J. W. Veiszen.

THE American Consul—Mr. Williams—at Rouen has prepared a report on the cost of constructing machinery in Europe, and mentions that at the recent International Exhibition at Amsterdam, in the category of competitors for the manufacture of machines, there were 380 exhibits from ten nationalities, divided as follows:—France, 70; English, 46; German, 119; Belgium, 86; other countries, 59. In the list of premiums awarded, France received 9 diplomas and 21 gold medals; England, 2 diplomas and 8 gold medals; Germany, 4 diplomas and 19 gold medals; Belgium, 4 diplomas and 15 gold medals. Mr. Williams points out that France thus received 9 diplomas, equal to 35 per 100, and 21 gold medals, equal to 28 per 100, whereas if France had only received her share she would have got only 18 per 100 of the prizes. These figures demonstrate the appreciation which was given to the design and finish of the French machines; but in the matter of cost France stood fourth in the list. This inferiority is ascribed to three causes, according to the best French authorities, such causes being (1) the higher price and inferior quality of the French coal; (2) the higher price of labour in France than in Germany and Belgium; and (3) the greater cost of transportation.

THE VICTORIA ELECTRIC LIGHTING INSTALLATION—BOILERS.

(For description see page 419.



THE VICTORIA ELECTRIC LIGHTING INSTALLATION—DETAILS.

(For description see page 419.)

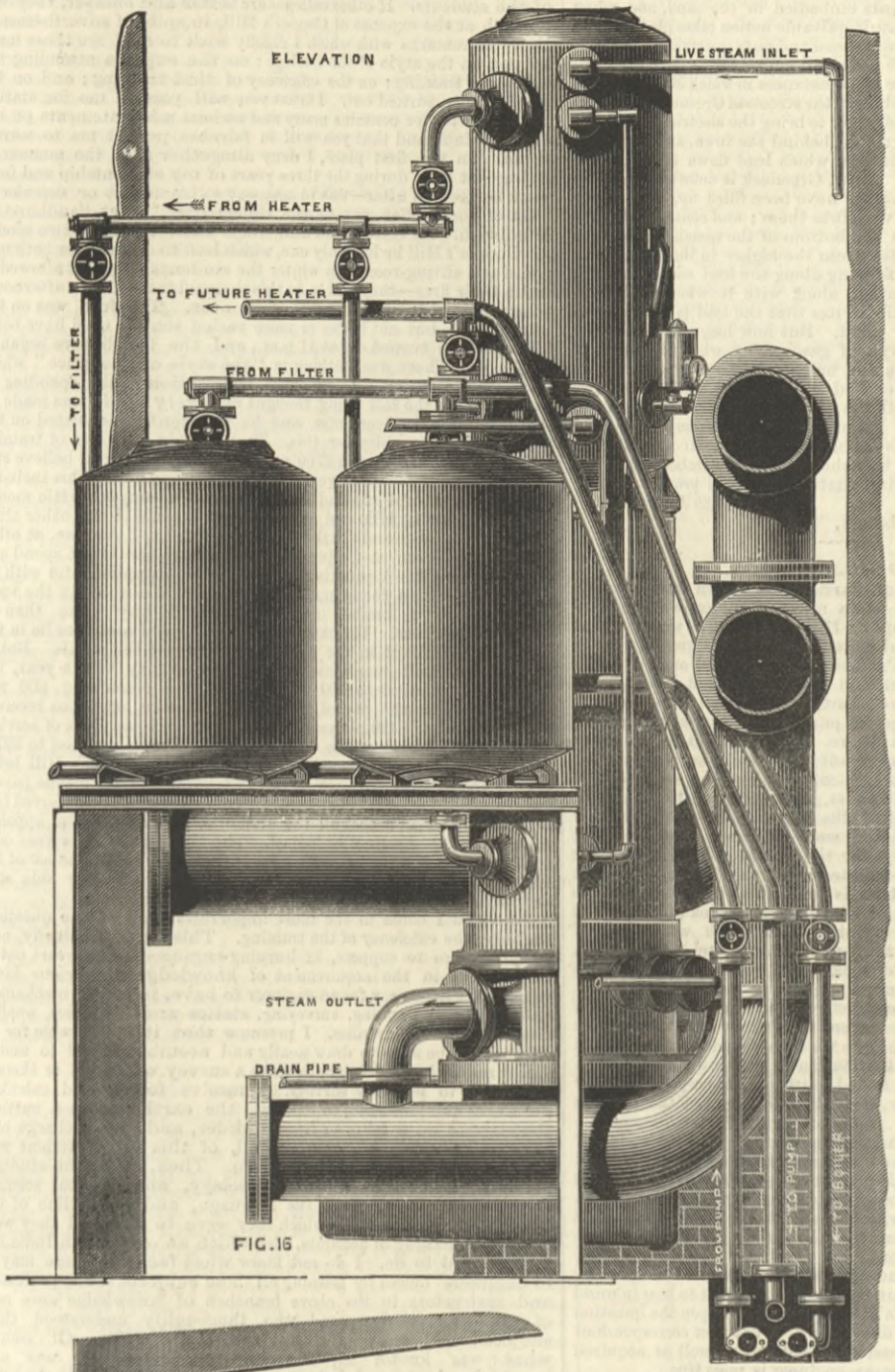


FIG. 16

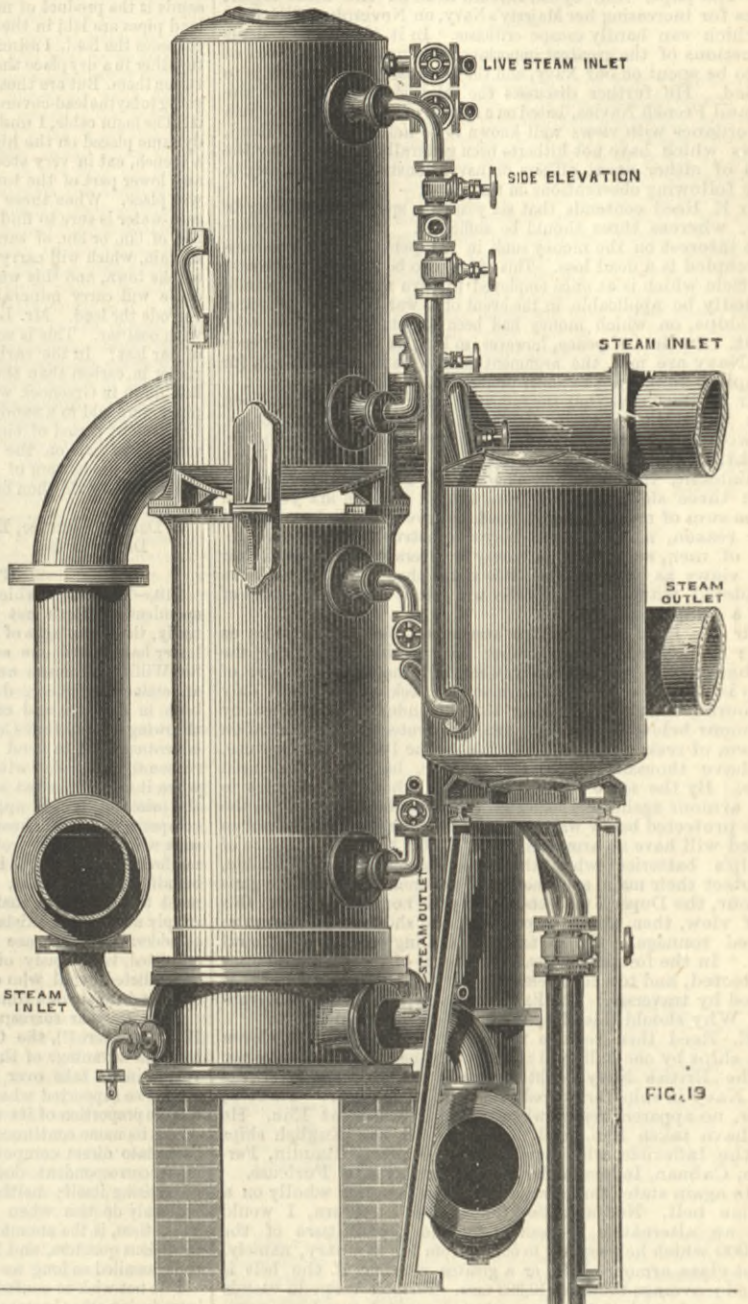


FIG. 19

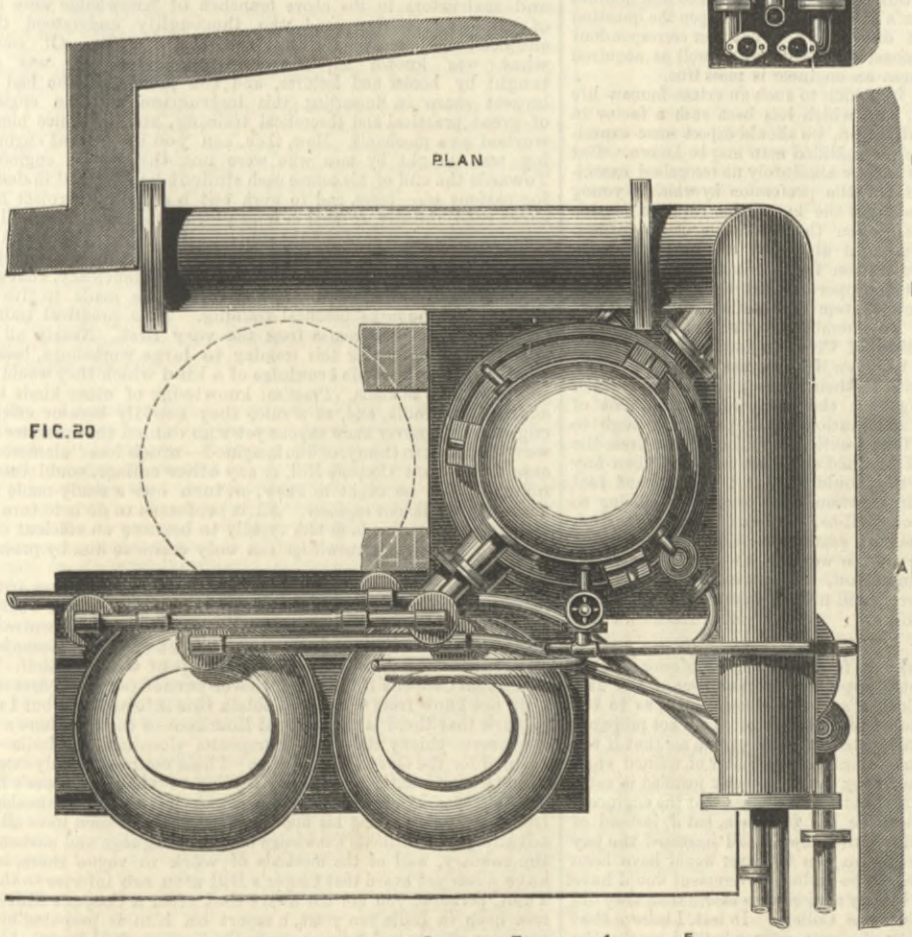
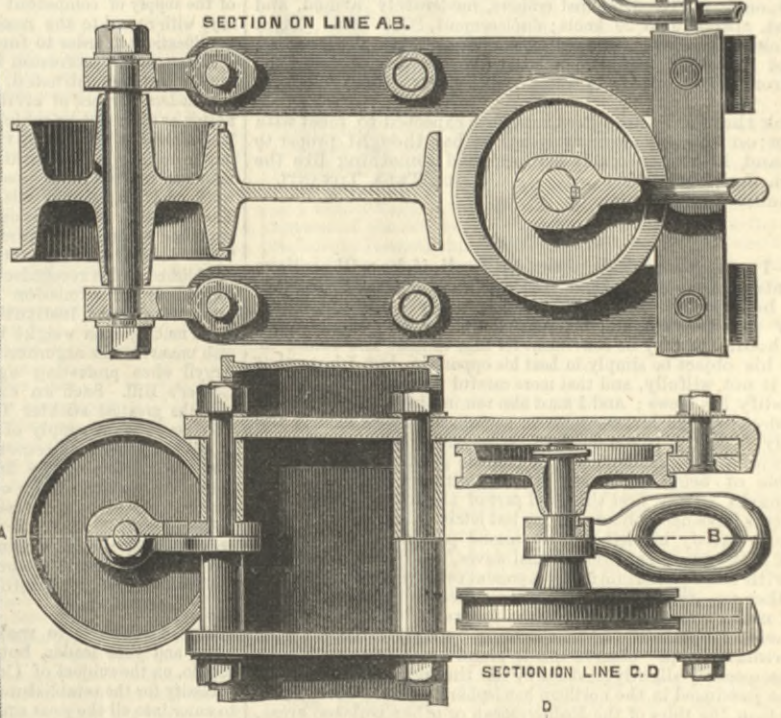


FIG. 20



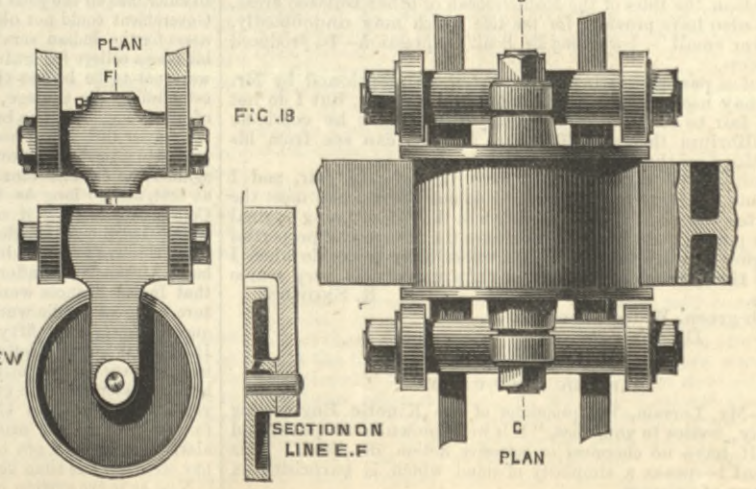
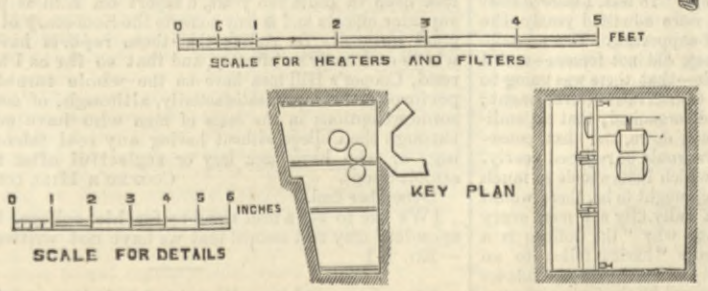


FIG. 18



JOHN SWAIN

LETTERS TO THE EDITOR.

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

THE CONDITION OF THE NAVY.

Sir,—The paper read by Sir Edward Reed on the most urgent measures for increasing her Majesty's Navy, on November 26th last, is one which can hardly escape criticism. In it the writer deals with questions of the greatest importance—namely, the amount of money to be spent on our Navy, and the purposes to which it is to be applied. He further discusses the relative strengths of the British and French Navies, based on a system of classification which is in accordance with views well known to be held by Sir E. Reed, but views which have not hitherto been generally endorsed by the opinions of either naval officers or naval constructors. I beg to offer the following observations on the paper:—

(1) Sir E. Reed contends that six years are spent in building an ironclad, whereas three should be sufficient. Hence he argues that the interest on the money sunk in the period thus unnecessarily occupied is a dead loss. This appears to be sound in the case of an article which is at once employed to earn money. It would undoubtedly be applicable in the event of a war breaking out and finding ships, on which money had been spent, unready to take part in it. In time of peace, however, so long as the current needs of the Navy are met, the argument cannot be fairly applied, for the complete ship is not actually productive.

(2) Sir E. Reed says that the following ships ought to have been built in three years—Rodney, Warspite, Imperieuse, Colossus, Collingwood, Edinburgh, Howe—and ought now to be complete. He ought, however, to make it clear that, with the money voted by Parliament, this would be impossible. The only choice lies between three ships in three years, and six ships in six years, on the same sum of money. Sir E. Reed, however, might have added another reason, namely, that delayed constructions involve removals of men, and waste of money in alterations, made to suit altered views as time goes on. It is stated that the Benbow is to be completed without delay. This will afford an opportunity of making a comparison.

(3) Sir E. Reed only reckons armour on the ship's sides as armour; horizontal plates, however thick or however near the water, he ignores. Consequently, when half the displacement of the ship is protected by vertical armour, he reckons that half only as armoured tonnage. Whether the remainder is protected by deck armour below the water, or totally unprotected, is ignored on his system of reckoning. On this principle, the Italia and Lepanto, which have thousands of tons of armour, have no armoured tonnage. By the same mode of reasoning, when he proposes to provide armour against torpedo attack, he should only reckon the tonnage protected below water against torpedoes, and ships not so protected will have no armoured tonnage. Or to take the case of the ship's batteries—while the Ajax, Agamemnon, Inflexible, &c., protect their main armament and the men working the guns by armour, the Duperré protects neither guns nor men. From this point of view, then, she is unarmoured, and should not reckon as armoured tonnage. Or to take the Collingwood and Amiral Baudin. In the former the gun detachments of the principal guns are protected, and to a considerable extent the lighter armament is protected by traverses. The Baudin offers neither of these advantages. Why should this difference in armour be ignored?

Sir E. Reed then reduces the armoured tonnage of eleven English ships by one-half, and at length advances two propositions:

(1) The British Navy ought to possess some excess over the French Navy in ships armoured with 15in. of armour. There is, however, no apparent reason why the limit is drawn at 15in. He might have taken 19in., and thrown out all the English ships except the Inflexible, while retaining the Duperré, Baudin, Formidable, Caïman, Indomptable, Requin, Terrible, and Furieuse.

(2) He again states that armoured tonnage depends wholly on a water-line belt. Not accepting Sir E. Reed's system, I would suggest an alternative proposition for the expenditure of the £6,355,000 which he proposes to obtain from the country, namely, five first-class armour-clads, or a greater number if the belt is shortened; average tonnage, 10,000 tons. Fifteen torpedo vessels of high speed, with machinery protected against machine guns, carrying a 6-pounder quick-firing gun, and costing from £30,000 to £35,000 each. Five armoured cruisers, moderately armed, and very fast, speed 19 to 20 knots; displacement, 8000 tons. Eight or ten fast unarmoured, but protected cruisers, with under-water deck not less than 2½in. to 3in., and a good reserve of buoyancy apart from coal; speed, 18 knots. Fifty boats of the Childers type.

I think that Sir Edward Reed must have expected to meet with criticism on the very sweeping system he has thought proper to follow, and he may probably have expected something like the above on the principle of

Sua Tela Tonanti.

December 2nd.

TIDAL ACTION.

Sir,—I must particularly request Mr. Boult, if he will continue this controversy with profit, to read my letters so that at the conclusion he may criticise—if he so essays—only such ideas as I actually put forward, and not such as are the very antipodes of those I hold. It may be convenient for him to take the course he does, if his object be simply to beat his opponent, but I hope that he does it not wilfully, and that more careful perusal of my letters will modify his views; and I must also remind him when he says, "Should encourage Mr. Snowdon to explain his views clearly and distinctly," that it is too much to expect an ordinary individual to so simplify the explanation of an abstruse principle as to render it capable of being understood entirely without mental effort. The remarks in the first three and part of the fourth paragraphs of his letter have no application to my last letter at all, as the reader may easily satisfy himself. In my second paragraph I distinctly speak of "the two great primary tidal waves," and everything connected with this equilibrium theory is present to my mind throughout; and further on—far from implying that no effect is produced by the sun and moon's resultant attraction on the waters of the northern hemisphere, I speak of our tides as being "simply offshoots from these primary neaps—observe this is plural—superimposed upon and consequently slightly modified by the tiny upheavals and depressions produced in the northern hemisphere. I am sorry I did not mention the tides of the Mediterranean or other isolated areas, I might also have provided for the tide which may undoubtedly, "however small"—borrowing Mr. Boult's expression—be produced in a teacup.

Men of a past generation, as some of those mentioned by Mr. Boult, may have adhered to the ideas of their youth, but I do not think it fair to Sir William Thompson to infer that he considers the equilibrium theory inadequate, as far as I can see from his observations on the Mediterranean tides.

The remainder of Mr. Boult's letter is perfectly fair, and I admire his ability as a statistician. I do not think I can meet the case better than by explaining—though at the risk of being original on some points perhaps—what I conceive the nature and properties of an aqueous wave to be, and this I will endeavour to do when I can find time, which fortunately, or unfortunately, is very scarce with me.

R. Snowdon.

Hough-green, Widnes, Lancashire,
December 2nd.

ELECTRIC LIGHT CABLES.

Sir,—Mr. Lorrain, the proprietor of the Kinetic Engineering Company, writes to you, that, "It is well known that pure sand can itself have no chemical or corrosive action on lead." This statement bespeaks a simplicity of mind which is surprising in these days of progress.

The only naturally pure sand is that of white quartz, but it is found in very small quantities. As I have studied the geology of the neighbourhood of Greenock, I know that there is no white quartz sand to be found there. The nearest approach to it is a sand which is the *débris* of a stone which consists of white quartz sand held together by a lime matrix. Now the most destructive soil that lead pipes can be laid in is sand having in it a small proportion of lime. The colouring matter of red, yellow, and grey sands is the product of minerals embodied in the sand, and when lead pipes are laid in these sands galvanic action takes place, which corrodes the lead. I admit that if lead and pure quartz sand are kept together in a dry place that no chemical action will be developed between them. But are these the circumstances in which Mr. Lorrain is going to lay the lead-covered cables in the streets of Greenock? Far from it! The main cable, I understand, is to bring the electricity from the dynamo placed on the high ground behind the town, and passes in a trench, cut in very steep streets, which lead down to the docks and lower part of the town. Now, Greenock is notoriously a very wet place. When these trenches have been filled up, the surface rain-water is sure to find its way into them; and consequently the bed of 6in. or 8in. of sand in the bottom of the trench will become a drain, which will carry water from the higher to the lower parts of the town, and this water flowing along the lead coating of the cable will carry mineral matter along with it which will soon corrode the lead. Mr. Lorrain writes that the lead is to be coated with coal tar. This is so far good. But how long will the coating of tar last? In the early days of gas-making, when the tar was richer in carbon than the gas tar now made, the iron water pipes laid down in Greenock were coated with coal tar, but when these pipes were laid in a sandy soil the gas tar coating lasted a comparatively short period of time. There is an abundant supply of peat moss to be had on the hills behind Greenock. If Mr. Lorrain would fill the bottom of the trenches with it and embed the cables therein, he would then be doing that which would prove a permanent good.

James Johnstone.

8, Dalhousie-terrace, Edinburgh,
December 1st.

COOPER'S HILL COLLEGE.

Sir,—The letter which your article has drawn from a correspondent sets forth not less than my own, but more circumstantially, the advantages of Cooper's Hill College. The writer of that letter having had one son educated at Glasgow University under Sir William Thomson and Professor Rankine, and another under an eminent engineer, determined after the fullest investigation both in England and on the Continent, to avail himself of the throwing open of that College for purposes of general engineering education, and to send him there. He states that he has every reason to be satisfied with the result; and, moreover, predicts that when it is known what splendid training there is there, and that the prizes are Indian appointments, that there will be no lack of competitors, or of those who, like himself, desire to have their sons well trained for professional work at home. The public will no doubt be gratified to hear that the outlay undertaken on their behalf is, at any rate, appreciated; but this, after all, does not meet the case. An institution is founded at a great expense to supply a want, the existence of which is a matter on which there is considerable difference of opinion, but which want, even if admitted, is obviously of a temporary nature, and consequently, as predicted by all who could look a few years ahead, the failure of the scheme in due time ensues.

Then, as your correspondent naively puts the case, as Cooper's Hill was there (!), the Government very wisely said, "Let others have the advantage of the College we have founded." But was it very wise to take over an institution which had hitherto been otherwise supported when it failed in its original purpose, and, for a large proportion of its work, departing directly from that purpose which its name continues to imply, to bring the resources of the State into direct competition with previously exisiting colleges? Your correspondent does not see any harm in Cooper's Hill advertising itself; neither, I presume, does anybody else, but it will only do this when it ceases to be supported by the public. This, then, is the anomaly which has been the cause of comment in various quarters, and it, and not the College itself, will continue to be assailed so long as it continues to exist.

I do not wish to confuse the present plain state of the case by introducing other matters, but it is most important to bear in mind that the founding of Cooper's Hill really turned upon the question of the supply of competent engineers. What your correspondent says with regard to the necessity for natural as well as acquired qualifications in order to form an engineer is most true.

Hence, in this profession in which to such an extent human life and property are entrusted, and which has been such a factor in the modern advance of civilisation, we should expect some examination or some test by which a qualified man may be known. But incredible as it may seem, there is absolutely no recognised examination entirely in the hands of the profession by which a young man may prove that he possesses the knowledge requisite for his work or is acquainted with even the rudiments of his calling. The Institute of Surveyors and also that of Architects have organised schemes of examination for admission to their bodies which have received hearty support. Had there been already established such a recognised system of examination, even if not compulsory for admission to membership, still conducted and undertaken by the Institution of Civil Engineers, it would have given much greater weight to, even if it had not been made to furnish unanswerable arguments in their memorandum to the Duke of Argyll when protesting against the proposed establishment of Cooper's Hill. Such an examination, made practical enough to suit the greatest stickler for practice, would have answered the question as to the supply of trained engineers far better than any number of general statements could do. It is a significant fact that the students of the Institution have been lately moving to obtain the sanction of the council to a system of voluntary examination for students. It seems scarcely possible that the most powerful body of its kind in the world, with its 4000 members, great wealth, perfect organisation, efficient officers, and so well suited to undertake this work, will much longer delay to do so.

H. S. Helb Shaw.

University College, Bristol,
December 2nd.

Sir,—I ask leave to make a few remarks on Professor Shaws' letter and your leader, both appearing in your issue of the 21st ultimo, on the subject of Cooper's Hill College. First, as to the necessity for the establishment of the College: I am not prepared to enter into all the *pros* and *cons.*, but it appears to me that if the Government could not obtain a sufficient number of trained engineers for the Indian service, they were perfectly justified in establishing a college for training them. You state that the engineers were not to be had at the price bid for them, but if, instead of establishing the College, the Government had increased the pay of all its engineers, the burden on the taxpayer would have been far heavier than it has been. The Indian Government would have protested a good deal more loudly against this course than they did against the establishment of the College. In fact, I believe that at first, and so long as fifty students were admitted yearly, the College was almost, if not quite, self-supporting. The mistake which Government made was that they did not foresee—and I think this was in some degree excusable—that there was going to be an Afghan War, under a succeeding Conservative Government; that Indian finances were to become disorganised; that expenditure on great public works was to be cut down, and that, consequently, fewer than fifty new engineers would be required yearly. If the great works, chiefly railways, of which India stands so much in need, were carried out as fast as they ought to be, there would be ample scope for the employment of fully fifty new men every year. The above are the only reasons why "the College is a failure." As to the number of students "having fallen to an alarming extent," I am not aware that the number of candidates has ever been less than the number required by the Government.

Next as to the system on which the College is now carried on. I agree with Mr. Bower, whose letter appears in your last issue, that as the College has been established, Government is quite right to keep it as full as possible. The staff of professors could not be much reduced, because one professor is not able to teach several totally different subjects; and for anything we know, it may be in contemplation to again increase the number of Indian appointments at no very distant date. Government has a right to advertise the College, and to construct the necessary laboratories, &c., for the use of the students. If other colleges are better and cheaper, they will flourish at the expense of Cooper's Hill, in spite of advertisements. But the remarks with which I chiefly wish to deal are those made by you on the style of the College; on the expense attending the course of training; on the efficiency of that training; and on the kind of men turned out. I trust you will pardon me for stating that your leader contains many and serious mis-statements on the above points, and that you will in fairness permit me to correct them. In the first place, I deny altogether that the manner of living—at least during the three years of my studentship and for a year before and after—was in any way extravagant or superior to that of young men, say, at the Universities, or at Sandhurst or Woolwich. At Oxford and Cambridge each man has two rooms. At Cooper's Hill he had only one, which had to do duty for both bedroom and sitting-room. In winter the students were not allowed to light their fires—they had to do this themselves—till the afternoon, when most of the lectures, &c., were over. The food was on the whole good, but not better or more varied than it need have been. The gas was turned off at 11 p.m., and the first lecture began at 7.45 a.m. There was nothing in "the style of the place" which conduced to outlay. So far from moderation in the spending of money being the last thing thought of, every effort was made by the President to economise, and he frequently inculcated on the students the necessity for this. Then, again, the cost of training at Cooper's Hill was not £700 or £800, but was, and I believe still is, £150 a year for three years, or £450 altogether. This included everything except medical attendance. Of course a little money might go in wine bills and subscriptions to cricket and other clubs—or, say, in beer and skittles—but so it might, I suppose, at other places, and even at Cooper's Hill a student could not spend any money unless his "parents and guardians" supplied him with it. Of course, also, a young man cannot live for nothing in the vacations, if he is trained at Cooper's Hill any more than if trained elsewhere. The expense of training did and does lie in the fees alone, and not in the manner of living of the pupils. But if the parents and guardians were unable to pay £150 a year, the fees were reduced to £90 a year, and the remaining £60 was deducted from the pay of the young engineer, who thus received £360 instead of £420 per year during his first three years of service. By this system the whole cost of training was reduced to £270. Is this "frightfully expensive?" So far from Cooper's Hill being a rich man's College, many persons of very slender means passed their sons through it. I suppose this arrangement of deferred fees does not exist now that all the students do not obtain appointments, but that cannot be helped. The fees of £150 per year only just sufficed, if they did suffice, for the proper maintenance of the College, and the adequate remuneration of the very able staff employed.

