SHEAF-BINDING REAPING MACHINES.

No. II.

In entering upon the descriptive part of this task, we have to depart from the alphabetic order as to names, which we should have followed, as we have not yet completed the engravings of Messrs. Hornsby's machines. We must describe Messrs. Howard's machine first, because this firm supplied us most quickly with the greatest number of drawings. They had three machines on the trial ground, all of which were to all appearances the same, but they were not—quite. One had the Appleby form of knotter, with rotary gripper, driven by a ratchet and pawl, like that illustrated in our impression of the 16th September, 1881. Another had the Appleby knotter with the same gripper, driven by means of a worm gearing into a small worm wheel on the rotary gripper spindle, as shown in the engraving, Fig. 9. A third was constructed so that the binding platform was rather lower than that of the others, while there was a difference in the trip gear. As to the rotary knotting hook and the worm-driven rotary gripper, it may be mentioned that, on the one hand, it is claimed by Appleby in America as a modification which he made on his own mechanism, while Messrs. Howard say:—"Each of the machines tried was fitted with the type of knotting hook and rotary string-holding device illustrated and described in the specification of J. and F. Howard's patent, No. 821, A.D. 1880. This form of knotting hook was first exhibited in England by J. and F. Howard at the R.A.S.E. Show at Carlisle, 1880. It was not until the following year at the Derby Show that the knotting hook and the rotary string grip were shown in sheaf binders of the Appleby type, manufactured by M'Cormick and others. Appleby had doubtless been working simultaneously with J. and F. Howard in solving this problem." We are not intending to argue the point or question here touched upon, but we give what Messrs. Howard say upon it as touching the history of the subject. To describe the binder we must premise that the corn being led by the reel to the knives working in the fingers at A', falls on the travelling web B, by which it is led to and between the pair of webs working in the inclined box, and by these it is carried up and delivered to the binding platform marked "table." Working on a crank shaft below, and passing up through slots in this table, are the packing arms appearing thus, by which the straw is taken and packed between themselves and the jaw piece standing up through the slot in the lower part of the table, and below the stripper board, Fig. 2&4, thus:

FIG. 3

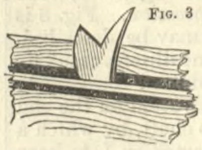
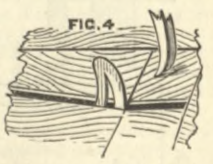
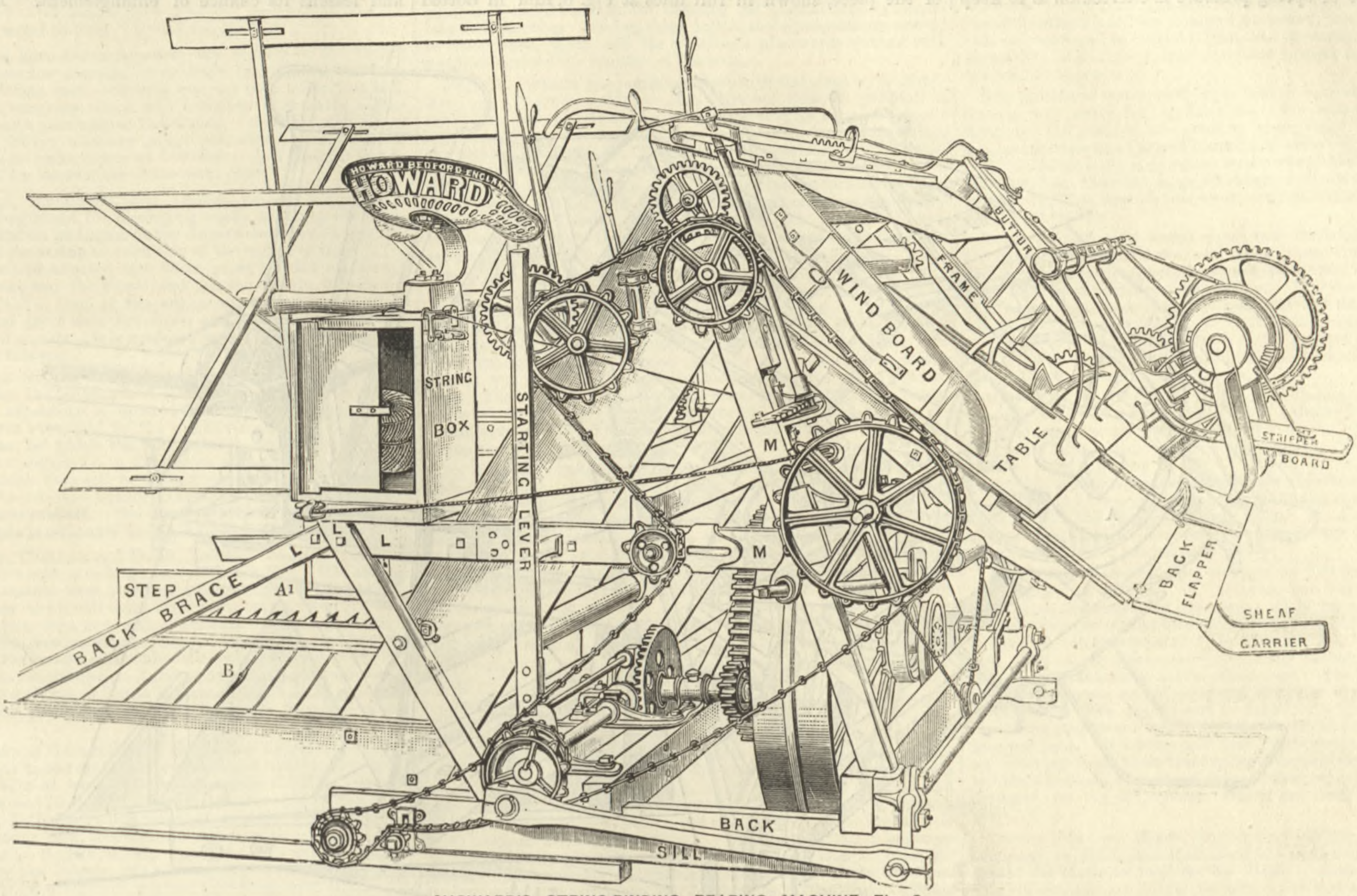


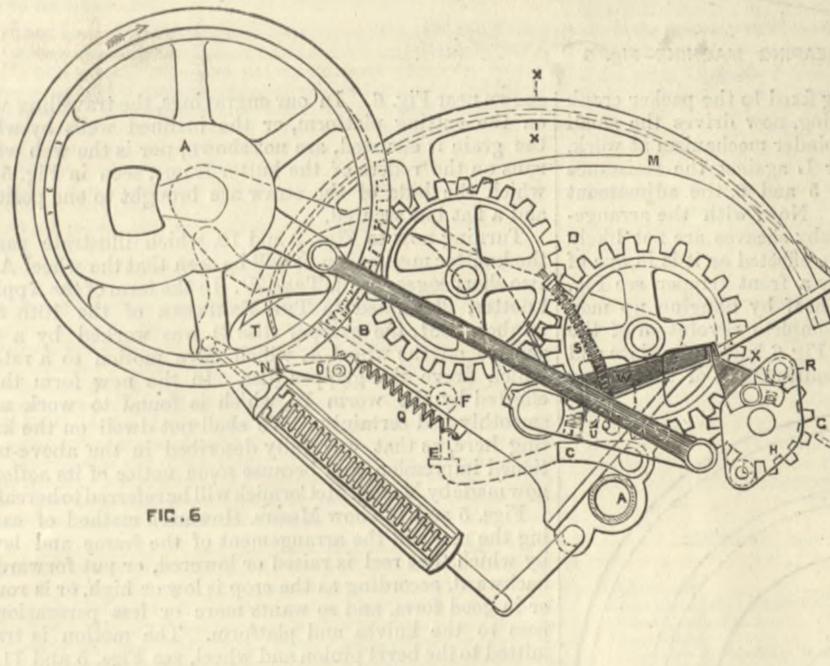
FIG. 4



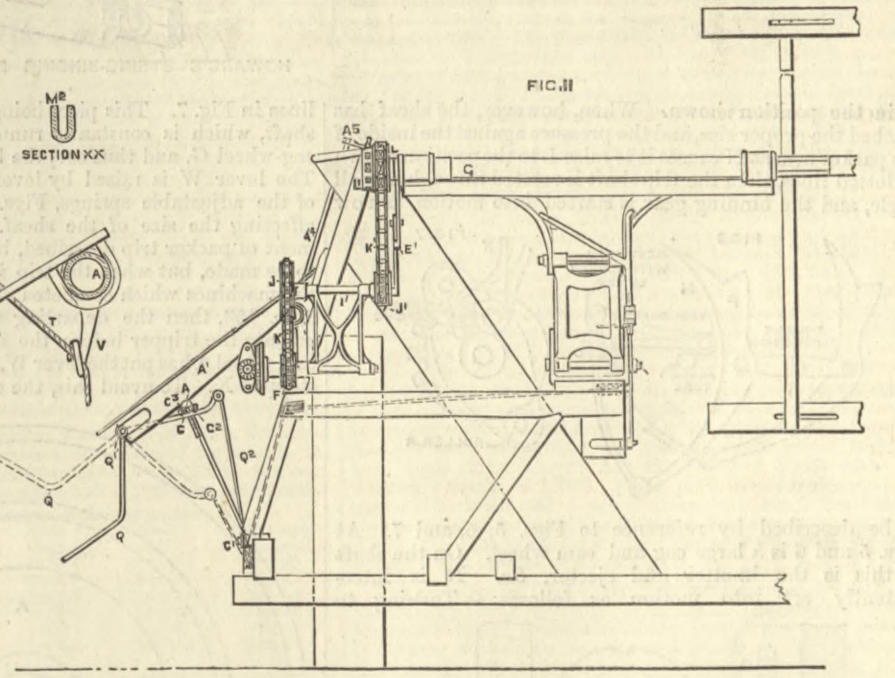
The string at this time is in the gripper of the binder above the table, and in the end of the binding arm, which is appearing at the upper part of one of the slots in the table. The engraving Fig. 2 shows the mechanism in the position it takes when the sheaf is just about to be tied. The pressure now brought against the compressor jaw or lever, seen in Fig. 2 and Fig. 4, causes it to move, and thus actuates the very ingenious gear shown at Fig. 5, and Figs. 6 and 7. This, however, we will describe in connection with an improvement made in this apparatus, by which the increasing pressure on one of the packing arms themselves is caused to actuate the trip. This, as will be seen, is of importance, as the drag of the outgoing sheaf sometimes pulled on Fig. 4 and started the binding mechanism, and thus bound up a baby sheaf. Even the latter had, however, been prevented by a simple device, shown by dotted lines in Fig. 6 and in Fig. 5; but the release of the trip and starting the binder by pressure on the packing



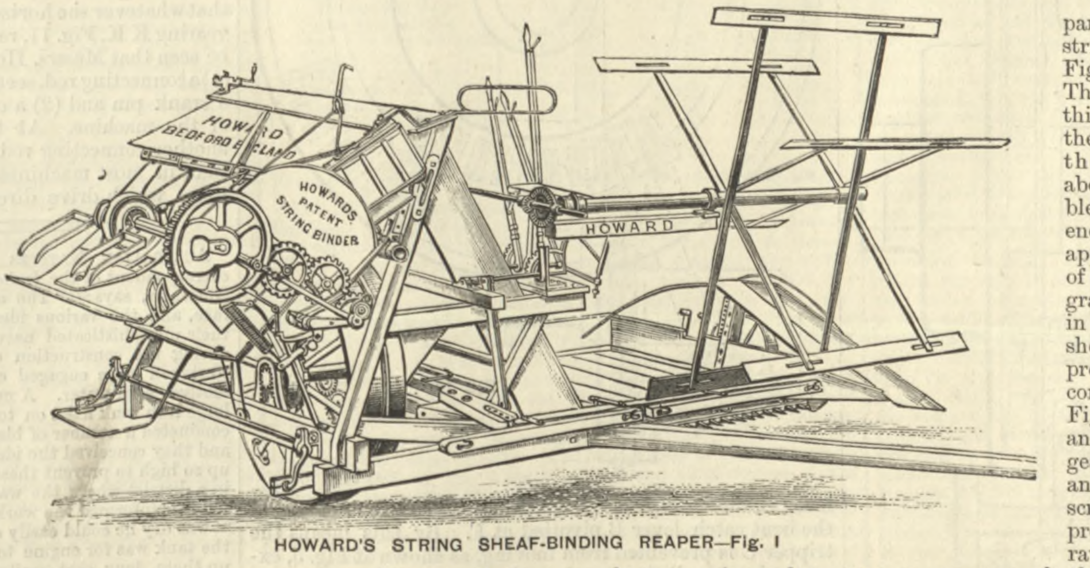
HOWARD'S STRING-BINDING REAPING MACHINE—Fig. 2



TRIP GEAR AND BINDING MECHANISM.

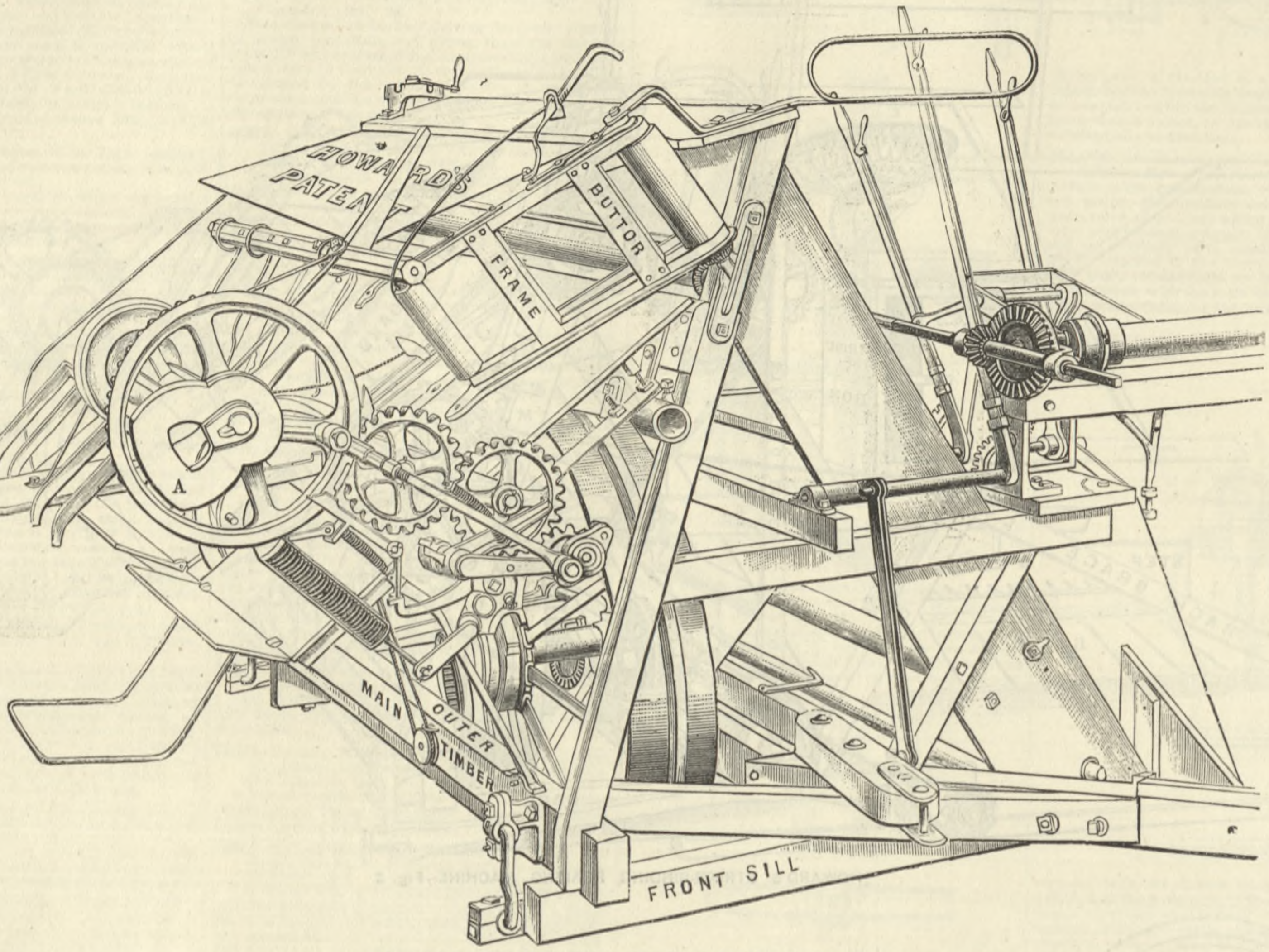


HOWARD'S SHEAF CARRIER AND REEL SUPPORT AND ADJUSTMENT.



HOWARD'S STRING SHEAF-BINDING REAPER—Fig. 1

arms, and therefore behind the sheaf, makes it much more difficult for the machine to choke with a rough crop, such as the barley referred to in our last impression. Fig. 8 is a diagram by which this improvement may be described. In this, P is a packing arm, working on one dip of a crank K, the other packing arm being shown in dotted lines. The arm P swings on the link X, which is pivotted on the end of the lever L. L is fixed to the trip shaft, by which a certain amount of spring pressure is exerted on L to keep it in the position shown. When, however, the sheaf has reached the proper size, and the pressure against the inside of the packer arm at N causes it to raise L to the position shown in dotted lines, then the trip shaft is rotated through a small angle, and the binding gear is started into motion, as now



HOWARD'S STRING-BINDING REAPING MACHINE—Fig. 5

FIG.8

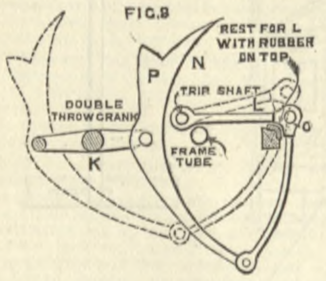
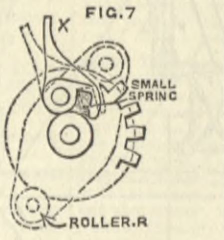


FIG.7



to be described by reference to Figs. 5, 6, and 7. At Figs. 5 and 6 is a large cog and cam wheel. On the shaft of this is the knotter and ejector, &c. It is intermittently set into motion as follows:—Turning to

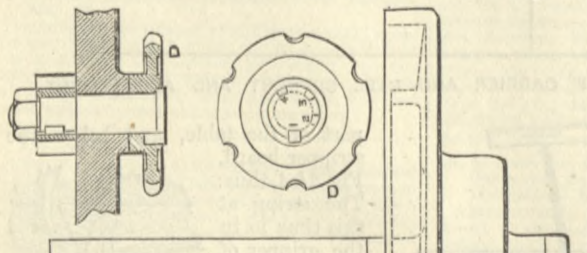


FIG.9.

Fig. 6, the end of the trip shaft, to which L of Fig. 8 is fixed, is seen, with the trip piece upon it, at C. When, then, L is raised by the pressure at N, Fig. 8, the lever W, Fig. 6, is raised, and the excentric pawl X pivotted on the small cog-wheel, which is loose on the packer crank shaft—see also Fig. 7—is freed. As soon as this takes place, the small spring B, Fig. 7, forces the excentric pawl X into the position shown in dotted lines, under the action of the small spiral spring B, Fig. 7. This causes the projecting part of the pawl near the spring to come into contact with one of the two rollers R, which are on the back of the piece, shown in full lines at Fig. 6, and in dotted lines in Fig. 7. This piece being fixed to the packer crank shaft, which is constantly running, now drives the small cog-wheel G, and thus sets the binder mechanism at work. The lever W is raised by lever L against the resistance of the adjustable springs, Figs. 5 and 6, the adjustment affecting the size of the sheaf. Now, with the arrangement of packer trip described, baby sheaves are not likely to be made, but when the trip is effected as it is in one of the machines which competed by a front tripper, see Fig. 2, p. 153, then the departing sheaf by hanging up may actuate the tripper before the complete revolution of the cam wheel A has put the lever W, Fig. 6, back in its place and stopped X. To avoid this, the continuation of the tripper

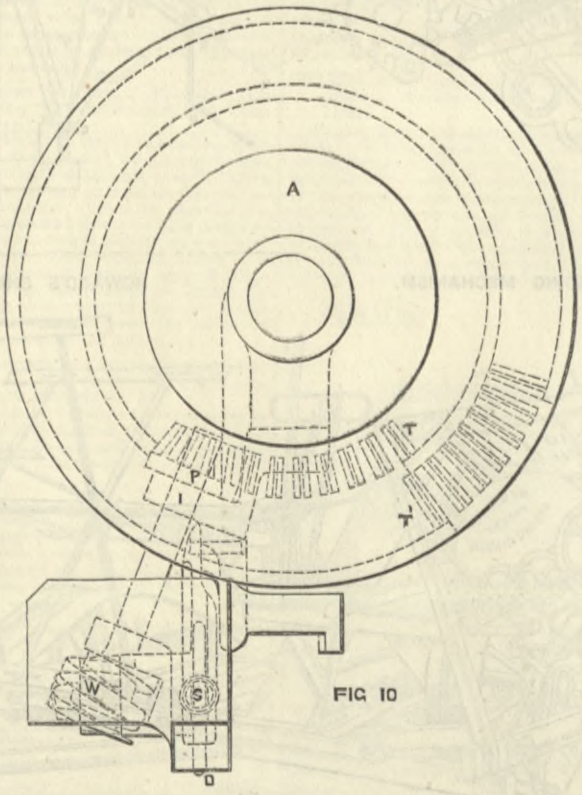


FIG 10

lever C, shown in dotted lines at Fig. 6, has been made, and the bent catch lever B pivotted at F. By this means the tripper C is prevented from moving, as shown at Fig. 5, except when the little cam piece above B on the periphery of wheel A depresses the lever B and so frees the trip at E. The cam of the wheel A works, by means of the spring, connecting rod, and levers seen below it, the sheaf packing jaw or abutment, Figs. 2 and 4. The shaft on which the wheel A is fixed carries the knotter device and the segmental cog and cam wheel by which the knotter and the ejector fork or arms are worked, as will be readily seen from Figs. 1, 2, and 5. The lever U, seen in Figs. 6 and 7, gets its motion from the wheel A, through the connecting-rod T, Figs. 6 and 5; and the shaft on which U is fixed carries the binding arm by which the string is carried round the hinder part of the sheaf to the knotter. The lever W, it should be mentioned, is loose on the shaft which carries it. The binding arm is grooved throughout its length, and thus securely carries the string, and lessens its chance of entanglement. Its section is shown near Fig. 6. In our engravings, the travelling webs on the cutting platform, or the inclined webs by which the grain is elevated, are not shown, nor is the web which runs on the rollers of the buttor frame, seen in Fig. 5, by which the buts of the straw are brought to one position, and a flat but secured.