And now I come to the most important part of the question, namely, the efficiency of the training. This consisted chiefly, not, as you seem to suppose, in learning engineering by heart out of books, but in the acquirement of knowledge of various kinds which it is necessary for an engineer to have, including mechanical and freehand drawing, surveying, statics and dynamics, applied mechanics and hydraulics. I presume that it is desirable for an engineer to be able to draw neatly and accurately, and to understand a drawing, to sketch, to make a survey with level or theodolite, and to plot his surveys, to resolve forces, and calculate pressures and momenta, to calculate the earthwork in a cutting, the stresses on a beam or framed girder, and the discharge of a channel or pipe. All, or nearly all, of this every student who passed out of Cooper's Hill could do. Then, again, the students attended lectures on chemistry, geology, and physical science; they learnt something of the language, and an outline of the history, of the country in which they were to live, and they were taught something of accounts, with which an engineer in India has a great deal to do. I do not know what facilities there may be in engineers' offices for learning all these subjects. The professors and instructors in the above branches of knowledge were men of the highest class, and who thoroughly understood their subjects, and most of them are there still. Of course, what was known as "descriptive engineering" was also taught by books and lectures, and the professor who had the largest share in imparting this instruction was an engineer of great practical and theoretical training, and had once himself worked as a mechanic. How, then, can you assert that engineering was taught by men who were not themselves engineers? Towards the end of his course each student had to send in designs for various structures, and to work out a complete project for a short road, railway, or canal in some place near the College, all the surveys, &c., being made by the students in groups. Then you say that at first no attempt was made to give a practical training in this country, and that so apparent was the deficiency, that at a comparatively early period arrangements were made to give the students six months' practical training. This practical training formed part of the course from the very first. Nearly all the students were sent for this training to large workshops, because there they would obtain knowledge of a kind which they would not easily pick up in India. Practical knowledge of other kinds they acquired in India, and, as a rule, they rapidly became efficient engineers. I never knew anyone yet who denied that practice was worth more than theory, or who imagined—much less "clamorously asserted"—that Cooper's Hill, or any other college, could teach a man all that he ought to know, or turn out a ready-made and thoroughly efficient engineer. All it professes to do is to turn out a man so trained as to fit him rapidly to become an efficient engineer. His practical knowledge can only come to him by practical experience.

But I deny altogether that Cooper's Hill men, when they arrived in India, were practically useless. On first arrival a man would be employed, perhaps in making a survey, setting out the centre line of some great work, or collecting materials at the site of some large structure. In a year he would be in charge of works himself. You state that Cooper's Hill men have never turned out quite first-rate. I do not know from whence you obtain this information, but I may remark that there is in India—at Roorkee—a college where a few engineers—chiefly the sons of Europeans domiciled in India—are trained for the Government service. Their course of study extends over twenty months, and is very similar to that at Cooper's Hill, and the passed student has to serve a year's apprenticeship in India before receiving his appointment. These men have all the advantages of intimate knowledge of the language and customs of the country, and of the methods of work in vogue there, but I have never yet heard that Cooper's Hill men are inferior to them. Then, perhaps, you are not aware that after a Cooper's Hill man has been in India two years, a report on him is prepared by his superior officers and is sent home to the Secretary of State. I have good authority for stating that these reports have been on the whole eminently satisfactory, and that so far as I have heard and read, Cooper's Hill men have on the whole turned out well and performed their work satisfactorily, although, of course, there are some exceptions in the cases of men who have managed to pass through the College without having any real talent for engineering, or who have been lazy or neglectful after receiving their appointment.

Cooper's Hill on Furlough.

December 2nd.

[We like to see a man stand up for his college, but our correspondent may rest assured that we have not written in ignorance.—Ed. E.]

Sir,—I am glad to see this subject is being again taken up. In your article some important points are not alluded to. The ostensible use of this college is to provide competent engineers—*i.e.*,

theoretically competent—because the college has no means of teaching the practice of engineering. Many Indian works were stopped on the ground that the expense was too great, and that they could never pay. This was quite true—the famine was cheaper than public works. But who designed and managed these works? Not men from civil engineers' offices, or from any university. The chief engineers were and are still men taught at Woolwich; and suppose the education at Cooper's Hill perfect, the connection between the education and the chief engineers is not visible. There is really no use in keeping up two engineering colleges, one at Woolwich and one at Cooper's Hill, and keeping up a chronic feud between the two classes of men.

Some years ago I printed a small paper to show that the heads of the Indian Irrigation Department did not know the elements of Euclid. The Department never attempted to answer this paper; on the contrary, they know my paper is correct. But of course no public Department will ever alter their standard pattern, however useless or extravagant.

I do not know if Euclid is taught at Woolwich. I fancy not, as many millions have been wasted on a system that can be proved wrong with a parallel ruler and a pencil. A. G. MURRAY.

141, George-street, Edinburgh,
December 1st.

SIR,—I have read with much interest your attack on Cooper's Hill College, and Mr. Bower's defence of it. It is quite natural he should defend his college, but I venture to submit that Mr. Bower is not in this case a fair judge. I happen to know something of Mr. Bower's sons. One of them at all events took during his career almost every prize he ever competed for, and I suspect that he is not the only clever son in the family. I suppose almost any college would be glad to have such men, and they could get more good out of even an indifferent college than others. Besides Mr. Bower has told us nothing of the part he as a practical engineer played, consciously or unconsciously, in training his son. I think I really must put Mr. Bower out of court. He has no case.

The men to speak of Cooper's Hill are those who got the pupils when they were sent out to India. I have not been in India myself, but I have known many Indian engineers—in the highest positions some of them—and I never heard one of them speak well of Cooper's Hill training. "They have to learn engineering when they come to India," that is what I have always been told. One-half their profession, to use your words, they learned in college, and no more. A practical fact such as the statement I have quoted is worth a bushel of such arguments as those used by Mr. Bower.

A very intimate friend of mine went in for an Indian appointment at the time when good men were wanted, before Cooper's Hill was established. He was a B.A. of Trinity College, Dublin, a Member of the Institution of Civil Engineers, a first-rate man at bridge and roof work, and in every way excellent in the field. Large contracts had been carried out under his superintendence. He passed an examination, which in his case was nominal, and got his appointment—£600 a year—in India. He declined his appointment at once. He offered to go for £800. The authorities refused. I have seen some of the examination papers which were used at last in order to get men of some kind. It is difficult to image anything more imbecile. No wonder that "hard bargains" were the result.

Lastly came Cooper's Hill, and College lads got salaries of £400 a year, while trained and experienced men could not get one-half the sum. Mr. Bower may rest assured that he has only seen one-half the Cooper's Hill picture. M. I. AND S. INST.

Sunderland, December 3rd.

THE EFFICIENCY OF FANS.

SIR,—The sublime height to which this discussion has attained makes me hesitate about interfering, but the bold, blunt manner in which you have put your query as to the little matter of "the energy in the moving air being '277-horse power, although it was produced by not more than '095-horse power," encourages me. What I want to know is, why these special manifestations or "stepping stones, whereon to rest securely an efficient general science of the nature, laws, and mutual relationships to each other of work and energy," are only met with in the Capell fan?

We have, of course, been assured from the first intelligence of its birth that it was a "double power" fan, and we know that power may exist in the form of motion, or it may exist in the form of force, with distance to act through. May we suppose that the moving air in this particular case is possessed of both attributes at the same time?

If I remember rightly, another investigator asserted that "there was measured within the entrance adjutages of the Capell fan a degree of energy and horse-power greater than was delivered to the fan shaft," and that he attributed this to the compensatory action of a fluid flowing through a constricted conduit.

Such a combination of excellences has never occurred before in my thirty years' of fan experiences; but I should like to make one suggestion, viz.: If, as Professor Herschel thinks, "energies of motion reside in moving matter"—like the animals in the ark—"two and two in latent states of neutral alliance with each other," they are possibly of opposite sexes, and that when "in the preparatory stage the neutral dual alliance of energy is broken up" by a process of natural selection, we have a spontaneous generation of power.

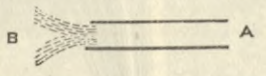
Durham, November 29th. A. L. STEAVENSON.

SIR,—I cannot resist the temptation to put forward, if you will allow me, some views on the water gauge question, particularly as I find my old master, Professor Herschel, has in turn got apparently paradoxical results out of the Capell fan.

It is probable that the conditions which affect the w.g. of a fan are three, viz.:—(1) Amount of resistance to be overcome by fan; (2) position of nozzle of air pipe—leading to gauge—opening, with relation to current, and to obstacles causing eddies and jet-like action in its neighbourhood; (3) position of gauge pipe opening with regard to what I shall call ripples in the air current. The effect of the first of these conditions is obvious, but with regard to the second it is very different. I have recently made some experiments on a fan of novel construction, 2ft. in diameter, which will send a good current—832 cubic feet per minute in normal direction with a peripheral speed of 425ft.—either way, according to the direction in which it is rotated, through an orifice 9in. in diameter, and having about a quarter of its area taken up with a boss and arms. I used an extremely delicate water gauge of special design, which would indicate the slightest variation in pressure, and I found, in taking the w.g. at the fan's inlet, that with a current flowing in the usual way, I got in one case 0·085in. negative w.g., while when I reversed the fan and produced an opposite current of the same amount, instead of getting a positive pressure, I had actually still a depression getting on for 0·06in., and this too happened with the opening of the pipe projecting straight from the side of the tube near to the above-mentioned orifice. By pointing the pipe opening towards the opening of the fan, I got near the maximum w.g. for either direction, as then the current to the fan acted as the wind acts upon one of those chimney pots which are bent and pivotted, so as always to point their open extremity to leeward, whereas the reverse current impinged against the pipe opening as in a ship's ventilator, in one case decreasing and in the other increasing the pressure. I also found places where practically no effect was produced upon the water gauge with one current; while, with the same current in the reverse direction, the w.g. reached near its maximum; and as I was making a number of experiments, from which to construct curves showing the relation of current to w.g. foot-pounds exerted to w.g., and to volume displaced, I had to be careful to fix the end of the gauge tube—india-rubber—securely, in order to get regular results, which enabled me to construct my curves properly, and having done so, I regard them as very interesting. The thing, however, which surprised me most was that with the gauge pipe end in precisely the same position, at the same point, in the same air drift, and, in fact, with the same fan—somewhat differently used—the water gauge required to produce a current of 928 cubic feet was in one case 0·335in., while in another, to produce a displacement of 934·4 cubic feet in the same direction, only 0·225 w.g. was required. I am inclined, however, to attribute this phenomenon to the third condition.

As to this third element, I will first quote from a letter written by Mr. A. L. Steavenson on efficiency of fans, which you published in December last. Mr. Steavenson spoke of the fact that "in the immediate vicinity of the centrifugal fan, we get what he—Mr. Cook, of Durham—called a pseudo w.g., and that as we go back from it, it falls rapidly in proportion to the suitability of the fan and its dimensions to its work, until at a point, say, 60ft. away, we get a virtually permanent depression, which is the w.g. the fan actually puts upon the mine. Now, if the fan is too small for the volume of air which the mine naturally would afford under that depression, the effect of that vacuum is lost upon the mine; the fan, in fact, at once exhausts, and obstructs the ventilation."

There is something very incongruous about the latter statement, and probably the truth is, that the phenomenon is capable of being exhibited by any fan, whether a displacement or centrifugal, large or small fan. That this must be so will, I think, appear from the following attempted explanation, which I trust may be of interest. It is too common to regard a stream of air or gas as if it were liquid. Bends, contractions, &c., in the path of the current will be acknowledged in either case to have somewhat corresponding effects, but the fact that the elasticity of air introduces effects which are imperceptible in liquids, is often overlooked. Suppose A B to be a parallel tube representing an air-drift, with the fan at the end A. As soon as the fan is put in motion the air in this tube is rarefied somewhat; this rarefaction is transmitted to the dead air external to the tube at B, and the air in B's neighbourhood is consequently moved towards the vortex B in a converging stream, and is therefore necessarily accelerated till some part of the tube's interior is reached. But since the stream is elastic, those particles which have passed the place where acceleration has fully taken place, and maximum velocity is reached, must be, so to speak, held back elastically by those which follow, and which in turn pass through the same phases, viz.: From minimum acceleration, where the air is practically just commencing to move at some distance outside the tube's vortex, to point where maximum acceleration is being produced just outside its vortex (?), and from this to minimum acceleration again, where the full velocity has been practically reached somewhere inside our parallel tube.



Now acceleration must be produced as long as ever there is a diminution of pressure in front of the individuals of the advancing procession of particles, that is to say, as long as there is a less pressure before than behind them; so that the maximum rarefaction, *i.e.*, the maximum w.g., will be found to exist—so far as it depends upon this cause—where the maximum velocity exists. But inasmuch as the particles which successively reach this point receive their acceleration by the pull of—if I may put it so—the elastic medium between them, they necessarily stretch—rarefy—this medium beyond the limit necessary to simply maintain the average amount of motion, consequently, after passing this point, the succeeding particles begin to catch up those which are in front of them, and a wave of condensation, in which the pressure may be considerably above that which represents the actual resistance the fan has to overcome, must be the result; but this coming closer together of the particles means a retardation of those in front, and if we regard this as negative acceleration, it will, I think, be clear that we may have a series of these waves or ripples, their position depending mainly upon the position of points where the air moves slowly in a wide gallery and then enters a narrow channel, or where frictional resistance alters quickly, or equivalent causes.

For the sake of avoiding confusion, I have taken as representative of a fan drift a parallel tube; the effect is, however, the same, whatever the nature of the drift; only complications in the cause render the effects complicated. I think I have now said enough to show that error may be made in determining w.g., which may be for or against the fan, according as the gauge pipe opening is placed in the region of a wave of rarefaction or of condensation.

Hough-green, Widnes, Lancashire, R. SNOWDON.
December 3rd.

CHILLED ROLLERS FOR FLOUR MILL MACHINES.

SIR,—It was with surprise we read in your issue of 14th inst. the statement that the rolls used in this country for flour milling machinery are generally "of American make;" with the further statement that "attempt after attempt had been made to produce these rolls in England, but all have so far failed that the best-known machinists buy their rolls in the United States." These statements are entirely misleading. Except the eminent firm referred to in your article, we do not know any machinist in this country who now buys American flour mill rolls.

It is now more than a dozen years since we made our first importation of American charcoal iron for the purpose referred to, and we have since made several thousand flour mill rolls, and we have certainly never heard of their failure in any single instance. On the contrary, we possess numerous spontaneous certificates testifying to the superiority of our rolls. We are not, however, the only successful makers of these rolls in this country. Besides Messrs. Herbert and Law in our own locality—who have for several years past devoted themselves specially to these rolls—there are a number of English makers also engaged with this work. The truth is, this branch of business is very much overdone, and there is, to our knowledge, a considerable amount of expensive plant at present idle in this country, which has been specially laid down for the manufacture of these rolls, prices having recently been cut down to a very low point by over competition.

As we pointed out in our letter addressed to you, and published in your columns on the 2nd February, 1883, uniformity in this work cannot be attained by mere "mixtures" of brands of iron. We realised this many years ago, when working with the most approved American cold-blast charcoal iron, and that determined us to establish in our works a chemical laboratory, so as to get down to the elements, and we have continuously worked since upon a purely chemical basis, analysing daily all raw materials and products. We have it from the best authority that the Americans are some years behind ourselves in this matter, and that they are still, without exception—like our competitors south of the border—working entirely upon the old "rule-of-thumb" method. Whether our cousins across the Atlantic excel us or not in making the article in question, we concede they do "lick all creation" in their modes of advertising their goods, and in their success in getting people to believe in them. MILLER AND CO.

London-road Foundry, Edinburgh, Nov. 26th.

[Our correspondents may not know of any other firm besides the one we mentioned as users of American rolls, but milling engineers in the South of England do. It is very satisfactory, however, to learn that chilled roller making may be carried on on a scientific basis, and we shall be glad to hear that those mill makers at present using American rolls are able to get their rolls in the United Kingdom.—ED. E.]

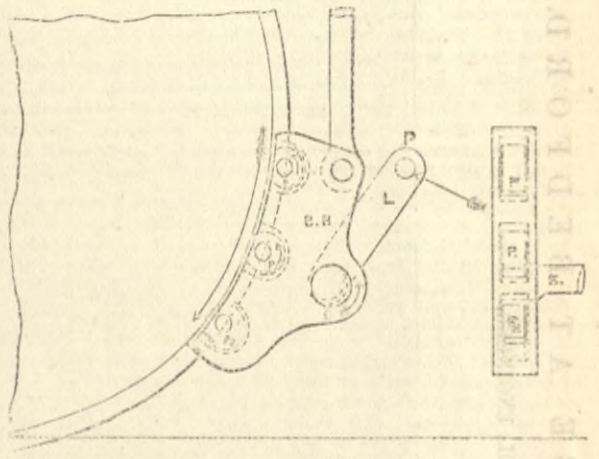
COMPOUND ENGINE ECONOMY.

SIR,—The important omission as to the different springs used for the diagrams given in your paper of the 7th, now supplied by Mr. R. Tinkler, was, to say the least, misleading. But I see another omission supplied as to the fuel in omitting all allusion to the "shavings and sawdust," and even with this I cannot accept the statement in the present vague form "our coal account," and "about 7s. per ton at Stockton." I am told that the price is 7s. 6d. to 8s. per ton, and was surprised at the result of the economy, of which no one can doubt. Mr. Tinkler says 6½ cwt. per day; suppose we take the cost laid down in the stoke-hole—the coal account cannot be made up till it gets there—to be 7s. 6d., then at 300 days in the year we get 6841b. per day of nine hours, or 76 lb. per hour, giving the result 0·76 lb. coal per horse-power per hour. If the coal has such heating power, it would be well to know how many pounds of water it will evaporate per pound of fuel. In the above calculation nothing is allowed for steam raising, and the quantity of wood burnt is set against that. GRADUATE.

December 1st.

BRAKE BLOCKS.

SIR,—I wish to call your attention to a new system of brake block which I have invented. The principle involved will be readily understood from the accompanying engraving and description. B B is ordinary brake block; H, ordinary brake block hanger; S, shaft connecting brake blocks with lever, L, attached, by means of which the pressure P may be applied to put the brake on. The shaft is simplified by means of the ends through the blocks being made excentric in form; and the shaft being carried at the ends, it is easily seen that when the pressure P is applied, the action of the block on the wheel is quick and effective; also, as the excentric parts O of the shafts may be towards any part of the various blocks, so that when a pressure P is applied to any one lever, the action of all the blocks will be towards their respective wheels. The increase in power due to this form depends, of course, on the amount of throw given. P, P_1, P_2 are pulleys or rollers, swelled or excentric in form, the action of which being as follows:—When the blocks are pressed hard against the wheel, then it follows that the tendency of the pulleys will be to revolve, as shown by the arrows in sketch, and being excentric in form, a very great retarding effect is thus brought to bear against the wheel. As this action will cause the blocks to move back from the wheel, the result of which being an increase of pressure in the



brake cylinder, due to the decrease in volume owing to the piston moving back, this wedge action and increase in pressure will depend, of course, on the amount of throw given to the pulleys. The pulleys or rollers may be fixed in the way that suits best; also, their axles might be solid with the pulleys. They could be made of tough cast steel annealed. By this arrangement, the energy stored up in the rim of the wheel is utilised as a retarding effect to a greater extent than by the ordinary block at present in use.

December 3rd. J. MCNIVEN.

PATENT-OFFICE BUSINESS.

SIR,—The question raised in your paragraph with the above heading is of considerable importance to those who are concerned in patent litigation. Without being unduly partial to my own profession, I think that I may assume that it will be pretty generally admitted that the necessary qualifications for directing and controlling the proceedings of opposing counsel requires experience which can only be gained by practice in the courts. The court over which the Controller of the Patent-office presides is really a court of first instance dealing with interests of great importance, and if the judge in such a court is not a strong and experienced man, an appeal from his decision follows almost as a matter of course. Officials trained in the office work of a Government department, more especially in the Board of Trade, are the last class to which one would look in choosing such a judge. Would it not be possible to appoint a deputy-controller having legal experience and some knowledge of patent law and practice to hear opposed cases? or I would suggest that all such matters might be left to the law officers of the Crown, who now form the appellate tribunal. The Solicitor-General and Attorney-General receive respectively £6000 and £7000 a year, originally given to them as a fixed salary in lieu of patent fees for examining specifications. The Patent-office, therefore, has some claim upon them, and with their decisions patentees would no doubt be generally satisfied. A BARRISTER.

Lincoln's-inn, December 4th.

THE ROCKET.

SIR,—There is one point to which I think too little attention has been given in this discussion. It has been mentioned twice, if not oftener, that on one occasion when Wakefield was having a "run out" with this engine she came to grief and the passenger was killed. At that time, and for about twelve years afterwards, the law of Deodand was in force, and so the engine would be liable in the sum put upon it at the inquest. The files of the local press at that time would form an interesting study. Can Mr. Boulton say who paid the penalty and what the verdict was? BOILER.

December 1st.

THE TRANSMISSION OF POWER.

SIR,—Referring to your recent note on the subject of the electrical transmission of power between Paris and Creil by the system of M. Marcel Deprez, we beg to inform you that it has been decided to use a cable manufactured under the Berthond-Borel patents, of which we are sole licensees in this country, and an order has been given for 78,000 metres—forty-nine miles—to be delivered forthwith. We shall shortly furnish you with full particulars of this cable, which is to carry a current of 20 ampères, with an electro-motive force of 7500 volts, equal to 150,000 watts or 200-horse power. H. BOISSELIN,

For the Kinetic Engineering Company.

36 and 37, Brooke-street, Holborn, Dec. 3rd.

THE WOLVERHAMPTON BOILER EXPLOSION.

SIR,—I note you remark, in reference to the above, "It is to be regretted, however, that nothing has been said concerning the behaviour of the steel plates over the fire." I think that this is a subject that requires further investigation. There is one peculiarity about the behaviour of steel from which plates are made which is not generally known. Take a bar of, say, best rivet steel, heat it to redness, allow it to cool, and just after it has got black bend it, when it will be found to give way; in fact, will break almost like cast iron. If the plates over the fire were heated to this critical point they may have started the explosion. JOHN PLAYER.

Clydach Foundry, near Swansea, December 1st.

ROAD BRIDGE OVER THE OUSE AT BEDFORD.

MR. JOHN J. WEBSTER, ASSOC. M.I.C.E., LIVERPOOL, ENGINEER.

(*For description see page* 433.)

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S. M.—*There is not the slightest chance that the twenty-four hour system of marking dials will be adopted. The advantages to be gained are as nothing compared with the disadvantages that the adoption of such an innovation would entail. Astronomers always have used the twenty-four hours' system, so that the change would in no way affect them. You may safely make your clock dial in the usual way.*

C. S.—(1) *The paper "On Masonry Dams" was written by Professor Rankine for* THE ENGINEER, *and we are not aware that it has been published in any other way.* (2) *There is no special work on the subject, but you will find a great deal of valuable information in the "Transactions" of the Institution of Civil Engineers. You will find a valuable series of articles on the subject in* THE ENGINEER, *Vol. xxiv., page* 312, *and Vol. xxvi., pages* 19, 35, 57, 75, 113, *and* 131.

R. T. C.—*Rankine's "Mechanical Text-book," page* 285. *Let the collective weight of the balls be* A, *and the additional load be* B. *Then, if the load rises vertically through twice the rise of the balls, the altitude for a given speed will be greater than that for a simple pendulum in the ratio of* $1 + \frac{2B}{A}$, *and the sensitiveness of the Porter governor will be greater than that of the common governor in the ratio of* A : A + 2 B.

STEAM LAUNCH.—(1) *A pressure gauge ought to have a syphon.* (2) *See Molesworth's Pocket-book.* (3) *Too heavy and noisy.* (4) *No.* (5) *Costly to make and bad to repair; not new.* (6) *We suspect this arrangement is not new; we are not sure. The thing seems ingenious and may be useful; worth trying.* (7) *The valve as shown in your sketch will not work. Cut out a section model in cardboard and try for yourself.* (8) *No.* (9) *We could not find space here to explain the action of the injector.*

H. B.—(1) *We do not know what amount of surface is required for a nominal horse-power, but* 1½ *to* 3 *square feet will do for an indicated horse-power.* (2) *Half-inch from tube to tube is the least possible.* (3) *With wood ferrules, which can be bought from any firm supplying engineer's stores.* (4) *Circulating pumps about* ⅛ *that of the high-pressure cylinder if double-acting, air pump half as much as the circulating pump, but no hard-and-fast rule can be laid down.* (5) *There is is no book on engineering formula that would be of use to you. Bourne's "Catechism of the Steam Engine" you may read with advantage.*

NOVICE.—*We have not seen the Brook and Wilson producer at work. We are familiar with the Siemens producer and several of its modifications. We have endeavoured to explain in what way it appears to us that you were wrong in your mode of working. You reply that we have misunderstood you. If this is the case, we regret the fact. Our explanation of your failure is that you did not pass sufficient air through the fuel you desired to convert into gas. You do not appear to have tried the modification we suggested, and which would have cost in the first instance not more than a few shillings. For each pound of coal that you burn—and bituminous coal is the best—you must admit* 6 *lb. of air, or say,* 7 *cubic feet, to the producer. The result will be in round numbers* 7 *lb. of gas, about* 35 *per cent. of which is useful as fuel, consisting principally of* C O. *This, when subsequently burned with plenty of air, becomes* $C O_2$, *and gives out great heat. Now we are quite at a loss to see how combustion of any kind could go on in your producer so long as you employ a* 2*in. pipe, and nothing else, to lead away the gas. Your complaint is that the fuel goes out in the gas producer. It cannot, as we understand your sketch and description, do otherwise. If this reply does not supply the information you want, write again. What we can do to get you out of your difficulties shall be done.*

CANDLE-MAKING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—We shall be glad if any of your correspondents will send us particulars and prices of candle-making machinery, or the address of a manufacturer. CANDLES.

HUTCHINSON'S GAS-PRODUCER.

(*To the Editor of The Engineer.*)

SIR,—Will any of your readers kindly tell me where I can obtain particulars of the Hutchinson gas-producer, recently alluded to by a correspondent in your columns? H. S.

November 29th.

EYELET MACHINES.

(*To the Editor of The Engineer.*)

SIR,—Will any reader tell me where I can get a machine which will rivet up eyelets without splitting them? I use hand punches now, but they are too slow and always split the eyelets. I want the eyelets to look the same on both sides, as in some French corsets. J. P. T.

Whitechapel, December 3rd.

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Friday, Dec. 5th, at 7.30 p.m.: Students' meeting. Paper to be read and discussed, "Trigonometrical Surveying," by Mr. Harley H. Dalrymple-Hay, Stud. Inst. C.E. Mr. Henry Law, M. Inst. C.E., in the chair. Tuesday, Dec. 9th, at 8 p.m.: Ordinary meeting. Papers to be discussed, "The Working of Tramways by Steam," by the Hon. R. C. Parsons, B.A., B.C.E., M. Inst. C.E. "The Sydney Steam Tramways," by Mr. W. Shellshear, Assoc. M. Inst. C.E.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, Dec. 11th: Annual general meeting for the election of Council and officers for 1885. Paper, "On Electricity in America, 1885," by Mr. W. H. Preece, F.R.S., Past-President.