Turning now to Figs. 9 and 10, which illustrate part of the knotter mechanism, it will be seen that the wheel A has two short cog segments T and T'. In the form of the Appleby knotter, illustrated in The Engineer of the 16th September, 1881, the gripper disc D was worked by a cam surface on the wheel A, which gave motion to a ratchet which drove the gripper disc. In the new form this is effected by the worm W, which is found to work more smoothly and certainly. We shall not dwell on the knotting here, as that was fully described in the above-mentioned impression, and because some notice of its action as now made by Messrs. McCormick will be referred to hereafter.

Figs. 5 and 11 show Messrs. Howard's method of carrying the reel and the arrangement of the frame and levers by which that reel is raised or lowered, or put forward or backward, according as the crop is low or high, or is rough, or in good form, and so wants more or less persuasion to pass to the knives and platform. The motion is transmitted to the bevel pinion and wheel, see Figs. 5 and 11, by means of the drive chain running on seven spocket wheels seen in Fig. 2. Without lengthy description it will be seen that whatever the horizontal or vertical adjustment the chain gearing K K, Fig. 11, remains unaffected. From Fig. 2 it will be seen that Messrs. Howard drive their knives by means of (1) a connecting rod, seen against the back sill, which connects a crank pin and (2) a cranked rocking shaft along the side of the machine. At the other end of this shaft is (3) another connecting rod. There is thus (2) and (3) more than in most machines, and four more bearings than in those which drive direct from one connecting rod.

Australian Natives and Railroad Water Tanks.—A correspondent of the *Indian Railway Service Gazette*, writing from Australia, says:—"The aboriginals of these colonies are a queer race, and the various ideas introduced by the white man are to their unsophisticated natures great mysteries. Some time back, during the construction of a railway in the back districts, the workmen were engaged erecting a tank for supplying the locomotives with water. A number of stout piles were erected and a large iron tank fixed on top. While these operations were being conducted a number of black fellows were watching their progress, and they conceived the idea that the water tanks were to be placed up so high to prevent these aboriginals stealing the water—it was in a district where the water supply is precarious. One of their number informed the workmen that if black fellow—the aboriginal—was dry he could easily climb up and get a drink. He was told the tank was for engine to get a drink. 'Why put him—tank—up there, long cart—railway train—not got long neck, him no drink then, and him take long time to grow to drink him there; besides fire no want water.' A few days after the ballast engine came along and took water at the crane. The black fellows set up a shout and cried it was a new animal, he drink big drink all at horse's tail—referring to the pipe of the water crane being put into the tender of the engine. I need not say this speech caused the driver and his stoker—a new hand in the colonies—to have a jolly good laugh at the new idea these blacks had of their iron horse."

RAILWAY MATTERS.

American journals record with pride that not a single passenger riding last year in a passenger train on the Massachusetts railroads was killed except from his own fault, and there were over 61,000,000 passengers carried an average distance of fifteen miles each.

"Suppose," said an examiner to a student in engineering, "you had built an engine yourself, performed every part of the work without assistance, and knew that it was in complete order, but when put on the road the pump would not draw water, what would you do?" "I should look into the tank and ascertain if there was any water to draw," replied the student.

Locomotives have fallen in price very heavily in the United States in the last few months. A contract for building ten locomotives at 8000 dols. each, delivered, has just been taken, it is said, by an eastern company which sold locomotives precisely similar only a little over a year ago for 15,000 dols. A broker who has an order for two 38-ton standard gauge passenger locomotives, has received offers to make them at 6000 dols. In December last he paid 8000 dols. for locomotives of the same class.

The Chicago, Burlington, and Quincy Railway Company is testing an arrangement for destroying weeds adjoining the track. It has been fitted on an engine at the Aurora shops, and consists of two iron pipes projecting on each side of the engine in front. The exhaust steam is conducted into these pipes instead of through the smoke-stack, and the steam and gas are thereby thrown out close to the track in front of the engine on each side. On a trial trip weeds and grass were cut down and destroyed some 2ft. on each side of the rails. It is proposed to run an engine over the entire road in this way.

Thirty-nine railway companies in the United States have had granted to them the fee simple of 179,922,528 acres of public lands—a territory exceeding in extent the State of Texas. Nearly 11,000,000 acres were sold to the railway companies during the last fiscal year, for which the Government received in cash over £700,000. The difference in the prices at which the companies buy and at which they sell is strikingly shown by the statement that they have received nearly £14,000,000 for 14,310,204 acres which they have sold off. The quantity which they still hold in their own hands is estimated at 164,512,234 acres.

The London, Chatham and Dover, Railway Company is carrying out an extensive station enlargement at Herne Hill. The enlargement of the station area is being effected by the erection of a series of arches which will carry three additional lines of rails, and also provide space for a new central platform upwards of 300ft. in length. Several new waiting rooms and other offices are in course of erection. The station will be almost double its former area. The enlargement is in anticipation of the greatly increased traffic which is expected to converge at Herne Hill consequent on the opening of the new station and bridge at Blackfriars, now in course of construction.

The statistics of the working of the Indian Railways during the half-year which ended on December 31st show that twenty broad-gauge lines were at work with an aggregate of 7261 miles open. These lines earned Rs.6,04,22,188, and there was expended a sum of Rs.3,11,75,775, leaving a balance of net earnings of Rs.2,92,46,413. The narrow-gauge lines, fourteen in number, with a length of 3148 miles, earned Rs.1,12,64,467, against an expenditure of Rs.71,61,613; the balance of net earnings being Rs.41,62,864. Taking all the lines together, we find that there were 10,410 miles open, on which the total capital expended was Rs.1,42,36,71,978, and which gave in the half-year a balance of net earnings amounting to Rs.3,34,09,267.

There are, an American paper says, more than 10,000,000 iron car-wheels in use on American railroads, and it requires about 525 lb. of pig iron to make one wheel. About 1,250,000 wheels are worn out every year, and the same number of new ones must be made to take their places. The iron men are called upon for only a small proportion of the 312,500 tons of material required for these new wheels, however, for nearly 290,000 tons are supplied by the worn-out wheels themselves. These figures do not include the wheels on palace coaches and the better class of passenger coaches. The wheels on that grade of rolling stock are now made almost exclusively of paper, and are lighter and quite as serviceable as iron ones.

The Chicago, Milwaukee, and St. Paul Railway is experimenting with Woolley's patent electric head-light. The engine and dynamo are placed on the running board on the left-hand side of the locomotive, opposite the air brake pump. The engine and dynamo occupy a space 34in. in length by 10in. in width. The dynamo is 18in. square by 10in. high. The armature is made up of discs, and is 12in. long by 6in. in diameter. The power is furnished by a small rotary engine, built by the Noteman Engine Company, of Toledo, O., which runs at 600 revolutions per minute. The engine is connected to the shaft of the armature direct, the governor being on the opposite end of the shaft. The *American Machinist* says: The dynamo is closed so that it cannot be injured by the weather, &c. The lamp used is a focussing arc lamp, with an ordinary locomotive reflector, regulated from the cab of the locomotive.

At the recent half-yearly meetings reference was made by the chairmen of the principal railway companies to the continual falling off during the past few years in the first and second-class passenger traffic, and to the remarkable growth of the third-class. The *Times* says the "only wonder is that the companies have not seen their way to remedying the state of things of which they complain. As a rule, there is absolutely no proportion between the fares of the three classes, and in many cases even a second-class passenger pays over 100 per cent. more than one who goes by third-class. The chief advantages obtained by travelling in a superior class are greater privacy, and above all, less risk of objectionable company, but too high a price is asked for these advantages. Moreover, as matters are at present, a person who has paid for travelling first or second-class cannot feel sure that he will not have his carriage filled with third-class passengers, especially in the busy parts of the day. This is, perhaps, a matter which the companies could remedy by increasing their rolling stocks, but in any case the only effective means for restoring the higher class traffic would be a reduction of the altogether disproportionate fares now charged for that kind of passenger accommodation, and a faithful observance of the implied contract entered into with the passenger—namely, that he shall not be subjected to the irregular incursions of persons who take third-class tickets and then 'get in anywhere.'"

Considering the extent of territory and population, the island of Sicily is one of the worst off in Italy as regards railways, and of the seven provinces of Sicily that of Syracuse is the poorest of all in this respect. Palermo had to fight sixteen years before it obtained a Bill for the construction of a line connecting it with Girgenti and Catania, and five or six years more were spent in idle talk as to whether the line should pass by Montedoro or Caldare. At last it was decided to direct it through Montedoro, but this decision was subsequently abandoned. The same procrastination has attended the construction of the line that was decreed in 1879 to run between Messina and Palermo, along the northern coast of Italy. Syracuse in 1864 was placed in communication with Catania and Messina by a line along the coast, but the interior of the province was not much benefitted; and in 1879 a decree was obtained for the construction of a line between Syracuse and Licata. The Italian Government, however, seems to be in no hurry to begin the works, and it is not yet decided what course the line will take. For want of means of communication, the once important town of Sciacca has lost its trade and industry, and has much retrograded of late. A Bill was accordingly passed some time ago for the construction of a line connecting Palermo with Sciacca *viâ* Corleone, and already the preliminary steps of expropriation have been initiated.

NOTES AND MEMORANDA.

In London 2660 births, and 1579 deaths were registered last week. The annual death-rate from all causes, which had been 21·1 and 21·2 per thousand in the two preceding weeks, declined to 20·5.

At the Royal Observatory, Greenwich, the mean temperature of the air last week, was 65·7 deg., and 4·2 deg. above the average. The duration of registered bright sunshine in the week was 47·9 hours, against 56·3 hours at Glynde-place, Lewes.

As a mixture for cleaning paint the following is given:—Dissolve 2 oz. of soda in a quart of hot water, which will make a ready and useful solution for cleaning old painted work preparatory to repainting. The mixture, in the above proportions, should be used when warm, and the woodwork afterwards washed with water to remove the remains of the soda.

Prof. F. Neesen has published a paper in the *Archiv für Artillerie-und Ingenieur-Offiziere* for 1884 on Sebert's method of registering the velocity of shot within the tube of a gun. Sebert's apparatus necessarily registers for a space somewhat shorter than the diameter of the ball. This defect is remedied and the registration extended to the whole length of the tube by means of a revolving appliance to which the registering tuning-fork is attached, and disposed parallel with the periphery of the cross section of the shot. Pencils fastened to the prongs of the tuning-fork and vibrating with it are thus made to describe curves indicating the velocity of the ball in its course through the tube.

In a report by her Majesty's Agent and Consul-General in Siam, which has just been published, it is stated that the casting of bronze statues of Budda is carried on in Bangkok. The process employed is that known as "en cire perdue," and the alloy used consists of copper and lead, sometimes with the admixture of a small quantity of zinc. A clay model is first made; upon this a coat of wax is moulded, and over this again is put another layer of clay. The whole is then baked, the wax running off through apertures left for that purpose, and the central core being kept in its place by iron pegs. The alloy is then run into the space previously occupied by the wax.

In his Cantor lectures on alloys used for coinage, Mr. Chandler-Roberts, F.R.S., chemist of the Mint, said:—"A short cylinder is the geometrical form which, next to the sphere, presents the smallest surface for the greatest weight, and, consequently, in order to reduce the wear of coins to a minimum, their thickness should be equal to their diameter. Such a form would present many inconveniences; but, on the other hand, coins should not be made too thin, and much may be gained by even a small approach to theoretical requirements. A good practical rule for calculating the most useful diameter of a coin from its weight is given by the following formula:—$D = P\sqrt[3]{G}$. D = diameter in millimetres, G = weight in grammes, P = a certain number found by experiment = 11·3 for all gold coins."