INVENTORS' INSTITUTE, Lonsdale-chambers, Chancery-lane.—The meeting on Monday next, the 8th inst., will be devoted to the discussion of the Patent Act, 1883, section by section, commencing with Part I., Section 1. The chair will be taken at 8 p m. by Vice-President Admiral Selwyn. The discussion will be continnued on January 12th, 1885. Gentlemen, not being members, who wish to attend, should apply to the Secretary.

SOCIETY OF ARTS.—Monday, Dec. 8th, at 8 p.m.: Cantor Lectures. "The Use of Coal Gas," by Mr. Harold B. Dixon, M.A. Lecture II. Coal gas as a source of light. Wednesday, Dec. 10th, at 8 p.m.: Fourth ordinary meeting. "The Preparation of Butterine," by Mr. Anton Jurgens. Thursday, Dec. 11th, at 8 p.m.: Howard Lectures. "The Conversion of Heat into Useful Work," by Mr. W. Anderson, M. Inst. C.E Lecture III. Molecular theory of gases—laws of volume, pressure, and temperature—lines of permanent gases and of vapours—Joule's equivalent—the doctrines of Carnot—the limits of efficiency of heat engines.

DEATHS.

On the 26th ult., at Thetford, suddenly, of heart disease, THOMAS TANK BURALL, aged 37, late of Devoran, Cornwall, the esteemed Manager of St. Nicholas Works, Thetford. Friends will please accept this—the only—intimation.

On the 27th ult., at 24, Clarendon-road, Notting-hill, W., AUGUSTUS JOHN DARLING CAMERON, M.I C.E., F.R.S.E., of 9, Victoria-chambers, Westminster, S.W. Friends will please accept this intimation.

On the 1st inst., at Sterndale-road, West Kensington, JOHN COOPE HADDAN, C.E., aged 73.

THE ENGINEER.

DECEMBER 5, 1884.

THE AUGMENTATION OF THE NAVY ESTIMATES.

ON Tuesday evening, December 2nd, Lord Northbrook and Sir Thomas Brassey, in both Houses, moved for returns of ships built and building. Considering their two speeches together, we may observe that an explanation of what had been done, and also of what was now contemplated, was given. We fear that most of our readers must be weary of the summaries that have been drawn up showing the relative strength of the British and French Navies, the centre on which everything pivots. We may briefly observe, that the result shown depends entirely on the system of classification adopted. Thus we find that, taking only ships carrying 15in. of armour, Sir Edward Reed, applying his peculiar method of reckoning only the citadels of citadel ships, finds the English armoured tonnage to be 51,570 tons, and the French 126,288. Drawing the line at 9in., Lord Northbrook and Sir Thomas Brassey put the English armoured vessels at thirty ships, with a total tonnage of 210,430, and the French at nineteen ships, with a total of only 127,828 tons. Sir Thomas Brassey, extending his limit so as to embrace semi-obsolete ironclads, makes the English fleet forty-six ships of 326,000 total tonnage, and the French thirty-one of 181,000 tons in all. We hold all these to be delusive systems framed so as to arrive at a certain logical conclusion; truly and conscientiously done, doubtless, but from a certain point of view, and utterly wrong for all practical purposes. Probably Sir Thomas Brassey would be sorry to pit a little more than half the English against the whole of the French fleet; and we are quite certain that Sir Edward Reed would not like in the Admiral Duperré to engage the Duilio, Dandolo, Italia, and Lepanto, with their sixteen 100-ton gun shot crashing into her and smashing up armoured and unarmoured portions impartially wherever a fair hit was made. Yet if his system is of practical application it ought to come to this, for he estimates a fleet's strength by armoured tonnage alone, on a system which shows this single French ship rather superior to the four Italian ironclads. We believe that the summaries we have given in past impressions much more really put the case in its practical bearings. We wish to grasp the practical position, and we think it may be briefly put as follows:—The French had many perishable wooden ships; for these they have been substituting new and very heavily armed craft. This has been done sufficiently rapidly to bring their effective strength nearly up to our own; nay, if not outmatching it already, with a prospect of doing so shortly. In all conscience this is serious enough. If England has seven-eighths of the carrying trade of the world; if she has 900 million pounds worth of shipping, and property afloat worth 144 millions always; if she has in the Southern Pacific alone 100 millions annual trade, where France has only 2½ millions—and these are statements taken from speakers on opposite sides of the question—if, we say, these are facts, then it is mad to spare the necessary money to secure our property. If England would literally starve in three months if her trade was cut off, as surely as Paris starved when surrounded by German armies, then it is suicidal to spare the money necessary to secure our supply of food.

We may dismiss, then, the reiterated explanation of the decay of French wood ships, and of difficulties caused by development of science, and examine what our rulers propose to do under the conditions. The Benbow appears to be a tempting point to begin at. She is a first-class armour-clad building by contract, and being pushed on without check to completion. She is to carry 18in. of steel-faced armour, and two 110-ton guns, as well as one 18-ton gun and twelve 6in. guns in a battery covered by 3in. of steel, so as to be proof against the new 6-pounder quick-firing Nordenfelt guns. Her speed is to be 15½ knots. She appears to be a representative ship, so we gather, of our first-class armour-clads, whose tonnage will be about 10,000 tons each. Besides the Benbow we are to have four first-class armoured ships commenced, two of these being built in Royal dockyards and either one or two by contract. Lord Northbrook appears to say three on our Government vacant slips and one by contract, and Sir Thos. Brassey speaks of two being built by contract. Next we are to have two torpedo rams of the Polyphemus class, but larger, and differing in the fact that the point of the ram itself is not a torpedo tube. These are each to have a displacement of about 3000 tons, and a speed of 17½ knots. This will come on some readers as a surprise, owing to the reports that the Polyphemus was found to be a complete failure. Recent experiments with her have given such satisfactory results that the series has been discontinued, and on the data arrived at these two ships are based. Next thirty first-class torpedo boats of 120 tons each—that is, boats going to sea and not carried on board ship, are to be built. Tney are chiefly for defensive purposes. The Childers, one of this type, has recently been despatched to Australia, and her behaviour at sea was not such as to justify the expectation that such vessels could ordinarily accompany a fleet. Then our ports are to receive attention. Why the subject should crop up with first-class torpedo boats we suppose is because these boats are for harbour defence. Torpedo boats are not being multiplied very rapidly, it is admitted, because improvements develope fast, and they can be quickly made at any time.

Protected cruisers form the next class. The Leander type, with 3in. steel deck, which is considered equivalent to 6in. of side armour, is to give place to a type called after our rivers—Mersey, &c.—with 10in. armoured belts and armoured directing house or conning tower. These will have a displacement of 5000 tons, and carry 1000 tons of armour and two 18-ton guns and twelve 6in. guns. Their speed is to be 17 knots. Five of these are to be built; this type is considered able to give a good account of many an inferior armour-clad. A considerable portion of these vessels—£3,085,000 of work in all, viz., one first-class ironclad, five belted cruisers, two torpedo rams, ten "Scouts," and thirty torpedo boats—will be built by contract. It is considered that it is a great advantage for the private shipbuilding yards to be in the habit of building war vessels. All this involves an expenditure of £3,100,000 in excess of the ordinary estimates of this year, and will occupy a period of five years. This will not include the armaments of the ships' guns, which will cost £1,600,000, that is, something over £300,000 per annum for five years. Then £850,000 is to be spent on our coaling stations.

The programme thus announced may appear considerable, but it falls far short of that suggested as a minimum by Sir Edward Reed, and pronounced far too small even as that by the distinguished officers and others who formed his audience. Let us compare them. For Sir E. Reed's five first-class armour-clads, to be completed in three years, the Admiralty propose four, to be finished in five years For his five armoured cruisers we are to have five protected cruisers of the Mersey type, which, we presume, Sir E. Reed would call armoured if their 10in. belt extends from end to end. To the eight unarmoured cruisers and fifteen auxiliaries, all very fast, mentioned by Sir E. Reed, there does not appear to be anything corresponding proposed by the Admiralty. For his fifty first-class torpedo boats we are to have thirty; and two enlarged torpedo rams of the Polyphemus class. The chief difference is the increased time allowed; but the programme altogether will be pronounced quite inadequate by most who are capable of forming an opinion, and the rejoinder will doubtless be made, that unfortunately those who are most capable of judging are at the same time those who are interested, directly or indirectly, in the increase of the Navy. However much truth this may contain, we do not see how such a complaint can be urged against the press, which has been the chief instrument of bringing up this question at this time. It is necessary for our independent existence as a nation, depending, as we do, on supplies brought in merchant ships, that we should have a fleet capable of commanding or holding the seas. If France has a fleet rivalling or slightly in excess of ours, the danger is so great that if the country is not roused by that, we hardly see why it should be roused by being told that the Navy of France is double our own.

PROFESSOR JAMES THOMSON ON MOTION AND INERTIA.

THE Institution of Engineers and Shipbuilders in Scotland is a society of some eminence and responsibility. It includes in its ranks men of no small attainments; and to belong to the Institution is a desirable thing. To be president of such a society is an honour; and we know that the presidential chair has been repeatedly filled by men of very high rank indeed as engineers. A president is expected to deliver an address when he takes the chair; and it is assumed that this address will be prepared with care, and be of such a nature that it can be listened to with profit and pleasure. As a rule all presidents do their best in this direction; the result, of course, varies. From some men a good address cannot be got, and this is so well understood that little disappointment is felt when such men have to speak, special qualifications compensate for oratorical deficiencies. But from others a good address is expected, and if it is not forthcoming, those who hear what is said go away discontented and disappointed. Now, we believe we express the sentiments of a great many of those who heard the address of Professor James Thomson, F.R.S., delivered to the Institution of Engineers and Shipbuilders in Scotland on the 24th of October, when we say that it was eminently disappointing. It was short, and it was heterogeneous. The first portion of it was devoted to a consideration of motion and inertia; the second part, which had not even the most minute connection with the first, briefly called attention to the possibility of Board of Trade surveyors, when testing old marine boilers, not putting on hydraulic pressure enough for fear the boiler should give way. Professor Thomson excused himself from going more deeply into this question because time was not available and the occasion was not suitable.

The first and longest portion of his address is that with which we wish to deal here. Professor Thomson was by no means lucid; and while, no doubt, some of his hearers understood him, others must have gone away with extremely hazy notions as to what the Professor had been talking about. The first part of the address, that of which we are now writing, related, to use the speaker's own words, "To considerations on the fundamental principles of the kinetic branch of dynamics—a science which forms

an essential part in the science of mechanics." Further on Professor Thomson, referring to the same subject, said: "We want more thoroughly clear fundamental ideas, and we want clear expressions in which to set them forth. Lately I have been able, I think, to clear up some parts of this subject a little; and I have, within the present year, submitted papers upon it to the Royal Society of Edinburgh, and my sayings to you this evening will include some passages from those papers." Having premised so much, Professor Thomson went on to speak of motion and inertia. "We are all accustomed," he said, "to speak readily of the inertia of matter, though generally we would find it very difficult to explain exactly what we mean by the term. No doubt we can understand that manifestations of inertia are strikingly exhibited in the blows of a steam hammer, in the collisions of railway trains, and in those of ships at sea, and in the impacts of projectiles; and we meet with it forcibly in the regulating effects of fly-wheels and governor balls. We are accustomed to overlook the deficiency of our knowledge of any explicitly clear principle of what shall constitute portions of time in the future equal to portions of time in the past, while we cannot bring them together to compare their lengths, as we might do with yard wands, if we wanted to test their agreement. The past time has vanished already and the future has not yet come, and we cannot make the two be present together for comparison."

We have in the passage just quoted a little inaccuracy of terminology and the enunciation of a metaphysical subtlety. It is above all things necessary that scientific men should always call the same things by the same name, but we here find Professor Thomson calling inertia that which is commonly known as *vis viva*. Inertia is the property by which a body is said to resist movement. As Professor Thomson has worded his sentence, the natural deduction is that inertia is exhibited by the blows of a steam hammer; while it is quite possible that he really meant his remarks to refer, not to the tup or the piston, but to the anvil. There is, moreover, no difficulty of any kind in explaining what is meant by the term inertia. What inertia is can be made clear by a very few words. We venture to submit our definition to Professor Thomson. Inertia is capacity for receiving motion. Momentum is the measure of that capacity. Thus, if we have two bodies, one weighing a ton, and the other two tons, we say that the latter has twice as much inertia as the former, and the momentum of the latter, if it is moving at the same speed as the former, will be twice as great. In other words, the body weighing two tons will have a double quantity of motion in it. Thus, to quote Magnus, as the first among a host of authors to come to our hand, "The unit of momentum is defined as the quantity of motion in a unit of mass moving with a unit of velocity." Inertia may be regarded as the complement of momentum. Professor Thomson, leaving inertia, went on to deal with motion, and he proceeded to show that up to a certain point it is impossible to know whether there is or is not such a thing as absolute motion, and he then went on to criticise Newton's three laws of motion. The first law runs: "Every body continues in its state of resting or of moving uniformly in a straight course, except insomuch as by applied forces it is compelled to change that state." We fancy that this extremely simple truth is not beyond the capacity of a school-boy of small age, but no one knows with how much difficulty a proposition may be invested until they try. It appears that Newton's first law is, at all events, too stiff for Professor Thomson, for he goes on:—"In attempting to draw from the statement a perfectly intelligible conception, we find ourselves confronted with the preliminary difficulty or impossibility as to forming any perfectly distinct notion of a meaning in respect to a single body, for the phrase '*state of resting or of moving uniformly in a straight course.*' Newton's previous assertion, *that there exists absolute space which, in its own nature, without reference to anything else, always remains alike and immovable*, does not clear away the difficulty. It does not do so, because it involves in itself the whole difficulty of our inability to form a distinct notion of identical points or places in unmarked space at successive times, or of our inability to conceive any means whatever of recognising afterwards in any one point of space, rather than in any other, the point or space which, at a particular moment of past time, was occupied by a specified point of a known body. We have besides, as I have already mentioned, no preliminary knowledge of any principle of chronometry; and, for this additional reason, we are under an essential preliminary difficulty as to attaching any clear meaning to the phrase, *state of moving uniformly in a straight course*, the uniformity being that of equality of spaces passed over in equal times."

Now, we do not hesitate to say that Newton met with no such difficulty as that here spoken of; and there is, perhaps, no notion more familiar to the mind of the mechanician than that of uniform motion along a straight line. If they were to deal with Euclid in the spirit in which Professor Thomson deals with Newton, mathematicians would soon be face to face with overwhelming difficulties. The straight line of which Euclid and Thomson alike speak has no existence in fact. The Euclidian point on which so much depends, is an abstraction, a thing without parts. Yet there is not a proposition in Euclid which may not be proved with a bit of chalk on a barn door; that is to say, the mind is perfectly competent to reason about and realise Euclid's propositions. Nay, there is perhaps no greater charm about Euclid than the fact that he rejects as unnecessary for the fulfilment of his purpose those mechanical refinements which might appear to be essential to his success. He takes it for granted that the mathematician can have an adequate conception of a straight line although he cannot draw one; but Professor Thomson, although he may admit the straight line, cannot admit the possibility of the mind forming a conception of uniform motion along that line. This difficulty is, we submit, solely the creation of Professor Thomson, who wishes Newton's law to be made to apply to a single point in absolute space, and, as we understand him, to nothing else; but Newton's law is just as true of relative motion as it is of absolute motion. It is true, to all intents and purposes, for engineers and astronomers, and the want of maximum comprehensiveness, with which Professor Thomson charges it, no more affects the truth, or the credibility, or the utility of the law, than does the fact that a mathematical proof cannot be given that two parallel lines, if prolonged to infinity, would never meet, affect the value of Euclid's definition. Professor Thomson's argument is, no doubt, quite sound from an extremely minute standpoint, but to all intents and purposes it was not true for his audience, save perhaps a very few; all the majority having no doubt very sound and practical ideas concerning the nature of continuous motion in straight and curved lines. Newton's second law of motion is, "Change of motion is proportionate to the magnitude and duration of the applied force, and takes place in the direction in which that force is applied." "It may now readily be noticed," says Professor Thomson, "that Newton's enunciations, set forth as the second law, involve elements of obscurity alike with that which has been shown already as rendering the enunciation of the first law inadequate for expressing the great natural truth to which it relates."

Professor Thomson, having so far demolished Newton, next proceeded to lay down the law of inertia in an improved form, as follows:—"For any set of bodies, acted on each by force, a reference frame and reference dial traveller are kinematically possible, such that relatively to them conjointly, the motion of the mass centre of each body undergoes change simultaneously with any infinitely short element of the dial traveller progress, or with any element during which the force on the body does not alter in direction nor in magnitude, which change is proportional to the intensity of the force acting on that body, and to the simultaneous progress of the dial traveller, and is made in the direction of the force. From this law of inertia the principle of chronometry is readily deducible, as a corollary, by elementary mathematical considerations, and it may be enunciated thus:—Any dial traveller, which would accomplish the conditions stated, would make progress proportionally with any other dial traveller, obtained likewise from the same set of bodies, or any other set of bodies with the same or any other reference frame. Then, in view of this remarkable agreement, we define as being equal intervals of time, or we assume as being somehow in their own nature intrinsically and necessarily equal intervals of time, the intervals during which any such dial traveller passes over equal spaces on its dial. Thus any dial traveller which would accomplish the conditions stated would constitute a perfect chronometer. This gives us the ideal of a perfect chronometer. It remains for men to aim at approaching as near as they can towards that ideal in the practical realisation of good chronometry." Whether this is an improvement on Newton or not our readers can form their own opinion. For ourselves we prefer Newton; on the whole, he seems to us to be more intelligible than Professor Thomson, and we have so far never had the smallest trouble in understanding what he means. But we have no doubt that to some of our readers the foregoing passage will be quite intelligible; to others it will not. We may note in passing the use of the words "dial traveller," instead of "hand." Professor Thomson no doubt speaks of the "minute dial traveller" of his watch. The "reference frame" is presumably the equivalent of the three dimensions of space.

It will not have escaped notice that Professor Thomson has only glanced at Newton's third law. It is a remarkable fact that the bearing of this law is systematically ignored by science teachers. Were it otherwise, much that is now regularly taught would not be taught. Professor Thomson, for example, could hardly talk of a force producing an effect, if he realised that, by Newton's third law, the amount of resistance offered to a force is the measure of that force for that particular application, and for this reason force is entirely incapable of producing any effect whatever in the way of motion, so long as it is isolated. Thus, for example, the pull at one end of the draw bar of a railway train is precisely equal to the resistance to that pull at the other end, yet the train follows the locomotive. Perhaps Professor Thomson will tell some of his classes why. He cannot refer his hearers to text books for an explanation, because they will not find one there. For the great mass of writers on dynamics, Newton's third law has had simply no existence.

SIR E. J. REED ON WAR SHIPS.

Last week we published a fairly complete summary of the paper on "The State of the Navy," read by Sir Edward Reed at the United Service Institution. This paper, and the discussion which followed, an abstract of which we give on another page, would have had considerable importance under any circumstances, but they have acquired additional value from the fact that the postponement of the Government statement respecting the Navy permitted the meetings to take place before the public had any definite knowledge of the official programme. The paper professed to deal with the most urgent measures that should be taken for increasing H.M. Navy. This subject had been selected by the Council, and it will be remarked that it assumes the need for increase. In the course of the discussion every speaker confirmed the accuracy of this assumption, and, curiously enough, the only other Navy whose strength appeared to be considered by most of the speakers was the navy of France. Occasional references were made to possible combinations of France with other Powers, but the argument for additional expenditure on our Navy was made to rest, and very fairly made to rest, almost entirely upon the circumstance that by the great exertions which the French had made since 1872, their Navy has become a good match for our own. We were the first to draw public attention to the need for prompt and extensive action, in order to recover lost ground, and we heartily endorse the view that no time should be lost in giving effect to most of the recommendations made by Sir Edward Reed; which recommendations are merely repetitions and enforcements of views repeatedly expressed elsewhere by other writers, and by Sir Edward Reed himself. It was very properly pointed out in the discussion that it would be waste of time and misplaced energy to enter now into discussions on points of detail; that action, and not discussion, was essential. We heartily support this view. At the same time, there can be no question that before a definite programme for the English Navy can be arranged, there must be discussion on many burning questions, and no good purpose can be served by attempting to bury away matters which must be of the highest importance to future naval construction. Nor need it be thought that the distinction which is now being drawn is one which will affect actual progress towards the necessary strengthening of the Navy.

Sir Edward Reed recommended the following measures:—The first was the rapid completion of all the new ships at present in hand. This necessity has been so often and so forcibly pressed upon the public mind, that we think Sir Edward devoted rather more time and space to its elucidation than was necessary. He went at great length into the financial questions involved in having large sums of unproductive capital locked up for long periods in incomplete ships. We do not think it necessary to dispute his figures in any way, but the plain truth is, as several speakers remarked, that no mere financial statement of the loss of interest and unproductive capital indicates the real loss to the country arising from having so many ships in progress, and that progress so very slow. Until a ship is ready to fight, she is of no value to the country, and in these days when wars break out so suddenly and proceed so rapidly, it is in the highest degree important that we should have as small a proportion as possible of our fighting ships on the stocks, and as large a proportion as possible ready for service. The second urgent measure in the list is that of increasing the number of our armoured line-of-battle ships. We will pass that by for the present and return to it hereafter. The third is the provision of unarmoured auxiliaries for line-of-battle ships. Here Sir Edward Reed recommended that we should follow the example set us by the French and the Italians, and build a number of swift small cruisers or "torpedo catchers." He was in favour of giving to these vessels light armaments of shell and machine guns, ram bows, and torpedo armament; his estimate of the total cost of such a vessel was about £30,000 to £35,000 each. One of the speakers asked him what were to be the approximate dimensions of these vessels, and received the reply that Sir Edward Reed had not considered the matter from that point of view. It may be assumed, therefore, that the estimate of cost is either based upon a consideration of the French designs or upon some general and indefinite conception. We have nothing to say against the addition to our Navy of sea-going torpedo cruisers, and we do not consider that the Scout now building for the Royal Navy is at all a typical vessel of its class; but, on the other hand, we think it very doubtful whether any substantial advantage would be gained by keeping down the size and cost of such vessels to the very low limit which the French have accepted. However, this is one of the matters upon which further consideration is, in our judgment, needed before any definite action is taken, and the type is one which can be so rapidly multiplied that time for consideration is available. The next recommendation of Sir Edward Reed is that swift armoured cruisers should be built for distant foreign services, and for the protection of commerce. It is suggested by him that these vessels should have speeds of from 19 to 20 knots, be supplied with abundant fuel, be fairly armoured and armed, and it is estimated that they would probably require to be of 8000 tons displacement. There is, no doubt, room in our Navy for a few swift cruisers, protected by armour, and having high speed, but we do not share Sir Edward Reed's views as to their great value to the protection of commerce; and it may be very well questioned, in view of the present position of shipbuilding and marine engineering, whether all the qualities enumerated by Sir Edward Reed, and particularly the abundant coal supply, will be obtainable on 8000 tons displacement. We say this, having full knowledge of what Sir Edward Reed has written on the subject elsewhere. In any case, the production of these armoured cruisers is not a matter of the first degree of urgency, if the protected cruiser class—respecting the design of which there are no questions of importance awaiting solution—is rapidly augmented in numbers. Sir Edward Reed prefers to call these vessels unarmoured cruisers; he says that their protecting decks should be from 2in. to 3in. thick; he emphasises the precautions which should be taken to protect their buoyancy. But on all these points he is really only endorsing actual practice; nobody would be inclined to differ from him as to the advantage of having protecting decks 2in. to 3in. thick instead of 1in., as in the Esmeralda. Naval constructors do not wait for Sir Edward Reed's advice before designing vessels having strong decks. The Mersey and Severn were begun at Chatham nearly two years ago; they have decks of the thicknesses specified. The two vessels for the Japanese Navy, now building by Sir W. Armstrong and Co., were designed considerably more than a year ago, and they also have strong decks. In the discussion which followed Sir Edward Reed's paper, Mr. White pointed out that the Esmeralda has a steel deck only 1in. thick simply because she was such a small and comparatively cheap ship; he also said that the two Japanese vessels, which are heavier in armament, stronger in protection, larger in coal supply, and more powerful in fighting efficiency, which he has designed, are also larger and more costly than the Esmeralda, and he recorded the opinion that the protected cruiser of the future will be a still more powerful vessel. This is the common sense of the matter; as armour has gradually grown in thickness on the sides and batteries of ships, so we may expect that the protecting decks of these cruisers will grow in strength, and probably the size and cost of the vessels will be considerably increased. All this, however, is by the way. The most important thing on which everybody is agreed, is the necessity for a large and immediate increase in the numbers of our armoured cruisers; here there is undoubtedly

unanimity. The same thing is true also as to the urgent necessity for increasing the flotilla of torpedo boats in this section of our naval force, where undoubtedly we are both absolutely and relatively weak.

In conclusion, we must revert to the remarks made by Sir Edward Reed respecting armoured line-of-battle ships. This portion of the paper is a powerful plea for the extended use of armour-belted ships. Armoured ships, according to Sir Edward Reed's view, are only ships which have a belt of thick side armour. If the belt extends throughout the water-line, then the whole displacement tonnage is to be reckoned as the armoured tonnage. If the belt extends only over a portion of the length, then the armoured tonnage is to be reckoned by the displacement of that portion of the ship which would be cut off by transverse planes coinciding in position with the ends of the armour belt. Armoured ships, according to this view, may or may not have armour protecting the guns or the communications between the batteries and the magazines or the pilot tower. All these matters, which seem to most people to be important, are quietly set aside; argument seems out of place here. It was pointed out in the discussion by Mr. White that, according to this view, the vessels which are generally regarded as the most powerful fighting ships afloat, namely, the Italia and Lepanto, would not be classed as armoured ships at all. Sir Edward Reed assented to this proposition, and said they were not armoured ships, whereupon Mr. White rejoined that it was clearly evident that armoured tonnage and fighting efficiency were not interchangeable terms. Calling a vessel armoured or unarmoured will not affect her real fighting power, and it is merely a play upon words to adopt a mode of classification such as that we have described. The truth is that armour, fitted either in the form of thick vertical plates, or sloping oblique plates, or very strong horizontal plates, is armour all the same as long as it protects either the vitals of the ships, or the guns, or the steering stations, or the communications. Incidentally Sir Edward Reed, in his reply to what had been said respecting the Italia and Lepanto, gave what he conceived to be a history of the design of these ships. We shall be extremely surprised if more is not heard on this passage of the proceedings, for it is inconceivable that the Italian designers can sit silent in face of such an accusation.

We do not support the views of those who would discard armour, neither do we concur in the very special use of the term "armoured tonnage" which Sir Edward Reed favours. But the divergence of opinion as to the proper method of protecting battle ships is so serious that it does seem necessary and important to refer the whole matter to some competent advisory body, and if necessary to make experiments before largely increasing expenditure on ironclads not yet begun. Push on the armoured ships in progress by all means, and as rapidly as possible; lose no time in reaching a definite conclusion as soon as possible as to the battle ships that shall be laid down; but let us not hastily embark on constructions which may prove disappointing or misplaced when they have been carried too far to permit of alterations. Before building more armoured ships, let the proper type be settled by some competent and impartial committee; this is obviously desirable, and need not involve serious delay.

NAVAL EXPENDITURE.

If it could be shown that the construction of men-of-war was a remunerative proceeding, it may be assumed that no objection would be taken to the development of our naval strength, save, perhaps, by a few fearless spirits like Sir Wilfred Lawson, who argued on Tuesday night that if we had more ships we could not resist the temptation to wage war on inoffending nations. The contention is, however, that money spent on ironclads, and guns, and cruisers is merely wasted, in the sense that it might be invested in some other way that would produce a direct return. Even from a commercial point of view there is an element of error in this argument, and it may be worth while to show that the five millions or so which it is proposed to spend will not in any accurate sense represent a dead loss. In the first place, the whole sum does not represent more than a very small percentage indeed of our national income. A little intelligent reflection will suffice to show that there is no civilised nation of importance which can protect itself from attack at anything like so small an outlay. The work done by the twelve millions or so which we annually spend on the Navy gives a return out of all proportion to that obtained for a like amount by any other nation. There is nothing on earth so costly as an army. Our insular position, and the natural bent of our people, enables us in great degree to dispense with an army and substitute ships and sailors for soldiers. An outlay of five millions on soldiers in war time would give results scarcely visible. The expenditure of a similar sum with prudence and promptness on the development of our Navy may place England in such a position that she need fear no foe. As England is the most peace-loving nation on earth, her influence ought to be paramount as a peacemaker; but this it cannot be unless she is strong, and in no way can strength be obtained for so little money as by augmenting our Navies. In the second place, it may be shown that even if this return was not so great as it really is, the cost of an ironclad is not dead loss.