The following is given respecting an interesting clock in Trinity Church tower, New York, which is the heaviest in America:—The frame stands 9ft. long, 5ft. high, and 3ft. wide. The main wheels are 30in. in diameter. There are three wheels in the time train, and three each in the strike and the chime. The winding wheels are formed of solid castings 30in. in diameter and 2in. thick, and are driven by a "pinion and arbor." On this arbor is placed a jack, or another wheel, pinion, and crank, and it takes 850 turns of this crank to wind each weight up. It requires 700ft. of 3in. rope for the three cords, snd over an hour for two men to wind the clock. The pendulum is 18ft. long, and oscillates twenty-five times per minute. The dials are 8ft. in diameter. The three weights are about 800, 1200, and 1500 lb. respectively. The *Scientific American* says, a large box is placed at the bottom of the well that holds about a bale of cotton waste, so that if a cord should break the cotton would check the concussion.

Mr. W. Crookes, F.R.S., and Drs. W. Odling and C. Meymott Tidy, reporting to the official water examiner for the metropolis on the composition and quality of daily samples of water supplied to London during last month, state that of the 189 samples collected by them from the mains of the seven London water companies deriving their supply from the Thames and Lea, "the whole were, without exception, clear, bright, and well filtered." Altogether the quality of the water supplied to the metropolis during the past month, as indicated by its state of aeration, and by its freedom from turbidity and excess of colour and organic matter, continued excellent. As commonly happens in July, the proportion of organic carbon found in the water, though still low, was a little in excess of that met with in June. Thus, the mean quality of organic carbon present in the Thames-derived water supply of the past month amounted to 0·123 part in 100,000 parts of the water, as against 0·114 part met with in the preceding month. This habitual slight rise in July is ordinarily followed by a more decided fall in August and September, to be succeeded, however, in its turn, by an appreciable rise in October and November.

According to the report of the secretary—Mr. J. S. Jeans—of the British Iron Trade Association, the make of pig iron in the United Kingdom for the half-year ended June 30th, 1884, compared with that of the corresponding half of 1883, was as follows:—

Total production of pig iron.

District.	First half of 1884. Tons.	First half of 1883. Tons.	Increase + or decrease − in 1884. Tons.
Cleveland	1,280,754	1,373,837	−93,083
Scotland (part estimated)	527,044	570,000	−42,956
West Cumberland	443,874	411,647	+32,227
Lancashire	368,706	345,919	+22,787
S. Wales (including Monmouthshire)	450,633	466,302	−15,669
Derbyshire	156,317	194,219	−37,902
South Staffordshire and Worcestershire	185,065	189,000	− 3,935
North Staffordshire	128,181	146,023	−17,842
West and South Yorkshire.	132,910	144,500	−11,590
Lincolnshire	123,952	108,118	+15,834
Northamptonshire	134,721	111,641	+23,080
Shropshire	23,000	37,320	−14,320
North Wales	10,463	21,199	−10,736
Notts, Gloucestershire, &c.	25,600	18,500	+ 7,100
Totals	3,991,220	4,138,225	

There was thus a net decrease of make in 1884 of 147,005 tons.

The Maerglin Lake is about to be drained. A correspondent of the *Times* says of the lake: "Like many another thing of beauty, it is capable of working terrible mischief. From time to time it breaks its icy barriers, leaps in a mad torrent into the bed of the Marsa, and spreads terror and destruction in all the valley of the Upper Rhone. This happened in 1872, and again in 1878; and albeit in the latter year the river for the season—July—was abnormally low, and consequently able to accommodate a tolerably large flood, it rose in a few minutes at Brieg, 1·50 metre—4ft. 11in.—and at Sion almost as much. Still it will be regretted that it has been resolved to drain the Maerglin See, and though it will not be quite emptied, the operation can hardly fail to rob this ice-born lake of much of its loveliness. The Maerglin contains ten million cubic metres of water, is 50 metres deep at the point where it is bounded by the Aletsch glacier, and 12·50 metres at the opposite extremity. The basin of the lake is 1500 metres long, its direction is from west to east, and at the eastern end is the overflow. It is here that the proposed operation will be effected, for a boring or lowering of the glacier would entail a greater outlay than Canton Valais is willing to make or the Confederation—which helps the undertaking with a subsidy—to sanction. The opening, 540 metres long and 12·50 metres deep, will thus be at the back of the lake, and its effect will be to lower its level by 12·50 metres and diminish its volume by about one-half, the present mean depth being some 25 metres; and although the operation may not absolutely prevent future floods, they will be rendered thereby both much rarer and far less dangerous."

MISCELLANEA.

Messrs. Charles Burrell and Sons, of the St. Nicholas Works, Thetford, Norfolk, have converted their partnership into a private limited company.

The London and North-Western Company's new steamer Banshee made the passage from the Poolbeg Light, North-wall, Dublin, to the Holyhead Breakwater, on the 11th inst., in three hours and one minute, the fastest cross-channel passage on record.

It is noted that when the White Star steamer Doric, which was chartered by the New Zealand Shipping Company and made the fastest passage from New Zealand on record, was dry docked, the bottom was found to be quite clean, and the coating of composition, Kirkaldy's, would have made another voyage, though the owners thought fit to renew it.

The structural waterproof paper, which we recently described, is finding very extensive applications. We understand that the Liverpool Corporation are erecting some large temporary small-pox hospitals on the Park-hill estate, overlooking the Mersey, and these are being built in detached tenements of the Willesden paper. We also hear that the large buildings of the Amsterdam Agricultural Exhibition, opened this week, are constructed of this remarkable paper roofing.

In our reference last week to roofs over the boilers of the Dowlais Company, we should have said they were designed by Mr. J. Hodgson, Newport. These roofs are, it is true, of small size, but they have some points of merit in them. It is noticeable that many of the roofs in these large ironworks are not made on the works, but are built by other firms, many of them—some of large size, as at Ebbw Vale, the Dowlais works, and several large collieries—having been built, we are informed, by Messrs. Dyne, Steel, and Co., of Newport.

Messrs. J. Bagshaw and Sons, of Batley, near Leeds, have recently fitted an engine with a 12in. cylinder 24in. stroke with a jet condenser, the air pump of which is of the rotary type, driven by a strap from a pulley on the crank shaft. The system has, we believe, been invented by Mr. A. Brearley, Queen-street Mills, Batley. It is stated that, under unfavourable conditions, a constant vacuum of 11 lb. was maintained, occasionally touching 11½ lb. and 12 lb., whilst the saving in dead weight of material, space, and power, is very great. The price, also, will come in much less than for an ordinary reciprocating air pump.

A new twin screw hopper dredger of 800 tons capacity, built and engined by Messrs. W. Simons, has been launched complete from the works at Renfrew. It is named Valencia, and is the property of the Harbour Authorities of Valencia, Spain. It has been constructed under the direction of the engineer of the port, Don A. de Lazar, and is a sister dredger to the Espana launched by this firm a few weeks ago. The Valencia is fitted with two separate sets of compound engines of 500-horse power; it dredges to 35ft. depth, and is fitted with the builders' patent traversing gear to cut her own way in shoals, and will raise 400 tons per hour. It carries 800 tons of its own spoil at a speed of ten miles per hour; these two duplicate hopper dredgers are intended to take the place of a large fleet of barges, tugs, and stationary dredgers, on the old system, which has been in use for many years.

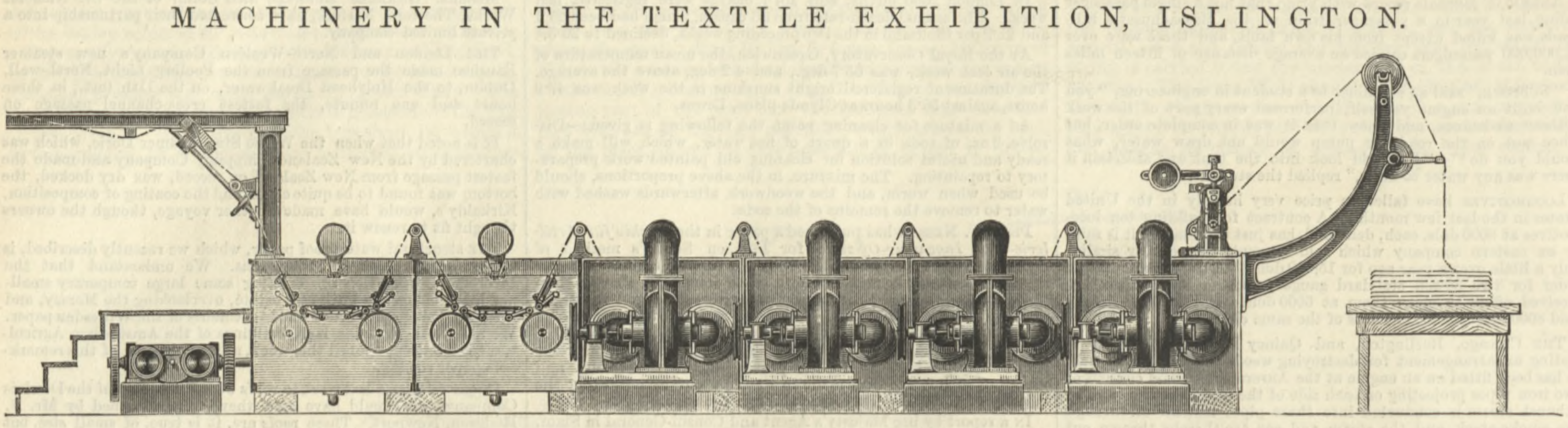
On the 19th inst. Messrs. Earle's Shipbuilding and Engineering Company, of Hull, launched from its yard a fine screw steamer named the Martello, built for the Atlantic cattle and grain trade. The dimensions are 370ft. by 43ft. by 28ft. 6in., with long full poop, and turtle back forward extending abaft the foremast. The stern frame and rudder are of cast steel, by Messrs. W. Jessop and Sons, of Sheffield, and are the largest made of this material up to the present time. The vessel has a double bottom on the cellular plan, and divided into five compartments. Provision is made for 600 head of cattle, with a complete system of ventilation, drainage, &c., for the same. Harrison's steam-steering gear is fitted amidships, and strong hand screw gear aft. She will be fitted by the builders with inverted compound engines of 400 N.H.P., on the three-crank triple-expansion principle, having cylinders 31in. and 50in. and 82in. diameter by 4ft. 9in. stroke, which will be supplied with steam of 150 lb. pressure from four steel boilers.

A steamer, the Crocus, built by Messrs. Allsup and Sons, of Preston, was launched on Saturday last, the 23rd inst., intended to run in the Wallasey ferry passenger service between Seacombe, New Brighton, and Liverpool. She is 130ft. long, 35ft. beam, and 7ft. draught, and is propelled by four screws, two at either end of the boat. Every means has been taken to ensure the safety of the vessel in case of any collision, and she is divided into eighteen watertight compartments, and is built of steel throughout to the highest class at Lloyd's. The saloons, which run fore and aft on the main deck, will be lighted with the electric light. Both main and promenade decks are of teak. There are two complete pairs of engines, of the inverted compound surface condensing type, with cylinders 18in. and 37in. diameter and 24in. stroke. The boilers, which are of steel, have been made under Lloyd's and the Board of Trade rules, for a working pressure of 100 lb. Steam and hand combined steering gear will be fitted, and a patent steam windlass. The Crocus is the second of three vessels built for the Wallasey ferries by Messrs. Allsup, from the designs and under the superintendence of Messrs. Flannery and Fawcus, of Liverpool.