Let us say that, in round numbers, the cost of a great ironclad is £500,000. The whole of this sum is spent in this country, or in our colonies. Scarcely one farthing of it need go to the foreigner. The number of separate articles required in the construction of such a ship is simply enormous. It is difficult, indeed, to name a single product of the earth that is not needed in some shape or way. The result is, that every conceivable trade finds employment in producing a finished ironclad. The iron and steel used are obtained here. Everything almost, save the teak timber employed in backing and the hemp needed for cordage and sails, is a product of British soil and British industry. The result is that the half million contributed by the taxpayer is spent in paying British workmen. Sir Wilfred Lawson, with the great perception of the fitness of things for which he is so remarkable, would not have ships of war built by contract, lest the contractor should be enriched. It is very certain that, in the present day of keen competition, no fortunes will be made in this way. Yet, even if they were, the profits of the contractor would not represent a dead loss. In time these profits would be spent in this country. To a very great extent the building of an ironclad in England is like the transfer of money from one pocket to the other. The taxpayers may grumble—and to this side of the question we shall refer presently—but, nationally speaking, the country is not the poorer because it has built a great ironclad. Here we may draw a contrast between our position in this matter and that of other nations. Brazil, China, Russia, and many others, cannot produce an ironclad for themselves. They have to buy them from us. Thus, when Brazil, let us say, gives an order for an ironclad costing £200,000, and pays for her, the sum is absolutely taken out of the country, the Brazilian taxpayer loses it, and there is no commercial return whatever for it. If Lord Northbrook had proposed on Tuesday night that five millions should be spent, say in France, on ironclads, we can realise what an outcry there would have been. We should have been told, and properly told, that we were going to spend the British taxpayer's money in enriching French workmen. When we attempt to urge that by spending the money at home we shall enrich British workmen, we expect to be assured that it is not so, and that an ironclad not paying a profit, her construction is dead loss. We need not stop, perhaps, to point out the inconsistency involved in such a contention. The truth is that there are three ways in which money may be laid out either by the individual or by the nation. In the first place, it may be spent in some way that brings in a clear return, as, for example—with good luck—on a railway. Secondly, it may be spent in an investment which represents neither loss nor gain, as though a man lent money on a mortgage, never received one penny of interest, and after some years just succeeded in getting his capital back; and, lastly, we may spend money to a loss, as foreigners do when they come here and buy ironclads. The worst that can possibly be said of our national outlay on men-of-war is, that it belongs to the second category.

A word remains to be said concerning the actual loss to the taxpayer. Taking the whole annual outlay of the nation as £85,000,000, it will be seen that the contemplated increase of expenditure, if divided over only two years, represents $\frac{5}{170}$ only of the total—that is to say, out of every £170 which would be taken by the Government out of the pockets of the taxpayer in the next two years, £5 only would be laid out on additional men-of-war. To bring the matter into a smaller compass, we may say that as 1d. in the pound income tax represents about £1,900,000, an increase of 2·64d. for one year, or 1·32d. for two years would furnish the required £5,000,000. Eliminating small fractions, we have then a tax of 1½d. in the pound sufficing for the required work; so that the new ironclads would cost every man with an income of £500 per annum £3 2s. 6d., and every man with £1000 per annum £6 5s. a year for two years. If these figures are compared with the annual expenditure on police, lighting, inhabited house duty, education, poor rate, &c. &c., it will be seen that the cost of ironclads appears almost nominal. It is really as nothing compared with the return which they give. Of course it may be argued that there should be no necessity for ironclads. On this we fancy most people are agreed; but we may add that neither ought there to be any necessity for police, or gaols, or courts of law. All past experience has gone to prove without exception that while peace is the greatest blessing a nation can enjoy, the only way to possess it is to be prepared for war, and we may add that nothing is so costly as a state of half preparation.

THE LIFE OF IRON STEAMERS.

There are now slowly accumulating the materials from which in the future some deduction may be safely drawn as to the length of life of our iron steamers. One of the difficulties that marine insurance clubs and marine insurers generally had to contend with was the absence of these facts. It is not so difficult to ascertain some of the dangers to which vessels are exposed; but the losses of iron vessels have as yet been comparatively few, and the causes are varied, so that it is still difficult for the marine actuary to decide as to the proportionate cost of the insurance against these. Still facts do now accumulate. For instance, in the return of the registrar of ships for the month of October, we find that there were eighteen iron steamers removed from the register. Out of these there were four that were sold foreign, and may be at once omitted from our calculations. Three were lost, their ages being respectively 3 years, 17 years, and 3 years. There are 5 described as wrecked, the ages respectively being 11 years, 1 year, 1 year, 31 years, and 4 years. One was removed owing to a collision, her age being 11 years; and there were 4 stranded, the respective ages being 28 years, 20 years, 26 years, and 2 years. Finally one was removed from the registry, because after 26 years' service she has now been used as a hulk If the record for the month prove to be one that is somewhere near the average, we shall find that the iron steamer, on the average, has what must be considered a fair life when all the perils of the seas and of navigation are borne in mind. It is not desirable to carry out the figures we have given to a general average, for the area in time and number is not large enough. But these facts are curious, and they may be read with interest, as showing what may be the fair deduction from the valuable returns to which we have alluded, when that process of accumulation has been longer in progress. It is by experience that the errors of the past may be avoided in insurance as in other matters; and the slow tabulation of that experience is a service to commerce, and especially to the shipowners.

THE IRONMASTERS AND THE RAILWAY COMPANIES.

The Railway and Canal Freighters' Association have at length received a categorical reply to their application to the London and North-Western, the Great Western, and the Midland Railway Companies for certain changes in their favour in existing regulations. The document leaves the ironmasters in much the same position they were in before; and confirms the expectation entertained at the close of the recent interview at Euston with the chairmen of the several companies named. The main features of the communication are given in our Birmingham letter. That the companies should be "not yet prepared to give an answer" to the chief request of the traders, notwithstanding the considerable time that has elapsed since it was preferred, is especially unsatisfactory in view of the nature of the notices which these same companies have served upon the Board of Trade, indicating the class of legislation which they intend promoting in the next session of Parliament. The rates to which the traders object with so much force are those to London, Liverpool, and Hull, and they believe that they are in excess of the maximum rates sanctioned by the Legislature. Replying to the traders' appeal for a reduction of 33 per cent. in the charge for damageable iron, the companies say that hoop iron has been taken out of the damageable class; but they do not point out that it is now carried at owners' risk. The blast furnace proprietors of Northampton are to be encouraged to send their crude iron to distant mills and forges and foundries; but blast furnace proprietors near to such works are to receive no encouragement to buy larger quantities of Northampton ore, though materials of that order from some other districts are to be favoured. The extent of the favour is, however, a doubtful quantity. The ironmasters hold that the change in the mode of delivery consumes the reduction—that in some cases they are left worse off than they were before. The companies' reply and their Parliamentary Notices convince the traders that effort must be more than ever directed towards the obtaining of augmented canal facilities.

NARROW ESCAPE OF AN EXPRESS TRAIN.

The 3.0 p.m. express from London to Bradford had a narrow escape on the 29th ult. Intending to stop at Nottingham, the driver applied his brake, but although there was plenty of vacuum showing on the gauge, the vacuum brake failed to act, and the train ran several hundred yards through the station, which was fortunately clear at the time. It would have run much further but for the fact that the auxiliary steam brakes on the engine and tender did good service, and not for the first time. It is sincerely to be trusted that the Midland Company will on no account abandon these safeguards so long as it employs the vacuum brake on its lines. It is, in fact, notorious that this brake has been from the first upheld by the steam brakes on the engine and tender.

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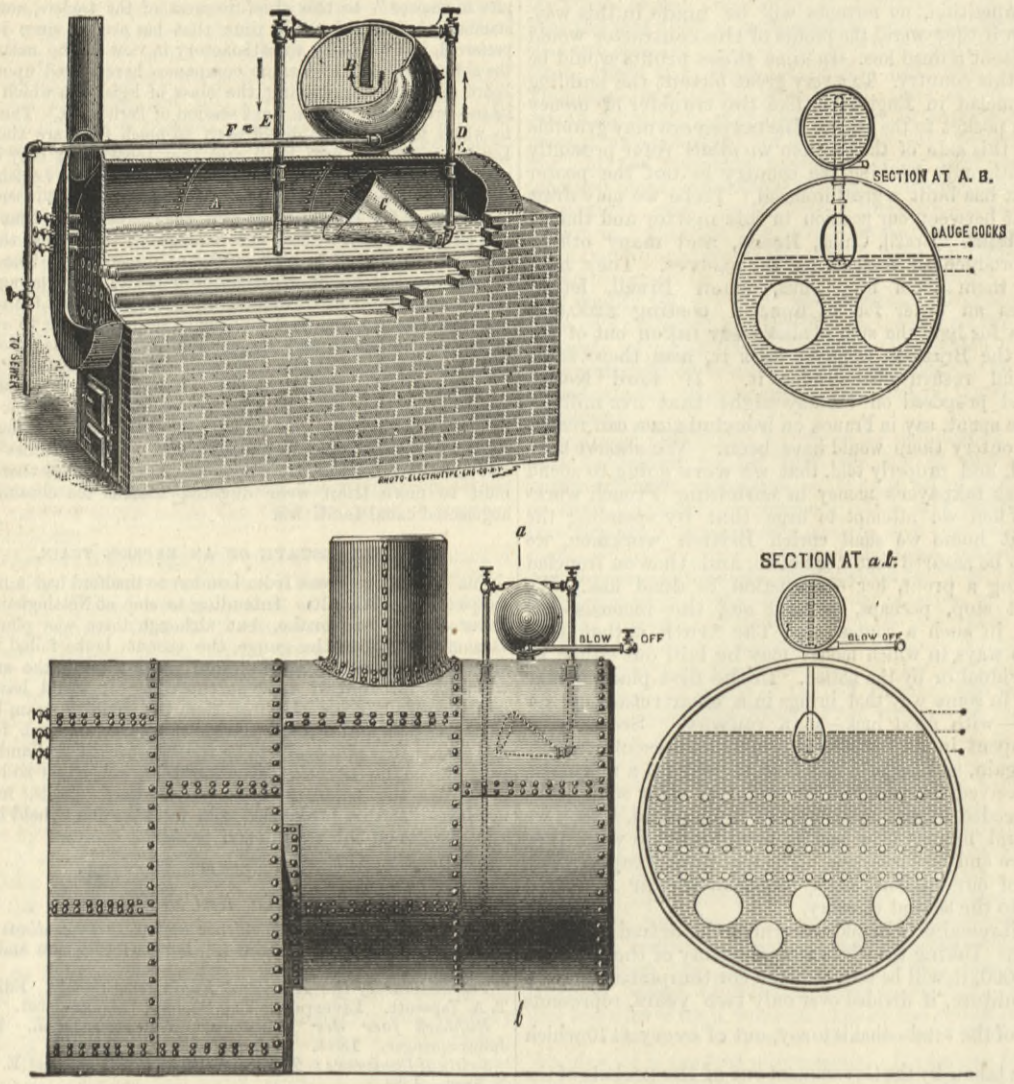
The Electric Light in Men-of-War.—The new United States cruisers are to be lighted by electricity. The electric plant for incandescent lighting supplied to the Trenton, beyond some slight defects in the insulation of the wires which could not have been anticipated, has given great satisfaction, and has added materially to the comfort and health of the officers and crew. The plant for the Atlanta is to be supplied by the United States Electric Lighting Company of New York; that for the Boston by the Brush Electric Company of Cleveland, and that for the Omaha by the Consolidated Electric Light Company of New York. In these vessels the defects referred to in the wiring of the Trenton will be remedied.

Antwerp International Exhibition, 1885.—The Lords of the Committee of Council on Education have received information, through her Majesty's Principal Secretary of State for Foreign Affairs, that her Majesty's Consul at Antwerp has been appointed British Commissioner for the International Exhibition, which is to be held at Antwerp next year, and that Mr. P. L. Simmonds has been appointed by the Executive Council of the Exhibition at Antwerp their agent-general for Great Britain and Ireland. The Exhibition in question is a national undertaking, under the immediate patronage of his Majesty the King of the Belgians, and of the Belgian Government. The president of the Exhibition is H.R.H. the Count of Flanders, and the vice-president the Minister of Agriculture, Industry, and Commerce. The office of the agent-general is at 35, Queen Victoria-street, and communications from intending exhibitors should be addressed to him there.

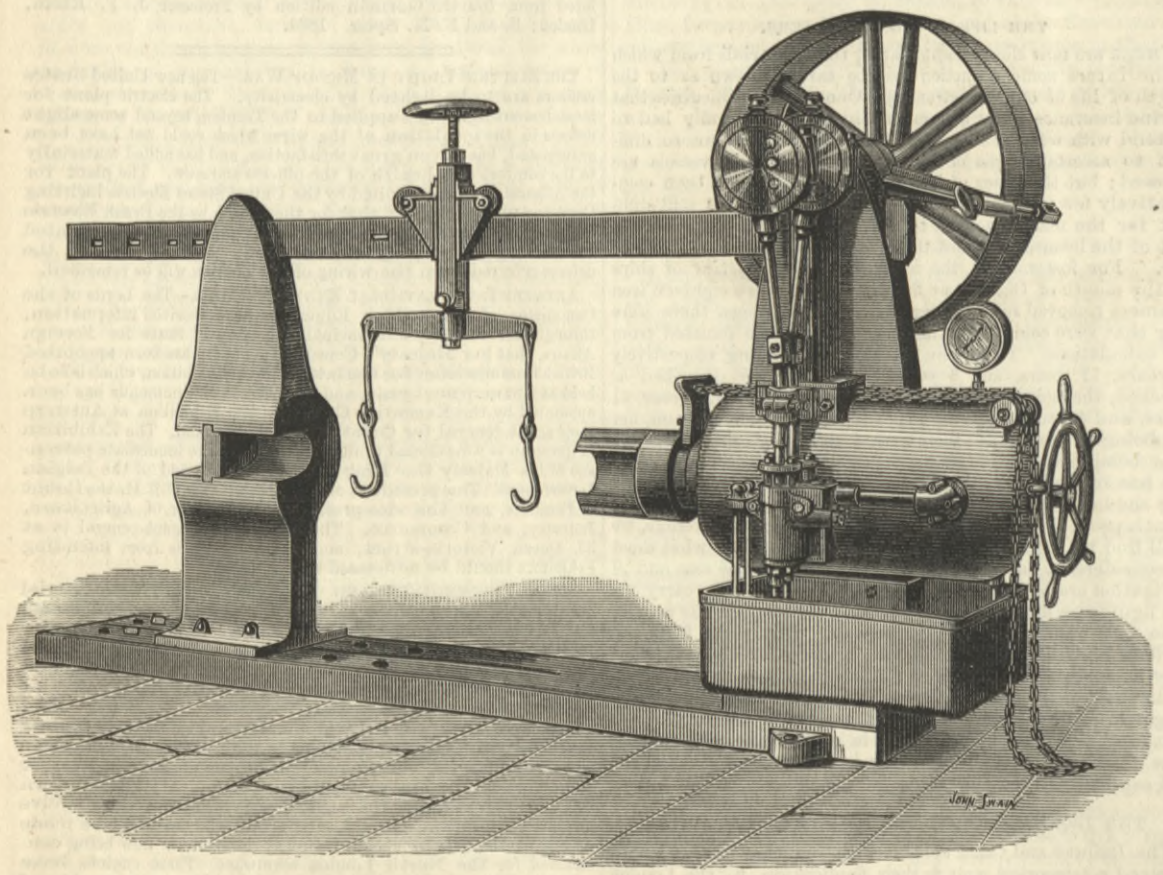
Steam Fire-engines and Tramway Locomotives.—A trial has recently taken place of two of the most powerful steam fire engines in the world. These have been constructed for the Corporation of Liverpool, and are similar to the powerful engines telegraphed for by H.I.M. the Emperor of Austria, and inspected by Count Karolyi, for pumping out the flood waters at Szegedin some few years since. Captain Nott Bower—chief constable of Liverpool—visited the works when the new engines were displayed. Steam was raised in the boiler of No. 1 engine—which indicates 100-horse power—in 9½ minutes, and the steamer was tested for its fire extinguishing powers. A jet was thrown 300ft. with great force, the engine being capable of working twelve streams simultaneously. A satisfactory trial has also been made of one of the fifteen steam tramway locomotives now being constructed for the North London tramways. These engines have cylinders 7½in. diameter by 12in. stroke, and are each capable of drawing three loaded cars, at a speed of 8 miles per hour, and, it is deemed, at a working cost of 30 per cent. less than horse-power. It is expected that the whole of these engines will be running in the course of the next two months. Messrs. Merryweather's works employ between 400 and 500 men, and are now running overtime.

HOTCHKISS' MECHANICAL BOILER CLEANER.



The accompanying engravings represent Hotchkiss' mechanical boiler cleaner for removing muddy deposits and sediments from the water in boilers before they become baked into scale. The cleaner is automatic. The funnel C is set near the surface of the water, but partly submerged, and in such position that its opening will intercept the currents of hot water flowing towards it. By the syphon action of the apparatus the hot surface water and floating matter that enters the funnel is caused to pass through the up-flow pipe D into the reservoir B, thereby displacing the cooler water therein, which flows back to the boiler through the return pipe E, which terminates at a lower level than the funnel. By this means, so long as firing is kept up, a constant circulation is maintained, and all the water in the boiler is caused to pass through the reservoir. The water while in the reservoir is comparatively quiet and entirely free from the agitating currents within the boiler, and while in this quiescent state the contained sedimentary matter B is precipitated and remains in the reservoir, from which it can be blown as often as necessary by the pipe F. The office of the cleaner is simply to provide a place for sedimentary accumulation outside of the boiler itself, from whence it can be readily removed as fast as it accumulates, instead of shutting down the boiler to clean it out by hand, or by blowing down the boiler in the ordinary way, thus losing a large amount of water already heated to the steam temperature. The makers say, "It is not claimed for the 'Hotchkiss mechanical boiler cleaner' that it will remove scale bodily from the boilers when the scale is already formed, but it is claimed for it, and guaranteed, that it will prevent the formation of new scale by removing all the floating deposits and mineral salts which become scale, if not removed from the water before they have had time to adhere to the heating surfaces. By preventing the formation of new scale, the old, by expansion and contraction of the heating surfaces, soon becomes loose and readily detached." It is being introduced by Mr. H. Nelson, 90, Worship-street, E C., and we understand that where it has been tried it has proved very successful with bad water. Amongst other places in or near London, it is at work in boilers in the works of Messrs. Peek, Frean, and Co., Bermondsey, and Messrs. Lawes' Chemical Manure Works. It is also designed for use in locomotives.

HYDRAULIC WHEEL PRESS.



We illustrate herewith a new and improved hydraulic press, for pressing locomotive and car wheels on their axles. The new feature in this machine is the method of operating the pumps, an improvement which has recently been patented by the Niles Tool Works. As will be seen from the cut, two plungers are employed, one of these is 2in. diameter, the other 1in. They are driven from the same shaft, and the plungers are brought into service or thrown out by means of the two rods shown to the right of the pump. When beginning operations both rods are raised about an inch, and immediately both plungers come into play, filling the cylinder and bringing the ram quickly forward. As the pressure begins to rise the rod connected with the larger plunger is dropped, and immediately that plunger ceases operation; the small plunger then continues the operation until the wheel is forced on to the axle, and to the position desired; then the other rod is dropped, and this plunger ceases operation instantly. When the rods are down the suction valves are raised off their seats, and hence the plungers are thrown out of service. The two rods for starting and stopping the pumps are attached to a weighted lever at the bottom of the suction pipe. From the other end of the lever other rods extend up to the suction valves of the pumps. When the rods are raised and hooked over the arrangement provided for the purpose, the suction valves are seated, and consequently perform their work. When the rods are dropped the suction valves are raised off their seats; hence the pump plungers continue working but do not pump any water.

The operation of starting and stopping is performed instantly; the machine does not make a single effective stroke after the rod is dropped. The whole operation requires no effort on the part of the operator whatever, and can be performed while he stands in position to see the entire operation of the machine. This improvement is held to be of great advantage in these machines, facilitating operation, and preventing the wheel being forced too far on the axle, as it can be stopped instantly at any point. It is, therefore, preferable to either shifting the belt, or moving a valve which requires some effort to open.

These machines are made of various sizes for different diameters of car wheels and locomotive drivers. The machine illustrated is designed for putting on and pulling off car wheels, and can exert a pressure of 150 tons. The ram is 8in. diameter. The presses for locomotive work have a capacity of 200 tons on a 9in. ram. The cylinder is made of cold-blast iron, and is copper lined, the lining being burnished in. The cylinder is provided with a relief valve, and the ram is weighted so as to return quickly. The machine is set upon a substantial cast iron base, upon which the resistance post moves on rollers. It is provided with a hydraulic gauge, lock-up safety valve, traveller for carrying the axle, and other attachments to make the machine complete. These machines are built by the Niles Tool Works, of Hamilton, O.—*Railroad Gazette.*

HOWARD'S ELECTRIC LEAD MOULDINGS.

The accompanying engravings illustrate in section and elevation a few of the forms of simple and special mouldings, made by Mr. F. Geere Howard, at the Cleveland Works, Cleveland-street, Fitzroy-square, for carrying and housing electric lighting leads and wires in buildings and ships. They are all of chaste design, and are made in many sizes and of different woods, as

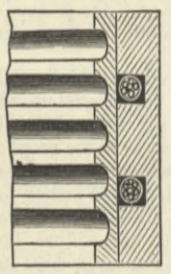


Fig. 1

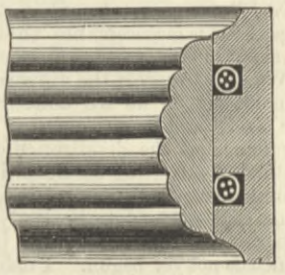


Fig. 3

may be best suited to their situations in use. Figs. 1, 2, and 3 are simple mouldings, the base half of which is fixed to the wall, and is provided with a couple of grooves, in which the leads or wires are placed. The face of the moulding is fixed by a few needle points. Fig. 4 shows a form in which the cover-strip, forming part of the face of the moulding, is let into the base-

Fig. 2

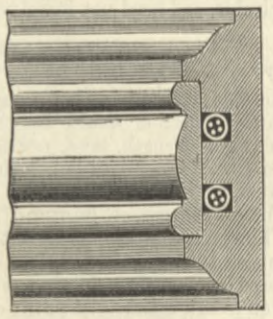


Fig. 4

strip, as seen in the section. There is, however, not much advantage in this arrangement, as pin points or brads of some kind must, after all, be used, to hold the cover-strip on the base, while there is the disadvantage, that with the same width of moulding the wires cannot very well be quite so far apart. Fig. 5 shows a section of a moulding for fixing round a room

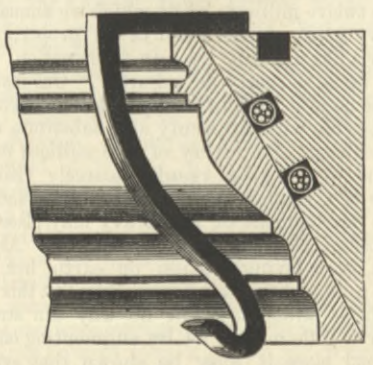
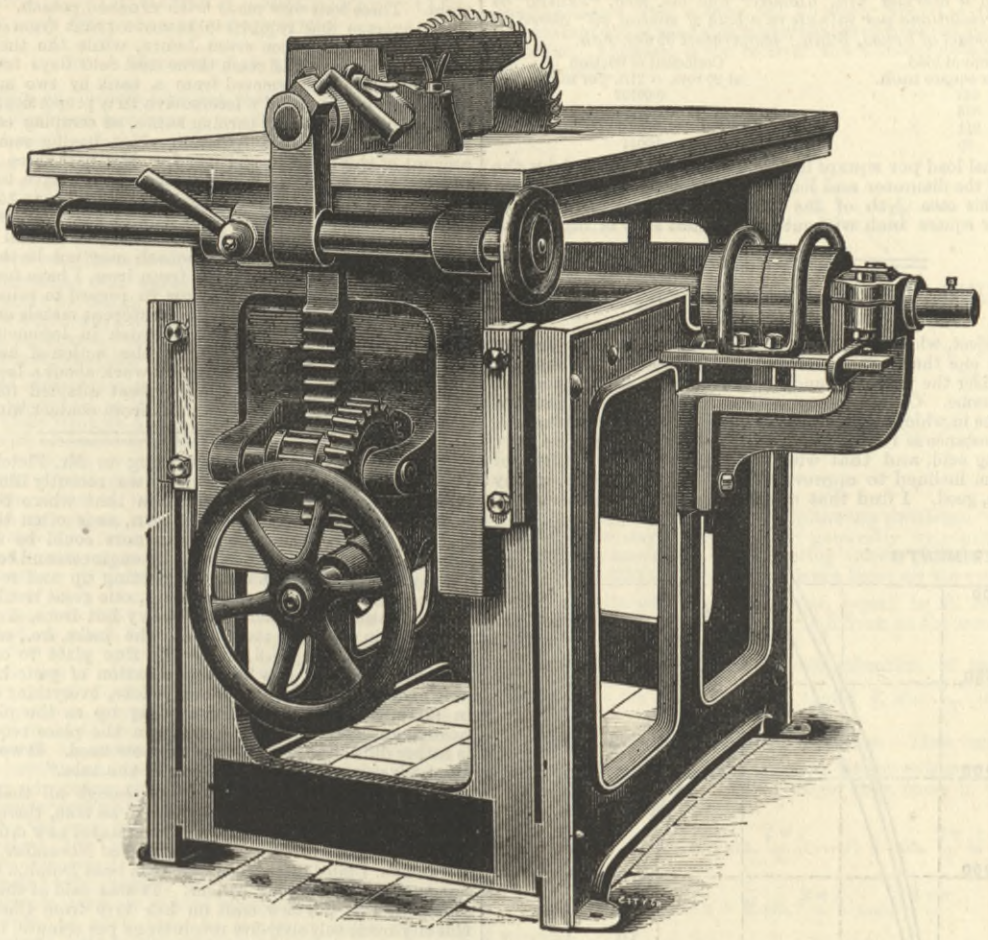


Fig. 5

immediately below the lowest member of a cornice, if one exists. The groove along the top is made to take the end of a hook, which is of neat and good form, not quite as shown in our engraving, from which pictures may be hung, thus dispensing with picture-rods or nails, the hooks being movable to any required position.

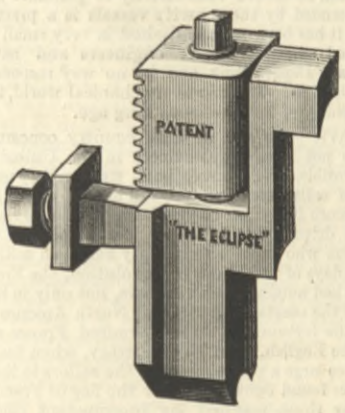
Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Edwin J. Comley, chief engineer, to the Mersey; Joseph A. Smith, chief engineer, to the Alacrity; Richard J. Tench, engineer, to the Gannet; Nathaniel E. Green, engineer, to the Penelope; John H. Adams and William Fedarb, engineers, additional, to the Asia; Josiah P. Thomas, engineer, to the Triumph; and George W. Hudson, assistant engineer, to the Malabar; Thomas Whebby, engineer, to the Firefly; Henry Charles Stansmore, chief engineer, to the Reindeer; and Richard Henry Tregenna, chief engineer, to the Flying Fish.

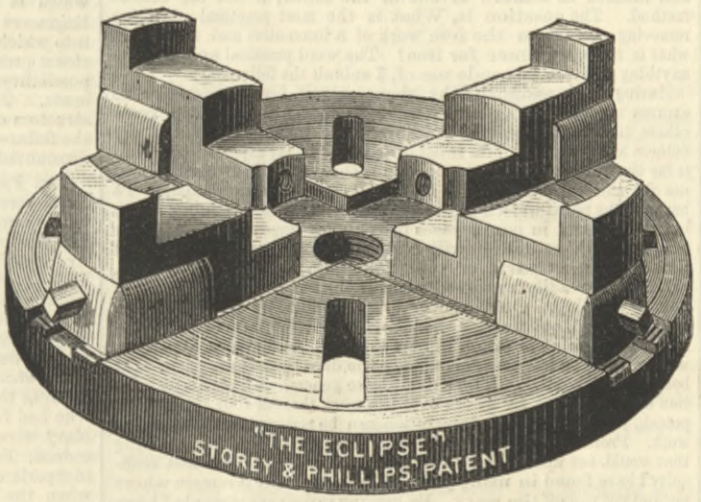
CENTRAL RACK RISING TOP SAW BENCH.



Messrs. Yates and Smith, of Halifax, have introduced an improvement in circular saw benches, in which they have succeeded in simplifying and reducing the number of working parts usually found in this class of tool. The main features of this improved rising top bench, of which we give an illustration, are that there is only one central rack, and one wheel casting at each end, and instead of the usual small slides and racks, and complement of wheels and pinions, the slide is made in one casting, nearly approaching the arch form. This slide is nearly the width of the bench itself, and on it is cast the broad central rack, which is capable of lifting four times its load. The raising of this slide, and with it the bench top, is effected in a very simple manner. The worm wheel and pinion are in one casting, and revolve loose on the short cross-shaft, which is a fixture carried in two brackets, cast, as shown, on the end of the bench. The same description of slide and motion applies to the opposite end of the bench, and both ends are worked simultaneously by the hand wheel and worm shaft, which traverses the whole length of the bench, and is carried by bearings cast on either end. With the simplifying of the working parts one important advantage is gained, that the liability to breakdowns, owing to the choking up with sawdust, is very considerably minimised ; and with the slide in one piece, and a strong rack cast on, increased rigidity is given to the bench. The worm wheel and pinion being cast in one also dispenses with any necessity for fastening, and simply revolve loose, whilst the compactness thus secured reduces the length of cross shaft one half. The worm at each end of the bench, after being adjusted in position, and held by set-screw, is bored right through its boss and the shaft that carries it, and a steel pin fitted in. The fence is made adjustable by a hand-wheel, to set at a bevel, and to swing over the end for cross cutting. The machine is provided with fast and loose pulleys, so that it is entirely under control. The saw spindle is made of good diameter, bored to the end to receive the auger, and is fitted with two adjustable lock-nuts, to take up all side play in the neck nearest the saw. The advantages claimed for a rising top bench, such as is shown in our illustration, is that the spindle and belt never move, whilst with a rising spindle bench the belt is never at one tension, consequently the work got out of the machine in a given time must necessarily vary in proportion as the belt varies in tension ; Messrs. Yates and Smith have apparently produced a very simple and compact machine of the rising bench class.

STOREY AND PHILLIPS' PATENT JAW CHUCK.





The above illustrations represent a new patent jaw chuck, introduced by Messrs. Phillips and Co., of Holborn Viaduct, for the more effective and ready adjustment of the dogs without the usual complication of parts. The principle can obviously be adapted to the fitting of these patent dogs to existing face plates without teeth, by having a bolt both on the dog and the block. It will readily be seen that the method of adjustment by means of the serrated teeth on the block and face plate as shown, and the supplementary set screw actuating the dog, forms in every respect a practical and effective method, as the strain is on the face plate and not on the vertical screw, as is usual. It is the only combined jaw chuck and face plate in existence. There are no slides or adjusting screws in the face plate, and it is claimed that an immense saving of time is effected in setting the work

NEW ROADWAY BRIDGE OVER THE RIVER OUSE AT BEDFORD.

The new roadway bridge over the river Ouse at Bedford, illustrations of which we give on page 428, has been now completed, and, amidst great rejoicings, was formally opened to the public on October 21st by Earl Cowper, K.G., in the presence of the Marquess of Tavistock—who laid the foundation stone—Lord Charles Russell, Mr. Whitbread, M.P., Mr. Howard, M.P., Mr. Magniac, M.P., the county and borough magistrates, Mayor and Corporation, and a long procession of the different trades and clubs, with their respective bands and banners. After the opening ceremony about 180 sat down to luncheon at the Shire Hall, at the invitation of the Mayor, Mr. Joshua Hawkins. The day's rejoicing ended with a grand display of fireworks.

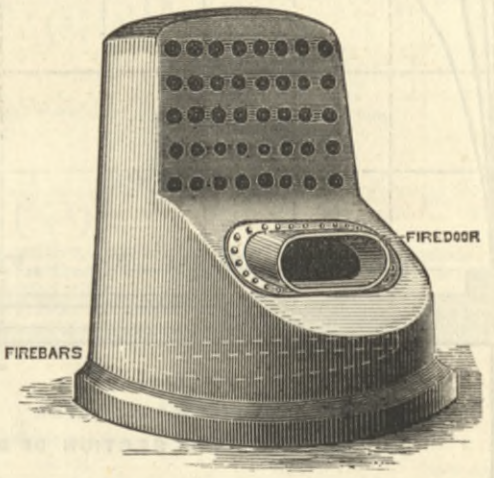
The bridge consists of one central span, and two smaller side spans, the distance between the faces of the north and south abutments being 200ft. The arches are segmental, and consist of four central wrought iron ribs, spaced 5ft. apart, to carry the vehicular traffic, and two outer ribs to carry the parapet and passenger traffic. The main ribs of the central span are made of four angle irons 4in. by 4in. by $\frac{11}{16}$in. and two web plates $\frac{11}{16}$in. thick ; the horizontal member consists of two angle irons 6in. by 4in. by $\frac{1}{2}$in., with braced spandrels of channel iron 5in. by 4$\frac{1}{2}$in. by 23 lb. The other ribs are of the same construction, with the thicknesses reduced in proportion. All the ribs are well braced laterally with angle iron 3in. by 3in. by $\frac{1}{2}$in., and rest upon strong cast iron skewbacks let into the Bramley Fall springings. The outer ribs are fitted with ornamental cast iron spandrels and cornice, as shown in our illustration, and surmounted with a handsome parapet railing. The flooring of the bridge is made of Westwood and Baillie's corrugated plates 6$\frac{1}{4}$in. deep, and covered with asphalt and concrete, on which is laid the macadam. The clear width between the inside of parapet railing is 35ft., with footways 7ft. wide.

The foundations have been taken down to the rock, which lies about 12ft. below the surface. The piers and abutments are made of Portland cement concrete, in the proportion of from 7 to 10 to 1, according to the position, and are faced with 14in. and 9in. brickwork up to the springings, and above with Darley Dale stone from Mr. Boden's quarry, the pilasters of the piers and abutments being entirely of this stone. Ornamental cast iron lamps are fixed to the cap of each of the pilasters. The bridge is approached on the north side by a new road, with a gradient of 1 in 87, having slopes of 1$\frac{1}{2}$ to 1, and fenced with Baltic red wood posts 9ft. apart, with three angle iron rails. The approach on the south side has a gradient of only 1 in 127, and has a close wooden fence on one side 5ft. 9in. high, and a panelled brick wall on the other, on the top of the retaining wall. This retaining wall, which is about 15ft. high at the abutments, is built of cement concrete 10 to 1, faced with white brickwork 14in. and 9in. thick, having a batter of 1 in 12, and was necessary on account of the contiguous property.

The works have been designed by Mr. John J. Webster, Assoc. M. Inst. C.E., of Stephenson-chambers, Liverpool, who also superintended the construction and erection. The contractors for the masonry, brickwork, and concrete, &c., were Messrs. S. W. Pilling, and Co., of Manchester and Bolton; and for the ironwork, Messrs. Goddard and Massey, of Nottingham, and great credit is due to them for the excellent manner in which they have completed their contracts. The whole cost of the works, exclusive of the purchase of land, has been about £8000, which must be gratifying to the engineer, as it is within his original estimate. This cost is extremely low, and considering the amount of labour necessary for such a class of bridge in comparison with the weight, it will be found to compare most favourably with any existing structure, either at the rate per ton or per superficial foot of space covered. The north approach is 530ft. long, and the south one 576ft. and 40ft. wide, having footways 8ft. wide paved with York 3in. tooled flagging, and the roadway of macadam. The river Ouse has also been very much improved near the bridge, from plans prepared by Mr. Webster.

BLAKE'S IMPROVED VERTICAL BOILERS.

Mr. Blake, Britannia Works, Newton Heath, Manchester, has recently effected an improvement in the construction of his well-known boilers, which we illustrate. In order to produce a cheaper boiler of small sizes, he has dispensed with the taper fire-box, and made the fire-box and combustion chamber in one



piece, and by placing the flat tube-plate in the way shown, it can be effectually stayed, the upper part by the tubes, the lower part by the fire-door neck-piece. The perspective sketch of the internal part of the boiler which we give will make the arrangement intelligible.

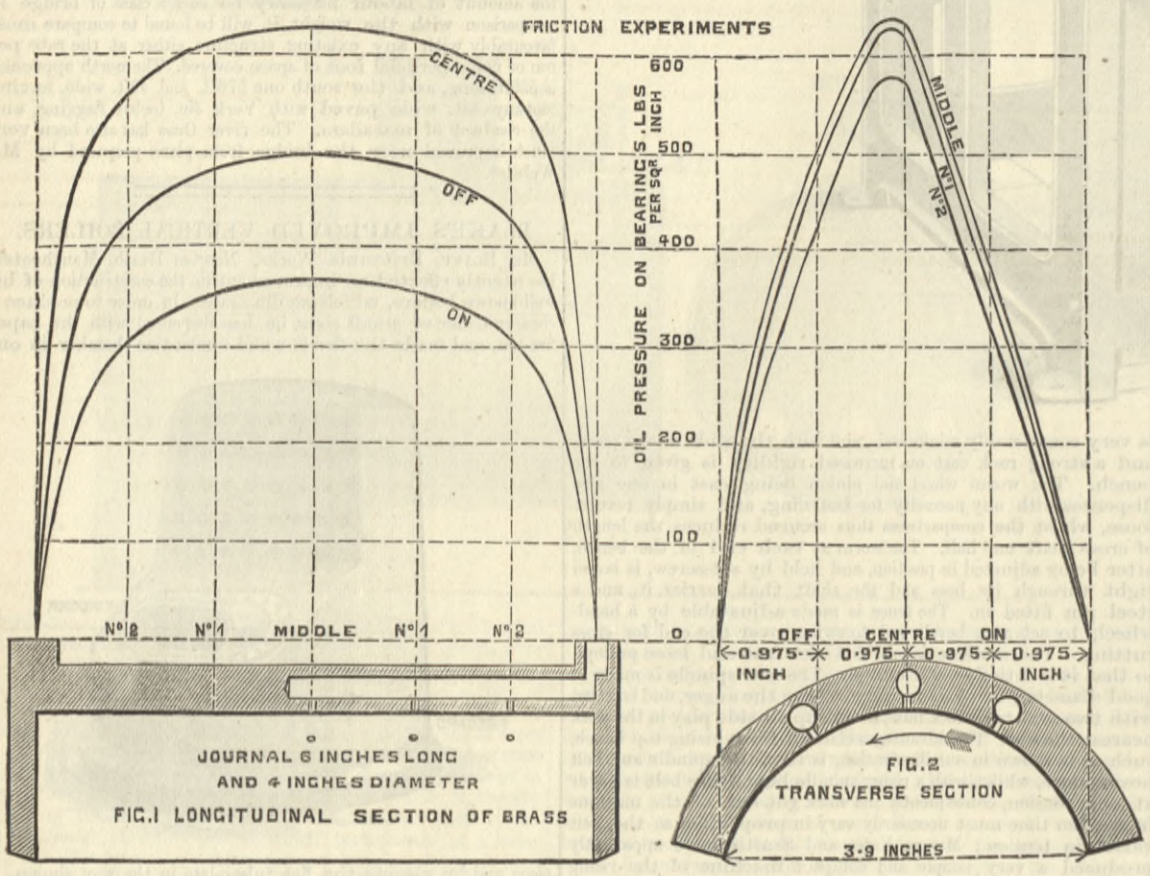
Society of Arts—Conversion of Heat into Work.—In addition to the usual courses of Cantor Lectures, the Society of Arts announces a course of lectures, the subject being "The Conversion of Heat into Useful Work," and the lecturer, Mr. William Anderson. The first lecture of the course was delivered on the 27th ult., and of the six lectures of which the course consists, three will be delivered before Christmas, and three after it. The following is the syllabus of the first three :—Lecture I., November 27.—Introduction; the laws of motion; potential and kinetic energy; laws of impact. Lecture II., December 4.—Oscillation, vibration, wave motion, pulsation in liquids and fluids; the luminiferous ether; porosity of matter, ultimate structure of matter; heat the consequence of molecular motion; transparency; diathermancy; specific heat; unit of heat; latent heat; absolute zero of temperature. Lecture III., December 11.—Molecular theory of gases; laws of volume, pressure, and temperature; isothermal and adiabatic lines of permanent gases and of vapours; Joule's equivalent; the doctrines of Carnot; the limits of efficiency of heat engines.

Eads' Proposed Panama Ship Railway.—A working model of the essential parts of Captain Eads' scheme is now on exhibition in New York. The model shows the means by which it is proposed to raise the vessel out of the water and place it on a gigantic car running on three tracks of rails. As the immense wheel-base of this car renders it impossible to traverse any curves of less than several miles radius, floating turntables are used when it is desired to change the course of the line, or enable two ships to pass one another *en route*. The details all appear to be very ingeniously worked out, but as the car, with its numerous wheels and journal boxes, is submerged some thirty minutes at each end of the journey, it seems doubtful whether the journals will run cool. The water in docks is always more or less muddy, and it would certainly appear that any lubricant would be likely to be washed away and some grit left in its place on the journals. It is proposed to employ the anti-friction metal often used on the bearings of emery grinders, which requires no lubricant of any kind whatever. Whether this will be successful or not under the heavy pressure on the journals of a car carrying a load of several thousand tons remains to be seen. Possibly the difficulty might be overcome by fitting a gland and packing to each journal box and filling the box with oil under pressure. The speed will be low, as it is not proposed to exceed a rate of 8 to 10 miles an hour, and with care this plan might succeed. The line as surveyed is 134 miles long. The summit level is 736ft. above low tide, and the worst grade is 53ft. per mile for a length of eight miles. The *Railroad Gazette* says, and it seems remarkable if true, that "many of the ablest engineers and naval architects have testified to the general practicability of the scheme as a whole. The importance of the project depends upon the amount of traffic which could go by this route with economy. This is very much less than most people suppose, and it is therefore the more important that the cheapest method of transferring vessels should be adopted, if any canal or ship railroad is to be built, and Captain Eads' scheme is estimated to require much less capital than either the Panama or the Nicaragua Canal." The scheme really seems to be seriously proposed.

SECOND REPORT ON FRICTION EXPERIMENTS.

THE following report on friction experiments has been furnished to the Institution of Mechanical Engineers by Mr. Beauchamp Tower :—

Experiments on the oil pressure in a bearing.—These experiments were tried with a brass similar to that which had been used for the friction experiments—see "Proceedings," 1883, pp. 638-9. The bearing was 4in. diameter and 6in. long. The brass did not embrace quite half the journal, having been reduced till the chord of the arc of contact was 3·9in., as shown in Figs. 1 and 2 in the accompanying engraving. Three ¼in. holes were drilled lengthwise in the body of the brass, and through a little more than half its length, Fig. 1. One of them was in the centre, and the other two were one on each side of it, Fig. 2. These holes coming out at one end of the brass were connected by converging copper pipes to a Bourdon pressure gauge. In order to ascertain the pressure at any point between the brass and journal, a hole $\frac{1}{16}$in. diameter was drilled from the bearing surface of the brass into one of these longitudinal holes, thus establishing a connection between that point and the pressure gauge. The pressure having been ascertained, the hole was stopped and another hole drilled, and so on. The arrangement of the holes, which were successively tested, was as follows :—The brass was supposed to be divided by six vertical planes, three of them parallel to the axis of the journal, and three at right angles to it; and the test holes were situated at the nine points of intersection of these planes. The planes parallel to the axis of the journal were 0·975in. apart, Fig. 2, so as to divide the brass longitudinally into four parts of equal breadth. Of these three planes one passed along the axis of the journal, and was



called the centre plane. One was on the side where the surface of the journal entered the brass, and was called the on plane. The other on the side where the surface of the journal left the brass was called the off plane. Of the three transverse planes, Fig. 1, one was in the centre of the length of the brass, and was called the middle plane; the other two were each 1in. apart, and divided the brass from the middle to the end into three transverse slices of 1in. length. The plane nearest the middle was called No. 1, and the furthest No. 2. The position of any one of the nine holes can thus be easily described by naming the two planes at the intersection of which it was situated. The pressure was thus actually read off at nine places in the bearing; but as it is reasonable to suppose that the pressure must be symmetrically disposed on either side of the middle transverse plane, Fig. 1, the pressures were observed on one side only of that plane, and those on the other side were assumed to be the same; so that in reality the pressure may be considered to have been ascertained in fifteen places distributed over the whole bearing surface of the brass. The bearing had a total load of 8008 lb. on it, and the journal rotated at 150 revolutions per minute. The temperature throughout was 90 deg. Fah. The observed oil pressures were as follows in pounds per square inch :—

TABLE XII.—*Oil pressure at different points of a bearing.*

Longitudinal planes.	On.	Centre.	Off.
Pressure per square inch.	lb.	lb.	lb.
Transverse plane, middle	370 ..	625 ..	500
Transverse plane, No. 1	355 ..	615 ..	485
Transverse plane, No. 2	310 ..	565 ..	430

Curves drawn by using these figures as ordinates are shown in Figs. 1 and 2 in the accompanying plate. Their most clearly marked feature is seen to be that the place of greatest pressure is on the off side of the centre, Fig. 2, the pressure at the holes in the on side being in every case considerably less than that at the corresponding holes on the off side. The total upward force exerted by these pressures is 7988 lb., or within 20 lb. of the actual load; this very small difference between the load and the oil pressure is probably due to errors of observation. In order to wear the brass down to a perfect fit on the journal, the bearing was first run for some time with a heavier load than that with which the experiments were taken. It was found that in taking off or putting on weight the pressure fell or rose exactly in proportion to the load. At the end of the experiments the speed of the journal was reduced from 150 revolutions per minute to twenty; but the pressure gauge indicated exactly the same pressure with both speeds. The oil used was a heavy mineral oil, the journal being about half immersed in a bath of it.

Experiments on friction at a low speed.—After the completion of the oil pressure experiments, the speed was reduced to twenty revolutions per minute; and observations of the amount of friction at this speed with various loads were made with the journal running about half immersed in a bath of mineral oil. By this time the brass had become by wear a very perfect fit on the journal; so perfect that, after stopping the journal, the pressure indicated by the pressure gauge fell very slowly; on one occasion it took about half-an-hour for the pressure to fall from 600 lb. per square inch to zero. The pressure indicated by the pressure gauge at twenty revolutions per minute was the same as that at 150, thus showing that the brass was as completely oil-borne at the lower speed as it had been at the higher. The friction was very nearly the same as that obtained in the former experiments with the same kind of oil at 200 revolutions per minute. The following was the observed friction :—

TABLE XIII.

Friction of a bearing 4in. diameter and 6in. long, running at twenty revolutions per minute in a bath of mineral oil; chord of arc of contact of brass, 3·9in.; temperature 90 deg. Fah.

Nominal load. lbs. per square inch.	Coefficient of friction at 20 revs. = 21ft. per min.
443	0·00132
333	0·00168
211	0·00247
89	0·0044

The nominal load per square inch is the total load divided by the product of the diameter and length of the journal; that is to say, it is in this case $\frac{1}{24}$th of the total load. It was increased to 676 lb. per square inch without the slightest signs of heating or seizing.

REMOVING OLD PAINT FROM THE IRON WORK OF A LOCOMOTIVE.*

THE subject, which in a measure has been assigned me for an opinion, is one that will command a vast amount of explanation if we consider the various conditions of the paint and methods of removing same. Of the many methods possibly in use I doubt if there is one in which there is not more or less difficulty attached. Many an instance is found where nothing can be accomplished save by scraping cold, and that with difficulty, while the method of which I am inclined to approve and will mention later is, in my estimation, good. I find that occasionally it becomes necessary to remove paint in which there is no life without the use of an ingredient or assistant, neither heat from our burners or steam heat having any effect thereon, and among the various methods that are and have been in use and with the possible improvements, if any, that have been made in removing paint from iron, I find that I am still inclined to adhere to one of the earlier, if not the oldest method. The question is, What is the most practical plan for removing paint from the iron work of a locomotive and tank, and what is the best primer for iron? The word practical applying to anything that can be made use of, I submit the following:—

Having been assigned the above subject, I will endeavour to express my views, hoping thereby to receive information from others that will be a benefit to myself; I cannot but express my opinion as to which is the most practical. In my experience potash is far the quickest. I have no doubt there are various methods in use for this purpose, but I find no trouble in using potash. To burn off the paint with heat is a good method, but it requires much longer time, and in some cases it is almost impossible to use the burners; with potash it will require a greater or less length of time on different parts or conditions. On Russia, or sheet iron, paint is very readily removed without the use of any ingredient or heat by scraping. On forge or bright finished work paint is also easily removed, but harder than from Russia iron. On rolled plate, iron or steel, paint is much harder to remove, and so with cast-iron, which I find the hardest, especially the drivers, or those parts that become most heated. The drivers have generally a large accumulation of grease; but by going over the work three or four times with potash, paints of every description can be removed from any iron-work. Professionally it has been claimed that there was nothing that would act upon lead as quick as potash. The greatest difficulty I have found in using potash has been to have it remain where put and not run off the work. By making various experiments I have found that good lime used in proper proportions with the potash will not only make it remain where put, but is also a benefit to the strength and quickening of the potash, the lime acting upon the grease more readily; when too great an amount of lime is used it has a tendency to harden upon the work, and then is as difficult to remove as the paint when first starting. One can also, I find, use too great an amount of potash in like manner; if the liquid is too strong and lime is used it has a tendency to crystallise and become hard. There are some objections to using potash, as it may injure the hands or clothes of the user, but to avoid this I have made use of hemp packing fastened to a stick, say, 2½ft. or 3ft. in length; this gives the workman plenty of distance from his work, and he does not injure himself or his clothes, and also gives him a good swab or brush with which to apply the potash. Another objection is the surplus of potash which may be left to remain upon the work, which, if not thoroughly removed, is injurious to the durability of the paint when repainted; but this can be avoided by extreme care being taken to remove the potash.

In making tests to obtain proportions and results of different strengths of potash and lime, I obtained the following:—My first was composed of 5 lb. lime, 6 lb. potash, and 7 quarts water; my second 5 lb. lime, 4 lb. potash and 6 quarts water, and I found that the latter was two hours the quicker in removing the paint from drivers of the same engine. Another trial was made with 14 lb. lime, 12 lb. potash 21 quarts of water for four pairs of drivers, and with this I found that it required equally as much time to remove the surplus of lime left upon the drivers as it took in the first place to remove the paint. Other tests being made of 1 lb. lime, 4 lb. potash and 6 quarts water, I found to work much better than any previously tried, and I am satisfied that this proportion is about right. These tests were made with crushed potash.

The average time required to remove paint from two pairs of drivers has been two men seven hours, while the time for scraping for same men would reach three and four days for same work The paint has been removed from a tank by two men in seven hours, and other parts of a locomotive in a proportionate length of time, while with heat for burning same, or scraping cold, the time is beyond mention for comparison. Not having removed a great amount of paint from locomotives for the past three years I have not had the experience possibly one should have to discuss this subject, but during the present year I have begun to thoroughly remove the old paint from some of the locomotives, and especially from the drivers, which I find have been painted and repainted at least six or seven times. While potash may not be the most practical plan for removing old paint from iron, I have found in it the best satisfaction. A few words now in regard to priming for iron; this may be varied according to the different metals or parts of an engine. In my opinion the entire finish in locomotive painting should be elastic from the start, as the action of heat and cold has much to do with the painting of work about a locomotive and tank, metallic or earth pigments are best adapted for priming on iron; and are less liable to be affected from contact with the metal.

* Paper read before the Boston Convention of the Master Car Painters, by A. T. Bishop, of the Cleveland, Columbus, Cincinnati and Indianapolis Railway.

REPAIRING BOILER FLUES.—Writing to Mr. Fletcher, of Warrington, respecting the large burners we recently illustrated, Mr. S. E. R. Capps, of Peckham, suggests that where the crown of boiler flues or furnaces has come down, as is often the case, that an arrangement of these powerful burners could be used to grea. advantage, and would be welcomed by engineers and boiler-makerst He says :—"As you are aware, the getting up and re-setting of a flue is a very difficult task to do nicely, one great trouble being the proper heating of the plate with heavy hot irons, &c., and then the delay in removing them before the jacks, &c., can be put in place and pressure applied, allows the flue plate to cool, and it is difficult to bend it. Now by an application of your burners, suitably arranged with blast and all complete, everything could be put in place, and jacks ready for setting up as the plates became heated, and could be heated exactly in the place required. This is rather difficult to do by the means now used. It would also be a great advantage to the men at work in the tube."

THE UNITED STATES CRUISERS.—Although all that appears in the *New York Herald* is not to be taken as true, there is reason to think that our criticisms on the United States new cruisers is being rapidly justified by events. The *Herald* of November 11th says :—"The new United States steel despatch boat Dolphin is still in the hands of John Roach, her builder. It was said at the Navy Yard yesterday that this new craft on her trip from Chester, Pa., to this city made only sixty-five revolutions per minute, but the speed that she showed was such as to warrant the attainment of the speed called for in the contract, and which the Advisory Board proposed for her, *i.e.*, 15 knots per hour. The general and particular ability of the Advisory Board that was selected by the Secretary of the Navy to design the new steel cruisers has been much criticised, and, as a matter of fact, their original plans for these cruisers have not been followed. The Dolphin was intended, as the Secretary of the Navy says in his report—1883—'to furnish an excellent model from which may be expanded a high speed commerce destroyer, instead of taking as a standard either the overgrown merchant line steamer or the expensive despatch vessels which have been built abroad, &c.' The Dolphin has been designed for high speed, and in this respect it is said by many experts this expensive vessel is a complete and signal failure. As a *Herald* reporter was told on board of the Dolphin yesterday, she left Chester, Pa., on her trial trip to this city flying light and with her bottom smooth and clean to the highest degree. Such conditions, of course, were favourable to speed, but she could only make at times 13½ knots and her blowing apparatus or system proved utterly worthless. Her mean draught of water, too, is now 12½ft., and the weights that she must carry when in seagoing trim will immerse her below this draught 2½ft., or to 15ft. This mean draught of water is 9in. more than her designers have calculated, which fact, too, puts the obtaining of the speed of 15 knots by the Dolphin, which she should be capable of easily, beyond all possibility, even if her engines be ever worked up to the calculated number of revolutions—seventy-five. In view of this vessel's engine and boiler design naval engineers scout the idea that her motive power can ever produce the contract speed of 15 knots. She is now at John Roach's, at the foot of East Ninth-street, having some alterations or additions made to her blowing system which it is hoped will increase her steam-producing capacity. Engineers of ability say that the system of an air-tight fire room into which a blast can be forced sufficiently to generate the high steam pressure demanded by these swift vessels is a practical impossibility, though it has been accomplished in very small torpedo boats. The trained and competent engineers and naval constructors of the Navy Department are in no way responsible for the failure of the Dolphin. The naval mechanical world, they say, discounted the stupidity of her sponsors long ago."

THE FRENCH NAVY.—The stir in this country concerning our naval strength has not passed unnoticed in the United States, where some very sensible articles have been written and published. The Boston *Herald* calls attention to the change which has been wrought in the French Navy by the return to the service of the Bretons, who were driven from it after the Revolution with the trained naval officers who were so strongly attached to the Royal cause. Before the days of the French Revolution, the French and English war vessels had numerous encounters, not only in European waters, but also off the coasts of India and North America; and in these encounters the fortunes of war favoured France about as often as they did the English. On the contrary, when the Bretons who had furnished so large a proportion of the sailors to the French Navy were no longer found fighting under the flag of France, then, indeed, French war ships, manned by incompetent officers and inexperienced sailors, were quickly defeated by the English, even when the number and strength of the latter were much less than that of their adversaries. At Aboukir, or the Battle of the Nile, while the number of line-of-battle ships was the same, the weight of metal, the gross tonnage, and number of men were on the side of the French. At Trafalgar, the allied French and Spanish fleets, which Nelson annihilated, were superior in weight of metal as well as in the number of ships. Even the less competent Lord Howe defeated the French fleet in the engagement of June 1st, 1794; and on board the captured vessels of the French fleet was found proof of the change France had undergone, in cartridges made of vellum on which Church music was painted, and of the titles and *preuves de noblesse* of the principal French families, many hundred years old, and illuminated in many instances with the genealogical tree. But, as the *Herald* shows, at the present time all this has been changed. The Bretons, who are the best men in the service, are descendants of men who left England between the fifth and seventh centuries, driven out by the Saxon invasions. They are of the same race as the sea-going population who inhabit the southern coast of England. Indeed, they have all of the quiet endurance and bravery which characterise the typical English sailor, and, throwing aside language and religion—for the latter they are strongly attached to the Roman Catholic Church—there is hardly any marked difference of character between the fishermen and farmers of the southern part of Great Britain and the fishermen and farmers of Brittany. If these two classes are brought into warlike opposition, victory is likely to rest with that side which has the best and strongest equipment. The English are beginning to recognise this fact, and to take into account that, whereas the French, German, or Italians could afford to run the risks of a naval defeat, a great naval defeat for England would be a calamity, the extent of which it would be almost impossible to over estimate.