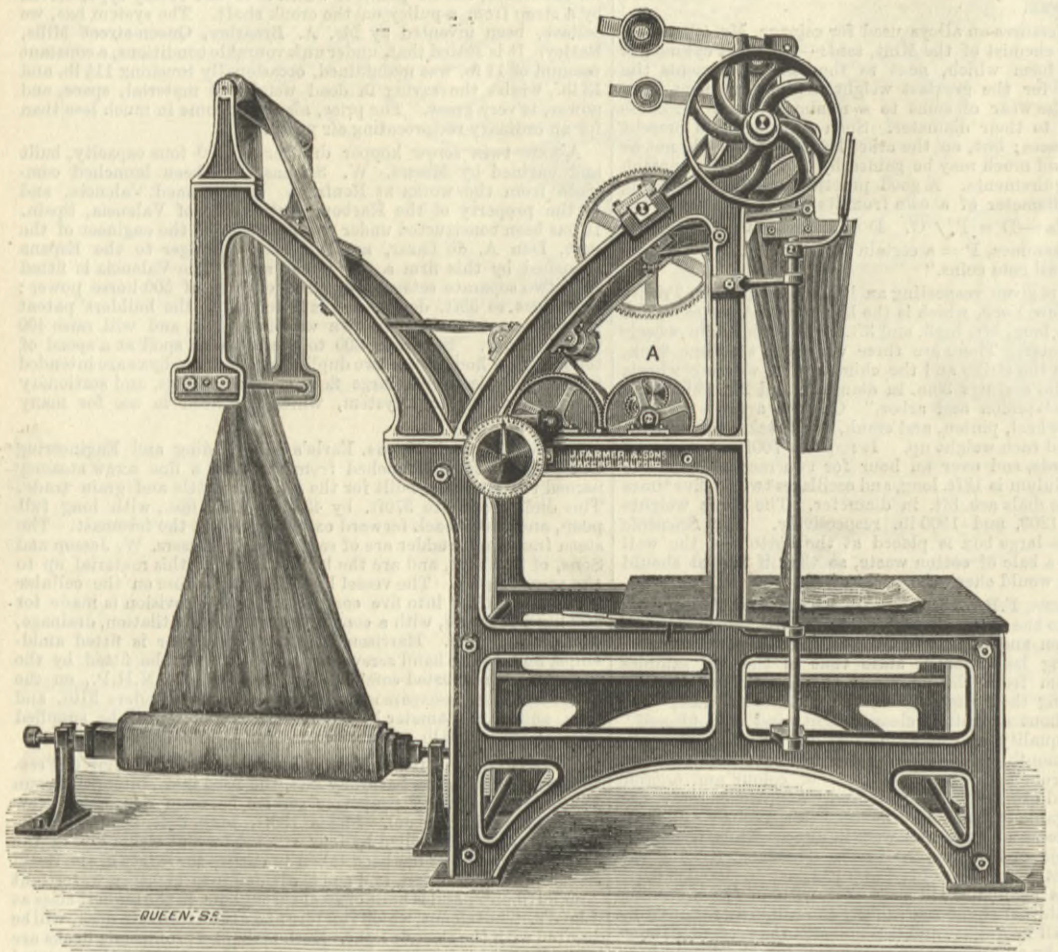
The new arm for the Swedish field artillery is an 8·4 centimetre steel breech-loader by Krupp, firing a shell weighing 6·7 kilogs., of which 0·24 kilogs. is explosive charge, with a charge of powder of 1·5 kilogs., at an initial velocity of 470 metres. The shrapnel and the case shot are almost as heavy, the former containing 135, the latter 192 balls. The gun barrel weighs 458 kilogs. Each battery, the American *Army and Navy* journal says, consists of six guns, eight ammunition and five baggage wagons, carrying 888 projectiles—that is, 148 charges per gun, of which fifteen shells and shrapnels and two case-shot are with the gun, and the rest in the ammunition wagons. For arming siege batteries, 12 centimetre guns and 15·5 centimetre howitzers have been experimentally introduced. Of the former arms, twelve of cast steel have been supplied by Krupp, the shell of which, weighing 16·8 kilogs., has an initial velocity of 475 metres. Other twenty-five guns have been manufactured in Sweden of cast iron with steel hoops. A 12 centimetre gun and a 15·5 centimetre howitzer have been made of Martin steel at the Bofors Works. Krupp has also supplied eight 15·5 centimetre steel howitzers, and another one of cast iron with steel hoops has been manufactured at home.

Signor Gabelli, civil engineer, has published, in a recent official report, his ideas on uniting the Island of Sicily with the Italian peninsula by means of a tunnel. The first thing to be considered, according to Signor Gabelli, is the conformation of the sea bottom at the straits, and he states that it is beyond all doubt that in a south-easterly and north-westerly course, starting from Pizzo, on the coast of Calabria, and ending at Sant' Agata, on that of Sicily, exists a submarine chain of mountains separating the basin of the Mediterranean from that of the Adriatic. The sides of these mountains are very steep; in fact, while the crest of this ridge is only 110 metres under the surface of the sea, at two kilos. away from it the depth attains 260 metres; in front of Messina it is 340 metres; and in the offing of Reggio, 657 metres. The course of the contemplated tunnel is therefore clearly established from these hydrographical conditions. It only remains to be seen whether the nature of the soil is sufficiently solid and compact for the purposes required. It was necessary to ascertain the exact formation of the rock to be pierced, and on this point geologists differ. The tunnel, according to Signor Gabelli, would be 13,546 metres from end to end; cost 70,000,000f., and would take, if everything went smoothly, five years to complete. The question then becomes, would it pay, and would any company undertake a work of such magnitude with such a little knowledge of the difficulties to be encountered?

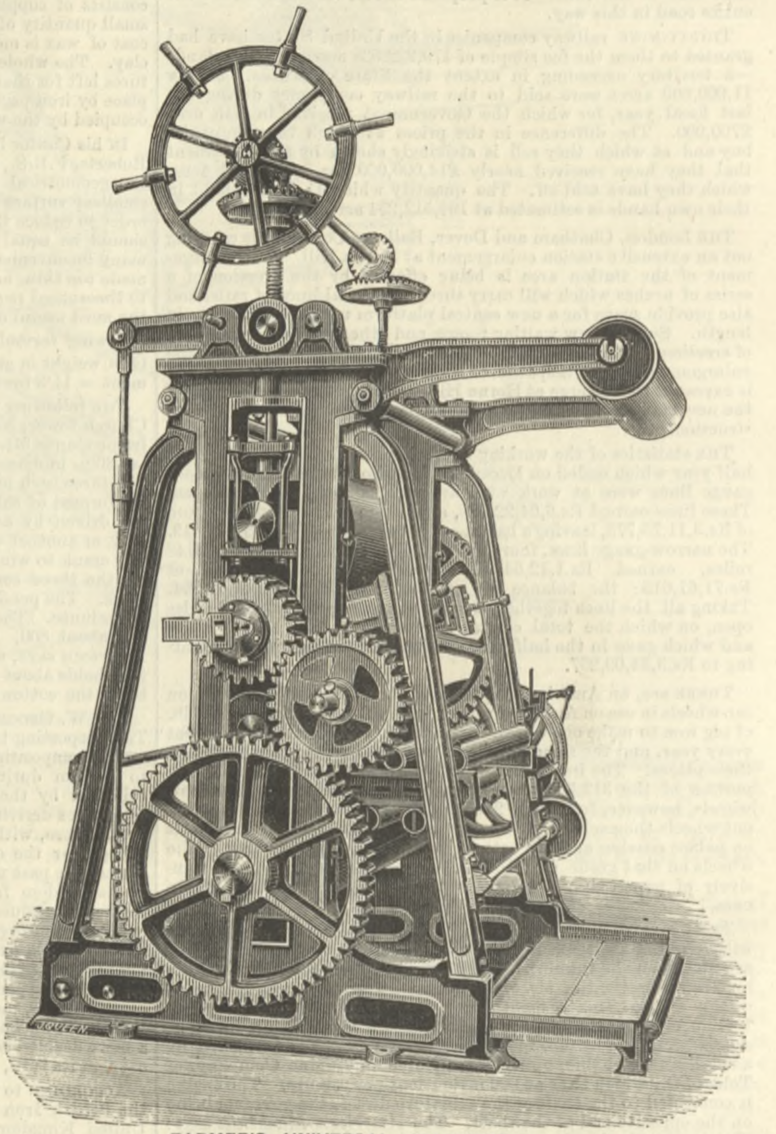
MACHINERY IN THE TEXTILE EXHIBITION, ISLINGTON.



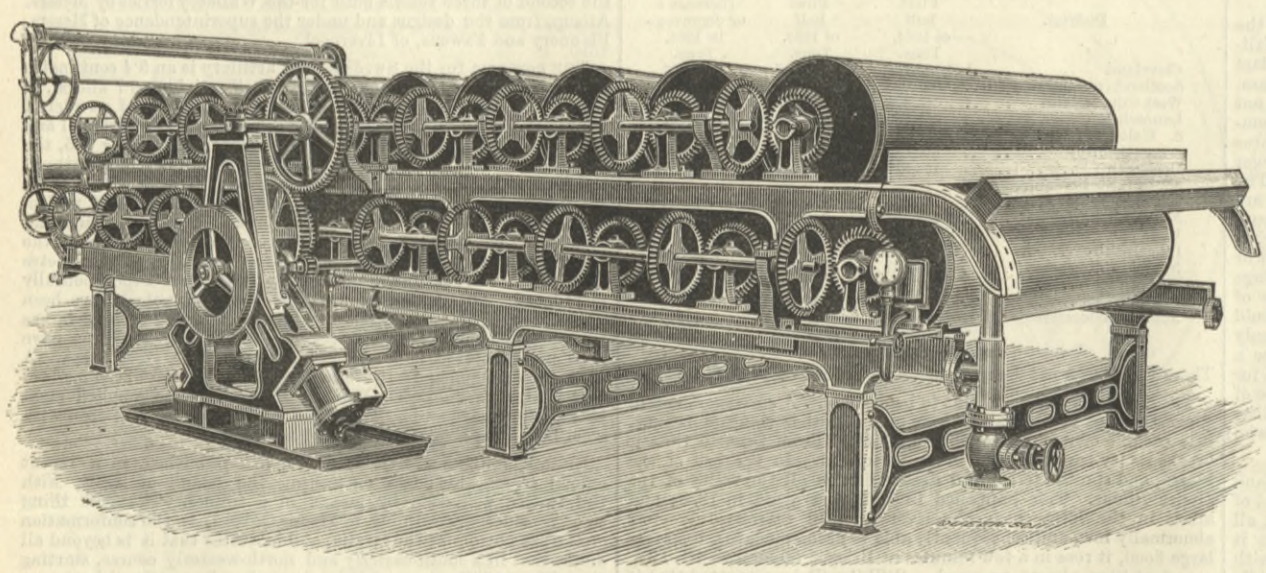
FARMER AND LALANGE'S SCOURING AND DYEING MACHINE.



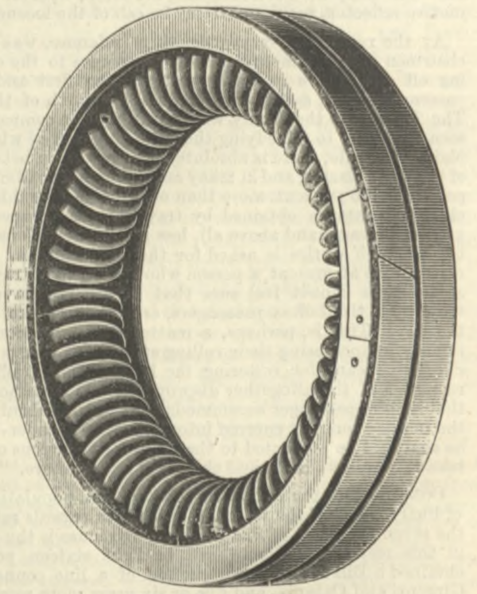
FARMER'S MEASURING MACHINE.



FARMER'S UNIVERSAL CALENDER.



FARMER'S DRYING MACHINE.



TONGE'S PISTON.

THE TEXTILE EXHIBITION AT THE AGRICULTURAL HALL.

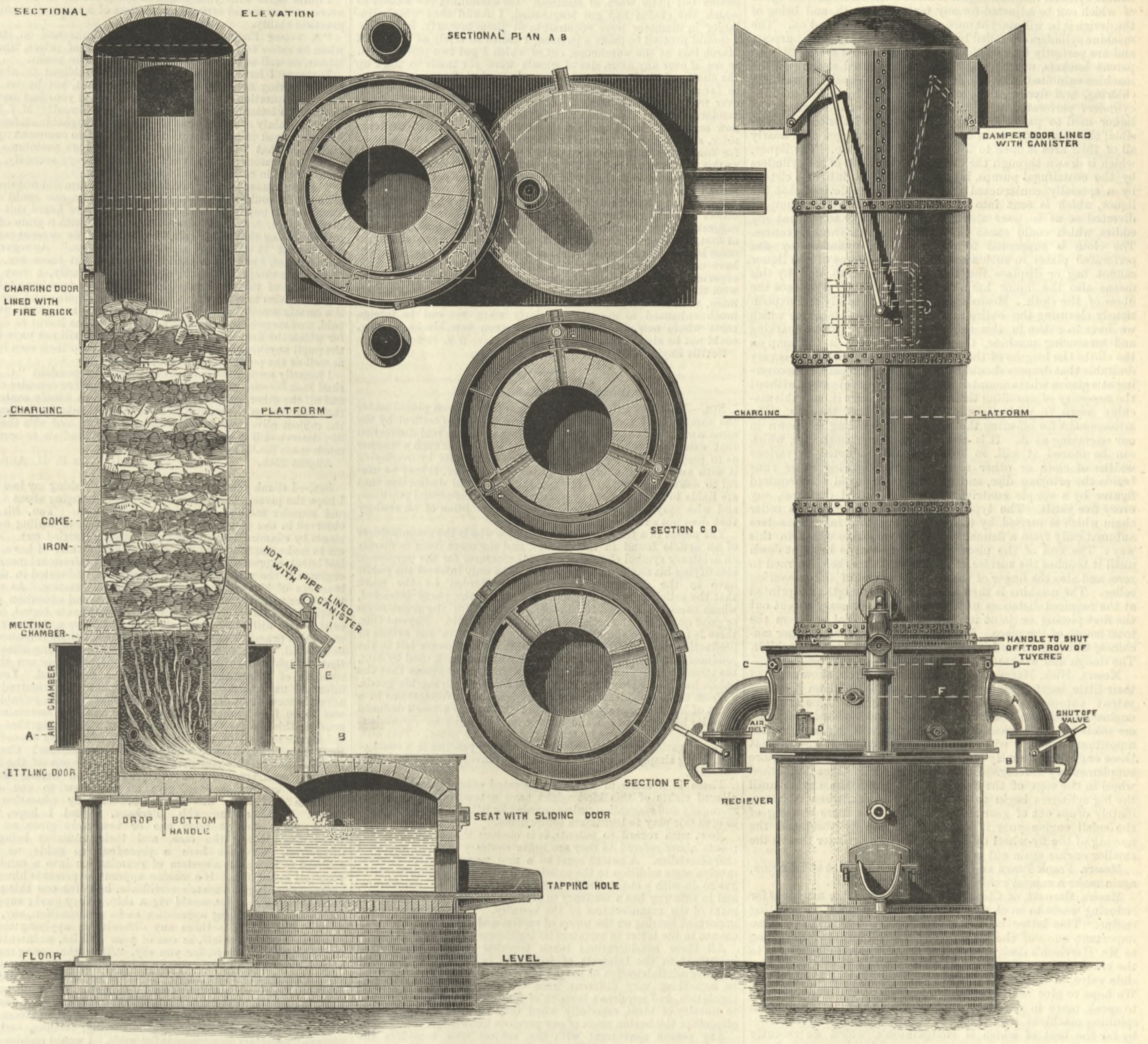
It is difficult, if not quite impossible, to imagine what commercial object is attained by the Exhibition now being held, under the above somewhat uninviting title, at the Agricultural Hall, Islington. Any exhibition fails or succeeds in the direct ratio of its popular interest, for few promoters are covered as to their risk by the rent which has been paid for space or for the pages of advertisements in the catalogue, and are therefore absolutely dependent on the shillings which are taken at the gates. The catalogue itself, unless it has been liberally patronised by advertisers, will not pay its expenses without a good sale, a sale which can only be secured by the presence in the exhibition of a large number of visitors; and, again, the exhibitors can only hope for a return of the great outlay incurred by them through the popularity of the show, which attracts not only the few who are directly interested, being of the same trade, but of the many who, in speaking of what they have seen, induce others to go, who spread the names of exhibitors abroad; and it is this spreading of names which gives firms their reputation and brings them business. In carrying out any exhibition it is imperative that it should be thoroughly advertised; advertised not only in newspapers, but by means of circulars and by agents who make it their business to call on all whom such an exhibition may concern. We know of an exhibition held in London last year, the management of which was in the hands of a gentleman who thoroughly understood advertising in its best and most inviting form, and irrespective of agents and the work of his own office, he sent out nearly one and a-quarter millions of circulars from the offices of a firm whose business it is to direct such communications. No trouble was spared nor money grudged to make it a success; but the exhibition did not take the popular taste, and therefore failed, insomuch as that it did not recoup the management for its great outlay.

The Textile Exhibition, so far as we can learn, has been very poorly advertised, even members of the trades to which it specially appeals being to a great extent ignorant of its existence. It is really an Exhibition which should have been held in Manchester, around which centre all who are interested in the textile trades, not in London, where there are so few who know anything about the machinery employed in the great industries of Lancashire and Yorkshire. The preface to the catalogue tells us that it "is the first Exhibition of its kind which has been held in the metropolis; that Lancashire and Yorkshire manufacturers

STEWART'S "RAPID" CUPOLA.

MESSRS. THWAITES BROS., BRADFORD, YORKSHIRE, ENGINEERS.

(*For description see page 165.*)

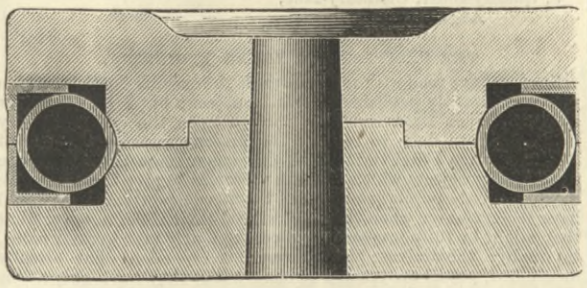


will find much in the Exhibition that will interest them, and it is believed that a large number of continental and colonial buyers will visit it." We are inclined to think that promoters of exhibitions have hitherto rather shown their wisdom in refraining from holding such an one. As nearly all the exhibits came from Lancashire and Yorkshire, we hardly see why manufacturers should come to Islington to be interested; and if colonial and continental buyers visit this country they would consult their own interests better by visiting the works of Manchester and its district than by going to the Agricultural Hall.

On the occasion of our last visit the line of shafting on the left of the Hall had through some oversight broken down, and the machines to be driven by it were inactive, while exhibitors on the right of the Hall, who expected to be driven from the shafting at their side, were calmly and patiently waiting the application of the motive power to the shafting, and were cynically doubtful as to whether they could get to work during the run of the Exhibition. The majority of the exhibits in the centre of the Hall were covered up, though it was the afternoon, and the number of visitors would certainly be included within ten; indeed, the only activity in the place seemed to be displayed by a female attendant with a new patent match-box, who asked us if we had seen this; by a foreign lady who was most anxious to sell us a wonderful cork-screw; and by the attendants at a stall on which perambulators with wax babies in them were being displayed. It may perhaps be unreasonable, however, to expect exhibitors to be energetic to the visitors with the thermometer at 85 deg. A little later in the afternoon, however, the Tower spherical engines were at work, and machines were running on all sides; but though the Hall seemed to wake to life, the visitors still remained an absent quantity.

The catalogue numbers the exhibitors up to 200, but as many of them are given two numbers for one stand, it does not follow that 200 firms are represented; further, in several cases the same firm makes two or more exhibits, and if it be taken that about 160 firms in all are represented, we shall be about right. Of these many are well known, and have gone to a great deal of trouble and considerable expense to make the Exhibition a success, and we can only regret that they are not likely to be considerably rewarded for their pains. Quite half the exhibits are to be shown in motion, power being supplied either from the line shafting at either side of the Hall, which is driven by a couple of Tower spherical engines, or by gas engines in the central part of the Exhibition.

The first exhibit we came to is that of Messrs. Lancaster and Tonge, of Pendleton, near Manchester, and in it we notice particularly the Lancaster steam trap, which have been previously illustrated in this journal. These traps have been improved and simplified during the last year by the employment of a quadrant which enables the trap to be pulled to pieces for examination, and to be fitted up again in a few minutes; they have also been improved by the use of an automatic air valve. These traps may be seen at work at the stands of Messrs. Farmer, Heenan



LANCASTER AND TONGE'S PISTON.

and Froude, Cooper Box and Co., and Frank Pearn, where they are acting with regularity and efficiency. The same firm also show their patent spiral spring piston, which indeed forms one of the main features of the exhibit, and which we illustrate. As will be seen from the engraving, the motive power is a straight spiral spring, diametrically forced into the usual rings. Messrs. Lancaster and Tonge claim that this piston differs essentially from any other in that the vertical is obtained from the lateral pressure and not *vice versâ*, thus obviating any chance of the rings being forced too hard against the side of the cylinder by screwing down the junk ring, and they are perfectly self-adjusting. They certainly give very good results in a small engine and pump in which they are working at this stand. This firm also exhibit their vibration lubricators, which are at work on the line shafting, and various other engineering specialties.

Messrs. Tinker, Shenton, and Co., of Hyde, Manchester, show some of their "Hyde duplex boilers," which are supplying a portion of the steam being used in the Exhibition. They are vertical compound boilers, if we may use the expression, the flame and heated gases being carried from the fire-box by means of a short vertical tube at the top—back—into a horizontal flue which runs from back to front of the boiler; this flue in turn discharges into an egg-shaped combustion chamber at the front of the inside of the boiler, and from which chamber a large number of horizontal tubes pass into the smoke-box which is at the back of the boiler. Messrs. Wm. N. and R. Dack have carried out a series of experiments to test the evaporative efficiency of these boilers, the results being extremely satisfactory.