ON THE THEORY OF ALTERNATING CURRENTS, PARTICULARLY IN REFERENCE TO TWO ALTERNATE-CURRENT MACHINES CONNECTED TO THE SAME CIRCUIT.*

BY J. HOPKINSON, F.R.S.

IN my lecture on Electric Lighting, delivered before the Institution of Civil Engineers last year, I considered the question of two alternate-current dynamo machines connected to the same circuit, but having no rigid mechanical connection between them, and I showed that if two such machines be coupled in series, they will tend to nullify each other's effect; if parallel, to add their effects. The subject is one which already has practical importance and application, and may have much more in the future; it is also one suited for discussion, and upon which discussion is desirable. I therefore venture to bring before the Society what I said in my lecture, some other ways of looking at the same subject, and an experimental verification, together with solutions of other problems requiring similar treatment.

The general explanation amounting to proof, so far as machines in series are concerned, is given in the following extract from my lecture:—"There remains one point of great practical interest in connection with alternate-current machines, How will they behave when two or more are coupled together to aid each other in doing the same work? With galvanic batteries, we know very well how to couple them, either in parallel circuit or in series, so that they shall aid, and not oppose, the effects of each other; but with alternate current machines, independently driven, it is not quite obvious what the result will be, for the polarity of each machine is constantly changing. Will two machines coupled together run independently of each other, or will one control the movement of the other in such wise that they settle down to conspire to produce the same effect, or will it be into mutual opposition? It is obvious that a great deal turns upon the answer to this question, for in the general distribution of electric light it will be desirable to be able to supply the system of conductors from which the consumers draw by separate machines, which can be thrown in and out at pleasure. Now I know it is a common impression that alternate-current machines cannot be worked together, and that it is almost a necessity to have one enormous machine to supply all the consumers drawing from one system of conductors. Let us see how the matter stands. Consider two machines independently driven, so as to have approximately the same periodic time and the same electro-motive force. If these two machines are to be worked together, they may be connected in one of two ways: they may be in parallel circuit with regard to the external conductor, that is, their currents may be added algebraically and sent to the external circuit; or they may be coupled in series, as shown by the dotted line, that is, the whole current may pass successively through the two machines, and the electro-motive force of the two machines may be added, instead of their currents. The latter case is simpler. Let us consider it first. I am going to show that if you couple two such alternate current machines in series, they will so control each other's phase as to nullify each other, and that you will get no effect from them; and as a corollary from that, I am going to show that if you couple them in parallel circuit, they will work perfectly well together, and the currents they produce will be added; in fact, that you cannot drive alternate-current machines tandem, but that you may drive them as a pair, or, indeed, any number abreast. We want to see whether they will tend to get into the same phase or to get into opposite phases. Now, if the machines are coupled in series, the resultant electro-motive force on the circuit will be the sum of the electro-motive forces of the two machines. This resultant electro-motive force is represented by the broken curve III.; by what we have already seen in Formula IV., the phase of the current must lag behind the phase of the electro-motive force, as is shown in the diagram by curve IV., thus——.——.——. Now, the work done in any machine is represented by the sum of the products of the currents and of the electro-motive forces, and it is clear that as the phase of the current is more near to the phase of the lagging machine II. than to that of the leading machine I. the lagging machine must do more work in producing electricity than the leading machine: consequently its velocity will be retarded, and its retardation will go on until the two machines settle down into exactly opposite phases, when no current will pass. The moral therefore is, do not attempt to couple two independently driven alternate-current machines in series. Now for the corollary. Let A B represent the two terminals of an alternate-current machine; a b the two terminals of another machine independently driven. A and a are connected together, and B and b. So regarded, the two machines are, in series, and we have just proved that they will exactly oppose each other's effects—that is, when A is positive, a will be positive also; when A is negative, a is also negative. Now, connecting A and a through the comparatively high resistance of the external circuit with B and b, the current passing through that circuit will not much disturb, if at all, the relations of the two machines. Hence, when A is positive, a will be positive, and when A is negative, a will be negative also; precisely the condition required that the two machines may work together to send a current into the external circuit. You may, therefore, with confidence, attempt to run alternate-current machines in parallel circuit for the purpose of producing any external effect. I might easily show that the same applies to a larger number: hence there is no more difficulty in feeding a system of conductors from a number of alternate-current machines than there is in feeding it from a number of continuous-current machines. A little care only is required that the machine shall be thrown in when it has attained something like its proper velocity. A further corollary is that alternate currents with alternate-current machines as motors may theoretically be used for the transmission of power."†

Although the proof of this corollary regarding motors is similar to what we have just been going through, it may be instructive to give it. In the accompanying diagrams, the full lines I. and II.

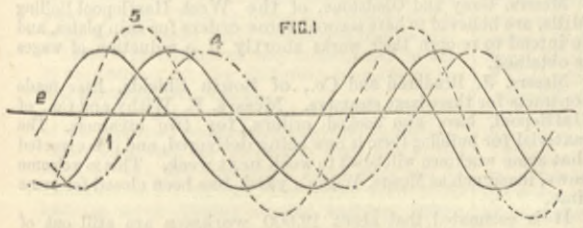
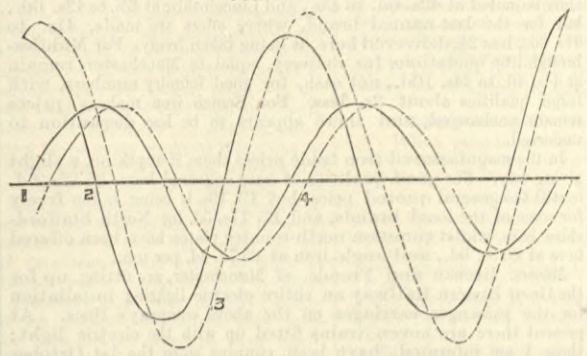


FIG. 1

represent the electro-motive forces of the two machines—generator and receiver—the dotted line, curve III.—. . . .—the resultant electro-motive force; and the curve IV., the resulting current, each in terms of the time, as abscissæ. The only difference between the two diagrams is, that in Fig. 1 the two machines have equal electro-motive forces, whilst in Fig. 2 the receiving machine has double the electro-motive force of the generator. In both figures the receiving machine lags behind the phase of direct opposition to the generator by one-quarter of a period, or something less. Now observe, the resultant electro-motive force must be in phase behind the receiver, but in advance of the generator. Also observe, the current must be in phase behind the resultant electro-motive force, and may be one-quarter of a period behind, provided only the self-induction be large enough compared with the resistance. The current will then be less than a quarter period behind the generator. This machine will do work upon the current, but the current will be more than a quarter period behind the receiving machine. Therefore, in the receiver the current does work upon the machine.

FIG. 2



The subject is illustrated by the following problems. Of course, any of them may be treated more generally by considering the machines as unequal, or by introducing other periodic terms, but I do not see that this would throw more light on the subject:—

I. Two alternate-current machines, equal in all respects, are connected in series and independently driven at the same speed, to determine the current, &c., in each.

Let γ be the coefficient of self-induction of each, r the resistance, x the current at time t, and $E \sin. \frac{2\pi}{T}(t+\tau)$ and $E \sin. \frac{2\mu}{T}(t-\tau)$ the electro-motive forces. Then regarding the coefficient of self-induction as constant, which it is not exactly, and neglecting the effect of currents other than those in the copper wire, the equation of motion is

$$2\gamma x' + 2rx = E\left\{\sin.\frac{2\pi}{T}(t+\tau) + \sin.\frac{2\pi}{T}(t-\tau)\right\}$$

or

$$\gamma x' + rx = E \sin.\frac{2\pi t}{T} \cos.\frac{2\pi\tau}{T}$$

whence

$$x = \frac{E \cos.\frac{2\pi\tau}{T}}{r^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left\{r \sin.\frac{2\pi t}{T} - \frac{2\pi\gamma}{T}\cos.\frac{2\pi t}{T}\right\}$$

Work done by the leading machine per second

$$= \frac{E^2 \cos.\frac{2\pi\tau}{T}}{2\left\{r^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}} \cdot \left\{r \cos.\frac{2\pi\tau}{T} - \frac{2\pi\gamma}{T}\sin.\frac{2\pi\tau}{T}\right\}$$

$$= \frac{E^2}{4\left\{r^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}} \cdot \left\{r\left(1+\cos.\frac{4\pi\tau}{T}\right) - \frac{2\pi\gamma}{T}\sin.\frac{4\pi\tau}{T}\right\}$$

From this at once follows that the leading machine does least work, and will tend to increase its lead until $\tau = \frac{T}{4}$, when the two machines will neutralise each other, as already proved geometrically. The leading machine may actually become a motor and do mechanical work, although its electro-motive force is precisely equal to that of the following machine.

Considering the important case when r is negligible, we have

$$x = -\frac{E \cos.\frac{2\pi\tau}{T} \cdot \cos.\frac{2\pi t}{T}}{\frac{2\pi\gamma}{T}},$$

$$\text{rate of working} = \frac{E^2 \sin.\frac{4\pi\tau}{T}}{4 \cdot \frac{2\pi\gamma}{T}}.$$

This is a maximum when $\tau = \frac{T}{8}$, and then it is equal to one-half of the maximum work which can be obtained from either machine when connected to a resistance only, which occurs when that resistance is $\frac{2\pi\gamma}{T}$; the current, however, is the same as when the maximum work is being done on resistance, and is $\frac{1}{\sqrt{2}}$ of the current the machine will give it short-circuited. The difference of potential between the two leads connecting the machines, whether $r = 0$ or not, is $E \cos.\frac{2\pi t}{T} \sin.\frac{2\pi\tau}{T}$. If there be no work done on the receiving machine, and $r = 0$, $\tau = \frac{T}{4}$, and the amplitude of the difference of potential between the leads is E; if, on the other hand, the maximum work is being transmitted, the potential measured will be $\frac{1}{\sqrt{2}}$ of that observed when either machine is run on open circuit

II. Two machines are coupled parallel and connected to an external circuit resistance R.

Let x_1 x_2 be currents in the two machines. The external current will be $x_1 + x_2$, and consequently the difference of potential at the junction, $R(x_1 + x_2)$.

Let the electro-motive forces of the two machines regarded in this case as connected parallel be $E \sin.\frac{2\pi(t \pm \tau)}{T}$, and let the self-induction and resistance of each be $e\gamma$ and $2r$.

The equations of motion then are

$$2\gamma x'_1 + 2r x_1 = E \sin.\frac{2\pi(t+\tau)}{T} - R(x_1 + x_2)$$

$$2\gamma x'_2 + 2r x_2 = E \sin.\frac{2\pi(t-\tau)}{T} - R(x_1 + x_2)$$

whence

$$\gamma(x'_1 + x'_2) + (R + r)(x_1 + x_2) = E \sin.\frac{2\pi t}{T} \cdot \cos.\frac{2\pi\tau}{T}$$

and

$$\gamma(x'_1 - x'_2) + r(x_1 - x_2) = E \cos.\frac{2\pi t}{T} \sin.\frac{2\pi\tau}{T}$$

Solving these

$$x_1 + x_2 = \frac{E \cos.\frac{2\pi\tau}{T}}{(r+R)_2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left\{(r+R)\sin.\frac{2\pi t}{T} - \frac{2\pi\gamma}{T}\cos.\frac{2\pi t}{T}\right\}$$

$$x_1 - x_2 = \frac{E \sin.\frac{2\pi\tau}{T}}{r^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left\{r \cos.\frac{2\pi t}{T} + \frac{2\pi\gamma}{T}\sin.\frac{2\pi t}{T}\right\}$$

electrical work done by the leading machine

$$= \tfrac{1}{2} E \sin.\frac{2\pi(t+\tau)}{T}\left\{x_1 + x_2 + (x_1 - x_2)\right\}$$

$$= \tfrac{1}{4}\frac{E^2}{(r+R)^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left\{(r+R)\cos.^2\frac{2\pi\tau}{T} - \frac{2\pi\gamma}{T}\sin.\frac{2\pi\tau}{T}\cos.\frac{2\pi\tau}{T}\right\}$$

$$+ \tfrac{1}{4}\frac{E^2}{r^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left\{r \sin.^2\frac{2\pi\tau}{T} + \frac{2\pi\gamma}{T}\sin.\frac{2\pi\tau}{T}\cos.\frac{2\pi\tau}{T}\right\}$$

This expression shows that the leading machine does most work in all cases. Suppose r is small compared with R and $\frac{2\pi\gamma}{T}$, also that $R = \frac{2\pi\gamma}{T}$, we have the work done per second

$$= \frac{E^2}{8R}\left\{\cos.^2\frac{2\pi\tau}{T} + \sin.\frac{2\pi\tau}{T}\cos.\frac{2\pi\tau}{T}\right\}$$

make $\tau = -\frac{T}{8}$, and we see that the following machine will then do no work; when τ exceed this, the following machine becomes a motor and absorbs electrical work.

III. Suppose the terminals of an alternate-current machine are connected to a pair of conductors, the difference of potential between which is completely controlled by connection with other alternate current machines.

Let γ and R be the coefficient of self-induction and the resistance of the machine and its own conductors up to the point at which the potential is completely controlled. Let the difference of potential of the main conductors be $A \sin.\frac{2\pi t}{T}$, and let the electro-motive force of the machine be $B \sin.\frac{2\pi(t-\tau)}{T}$.

Equation of motion is

$$\gamma x' + R x = B \sin.\frac{2\pi(t-\tau)}{T} - A \sin.\frac{2\pi t}{T},$$

whence

$$x = \frac{1}{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left[B\left\{R \sin.\frac{2\pi(t-\tau)}{T} - \frac{2\pi\tau}{T}\cos.\frac{2\pi(t-\tau)}{T}\right\} - A\left\{R \sin.\frac{2\pi t}{T} - \frac{2\pi\gamma}{T}\cos.\frac{2\pi t}{T}\right\}\right]$$

electrical work done by the machine in unit of time

$$= x B \sin.\frac{2\pi(t-\tau)}{T}$$

$$= \frac{1}{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left[\frac{B^2 R}{2} - \frac{AB}{2}\left\{R \cos.\frac{2\pi\tau}{T} + \frac{2\pi\gamma}{T}\sin.\frac{2\pi\tau}{T}\right\}\right]$$

if τ be positive, that is, if machine be lagging in its phase, work done is less than if it be negative; hence, τ will tend to zero, or the machine will tend to adjust itself to add its currents to that of the system of conductors. The machine may act as a motor even though its electro-motive force be greater than that of the system, for let

$$\frac{R}{\frac{2\pi\gamma}{T}} = \tan.\frac{2\pi\phi}{T},$$

work—electric—done by machine

$$= \frac{B^2 R}{2\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}} - \frac{AB}{2\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}} \tfrac{1}{2} \sin.\frac{2\pi(\phi+\tau)}{T}$$

this has a minimum value when $\phi + \tau = \frac{T}{4}$, and then the mechanical work done by machine or electrical work received by the machine

$$= \frac{B}{2\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}^{\frac{1}{2}}}\left\{A - \frac{RB}{\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}^{\frac{1}{2}}}\right\}$$

and this is positive provided

$$\frac{A}{B} > \frac{R}{\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}^{\frac{1}{2}}}$$

There are two or three other problems of sufficient interest to make it worth while giving them here, although not directly relating to alternate-current machines coupled together.

(To be continued.)

* Paper read before the Society of Telegraph-Engineers and Electricians on November 13th, 1884.

† "Of course, in applying these conclusions, it is necessary to remember that the machines only *tend* to control each other, and that the control of the motive power may be predominant and *compel* the two or more machines to run at different speeds."

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 22nd.

THE Gould System Railway managers contemplate the purchase of 150,000 tons of steel rails—this number for delivery through 1885—to extend and perfect that system, and to make connections with lines now disconnected west of the Mississippi. Orders for about 50,000 tons steel rails will be placed before Christmas. Orders for 5000 tons structural iron for bridges will be placed soon. Orders for 15,000 tons Virginia and Ababama pig iron have been placed for delivery at 16·25 dols. for forge, and 17 dols. to 18 dols. for foundry iron. A number of 100 to 500-ton orders for Pensylvania and Ohio iron have been placed to take the place of anthracite iron. New England textile manufacturers are still in trouble over low prices and backward demand. Secret conferences have been held at Fall River, Providence, and Boston, to determine upon some decisive policy, but failed to come to any agreement. Coal miners to the number of 4000 have had their wages reduced 20 per cent. in the Cumberland coal region. The Hocking Valley strike continues. Navigation will soon be closed, and coal and lumber shipments will be terminated until April, except to and from South Atlantic ports. In financial circles there is an abundance of money at nominal rates of interest.

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

(From our own Correspondent.)

THE doubt entertained by the chairman of the South Staffordshire iron trade as to whether we have yet reached the lowest stage in the depression, and which he enunciated at the meeting of the Iron Trade Wages Board this week in Birmingham, finds an echo in other quarters. Export consumers are still limiting their orders, and even the present very low prices fail to stimulate purchases. Consequently, the inquiries received from merchants are not for large individual lots, yet early execution is mostly stipulated.

On 'Change in Birmingham to-day—Thursday—and in Wolverhampto sterday, inquiries for merchant steels and for galvanis-

ing sheets were upon the market in encouraging numbers, considering that the last month of the year has been entered upon. Outside this description of iron business was dull, and makers do not anticipate much buying until next year. Happily, the settlement of the wages question has removed an element of uncertainty from the market.

Prices all round were again a matter of much dissatisfaction, and for several descriptions of iron they were scarcely ever so low. Rates for sheets were stationary at £6 15s. for merchant singles, £7 for galvanising singles, and £7 7s. 6d. to £7 10s. for doubles. The galvanisers were reticent as to the prices which they are prepared to accept, but ordinary brands of 24 w.g. bundled might have been had at a little less than £12 per ton delivered Liverpool.

Hoops were depressed at an average of something under £6 5s. per ton at works. Makers were better able to negotiate with customers who buy very keenly, because of the trifling concession by the railway companies, mentioned further on. It is hoped that practically the relief at the beginning of the new year may work out to about 2s. 6d. per ton, but it may be only 1s. 6d.

Marked iron is closing the year very quietly. Although the list prices remain unchanged at £7 10s. for bars, with 12s. 6d. extra for Round Oak qualities, the values of other descriptions vary very much, according to the extent of the orders offered. Certain of these are for lots of so small dimensions that the profits would barely cover the cost of changing the rolls, and they are promptly rejected.

Messrs. Millington and Co. quote cable iron, plating bars, and small rounds and squares, $\frac{3}{8}$in., £8; best chain iron, best plating bars, and rounds and squares, $\frac{1}{4}$in., £9; rivet iron, £8 10s., £8 15s., and £10 5s., according to quality; angles, 1$\frac{1}{2}$in. to 3in., £8 10s., £9, and £10, according to quality; tang iron, $\frac{1}{2}$in. and $\frac{7}{16}$in., £7 10s. for ordinary, £8 10s. for best, and £9 10s. for double best. Horseshoe and shutter bar iron, 1$\frac{1}{2}$in. to 2in., £7 10s.; rounds and squares, $\frac{5}{16}$in., £8 10s.; ditto, No. 5, £9 10s.; ditto, $\frac{3}{16}$in., and No. 6, £10; No. 7, £11; No. 8, £12; No. 9, £13 10s.; No. 10, £15 10s.; and No. 11, £17 10s. Treble best bars they quote £11 10s.

Plates Messrs. Millington quote at £9 for ordinary, £9 10s. for best boiler, £10 10s. for double best, £12 10s. for treble best for flanging inwardly. Sheets not larger than 10ft. by 3ft. by $\frac{1}{8}$in. they quote £9 10s., and best qualities 20s. per ton additional.

New sales of pig iron are also for only small lots, most consumers having during the past few months negotiated considerable contracts. Some vendors of hematites stated this afternoon that their sales during the past four months had aggregated a larger total than during any four months of their experience. Deliveries of pigs are going forward under these contracts, some of which have almost run out, and will shortly have to be renewed. Best mine pig iron is quoted at £3 and £3 2s. 6d. per ton; but some transactions for large lots have taken place at £2 17s. 6d. Part-mine pig iron is priced at £2 5s.; cinder iron, £1 17s. 6d. and £1 15s. per ton. Hematites are quoted 55s. delivered, and except in September, 1879, Tredegar—South Wales—qualities were never before to be had at so low a figure as this. It will be remembered that in November and December, 1879, a sudden revival sprang up and prices rapidly rose to a high point for a short time. There seems no probability, however, of a recurrence of such an event this year.

Minerals are selling only quietly, and prices favour buyers. Northampton ironstone varies from 5s. 6d. to 6s., and for best sorts, 6s. 6d. per ton delivered.

Coal prices are weak and supplies abundant.

Coal miners' wages are 3s. 4d. "per day," or stint, in thick coal, 2s. 8d. in the thin coal seams. Colliery enginemen are receiving 3s. 8d. per day.

The ironmasters have this week withdrawn their claim for a reduction in wages. At a meeting of the Iron Trade Wages Board in Birmingham, on Monday, Mr. B. Hingley announced that the employers had determined to adopt a waiting policy, and go on paying 7s. 3d. per ton for puddling, with the consent of the Board. They, however, strictly stipulated that it should not become an established fact that they were always to pay that price without reference to the prices ruling in the North of England. Mr. James Capper, the operatives' secretary, accepted the offer, but contended that the conditions of labour and the selling prices of South Staffordshire and the North of England were very dissimilar. The greater proportion of the output in Staffordshire consisted of sheets which realised 30s. and 50s. more per ton than the iron produced in the North.

The leaders of the late colliers' strike met in "conference" at Greatbridge this week; but not alone, for they had the advice and assistance of delegates from other trades, representing altogether, it was asserted, some 20,000 men. That this advice was not sound is to be seen in the fact that it was agreed "that notice for an advance of wages of 4d. 'per day,' or stint in thick coal, and 2d. 'per day' in the thin coal, to be given on the first pay day in January, 1885." Considering the present depression, it is superfluous to add that it is most improbable that such an advance will be conceded.

At the monthly meeting in Wolverhampton on Wednesday of the Mines Drainage Commissioners, the chairman announced that the agreement between the Birmingham Canal Company and the Commission expired on December 31st. The company were glad of the water from the Commissioners' pumping engines, because their supply was short, but they would not pay for it. Some definite understanding would, however, now have to be come to.

An application relative to the rates for the carriage of iron wire rods between Oakengates, Shropshire, and Birmingham, has been filed by Messrs. Thomas and Leonard Jenkins *v.* the Great Western Railway Company, and is set down for hearing before the Railway Commissioners on the 8th proximo.

The depression in the spike trade at West Bromwich is marked. The few orders out or coming in are easily met by the machinery which has been introduced, and therefore the occupation of the hand spike maker has gone. The poverty amongst the men is great, and the leaders agree that the only effectual remedy is emigration.

The export orders still indicate a desire by hardware purchasers to limit responsibilities, and the large stocks of certain descriptions of hardware which continue on hand in some shipping markets render such caution almost necessary. Information is received here, however, that of some sorts of Midland goods the South African stores are absolutely empty.

Trade in North Staffordshire is unsatisfactory. The cessation of buying is very perceptible, merchants preferring to let the New Year come in before giving out any large orders. Bar makers appear to be best supplied with specifications. South America, Australia, and India are sending in orders. Crown bars are £7 10s. to £7, with inferior qualities £5 12s. 6d. to £6. Some merchants, however, assert that they can buy at £5 10s. The plate trade rules dull. So active is the competition of steel that it is believed that its manufacture must before long be introduced into North Staffordshire. Quotations for iron plates are £7 2s. 6d. to £7 10s. delivered Liverpool or equal.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—There is still a generally dull tone throughout the iron trade of this district, and it is only on a very unsatisfactory basis that business can be done. The weight of orders offering in the market either for pig or finished iron is very small, and buyers press for concessions that makers are unable to concede, except at an absolute loss. The result is that there is a fight as to prices over every order of importance that is given out, and although there is no real margin upon which makers can give way, the advantage as a rule is on the side of the buyer. The decision of the Government to give out large orders for war vessels, although it does not affect this immediate district directly, will no doubt tend towards a better feeling, as it will help to remove some of the competition here of outside districts, whilst it may also lead to orders being placed with some of the local machine tool makers, and, in fact, boilermakers have already received enquiries from shipbuilding yards, evidently based upon anticipations of extra work coming forward.

There was only a very quiet iron market at Manchester on Tuesday. For pig iron the enquiry generally was small, and where sales of any weight are reported, it is only where sellers have come below their quoted list rates to secure them. Quotations for Lancashire pig iron, delivered equal to Manchester, remain at 41s. for forge, and 41s. 6d. for foundry, less 2$\frac{1}{2}$; for district brands, Derbyshire is quoted at 42s. 6d. to 43s., and Lincolnshire at 42s. to 42s. 6d., but for the last-named brand, where offers are made, 41s. to 41s. 6d., less 2$\frac{1}{2}$, delivered here, is being taken freely. For Middlesbrough iron quotations for delivery, equal to Manchester, remain at 44s. 4d. to 44s. 10d., net cash, for good foundry numbers, with forge qualities about 2s. less. For Scotch iron makers' prices remain unchanged, and there appears to be less disposition to undersell.

In the manufactured iron trade prices show, if anything, a slight giving way. For good qualities of bars delivered here, £5 12s. 6d. is still the general quoted price, but £5 10s. is being taken freely for some of the local brands, and £5 11s. 3d. for North Staffordshire bars, whilst common north-country plates have been offered here at £5 9s. 6d., and angle iron at £5 7s. 6d. per ton.

Messrs. Heenan and Froude, of Manchester, are fitting up for the Great Eastern Railway an entire electric lighting installation for the passenger carriages on the above company's lines. At present there are seven trains fitted up with the electric light; these, I am informed, have been running since the 1st October without any hitch having occurred, and the company are so satisfied with the experiments that they have in contemplation the introduction of electric lighting for both their local and through traffic. The engine for driving the dynamo machine is Messrs. Heenan and Froude's Tower spherical engine, which has been already fully described in The Engineer; and the dynamo machine is made by Mr. E. Crompton. The engine and dynamo machine, which are only 3ft. 3in. long over all, 13in. wide, and 2ft. high, and with bed-plate and couplings complete do not weigh more than 3$\frac{1}{2}$ cwt., are placed on the boiler of the locomotive in the rear of the dome, where they do not interfere with the side view of the driver; and the steam which is taken from the dome exhausts up the funnel. The wires and lamps are so arranged as not to interfere with oil lamps being put in at a moment's notice, as the electric lamp with its reflector can be simply lifted on one side to allow an oil lamp to take its place for lighting the carriage in the ordinary way, when it becomes necessary to divide a train from the main line for a train on which the electric lighting may not be working.

I may also add that Messrs. Heenan and Proude have secured the contract for the construction of a new pier for the Folkestone Pier and Lift Company, which is to be carried out from the designs and under the supervision of Mr. John Wilson, M.I.C.E., Dean's-yard, London. The pier is to be about 500ft. long, 30ft. wide, and will terminate with a platform in the form of a cross, 60ft. by 90ft. There will also be a pavilion for promenade concerts, but this will be placed about 120ft. from the shore end, so as to be available in all weathers. I understand that the work is to be commenced in the ensuing spring, and to be finished by the end of next year.

Messrs. Crossley Bros., of Manchester, who have now got their new works at Gorton into full operation, have been taking a record of the consumption of coal in supplying the Otto gas engines by the Dowson process, the results of which will be of interest. The works are driven by eight gas engines, indicating collectively about 150-horse power, and the firm have taken records of the consumption of coal over a period of thirty-five weeks, and they have found that, including the waste on Sundays, when about 5 cwt. of coal is used for keeping the fire of the Dowson producer going, the consumption does not exceed 1·3 lb. of coal per indicated horse-power per hour. I may add that Messrs. Crossley have just turned out an Otto engine for indicating 90-horse-power, which is the largest gas engine ever made in this country. It is of the new double-cylinder type, and is fitted with an ingenious valve arrangement.

At the meeting of the Manchester Geological Society on Tuesday, Mr. J. S. Martin, Inspector of Mines, exhibited a safety miners' lamp, which he said had attracted his attention, by the successful manner with which it had undergone tests made at the Aldwark Main Colliery. The main features of the lamp had been suggested by a Welshman named Evans, who was not acquainted with mining, and these had been put into practical shape by Mr. C. E. Rhodes, the manager of the Aldwark Main Colliery. The lamp itself was of the ordinary Clanny type, but it was provided with two shields, one similar to the shield used in the Marsant and other lamps, whilst the other, which was of larger size than the gauze, was made to act as an extinguisher in the event of the gauze becoming filled with flame, this shield being brought into operation by the flame burning a fibre of cotton or other material, when it at once closed all access of air and extinguished the light in the lamp.

The coal trade of this district continues quiet, with most of the pits still being kept on a restricted output, and prices not more than maintained at last month's rates. At the pit mouth the average prices are about as under:—Best coals, 9s. to 9s. 6d.; ordinary second qualities, 7s. to 7s. 6d.; common house fire coals, 6s. to 6s. 6d.; common round coals for steam and forge purposes, 5s. 6d. to 6s.; burgy, 4s. 6d. to 5s.; good slack, 4s.; and common sorts about 2s. 9d. to 3s. per ton.

In the shipping trade there has been rather more doing during the past week, with steam coals delivered at the high level, Liverpool, or the Garston Docks fetching about 7s. 3d. to 7s. 6d. per ton.

Barrow.—This week I have to report that the local hematite pig iron trade remains firm, with a slightly improved inquiry all round. Prospects are in favour of the idea that we shall have a better winter, for it is said on the most reliable authority that several good contracts are expected. In view of this upward tendency, makers are now less disposed than ever to make concessions, and refrain from pressing their stock on unwilling buyers. Prices have for a long time been remarkably low, allowing but little profits to be realised, but things are now more in makers' favour. Mixed Bessemer samples are still quoted at from 45s. to 46s. per ton net at works, while forge and foundry samples are 43s. to 44s. per ton. The output does not increase. The steel rail trade is a little more active, but the new orders coming to hand are both few in number and limited in quantity, and unless others of greater magnitude are received, that depression which has so long marked this industry will again be noticeable. Even now many mills are unemployed. Shipments are very small. Quotations for ordinary sections of rails range from £4 15s. to £5 per ton. Angle and tires are in limited request. Hoops and wire are selling freely, and works are busily employed. Engineers and boiler makers are badly off for orders. Shipbuilders are expecting to be more active in the spring. Coal and coke quiet, though improving. Iron ore selling slowly at from 8s. 6d. to 9s. 6d. per ton net at mines. Stocks are heavy. Shipping inactive.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

I am afraid, from the many cases of distress which come under my notice in various parts of the town, that there is more of it in this district than most people are aware. There seems in the general staple trades to be a fair volume of work done, though at little or no profit; but I find that in many industries the men are only partially employed, and in several instances large families have to be maintained on 8s. to 10s. a week, which is mere paupers' allowance. The chairman of the Sheffield Board of Guardians informs me that the number of persons now in receipt of parish relief in Sheffield exceeds 10,000. This is a deplorable state of affairs, to parallel which we have to go back to 1858 and 1842. In 1858, when the population was about 160,000—it is now slightly over 300,000—the number of persons receiving out-door relief was 10,119, with 897 in-paupers, and 310 on the farm. This was caused by an American panic, causing many failures, the commercial relations of Sheffield and the United States being much closer than now—or, to put it more accurately, the United States was a market on which the prosperity of Sheffield depended. Then every person in fourteen was a pauper. In 1842 so hopeless were affairs, that Montgomery compared Sheffield to "a person suffering from consumption," and it is gravely recorded in the local papers of the time:—"The oldest inhabitant of Sheffield cannot remember a crisis of calamity so general and apparently so hopeless as that which has come upon us. The labouring classes have been going down into abject destitution." Affairs, as we know, cleared up wonderfully after that, but at present the outlook, though not so gloomy as in 1842 and 1858, is far from cheering.

Miners are proverbially reckless. A notable case in point is reported from Rotherham. George Pawson, a collier, of Bow Broom, was summoned for a breach of special rule 30, under the Mines Regulation Acts, at Manvers Main Colliery, on November 12th. According to the underviewer, the defendant was getting his "snap," and his trammer removing coal at a place holed ten yards long and 20in. under without a sprag being set. It was argued for the defendant, who was supported by a miners' agent, that he had done all that he possibly could to carry out the law, as the "hards" had not been removed. The presiding magistrate said he was very sorry to see the Miners' Association take up these cases where the man was really in fault, and bringing the man working with him into danger. Here was an experienced man who had been employed in a mine for twenty years, and yet he had left his mate (his trammer) to incur danger, and himself gone coolly off to breakfast. The bench would impose the full penalty of 40s. and costs, or one month's imprisonment. The rules were devised, not for the benefit of the master, but the workmen, and the whole of the workmen should join in the endeavour to carry them out. This is only a typical case of what occurs almost every day. It is not only serious on account of the trammer, Pawson, left behind him, and who might have been crushed under falling roof, but these falls disturb the ventilation, and lead to unexpected outbursts of gas with most grave results. A single reckless act, such as neglecting to use sprags freely, may lead to a great calamity. In fact, every miner while he is in the pit has not only his own life in his hands, but that of every person in the workings. These facts are repeatedly impressed upon the colliers, and yet many of them go on running the same awful risks.

The colliery dispute near Barnsley is assuming an acute phase. I noticed last week that the settlement come to by a few of the men had been promptly unsettled by the majority of the men, and now fifteen miners have been remanded on a charge of intimidation. The Barrow Company took on several colliers who were anxious to return to work, and it is these men whom the fifteen are charged with attempts to terrorise.

Work has been resumed on the Hull and Barnsley line, and there is every prospect now of the undertaking being completed with the extra capital which has been raised for the purpose.

No news has yet been received by our local armour-plate makers as to the decision of the Italian Government in regard to the coating of their future war-ships. It is singular, to say the least, that there is an utter absence of confirmation or contradiction of the Reuter telegram, which came to the effect that the French all-steel plates were to be preferred.

There is no change reported in the condition of the local light and heavy industries this week. At the Cutlers' Hall on Tuesday night, the Master Cutler—Mr. J. E. Bingham—gave a Charity Ball in aid of the Clayton Orphanage. I mention the matter here because the occasion brought out a magnificent display of gold and silver plate, the whole of which was made at the establishment of Messrs. Walker and Hall, Electro Works, Howard-street, of which Mr. Bingham is the head.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The Cleveland pig iron trade has been exceedingly quiet during the last few days, and few sales were made at the market held at Middlesbrough on Tuesday last, though the attendance was not less than usual. Makers for the most part have sufficient orders to last till the end of the year, and they are not eager to book ahead at present prices. The circumstance that stocks are likely to increase owing to lessened exports has not, so far, had any effect on prices, which are the same as have ruled for the last few weeks. No. 3 g.m.b. cannot be had from either makers or merchants under 36s. 3d. per ton for early delivery; and for deferred delivery 3d. to 6d. per ton more is demanded. Consumers seem more anxious than sellers to do business at these figures. There is no change in the value of forge iron, 34s. 6d. per ton being the lowest at which it can be bought. The available quantity of this quality, though increasing, is still very low.

The stock of pig iron in Messrs. Connal and Co.'s store continues to decrease, though but slowly. On Monday last there were at Middlesbrough 52,814 tons, equivalent to a reduction of 150 tons during the week. At Glasgow the stock was 579,613 tons, or a reduction of 273 tons.

The shipments of pig iron from the Tees during November fell considerably short of those for October. The quantity exported in November was 74,654 tons, as compared with 86,336 tons in October. To Scotland 30,835 tons only were sent, that being the heaviest shipment this year to that country. Holland took 9305 tons; Germany, 8685 tons; Wales, 5336 tons; Spain, 3778 tons; France, 3344 tons; and Belgium, 3255 tons.

In the finished iron trade there is a fair amount of inquiry, and quotations are the same as last week. Ship plates are £5, and bridge plates £5 2s. 6d. per ton; common bars, £5 2s. 6d. to £5 5s., and angles £4 15s. to £4 17s. 6d., all in trucks at makers' works, less 2$\frac{1}{2}$ per cent. discount for cash. Dr. Watson's award in respect of ironworkers' wages is expected daily. When it is known, the finished iron trade may possibly improve somewhat, as some consumers are said to be holding back their orders in expectation of obtaining some advantage therefrom.

Messrs. Gray and Gladstone, of the West Hartlepool Rolling Mills, are believed to have secured some orders for ship plates, and to intend to re-open their works shortly if a reduction of wages is obtained.

Messrs. J. Readhead and Co., of South Shields, have made contracts for three large steamers. Messrs. E. Withy and Co., of Hartlepool, have also booked orders for two steamers. The material for building them is now being delivered, and it is expected that some workmen will be set to work next week. This is welcome news, inasmuch as Messrs. Withy's yard has been closed for some time.

It is estimated that about 12,000 workmen are still out of employment between Newcastle and Tynemouth, representing £15,000 less paid in wages per week now as compared with a year ago.

Messrs. Bell Bros. have just reached salt at another bore-hole at Port Clarence.

The West Cumberland miners have agreed to a new sliding-scale for the regulation of their wages, to remain in force from the present time till the end of 1886. The standard realised price of coal is fixed at 4s. 6·19d. per ton. Each rise or fall between 4s. 6·19d. and 6s. 6·19d. will carry with it 1$\frac{1}{4}$ per cent. in wages for every 1$\frac{1}{4}$d. per ton in the ascertained realised price of coal. Beyond 6s. 6·19d. the rise or fall in wages will be 1$\frac{1}{4}$ per cent. for each 2d. per ton in the price of coal.

Since the foregoing was written, Dr. Spence Watson's award has been published. He decides that the claim of the employers and that of the operatives be equally disallowed, and that ironworkers' wages remain undisturbed until the end of January, 1885. This award is naturally claimed by the operatives as a victory for them, as their demand for an advance

was never looked upon, even by themselves, as other than a strategical move. The employers are, of course, disappointed, as they say that all the logic was on their side, and on that of their opponents there was nothing but declamation. They contend that these awards by third parties, outside of the trade, are apparently given upon grounds inconsistent with any known or rational principle, and that arguments, facts, and figures seem to have no influence whatever. In the opinion of thoughtful men of business, unconnected with the immediate interests involved, the workmen, and not the employers, are likely as a class to suffer by the award; for the employers are, for the time being, spared from the fresh competition which threatens them from various quarters so soon as it becomes clear that the cost of production can in any way be lowered. They will also now get the benefit of the orders of those consumers who have been holding them back for a fall, and who can no longer expect to place them at a reduction. They will also get the benefit of that steadiness of the market which is certain to ensue from the conviction among buyers that the minimum has been reached in ironworkers' wages. But the workmen, as a body, have gained but a doubtful victory. Truly, those who are fully employed have avoided a 5 per cent. reduction; but as for the many hundreds, and even thousands, who are unemployed, these must remain so. Lower wages would have brought more demand, and have set to work some of the idle mills and forges. These would have absorbed some of those ironworkers who are unable to earn their bread, to the relief of themselves and of their comrades, and of the public who have the burden of supporting them. Employers will certainly not get a profit upon their manufactures so long as so many potential competitors are idle, and waiting to re-enter the trade. But operators as a class, and traders generally, will benefit by any increase of works in operation. In short, increased volume of trade benefits operatives by increasing the demand for them, and affording more of them wages. But it does not benefit employers who look for profit, until it equals, and threatens to overpass, existing facilities for supplying the demand. In this way it is argued that Dr. Watson's refusal to lower wages to a point proportionate to the ascertained fall in the value of finished iron, will redound to the disadvantage of the operatives rather than to that of the employers, although few of those immediately concerned are likely to regard the matter in that light.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been more business doing in the Glasgow warrant market in the past week than for several weeks previously. The speculative transactions that have taken place, however, were mostly passing between brokers, the outside public still taking little interest in pig iron as means of speculation. Warrants have fluctuated to the extent of about 6d. a ton, advancing to that amount, and again receding. The shipments of Scotch pigs continue unsatisfactory, amounting to only 6540 tons, as compared with 6935 in the preceding week, and 9268 in the corresponding week of 1883. The demand is very quiet, and there is not much prospect of the shipments becoming materially greater before the close of the year. There is a reduction of about 130 tons in the stock of pig iron in Messrs. Connal and Co.'s stores since this day week.

Business was done in the warrant market on Friday at 43s. 2d. to 43s. 3d. and down to 42s. 9½d. cash; on Monday the quotations were 42s. 9½d. to 42s. 11d. cash; on Tuesday business was done at 42s. 11½d. to 43s., and back to 42s. 11d. cash. On Wednesday business was done at 42s. 11d. to 43s. 1½d. cash. To-day—Thursday—the market has been very flat, and prices declined to 42s. 8½d. cash. Gartsherrie reduced 2s. 6d. a ton.

The market values of makers' iron have been tending downward, and the quotations are as follows;—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 55s.; No. 3, 50s.; Coltness, 58s. and 52s. 6d.; Langloan, 58s. and 52s. 6d.; Summerlee, 54s. and 47s. 3d.; Calder, 54s. and 48s.; Carnbroe, 50s. 6d. and 47s. 6d.; Clyde, 48s. 6d. and 45s.; Monkland, 44s. 6d. and 41s. 9d.; Quarter, 43s. 6d. and 41s. 6d.; Govan, at Broomielaw, 43s. 6d. and 41s. 6d.; Shotts, at Leith, 54s. and 52s. 6d.; Carron, at Grangemouth, 49s. 6d. (specially selected 54s.) and 48s. 6d.; Kinneil, at Bo'ness, 45s. and 44s.; Glengarnock, at Ardrossan, 50s. and 43s. 6d.; Eglinton, 44s. 6d. and 41s. 6d.; Dalmellington, 48s. 6d. and 44s. 6d.

The Kinneil Iron Company, which has had two furnaces in operation for a considerable time, has extinguished them both within the last few days. I hear it is its intention to stop the manufacture entirely, until better times arrive, when it can be resumed under such circumstances that it will yield a profit. This reduces the furnaces in blast to 93, as compared with 100 twelve months ago.

There is no change of any consequence to note in the position of the different branches of the manufactured iron trade.

The shipments in the past week from Glasgow of iron and steel goods embraced four locomotives, valued at £6800, for Bombay; machinery to the value of £18,300, including sugar mills sent to Demerara and Trinidad, the former worth £4350 and the latter £3660; sewing machines, £2500; steel goods, £1500; and iron manufactures, £35,500, of which £8800 were pipes, &c., for Sydney, £4960 ditto for Bombay; £4440 marine engine work for Adelaide, and a large quantity of miscellaneous articles elsewhere.

The coal trade is also quiet on the whole, although a fair inquiry exists at present for household qualities. There were considerable shipments at some of the ports, while the others have been very dull. Upwards of 11,000 tons were despatched from the Queen's Dock at Glasgow, 170 tons from Greenock; Irvine, 114 tons; Ayr, 6849; Troon, 8186; and Grangemouth, 8149 tons. The quotations are generally flat, without any particular change. In the Fife district a healthy demand is reported for household coals. The shipping prices current at Burntisland vary from 6s. 6d. to 7s. free on board.

Messrs. Merry and Cuninghame having resolved to close their Rysholm and Boghead ironstone pits at Dalry, in Ayrshire, for repairs, a large number of miners will, it is expected, be thrown temporarily out of employment.

The customs revenue, at the Port of Glasgow, for November, amounted to £87,725, being £6678 less than in the same month last year.

During the past month, the fresh tonnage launched from the Clyde shipyards was about 13,850, and the work of the eleven months is fully 100,000 tons less than in the corresponding period of 1883. Much talk has been occasioned in the past week by the refusal of the ironworkers at the Fairfield shipyard of Messrs. John Elder and Co. to accept employment at reduced rates. It appears that the authorities of the Burgh of Govan, in their endeavours to relieve the distress which prevails, owing to so many workmen being out of employment, approached Mr. Pearce, to ascertain whether he could render any assistance. He accordingly called a meeting of a few representative men, and stated that he was willing to begin the construction of a 5000 ton vessel at his own risk, if the men would agree to work at certain reduced rates, these to be in force for twelve months, and three months' notice to be given on either side before they were altered. The men present expressed their readiness to fall in with the proposal; but on its being submitted to a meeting of the trade, they declined to entertain it. This action has aroused a strong feeling adverse to the workmen among the public, who are in various ways called upon to contribute to the support of the unemployed. There is every likelihood, however, that Mr. Pearce's terms will be ultimately accepted, and that he will be able to keep his works open until the depression of trade shall have passed away.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

NEXT in significance to the Bute Dock and Taff Vale amalgamation, is the re-starting of the Cardiff and Monmouthshire Valleys Railway scheme. This is one of the most important railway movements of late years. A large virgin coal district will be opened out by it. How or why delayed so long is a mystery. We have only to imagine the district that is developed by the Taff Vale Railway without the Taff Vale Railway to realise the position. Twenty-four miles of hill and moorland, with deep coal ravines and a swarm of industries, and all in a semi-stagnation—coal-owners resorting to tramways and other obsolete means to get a spare output to port, and those doing a large coal trade—such as Blaina—sending its 100,000 tons per annum round to Cardiff by the way of Newport, instead of promptly and direct. The chief line will be from Risca to the new docks at Cardiff, and if Barry should take its moiety of coal from Cardiff, and thus lessen Cardiff income, this line, by bringing in a large tonnage from a new colliery district, will make amends. It may thus be expected to have the strong support of the Marquis of Bute, the Taff Vale, the London and North-Western, and Brecon Railways; possibly will be opposed by Lord Tredegar and the Great Western line.

The new year promises to bristle with new schemes. Cardiff Tramway, one of the most successful of undertakings, is going in for various extensions, one notably to Penarth. Taff Vale, Great Western, Brecon Railway, Alexandra Dock, Newport, Barry Dock railways and adjuncts, all promise well. Then in colliery promotions there is more activity than ever. The Neath Abbey and Duffryn Estates Company is being floated, capital £120,000, with good practical men at the helm. Then we have the new Llantwit Coal Company, which starts with a capital of £10,000, in shares of £10 each, and for small investors is certain to be well recommended. The directors are Mr. Jones, of Fairwater; Mr. W. H. Williams, well known in local colliery enterprise; and Mr. Robert Hooper, Bute Docks. Perhaps few coal ventures can be cited as so certain of success.

A slight improvement is felt in some of the coal valleys, but, as a whole, trade is slack. The Rhondda has suffered a good deal in this respect during November, and small outputs and short time have been the leading features. In some cases men have been idle for three days running. During the last few days there has been a better demand, but there is ample scope for improvement.

I shall expect shortly to report the results of the shot firing at Ynyshir. Rhondda men say that this is one of the best managed collieries in the valley, and if the inspector proves his case at this colliery, by showing that shot firing has been attended with danger, then prohibition of all shot firing, except when the men are withdrawn, must follow.

Though the coal trade is dull, prices are maintained; 10s. to 11s. are the quotations for colliery screened coal.

Steam coal is in better demand, and prices are firm. House coal is improving in demand, but prices remain stationary. Good contracts are being secured. With respect to steam coal contracts, these are beginning to come in. The Royal Mail contracts have been secured by three of the leading Cardiff shippers.

Cardiff showed a falling off in exports last week, and this applies generally. Newport tips were much quieter.

I have no improvement to note in connection with the iron and steel industries. Things are not worse, and some degree of life can be seen at all of the works, though stock making is, in some quarters, simply prodigious. Makers know that pig cannot be made cheaper than at present, and any alteration in price must be upward. No further stoppages have taken place, and the Treforest Works, which were to have been stopped, are still going on.

There is a preliminary movement to get a colliers' representative into the House of Commons. Colliers had the opportunity a few years ago, when Mr. W. T. Lewis came forward; but they preferred to get a chapel representative, and have sorrowed and suffered since. The industries of Wales urgently require a representative in the House of Commons.

Tin-plate is being again overdone. Stocks are increasing and prices lowering. Cokes are quoted as low as 14s., and some of the neediest are supposed to be selling below this.

Two boys were injured at a colliery at Caerphilly last week, through alleged shot firing.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

21th November, 1884.

15,464. VENTILATION, &c., J. G. Lorrain, London.
15,465. EXPANDING DINING TABLES, B. A. Blackburn, London.
15,466. PROCESS of DYEING, A. M. Clark.—(*A. Bosquet, Paris.*)
15,467. ENVELOPES, E. P. Hawkins, London.
15,468. CUTTING and DRESSING STONE, &c., J. Rettie, London.
15,469. SLOW COMBUSTION STOVES, E. Edwards.—(*R. le Javiel, Rennes.*)
15,470. GAUGING the LENGTH of AIR PIPE throughout a RAILWAY TRAIN, &c., A. P. Kapteyn, London.
15,471. LUBRICATORS for SHEARING MACHINES, C. Kurtz, London.
15,472. REGULATION TENSION on BOBBINS for SPINNING &c., FIBROUS MATERIALS, J. Barbour and J. Berkeley, London.
15,473. TRICYCLE for CARRYING PARCELS, J. K. Stanley, London.
15,474. MANUFACTURE of CIGARETTES, R. Barkof, London.
15,475. PRODUCTION of COLD, H. H. Lake.—(*W. Raydt, Hanover.*)
15,476. ELECTRIC ARC LAMPS, J. H. Selwyn, London.
15,477. SAFETY LOCKING APPARATUS for RAILWAY POINTS, C. E. Carr, London.
15,478. PROTECTION of VESSELS of WAR, W. Hope, London.
15,479. BEDSTEADS, J. Corp, London.

25th November, 1884.

15,480. MEMBRANE TELEPHONES, S. P. Thompson and P. Jolin, Bristol.
15,481. DUPLEX PETROLEUM BURNERS, W. K. Fulleylove, Bulkington.
15,482. BALL TAPS or VALVES, T. Gameson, Birmingham.
15,483. FOLDING PACKING CASES, J. G. Watkins, Birmingham.
15,484. OPERATING SHUTTLE BOXES, F. Leeming, Halifax.
15,485. IGNITION VALVES as used in GAS ENGINES, A. Eckford and J. Hunter, Edinburgh.
15,486. SADDLERS' SPLITTING MACHINES, T. and W. Dixon. Walsall.
15,487. GOVERNOR for WATER-WHEELS, C. L. Hett, Brigg.
15,488. CONNECTION for WATER-CLOSETS, C. L. Hett, Brigg.
15,489. WATER-CLOSET CISTERNS, J. Fagan, Skipton-in-Craven.
15,490. CURLING IRONS for HAIR, W. Brierley.—(*R. Arndt, Breslau.*)
15,491. VERTICAL STEAM GENERATORS, B., G. F., and J. H. Riley, Leeds.
15,492. PENHOLDERS, W. P. Thompson.—(*M. Wettich, Cassel.*)
15,493. WINDMILLS, W. P. Thompson.—(*G. H. Pattison, U.S.*)
15,494. CENTRIFUGAL DRAINERS for GRAIN, W. Rowlandson, Liverpool.
15,495. TREATING TEXTILE MATERIALS, J. Sandeman, Glasgow.
15,496. AMMONIACAL SALT and PURIFYING GAS, A. McDougall, Penrith.
15,497. OVENS for HEATING INGOTS, P. Kirk, Manchester.
15,498. MINERS' SAFETY LAMPS, W. S. Laycock, London.
15,499. SPADES and SHOVELS, D. Ward and G. Hayward, London.
15,5 0. CONTROLLING CLOCKS by ELECTRICITY, W. P. Thompson.—(*C. H. Pond, U.S.*)
15,501. GAS STOVES for HEATING, &c., C. Partington, London.
15,502. MAKING OATMEAL, &c., J. Milne, Glasgow.
15,503. COMBINED AUTOMATIC SASH FASTENER and LIFTER, J. M. Bryden, Glasgow.
15,504. EXTRACTING METAL from ORES, J. J. Shedlock, Barnet.
15,505. VALVE to PREVENT NOISE of WATER filling a CISTERN, S. Owen, London.
15,506. BATHS. S. Owen, London.
15,507. ANTI-FRICTION STEP BEARINGS, G. L. Brownell, London.
15,508. STAIR-ROD FASTENER, J. M. Bryden, Glasgow.
15,509. DENTAL TOOLS, J. G. Morey and L. B. Sturges, London.
15,510. SPARK ARRESTERS for ENGINES, F. Garrett, London.
15,511. SCREW LEVER ROTARY STEAM ENGINE, T. T. Tucker, London.
15,512. GATES, J. Nicholas and H. Lafone, London.
15,513. GOODS TRUCKS, W. F. Clarke, London.
15,514. WORKING TORPEDOES, S. Butler, London.
15,515. PROPELLING STEAMERS, &c., E. B. Cullen, Queensland.
15,516. HEELS and INNER SOLES of BOOTS and SHOES, H. and J. Whitehead, London.
15,517. TUBULAR STEAM BOILERS, B. J. B. Mills.—(*C. T. Burchardt, Berlin.*)
15,518. MOULDS for CASTING CANNON, A. W. L. Reddie.—(*B. T. Babbitt, U.S.*)
15,519. WHEELS for BICYCLES, E. J. Curtin, London.
15,520. CONTINUOUS KILN, H. J. Haddan.—(*A. Dufour, Dôle.*)
15,521. BREAKING or CRUSHING ORES, T. Archer, jun., London.
15,522. PERMANENT WAY of RAILWAYS and TRAMWAYS, W. L. Wise.—(*E. Boyenval and Messrs. Ponsard and Co., Paris.*)
15,523. CONNECTING the STRANDED WIRES USED as STAYS for TELEGRAPH POLES, &c., H. C. Jobson, London.
15,524. CLUTCH for ELECTRIC ARC LAMPS, J. Brockie and M. W. W. Mackie, London.
15,525. WATER-CLOSET APPARATUS, W. R. Lake.—(*F. B. Hanson, U.S.*)
15,526. COMBINED LETTER SHEET and ENVELOPE, W. R. Lake.—(*D. W. Clegg, United States.*)
15,527. VAPOUR BURNERS, W. R. Lake.—(*H. T. Coffee and Patterson, United States.*)
15,528. COMBINED LETTER PAPER and ENVELOPE, H. H. Leigh.—(*E. Fleular, Paris.*)
15,529. GLOVE FASTENERS, W. R. Lake.—(*F. Liska, Austria.*)
15,530. ATTACHMENT for LAMPS, G. Lahive, London.
15,531. PURIFYING FATTY SUBSTANCES, W. R. Lake.—(*A. F. L. Myé, London.*)
15,532. REVERSIBLE LETTER SHEET and ENVELOPE, W. R. Lake.—(*D. W. Clegg, United States.*)
15,533. SELF-LEVELLING SHIPS' BERTHS, W. R. Lake.—(*W. T. Milligan, United States.*)
15,534. UMBRELLAS, J. Koppel, Forest Hill.
15,535. PROPELLING BOATS by MANUAL POWER, J. Adams, London.
15,536. MATCHES and MATCH HOLDERS, C. J. Lungley, London.
15,537. LUBRICATORS, D. Jones, London.
15,538. TWENTY-FOUR HOURS DIALS for CLOCKS, &c., J. T. Buckley, London.
15,539. PAPER KNIVES, J. Wheeler, London.
15,540. FOLDING CHAIRS, CARRIAGES, and TABLES, J. Beck, London.
15,541. STEAM ENGINE PACKING, A. Albutt.—(*Wirth and Co., Frankfort-on-the-Main.*)
15,542. HOLDERS for PHOTOGRAPHIC FILMS, A. J. Boult.—(*G. Eastman and W. H. Walker, United States.*)
15,543. VALVULAR ARRANGEMENTS for TAPS, &c., H. F. Hill, London.
15,544. ELECTRICITY GAUGES, J. and H. M. Goodman, London.
15,545. POCKET KNIVES, B. McGovern, London.

26th November, 1884.