One of the most extensive exhibits is that of Messrs. James Farmer and Sons, of Salford. Indeed, this firm has gone to a great expense in sending to and fitting up in the Exhibition a quantity of heavy machinery. The exhibit consists of a Universal calender, drying machines, patent creasing, measuring, and marking machines, and apparatus for bleaching, washing, chloring, scouring, soaping, dunging, and dyeing woven fabrics. The purpose of the Universal calender is to enable limited quantities of goods to be finished in various ways without requiring different machines. The machine consists of suitable framing, to which is attached all the requisite stave rails, batching apparatus, compound levers, top and bottom adjusting screws, and level setting down gear, also Stanley roller with all its adjustments. It is furthermore supplied with chasing arrangement and four bowls; the bottom one is of cast iron, with wrought iron centre; the next is of paper or cotton; the third of chilled iron fitted for heating by steam or gas, and the top of paper or cotton. By this machine are given such finishes as are known as "chasing finish" when the thready surface is wanted; "frictioning," or what is termed "glazing finish," "swigging finish," and "embossing finish;" the latter is done by substituting a steel or copper engraved roller in place of the friction bowl. This machine is also made to produce the "Moire lustre" finish. The drying machine consists of nineteen cylinders, arranged with stave rails and plaiting-down apparatus. These cylinders are driven by bevel wheels, so that each one is independent of its neighbour, and should any accident occur to one or more of the cylinders or wheels, the remaining ones can be run until a favourable opportunity arrives to repair the damage. A small separate double-cylinder diagonal engine is fitted to this machine, the speed of which can be adjusted for any texture of cloth, and being of the design it is, will start at once on steam being turned on. The machine cylinders are rolled by a special machine for that purpose, and are perfectly true on the face. Their insides are fitted with patent buckets, which remove all the condensed water. In the machine exhibited, which is designed for the bleaching, washing, chloring, and dyeing, the cloth is supported by hollow metallic cylinders perforated with holes and corrugated to allow the liquor used to pass freely through as much of the cloth as possible; the open ends of the cylinders are so arranged that nearly all of their area is open to the action of the pump. The liquor, which is drawn through the cloth into the inside of the cylinders by the centrifugal pumps, is discharged back into the cistern by a specially constructed discharge pipe, so devised that the liquor, which is sent into it with great force by the pump, is diverted so as to pour straight down in order to prevent any eddies, which could cause the cloth to wander from its course. The cloth is supported to and from the cylinders by flat perforated plates in such a manner that the force of the liquor cannot bag or displace the threads of the cloth, and by this means also the liquor has a further tendency to penetrate the fibres of the cloth. Means are provided for readily and expeditiously cleansing the entire machine. The next machine which we have to notice in this exhibit is Farmer's patent marking and measuring machine, the purpose of which is to stamp on the cloths the lengths of the same at regular distances. It is very desirable that drapers should have some simple means of discovering at a glance what amount of material they have in stock without the necessity of unrolling their cloth to measure it, and this machine seems to perfectly meet the demands of the case. The arrangement for effecting the printing and inking is shown in our engraving at A. It is contained within a small disc, which can be moved at will, so that it can be adapted to various widths of cloth or other material. A measuring roller runs beside the printing disc, and on this is stamped the required figures by a simple contrivance at the desired distances, say every five yards. The types are linked together into a roller chain which is carried by the disc A, and they ink themselves automatically from a flannel pad. The machine works in this way: The end of the piece to be measured is brought down until it touches the surface of the table, the marker is turned to zero, and also the finger of the dial on the end of the measuring roller. The machine is then started, and the lengths are printed at the required distances until it becomes necessary to cut out the first piecing or joint in the fabric. The dial registers the total length of the piece. Messrs. Farmer show many other machines, which go towards making up a fine and handsome exhibit. The design and workmanship is of the highest order of merit.

Messrs. Hick, Hargreaves, and Co., of Bolton, show some of their little barring engines, and some of Mr. William Knowles' patent automatic supplementary governors. The barring engines, which are admirably designed and finished machines, are made for the purpose of turning heavy mill engines into such a position that they will readily start, for it is well known that these engines frequently stop in such a way as that they require supplementary moving. The barring engine engages its toothed wheel in the cogs of the fly-wheel, and turns the engine until the big cylinders begin to do their own work, when it immediately drops out of gear automatically. The mere starting of the small engine puts it into gear on the fly-wheel, and the moving of the fly-wheel by means of its own cylinder throws the smaller engine again out of gear.

Messrs. Frank Pearn and Co., always to the front at Islington, again make a capital exhibition of their specialities.

Messrs. Garnett, of Cleckheaton, show some fine machines for reducing waste to wool, which are driven by a little oscillating engine. This latter is one of the features—though small, an important one—of the Exhibition; it is constructed according to Mr. Harrison's design, inverted, the piston-rod coming on to the crank. Steam is admitted to the cylinder by means of a slide valve, in which friction has been reduced to a minimum. We hope to give some diagrams from one of these engines, and to speak more in detail of it at another time. A few cotton spinning machines, sack hoists, ventilators, mechanical stokers—by far the best of which is Hodgkinson's, which we recently illustrated, and spoke of very favourably — an "Influx" injector, recently illustrated in our columns, and Gunnell's automatic fire-extinguisher, both of which will be found in the exhibit of Messrs. Mather and Platt, No. 2, are the only remaining exhibits of interest in an otherwise most uninteresting and unsuccessful exhibition.

LETTERS TO THE EDITOR.

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

CHAIN PULLEY BLOCKS.

SIR,—You kindly inserted in THE ENGINEER two letters and illustrations from me some months ago, the first making it known that I had made an addition to the variety of chain blocks, having the chain passed on and off the wheels through guides; and the second as having applied guides to the chain of the old common Weston's. And now I would ask you for space for a third, to give my twenty years' experience in the working of these useful appliances, chiefly from purchaser and user's point of view, and also the economy that can be applied to them in the course of tear and wear. Some fourteen years ago I came by a pair of Weston's that had been a short time in use, the chain links had just got to the period of wear to nicely fit one another at the inner ends, and the wheels looked at their best; but on trying them to lift even less than half the weight they were given out to do, the chain could scarcely be pulled on over the teeth of the largest wheel. On looking at the wheel and chain closely, I came to the conclusion that all that was wanted was a new wheel $\frac{1}{4}$in. larger in diameter, and accordingly ordered one, and when it came to hand and put to work, found it to be very little easier to lift with than the old one. I had the calibre of it taken and compared with the original, and saw that the new wheel was just a cast off the same pattern as the first. I thereupon re-ordered a wheel for certain to be $\frac{1}{4}$in. or $\frac{5}{16}$in. larger than the first, and after waiting several weeks, was told that no such thing as a second larger size of wheel was made for any size of blocks, and was told that the best way was now to get a new chain, then they would be like a pair of new blocks. The old chain could be cut up for some useful purpose. But I could not brook this very kind advice, and set about getting up a pattern myself of the required diameter, got a cast off it of as hard iron as would bore out in the centre, and so I got out of my trouble in this case by helping myself, and the same blocks are doing an occasional lift yet; but several years ago I had to get up a second larger wheel to suit the lengthened pitch of the chain.

By the circumstance of chain links when first put to work getting much more quickly worn at the inner ends than they do after the whole link end surface is bearing, the wheel and chain soon get away from the pitch of one another; the chain getting longer and the wheel smaller, and consequently shorter in the pitch, and so they get antagonistic by degrees, and at length almost refuse to lift at all. For some years past I have had several repairs of 2 ton blocks bordering on this state, and all of them with the chains but little worn or strained. On examining the extent to which the chains had got lengthened, I found that wheels $\frac{1}{2}$in. larger in diameter were required to fit them properly, but before I should proceed to make a pattern, I called so lately as the 3rd of March last at the warehouse, out of which I got two pair of them to see if ever any extra size of wheels were yet made to work up the chains of blocks, so far as safe to do so, but was assured that so far as was known to them, no second extra size of wheels were ever made, and then came the old story from manufacturers' and vendors' point of view, that the best and sure way was to purchase new ones, &c. But I thought that I would take my time and consider, so I set the pattern-maker to work again and got wheels cast for four pairs, but those two pairs I put the guides on work best, as the chains never got hurt from getting jambed afterwards, and I have no doubt but they will do as much good service with the second wheels as they did with the first.

As economy and durability in chain blocks may be looked to by others who have to buy them as well as myself, I would make the suggestion that they should all be fitted out with a second wheel at first, the largest one to fit the chain when it comes to be troublesome to pull on the teeth of the first. The chain at this point will have come to the best time of its usefulness, and from my little experience and knowledge of them, I believe they will do more with the second wheel than they have done with the first; furthermore, with a second wheel the value of chain blocks would be very much enhanced to users, particularly when set out to foreign parts where new wheels or chains, or even new blocks possibly, could not be always got when required. WM. ROBERTSON.

Seville Engineering Works, Dublin,
August 11th.

PATENTS AND TRADE MARKS.

SIR,—Now that patents and trade marks have been placed under the same Act of Parliament, and made subject to control by the same authority, there may be some danger of the real distinction that exists between them becoming lost sight of in such a manner as to prejudice the legal administration of patents by overlaying it with an excess of officialism. I think, therefore, it may be useful to draw attention to a few points of essential distinction that are liable to be overlooked by some who occupy influential positions, and who may be disposed to act on the assumption of an analogy that does not exist.

The object of a trade mark is to indicate who is the manufacturer of an article found in the market, and the mark itself is merely an arbitrary symbol chosen by the manufacturer for the purpose of identifying his name with the article. The only interest the public have in the matter is the security afforded by the mark that the article is really the manufacture of the party intended, whose name is supposed to be some guarantee for the genuineness or good quality of the article manufactured or sold. Beyond this, there is nothing to show value or improvement in the article or production, it is only to be inferred from the confidence felt in the producer; and the greater the antiquity of the mark used by him, the stronger is the inducement to trust to it, as evidence that the public have for a long time been in the habit of buying his goods.

From these considerations it will appear that investigations in a court of law will merely turn on the right to use a mark deduced from its history, and on the evasion of the right by fraudulent imitation of it, and thereby trading on another's name. This kind of investigation is such as belongs to ordinary practice in a court of law, being simply an inquiry into fact not involving any technical question.

There is a sense in which exaggerated official recognition of alleged rights of this kind might have a tendency to promote monopoly and stagnation unless guarded by judicial decisions, so as to give fair play to legitimate competition.

Now, with regard to patents, it is obvious that in many of the points above refered to they are quite contrary in their essential characteristics. A patent must be a new manufacture. It must involve some addition to the existing stock of public knowledge. It has to do with a change in the intrinsic character of a manufacture, and in this way has a tendency to promote the growth and improvement of the manufactures of the country. It has, moreover, an important bearing on the union of capital and labour, and gives a chance to the latter to maintain its legitimate independence.

All these considerations taken together serve to show how important to the interests of society it is to have a good and effective administration of patent law. This administration must be something very different from the exercise of mere official regulation, and requires a breadth of treatment that will do justice to novelty of ideas, especially when they surprise us by leaving altogether the beaten track of our previous knowledge.

Any person conversant with the subject who considers the various provisions in the "Patents, Designs, and Trade Marks Act, 1883," must see how much effort has been made to enable the inventor to put on record the exact particulars of invention which he is entitled to claim as secured to him by law, and, on the other hand, it will be seen how much has been done to enable the public to test the legitimacy of the inventor's claims—at least, so far as regards individuals specially entitled to be heard, and to prevent the public from being taken by surprise.

It will thus be seen that much technical investigation will be thrown on the courts of law, and many abstruse points will have to be determined in adjusting the rights of patentees and the public, respectively, on the several points raised by the provisions of the new law. For this reason it appears to me advisable just now, when we are about entering on the real work of the Patent-office—by dealing with complete specifications—to draw attention to the special characteristics of patents in distinction from trade marks. WILLIAM SPENCE.

8, Quality-court, Chancery-lane,
August 21st.

THE PROSPECTS OF YOUNG ENGINEERS.