15,546. PROPELLING COMPOSITION and CARTRIDGES, G. Quick, Chipping Campden.
15,547. TELEPHONE SWITCHES, T. Ballard, Bristol.
15,548. CARRYING LADLES, &c., W. Brown, Stockton-on-Tees.
15,549. RAISING the TEMPERATURE of LIQUIDS, S. B. Woodhead and W. Baker, Liverpool.
15,550. AUTOMATICALLY CLOSING the BUNG-HOLES of BARRELS, T. B. Sharp, Smethwick.
15,551. ENGINES and PUMPS, T. Thorp, Whitefield.
15,552. DUPLEX ENGINES, P. Dunlop, London.
15,553. BLOTTERS, G Green, Bristol.
15,554. WATCHES, J. Robinson, Halifax.
15,555. PORTABLE and DISJUNCTIVE TELEPHONES for RAILWAY TRAINS, W. H. Blackwell and H. H. and A. Turner, Denton.
15,556. GUARD for CARVING FORKS, E. Baller, Birmingham.
15,557. FLOATING BREAKWATERS, J. Cameron and D. R Dawson, Glasgow.
15,558. GOVERNORS for SCREW PROPELLER ENGINES, J. B. Sanderson, Glasgow.
15,559. ATTACHING COPPER SHEATHING to the BOTTOMS of IRON SHIPS, W. Browett, Swansea.
15,560. TREADLE ACTION, &c., D. J Fleetwood, Birmingham.
15,561. READING LAMPS for RAILWAYS, W. P. Mather, Manchester.
15,562. STEAM GENERATORS, J. Blake, Manchester.
15,563. LINK DRIVING BELTS, J. K. Tullis, Glasgow.
15,564. MARKING the GAME of BILLIARDS, T. Trussell, Nottingham.
15,565. RAIL FASTENERS for RAILWAYS and TRAMWAYS, W. Corteen, London.
15,566. REGULATING APPARATUS for ELECTRIC ARC LAMPS, G. E. Vaughan.—(*The Austrian Small-arms Manufacturing Company, Steyr.*)
15,567. NEW PRIMARY BATTERY, A. R. U, ward and C. W. Pridham, London.
15,568. PUSHES applicable to FITTINGS for ELECTRICAL BELLS, &c., G. Richardson and W. Raworth, Brixton.
15,569. OIL FEEDERS, E. T. Darke, London.
15,570. DRAINAGE PAVINGS for STABLES, &c., A. J. Ward, London.
15,571. PUMPING ENGINES, W. Brown, C. N. May, and A. Butler, London.
15,572. PEN-HOLDERS, R. Gosky, London.
15,573. ELEVATED RAILWAYS, H. J. Alison.—(*A. and C. Milinaire, Paris.*)
15,574. GENERATING ELECTRICITY by MOTIVE-POWER, W. A. Duncan, Southport.
15,575. ALARM GUNS, A. Farquharson, London.
15,576. RESERVOIRS for the STORAGE of PETROLEUM, &c., A. A. Croll, London.
15,577. PREVENTION of ACCIDENTS in HOISTS, W. Dean, Bradford.
15,578. METALLIC STANDARDS for FENCING, &c., W. Bayliss, London.
15,579. TELEPHONY, C. A. Day.—(*J. Lowth and W. D. Ewart, U.S.*)
15,580. TELEPHONY, C. A. Day.—(*J. Lowth and W. D. Ewart, U.S.*)
15,581. TELEPHONES, C. A. Day.—(*J. Lowth and W. D. Ewart, U.S.*)
15,582. TELEPHONES, C. A. Day.—(*J. Lowth and W. D. Ewart, U.S.*)
15,583. TELEPHONES, C. A. Day.—(*J. Lowth and W. D. Ewart, U.S.*)
15,584. PURIFICATION of SEWAGE, F. W. Lacey, London.
15,585. SMOOTHING YARN in SPINNING, &c., MACHINES, J. J. Broadbent, London.
15,586. CHAMBERS employed in the MANUFACTURE of WHITE LEAD, E. V. Gardner, London.
15,587. SUGAR, A. C. Henderson.—(*L. Aubert and V. Giraud, Lyon.*)
15,588. MOUNTING RUDDERS of BOATS, E. W. Wheatley, London.
15,589. NECKTIES, F. W. Jones, London.
15,590. TRICYCLE, A. C. Phillpotts, London.
15,591. COLLAR, &c., STUDS, &c., J. H. Forrester and T. H. Free, Birmingham.
15,592. ELECTRO-TELEPHONIC APPARATUS, A. A. Campbell-Swinton, London.
15,593. STATIONERY, &c., BINDING, F. H. Brooks and J. S. Turner, London.
15,594. ENABLING CHAINS, &c., to SUSTAIN TENSILE STRAINS when SUBJECT to SHOCKS, J. G. Lockwood, London.
15,595. FIRE-ARMS, W. R. Lake.—(*The Winchester Repeating Arms Company, U.S.*)
15,596. FORMING STITCH known as REVERING, J. B. Robertson, London.
15,597. CONTACT and REVERSING GEAR for DYNAMO-ELECTRIC, &c., MACHINES, E. J. Houghton and T. M. Collet, London.
15,598. MANUFACTURE of LACE, G. Bentley, London.

27th November, 1884.

15,599. DISINFECTANTS, A. D. Cohen, London.
15,600. COOKING RANGES, F. R. Baker, Birmingham.
15,601. WHEEL and PULLEY BOSSES, &c., E. Cope and A. Hollings, Liverpool.
15,602. WASHING APPARATUS, J. Turner, Manchester.
15,603. QUILTED MELTON SKIRT, D. Barker, Manchester.
15,604. RAILWAY CARRIAGE FOOT-WARMER, W. K. Fulleylove, Rugby.
15,605. EXPANDING MANDRELS, H. B. and A. B. Barlow, Manchester.
15,606. SELF-INKING, ENDORSING, &c., MACHINES, J. Wright, Sheffield.
15,607. LEATHER-DRESSING B. Hunt, Glasgow.
15,608. PREPARATION, &c., of CHOCOLATE, &c., W. Lucock, Birmingham.
15,609. MEASURING APPARATUS, J. Wright, London.
15,610. CRANES, W. F. W. and J. E. Ellis, Manchester.
15,611. WET SPINNING FRAMES, J. V. Eves, Belfast.
15,612. SAFETY FUSES for ELECTRIC CIRCUITS, G. C. Sillar, London.
15,613. WATER-WASTE PREVENTERS, F. T. Watts, Cardiff.
15,614. WEIGHING MACHINES, W. P. Thompson.—(*Jules Dusautoy, Paris.*)
15,615. BUTTONS, W. P. Thompson.—(*Messrs. Sell Brothers, Barmen.*)
15,616. BOXES for CONTAINING, &c., TOBACCO, W. W. Walker, Liverpool.
15,617. REVOLVING GLOBES, &c., for ADVERTISING, J. B. Adams, Liverpool.
15,618. VELOCIPEDES, H. Leeming, Manchester.
15,619. REGULATING SPEED of STEAM ENGINES, &c., A. Söderström, Paris.
15,620. MARINE and other BOILERS, T. Wood, Tynemouth.
15,621. WATERPROOF FABRICS, H. H. Waddington, Manchester.
15,622. UPPERS of BOOTS and SHOES, S. Chamberlain, London.
15,623. INSTANTANEOUS GRIP BELT FASTENER, G. Smith, Leicester.
15,624. TRICYCLES, J. A. Leeming, Halifax.
15,625. DRIVING GEAR for BICYCLES, N. Frost, Birmingham.
15,626. TURNSTILES, J. Mowat and J. A. Fulton, Glasgow.
15,627. COPYING DRAWINGS, J. W. Parkins and T. H. Higgins, London.
15,628. COLOURING STONE, G. J. C. Marie, London.—*23rd May*, 1884.

15,629. Stoppering Bottles, J. Rebbla and T. Milnes, Halifax.
15,630. Lock-up Brush Holder, F. N. Seyde and H P. Lavender, London.
15 631. Suspended Lights from Gas Fittings, J. J. Royle, Manchester.
15,632. High-pressure Steam Kettles, J. J. Royle, Manchester.
15,633. Gas Motor Engines, O. T. Newton, London.
15,634. Lime, &c., Kilns, W. Cunningham, London.
15 635. Waste-water Preventer, R. Chantry, London.
15,636. Making Articles of Metal, H. R. Hiorns, London.
15,637. Holders for Incandescent Electric Lamps, H. H. Leigh.—(*J. D. Petersen, Hamburg.*)
15,638. Apparatus to be used in Marine Propulsion, J. Keen, London.
15,639. Tobacco Pipes, F. Upton, London.
15,640. Carrier Velocipedes, J. White and J. Asbury, London.
15,641. Stoppering Bottles, F. J. Beaumont and F. Hallows, London.
15,642. Wire Netting, J. B. Brown and W. Scarles, London.
15,643. Umbrellas, H. Williams, London.
15,644 Metallic Alloys, A. G. Brookes.—(*H. J. F. Nieuerth, Hanover.*)
15,645. Connecting Ferrules for Valves, &c., F. G. S. Ham, London.
15,646. Sewing Machines, W. Beecroft, London.
15,647. Explosives, C. W. Curtis, London.
15,648. Dynamo-electric Machines, W. Mather and J. and E. Hopkinson, London.
15,649. Embroidered Edgings, W. R. Lake. —(*D. Guggenheim, U.S.*)
15,650. Obtaining Fibrous Material from Plants, W. R. Lake.—(*J. O'Neil, U.S.*)
15,651. Mechanical Motors, W. R. Lake.—(*J. Morgan, U.S.*)
15,652. Cleansing Grooved Cylinders, C. D. Abel. —*La Société Harmel Frères, Warmeriville.*)
15,653. Hot-air Self-feeding, &c., Furnace, C. L. Bergmann, London.
15,654. Treating Textile Materials, H. J. Haddan. —(*J. Brandt and G. W. von Nawrocki, Germany.*)
15,655. Facilitating the Teaching of History, H. J. Haddan.—(*C. Morel, Louhans.*)
15,656. Electric Call Bells, E. Haynes, London.

28th November, 1884.

15,657. Perforated Steel Guide Bars, H. Hill, London.
15,658. Punching or Countersinking Holes, H. J. Harrison, London.
15,659. Sulphite of Calcium, J. W. Kynaston, Liverpool.
15,660. Spoons or Servers for Rice, &c., J. Ryland, Birmingham.
15,661. Metallic Brackets, P. E. Ayton, Birmingham.
15,662. Door Chains, P. E. Ayton, Birmingham.
15,663. Washers, H. S. Stewart, London.
15,664. Electric Lighting, C. Sibley and A. Swinford, Cheltenham.
15,665. Wood Pavements, J. J. C. Davis, London.
15,666. Non-vacuum Electric Glow Lamps, E. Fahrig, Eccles.
15,667. Carbon for Incandescence Lamps, E. Fahrig, Eccles.
15,668. Moulding Fire-lighters, &c., R. Lamont, Glasgow.
15,669. Straightening Lead Calmes, W. J. Ashley, Birmingham.
15,670. Footballs, J. Keane, Birmingham.
15,671. Tram-car, &c., Wheels, F. G. Myers, Northampton.
15,672. Measuring Liquor, G. F. Andrews, London.
15,673. Destruction of Gases, E. Crummack, Manchester.
15,674. Comb-cutting Machines, R. Clarke, Sheffield.
15,675. Printing Rollers, &c., D. Appleton, Manchester.
15,676. Metallic Boxes, W. H. and B. Jones, Wolverhampton.
15,677. Envelope or Wrapper, H. Chattell and E. L. A. G. de S. de Cortenberg, London.
15,678. Driving Spindles, S. Littlewood, Halifax.
15,679. Compressed Food for Horses, &c., C. P. Rogers, Studley.
15,680. Vehicles for Passengers, W. E. Williamson, London.
15 681. Railway Sleepers and Chairs, J. Williams, London.
15,682. Size, W. Gratrix and J. Best, London.
15,683. Counterbalance Weights, D. Quare, London.
15,684. Compound Analysing, &c., Prism, J. Swift, London.
15,685. Bicycles, E. W. Tabor, London.
1 5,686. Permanent Way of Light Railways, M. Clark, London.
15,687. Clutch, A. S. Bowley, London.
15,688. Bottles, D. Rylands, Barnsley.
15,689. Bottles, D. Rylands and R. Potter, Barnsley.
15,690. Hand Grenades, A. F. Spawn, San Francisco.
15,691. Serrated Horseshoe Iron, &c., J. R. Way, F. Algar, and S. Hill, London.
15,692. Thermo-electric Piles, J. Lea and G. C. Harvey, London.
15,693. Hall Lamps, &c., R H. Hughes, London.
15,694. Indicating the Presence of Gas, J. D. Bella, T. and W. Chaloner, London.
15,695. Hygrometer Apparatus, J. Kernaul, London.
15,696. Cigarette, W. Beck.—(*C. and A. Bletry, Paris.*)
15,697. Velocipede, A. C. A. Holzapfel, Newcastle-upon-Tyne.
15,698. Heating Box and Smoothing Irons by Gas, F. Rath, London.
15,699. Compound Locomotives, A. J. Bickmore.—(*A. von Borries, Hanover.*)
15,700. Stop-work of Going Barrel Watches, &c., A. L. S. C. Hatch, Maidstone.
15,701. Water Waste Preventer, S. B. Goslin and J. J. Brown, London.
15,702. Lamps, A. Martin, London.
15,703. Batting Gloves, J. G. Heard, London.
15,704. Consuming Smoke in Steam Boiler Furnaces, W. Noble, London.
15,705. Watches and Clocks, J. Kendal and M. Laval, London.
15,706. Water and Dirt Proof Sleeve and Cuff Protector, M. A. Lovell and M. Laval, London.
15,707. Couplings for Pipes, F. P. Preston and A. T. Cornish, London.
15,708. Cutting and Sawing Cloth, &c., G. J. Hill, Manchester.
15,709. Horse-hoes, &c., J. V. Vipan and E. P. G. Headly, London.
15,710. Locking Nuts and Screws, A. W. L. Reddie.—(*A. Haarmann, Osnabrück.*)
15,711. Electro-telephonic Apparatus, A. A. Campbell-Swinton, London.
15,712. Explosive Projectiles and Fuses, R. Elliott, London.
15,713. Primary Voltaic Batteries, D. G. FitzGerald and T. J. Jones, London.
15,714. Flexible Bracelets, &c., G. J. Payton, London.

29th November, 1884.

5,715. Stenographic Machine, F. Roberts, London.
15,716. Portable Railways, W. P. Thompson.—(*A. Haarmann, Osnabrück.*)
15,717. Securing Formes of Type in Printing Machines, J. B. Freeman, Boughton.
15,718. Water Indicators, &c., T. Mackenzie, Fallings Heath, near Wednesbury.
15,719 Sulphide of Zinc, H. Knight, Liverpool.
15,720. Insuring Differential Motion on Slubbing and Roving Frames, S. Tweedale, Halifax.
15,721. Picker Spindle Studs, &c., of Looms, T. Duerden and W. Heaton, London.
15,722. Rings for Spinning and Doubling Fibres, E. Tweedale, Halifax.
15,723. Automatic Fire Extinguishers, A. J. Eastwood, Manchester.
15,724. Jacquard Machines of Looms, T. Taylor and M. Whittle, Manchester.
15,725. Steam Cylinders for Drying Purposes, A. Entwistle, Manchester.
15.726. Glazed Brick Walls, W. D. Cliff, London.
15,727. Tables, &c., C. A. Jones, Gloucester.
15.728. Pipe Founding, J. Whitley, Leeds.
15.729. Ventilating Apparatus, M. J. Adams, York.
15,730. Eyed Fish-hooks, J. Warner, Redditch.
15,731. Apparatus applicable to Doubling Frames, W. S. Barlow and F. W. Broadbent, Manchester.
15,732. Straightening Wire, T. C. Horsfall, S. H. Bickham, jun., and W. Houldsworth, Manchester.
15,733. Beating or Cleaning Carpets, W. and J. Bowie, Glasgow.
15,734. Combinations of Spur Gearing for Reducing Motion, T. Milburn, C. W. Haydon, and E. Mundy, Manchester.
15,735. Adjusting Chain Gear for Bicycles, &c., H. W. James, Birmingham.
15,736. Watches to Indicate Standard Time, &c., G. M. Whipple, London.
15,737. Securing Sign Plates to Walls, &c., R. J. Rae, London.
15,738. Embossing Leather for Toe-caps, &c., H. A. Oldershaw, London.
15,739. Portland Cement, W. G. Margetts, London.
15,740. Tubular Brace Web, J. H. Brierley, London.
15,741. Valves, W. D. Cliff, London.
15,742. Belts for Driving Grooved Wheels, S. Rowbottom, London.
15,743. Spring Motor, W. R. Holyoake.—(*T. K. Austin, United States.*)
15,744. Valve Gear of Steam Engines, J. Tweedy and J. Patterson, London.
15,745. Decoration of Chimney-pieces, &c., E. Reese, London.
15,746. Window Curtains, F. H. Goodyer, London.
15,747. Steam Lubricators, J. S. Miller, London.
15,748. Brushes, F. Wilde, London.
15,749. Fitting Wash-stands, &c., H. A. Whitaker, London.
15,750. Stopper for Bottles, B. Wood and D. Rylands, London.
15,751. Drain Traps, J. Howie, London.
15,752. Metal Tubes, J. Robertson, London.
15,573. Ladders or Steps, J. Campbell London.
15,754. Incandescent Electric Lamps, G. Davidson, R. C. Jackson, and J. B. Duncan, London.
15,755. Gully Traps, T. Durrans, London.
15,756. Railway Ferry Raft, H. J. Haddan.—(*Captain J. Caudwell, Boulogne.*)
15,757. Heliographic Copying Apparatus, H. J. Haddan.—(*H. Sack, Plagwitz-Leipzig.*)
15,758. Stencils and Stencil Frames, J. Bartlett, London.
15,759. Block System Spelling Toy, A. C. Calmour, London.
15.760. Armatures of Dynamo-electric Machines, T. Parker, London.
15,761. Artificial Pigeon-shooting, S. E. Gunyon.—(*A. V. Cernay, Houilles.*)
15,762. Dip Candles, L. J. Pirie and H. Roberts, London.
15,763. Telescopic Fire-escape, E. Bayley, London.
15,764. Producing Vacuum in the Bulbs of Incandescent Electric Lamps, G. Davidson, R. C. Jackson, and J. B. Duncan, London.
15,765. Lanterns or Lamps, R. E. Keen, London.
15,766. Bicycle Handles, F. Haslam, London.
15.767. Steam Engines, A. M. Clark.—(*W. S. Arnold, Canada.*)
15,768. Electro-dynamic Motors, T. J. Handford.—(*F. J. Sprague, United States.*)
15,769. Manipulation of Captive Balloons, J. L. Clark.—(*L. E. Clark, Brussels.*)
15,770. Mechanical Trimmer for Bulk Cargoes, A. G. Nicholls, London.
15,771. Letting-off Motions of Looms, T. H. Brigg, London.
15,772. Voltaic Batteries, D. G. Fitz-Gerald and T. J. Jones, London.
15,773. Locomotive Engines, J. A. Longridge, London.
15 774. Blower for use in Lighting Fires, H. Neumann, London.

1st December, 1884.

15,775. Machine for Boring Rocks, &c., J. A. McKean, London.
15,776. Shield to Protect the Fingers in Hand Sewing, W. Egerton, jun., Erith.
15,777. Wedges, &c., T. H. Garstang, Manchester.
15,778. Refrigerating and Congealing Liquids, E. Fontenille, Paris.
15,779. Boots and Shoes, W. Freeman, Leicester.
15,780. Governors, E. Wright, Worcester, U.S.
15,781. Box-nailing Machines, F. Blood, Liverpool.
15,782. Lock and Latch Furniture, W. Sanderson and T. A. Moffit, Aston.
15,783. Cleaning Tin and Terne Plates, W. H. Bolton, A. Evans, and T. Bright, Cinderford.
15,784. Knitting Machines, W. White, London.
15,785. Twist Lace Fabrics, T. S. Birkin, London
15,786. Trouser Stretcher, J. Lucas, Birmingham.
15,787. Cutting the Pile of Cotton or other Cords, F. Osbourn and J. H. Beresford, Manchester.
15,788. Gloves, S. Morgan, Atherstone.
15,789. Petticoat Drawers, E. M. Paice, London.
15,790. Horse-hitching Device, S. T. Osborne, London.
15,791. Self-locking Fastener for Leggings, J. M. Dennison, London.
15,792. Friction Clutches, F. G. Riley, London.
15,793. Stretching Trousers, &c., R. H. C. Nevile and E. Whitworth, Grantham.
15,794. Controlling the Speed of Engines, R. H. C. Nevile, Grantham.
15,795. Driving Motion for Wringing, &c., Machines, J. Wilks, South Stockton-on-Tees.
15,796. Communicating Power to Machinery, E. Fletcher, London.
15,797. Regulating Electric Currents, W. H. Scott and E. A. Paris, London.
15,798. Raising and Lowering Boats, J. Donaldson, London.
15,799. Piano Actions, J. Y. Johnson.—(*W. Fischer, Leipzig.*)
15,800. Coating Boilers, &c., with Lead, I. S. McDougall, London.
15,801. Windmills, A. C. Henderson.—(*J. Tivole, Lyon.*)
15,802. Machinery for Cultivating Land, J. Barber and W. Stafford, London.
15,803. Sashes, J. B. Robinson, London.
15,804. Safety Letter Pillar, &c., O. Reimenschneider, London.
15,805. Ventilators, G. S. Buchanan, London.
15,806. Oil Lamps, J. Battye, London.
15,807. Spacing or Scaling Rulers, T. Durrans, London.
15,808. Boot Cleaner, H. G. Wells, London.
15,809. Bicycles, &c., J. Cornforth, London.
15,810. Preparing Agent for Treating Sewage, J. W. Slater and W. Stevens, London.
15,811. Sounding Boards of Pianofortes, N. Berry, London.
15,812. Purifying Oils, &c., W. L. Wise.—(*A. Skrobanck, Vienna.*)
15,813. Closing the Frames of Umbrellas, W. L. Wise. —(*F. A. Boin, Vincennes.*)
15,814. Plain-faced Paste Rolling Mills, W. Pickering and E. J. T. Digby, London.
15,815. Planing Edges of Books, &c., A. J. Bickmore. (*C. Gerster and W. Leo, Stuggart.*)
15,816. Furniture, A. J. Bickmore.—(*E. Semal, Nivelles.*)
15,817. Roller Mills for Grinding Corn, W. R. Lake. —(*L. Nemelki, Vienna.*)
15,818. Swing Joint for Pipes, A. Feist, London.
15,819. Rolls for Drying Paper, &c., J. A. and J. Hopkinson, London.

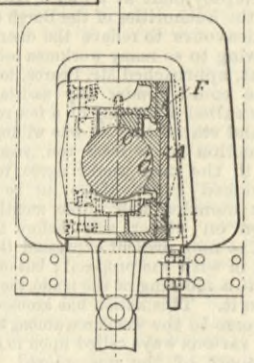
SELECTED AMERICAN PATENTS.

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

306,427. Axle Box, *Léon Raymond and André Henrard, Brussels, Belgium.—Filed February 4th*, 1884.

Claim.—An axle box having one or two movable cheeks A, connected with the upper part of the box by studs or guide pins F, and inclosing three bushes C C^1 C^1, held in place by lateral flanges only, and adapted (as regards their height and width) to allow the two vertical bushes C^1 vertical play without

306,427

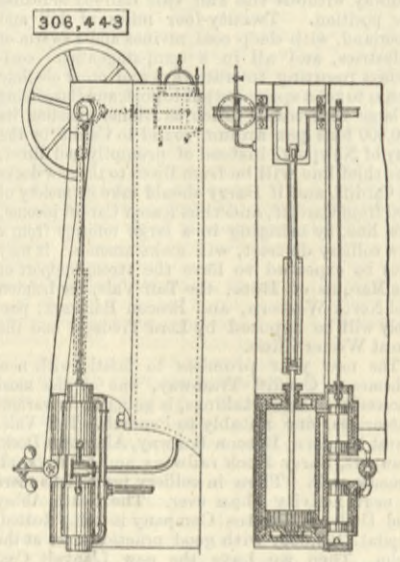


hindrance from the third bush C, or from the box, and to allow the upper bush C horizontal play without hindrance from the two other bushes or from the box, substantially as described, and illustrated by the drawings.

306,443. Gas Engine, *Wm. L. Tobey, Boston, Mass.—Filed March 14th*, 1884.

Claim.—(1) The engine cylinder and valve chest, and inlet and exhaust ports leading to and from the said valve chest, and ports connecting it with the ends of the cylinder, combined with the valves arranged in said valve chest with relation to said ports as shown and described, and valve-actuating mechanism whereby communication is alternately established and cut off between the inlet port and portions of the said valve chest adjacent to each end of the cylinder, and one end of the cylinder is connected with the exhaust port while communication is established between the adjacent portion of the valve chest and

306,443

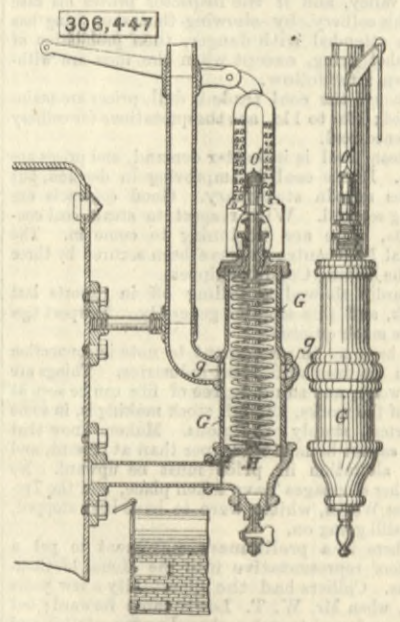


the inlet port, and also between the other end of the cylinder and the portion of the valve chest adjacent thereto, which is then cut off from the inlet port, substantially as set forth. (2) In a gas engine, the engine cylinder, and a tank or reservoir for an explosive gaseous mixture, and an intermediate chamber and valve mechanism, whereby the said chamber is alternately placed in communication with the said tank and cylinder, without at any time establishing direct communication between the said tank and cylinder, substantially as described.

306,447. Safety Valve, *Jas. White, Canton, Ohio.—Filed December 12th*, 1883.

Claim.—In a safety valve, the combination of the cylinder G having the apertures *g*, communicating with the blow-off pipe, the steam passage connecting said cylinder with the boiler, the head or piston H, working in the cylinder, the spring situated within the cylinder and bearing against the head or piston to counterbalance the steam pressure, substantially as

306,447

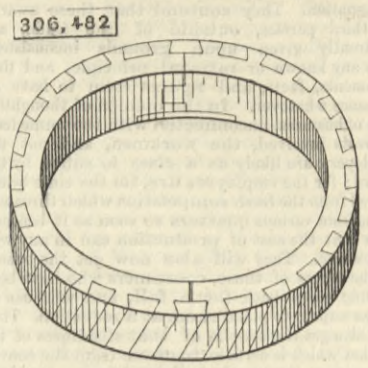


set forth. The combination of the cylinder or barrel G, the head or safety valve H, the spring which resists the pressure of the steam on the valve, the graduate scale, the index, the support for the index connected with the head or safety valve H, the escape passage way for the steam communicating directly with the interior of the barrel or cylinder G, the means for regulating the draft in the furnace, and the movable part O^1, connected directly to the head or safety valve H, and adapted to operate the draught-regulating means, substantially as set forth.

306,482. Packing for Pistons, *Lyman Gray, Pittsburg, Pa.—Filed April 10th*, 1884.

Claim.—A new and improved packing consisting of a metallic ring composed of two or more segments or sections jointed endwise together, and provided with

306,482

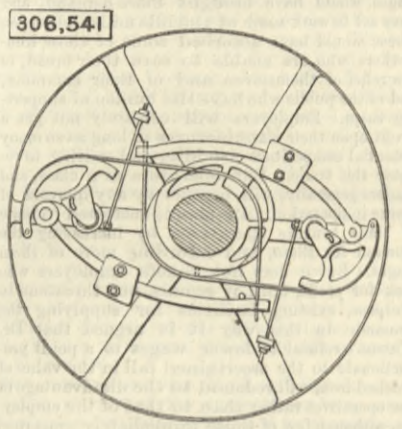


segregated non-metallic panels arranged diagonally across the entire width of the periphery of the ring.

306,541. Engine Governor, *John P. Simmons, San Francisco, Cal.—Filed May 23rd*, 1884.

Claim.—In a governor, the excentric fitted loosely to the main engine shaft, and the curved weighted arms connected with the hub of the excentric by

306,541



straps attached to the arms and to segments, so as to rotate it when turned outward by centrifugal action, the said segments having a returning spring coiled around their pins, as herein set forth.

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