SIR,—I have read with much interest the excellent articles which you have recently published on this subject; but I consider that although much light has been thrown upon the question, very little has been done to remedy the present lamentable state of affairs. When I first started the discussion some time back, one of the many objects which I had in view was to give those who are at present only pupils some idea of the struggles which they would have to encounter when they had served their time, in order that they might be fully prepared, and consequently take greater pains, to qualify themselves; for as one correspondent has already mentioned, pupils are trained to believe that they have only to be able to say that they have served so many years with such a firm, who will give them a good character—or, perhaps, advertise to that effect—and they will receive an immediate appointment. But, alas, how soon they are doomed to disappointment! However, "Forewarned is forearmed," and I venture to hope that some will have learnt a lesson from the correspondence which has taken place.

I could not help feeling somewhat amused, on reading your article of August 15th, to find that "as no young man had written to say that he knew exactly what a mechanical engineer ought to know, and lacked work," you seemed to think it a proof that no competent man was out of employment; but I should like to ask you if you really expected that any good man would "sound his own trumpet" in such a fashion. As a matter of fact, is it not the case that those who talk such a lot about what they know usually know the least? and I think I am perfectly correct in stating that a man's bluster varies inversely as his abilities; and for any man to have the presumption—for such it would be—to write to a newspaper and assert that he knew all that a mechanical engineer ought to know, would be mere bluster. Moreover, I contend that no young man could truthfully make such an assertion, because it takes a man years and years to learn "just what a mechanical engineer ought to know," and by the time he has finished learning, or thinks he has, he is an old man.

I quite agree with your remarks about examinations for engineers, as they would certainly be no test of a man's ingenuity and practical ability.

"A Young Engineer" has decidedly hit the nail on its head when he refers to young engineers' ignorance of prices, time, and labour, as well as their inability to take notes in works.

Hitherto I have, except when absolutely obliged to, abstained from referring at any length to the worn-out, but by no means remedied, question of premium pupils; but in your last issue you published a letter by a correspondent signing himself "M. I. M. E.," which certainly contained one of the most laughable statements I have ever read in my life, and I feel obliged to comment upon it. He stated that "he knew firms who took high premiums—£700—for two reasons: firstly, to keep pupils away; secondly, to pay for time lost in giving them a special training."

The first reason is really too funny. If a firm did not desire to take pupils, could they not say so? Surely no one could compel them to take pupils against their will. I have heard this excuse made before, but have always taken it "with a grain of salt," fully believing that the people who have told me so most certainly believe that "a bad excuse is better than none." As regards the second cause, I can understand that better; but there are, nevertheless two things to be said against that: firstly, a very small proportion of the firms who do receive large premiums take the slightest pains to spend any time with their pupils; and secondly, if a certain amount of time be lost in training the pupils, it is repaid, and more than repaid, when the pupil has learnt to do work for which the firm will get a good price, and will not have to pay the pupil anything for his services. Thus it is to their own interest as well as the pupil's, to teach him properly.

I heartily second the opinions of your correspondent "C.," and shall look forward to his second letter. I further consider that he and all the other correspondents who have so kindly contributed their remarks on the subject deserve many thanks for having kept the subject alive, and not allowed it to flag; and also that you, Sir, deserve still more thanks for having allowed us to occupy so much space for this most important subject.

August 25th. CLAUDE E. H. AUDAIN.

SIR,—I thank you for your courtesy in publishing my last letter. I hope the present discussion will result in bringing about a better and sounder method of training young men. You, Sir, have observed in one of your leaders that a system of testing acquirements by examination cannot be practically carried out. Permit me to make the following observation about this:—I have, in my last letter, expressed the opinion that a true professional mechanical engineer is the man who is thoroughly well educated in the two branches of his business, viz., theory and practice. As regards theory, excellent means both of gaining a sound education and of having the extent of the student's requirements tested, already exist. You will admit this. As regards testing a student's information on practical subjects by examination, I think this also might be effected. Indeed, a little experience of a drawing-office shows that it might; any chief draughtsman speedily finds out the real measure of information possessed by a new hand. You have informed us that recently over 200 replies were received to an advertisement for a draughtsman, and that not one suitable man was to be found amongst them. How was this ascertained? I consider this is a very important question. Assuming that 150 of the letters showed in themselves a lack of English education on the part of the writers, what about the remainder? Can it be possible that in this year of grace, 1884, every one of the letters betrayed such ignorance on the part of their writers that the advertiser could not even give an interview to one or two of them? If such was the case, certainly education must indeed be at a low ebb. Perhaps, indeed I hope, I am wrong, and that at least one or two were given an interview. Such being the case, and their unfitness being thus discovered, we have here a precedent to guide us in an attempt to formulate a system of examination into a candidate's practical knowledge. If a marine apprentice presents himself for examination, to get a mate's certificate, he is for one thing called on to describe how he would rig a ship. Very good; suppose a mechanical engineering apprentice seeks examination, say, in the second-class grade, is there any difficulty in applying the same principle? You yourself, in one of your articles, unintentionally suggest how to apply it, for you say, "Take the young man into a yard, show him a fly-wheel," &c. I would apply the examination test on nearly the same lines. I would request the candidate to design a fly-wheel, so many feet in diameter, to weigh so many tons, to give the mixture to be put in the cupola, and its quantity; to generally describe the processes of making the pattern for it, the wood used, &c.; to describe the casting, fettling, and other processes necessary to prepare it for work. I would require him to state the safe maximum speed at which it could be run without bursting the rim, giving him a margin of safety constant. The same operations to be performed as regards a steam cylinder of given diameter and stroke, calling on him to design it complete, and describe all other operations connected with its manufacture to fit it for work, and to give cost of each of the arts applied to it; time spent on drawings, on pattern, on casting, fettling, boring, facing, &c., and total first cost, adding also the usual trade additions for other expenses, and, finally, percentage for profit.

In order to obtain the necessary education in a works to prepare a young man for such an examination, I would seek out a really good firm, willing to take premium pupils, and I would propose as follows: That my son be trained during, say, three years, to qualify him to pass a second-class examination before the proper body; a certain sum to be paid as premium whether he passed or not, and a certain other sum or bonus to be paid only if he passed. If the pupil passed this first examination, and desired to gain a first-class certificate, let him return to these works, or, if expedient, go to others, to acquire a knowledge of a chief draughtsman's or works manager's duties, and again present himself for examination, the same method of paying premium being pursued. Employers would quickly find out the value of certificated men, and would employ them in preference to those who failed to pass. This would tend to prevent pupils purposely failing to pass, so as to escape paying the bonus, though I imagine there are few so dishonest as to attempt it in any case.

A correspondent of yours, "M.I.M.E.," writes in a rather abrupt and discourteous style, and his feeling of anger seems to have spoilt his reasoning powers, for he says that firms ask premiums merely to deter parents from seeking to apprentice their sons. It is a free country, and I am not aware of the existence of any law compelling a firm to take an apprentice. He tells us that one firm charges £700, and it does so in order to cover time lost in teaching, and to pay for work spoilt. He, in the same letter, speaks of a firm in the North which takes pupils without any premium. I confess this sort of reasoning is beyond me. The routine of work is much the same everywhere. If, then, one firm cannot receive an apprentice without £700 to cover expenses entailed, how is it that another firm can afford to take him without any premium? My own interpretation of "M. I. M. E.'s" meaning is—and I give it subject to his correction—that the £700 firm does not know how so to train a man as that he will speedily become in himself useful and profitable to it, and the firm in the North does know.

"M.I.M.E.'s" reasoning is weak in another way also; he protests against any one supposing that an engineering works is a training school. "No one," says he, "has time to teach." And in the same letter he tells us of the £700 firm. Perhaps he means that that firm gets so little business that its staff has time to teach, and perhaps its need for £700 to perform what another firm can do for nothing explains why it gets so little business. I write, of course, subject to correction, from "M.I.M.E." I have had a good deal of works experience myself. I have, of course, been a pupil. I have been a leading, and a chief draughtsman, and I confess I fail to see what difficulty there is in teaching pupils. In my last letter I expressed the opinion that it was not essential for any one proposing to become a mechanical engineer to become an expert fitter or smith. In my opinion, the drawing-office is the true school so long as the apprentice has access to the workshops, and is allowed to ask questions of the men, and to go about with note-book, rule, and callipers. It is not that there is no time to teach; every time a new hand comes on he has to be taught, and taught a good deal, too, because the class of work will be strange to him, the existing patterns available for adoption, what drawings he is to refer to, where they are kept, and divers other matters are and must be told him; and as he is drawing wages, the sooner he is taught the better. The chief draughtsman must make time for this, for he will be expected to turn out just as many drawings as if the new hand was an old one.

The root of the evil of the system of premium apprentice, is that once the premium is paid, there is no longer a motive to do anything with him, save to keep him out of mischief by keeping him in as much ignorance as possible. No doubt the heads of the firm are, in most cases, honest, well-meaning men, but from the nature of their own avocations they cannot personally train the apprentices. Yet they get all the money. The real trainers are, first, the chief draughtsman; and after him, in a lesser degree, the various foremen, not forgetting the works manager. These get no part of the premium, however. I am decidedly of opinion that all who share in training the apprentice should share the premium, and I would pay the shares on the bonus system I have described.

Complaints are common that good draughtsmen are not to be had. Would it not be to the advantage of firms to train their own men? I will, perhaps, be told, "Oh! if we train men, they will leave us when trained, to seek better places, and they will deprive us of the fruits of our instruction, and also expose our trade secrets elsewhere." My reply is that, as a rule, firms can keep their men by giving them fairly good pay. The very argument, I anticipate, shows in itself that the apprentice when trained is worth more to his trainer than to any one else. Besides, even if the young man does go elsewhere, why the system is an all-round one, and if A's trained man goes to B or C or D, then either of these last will probably lose a man of theirs who will go to A.

In the present dull state of trade, coupled with the anxiety of parents to have their sons really taught, might it not be worth a firm's while, if it cannot teach otherwise, to open a regular pupils' office, and put it in charge of a competent instructor, premiums being paid as I have suggested, and thus really add a profitable branch to its usual business. When a salaried draughtsman left it, another could be taken from the "school." Any young man thinking of adopting mechanical engineering as a pursuit must make up his mind, unless he have either capital or influence, to win his bread as a draughtsman for the earlier years of his life, even as the man who goes into the Church has to work for a long time as a curate. In the present wretched state of half information prevailing amongst the general run of draughtsmen, they, as a body, really possess little social standing. They may struggle to be thought gentlemen, struggle to be received as professional men, but I fear that in the majority of cases they are regarded as little better than fitters. A better system of training, better pay, and the elevating moral influences attendant upon these, will exercise a refining effect on them as a body, and will bring them, I hope, that social consideration which the nature of their duties really deserves. It will tend to weed out those who are unfitted for the profession, and to elevate the tone of mechanical engineering itself. C.

August 26th.

SIR,—I have followed the discussion in your columns on the "Prospects of Young Engineers" with much interest, but hitherto it has practically been confined to the training and prospects of mechanical engineers; it is on that of civil engineers that I would, with your permission, say a few words. If a man is to succeed as a civil engineer—and by succeeding I mean build up an independent and lucrative practice—he must not only acquire a knowledge of the branch of engineering he takes up, and be able to design, estimate for, and carry out works satisfactorily, but must also have a knowledge of men, the power of impressing those with whom he has to deal with his own fitness, and the ability to put his ideas forward in a taking guise. Professional knowledge is partially acquired during pupilage, but those who have had the advantages of a liberal education are probably better able to deal with men, and have more knowledge of the world than others. Where possible, therefore, I always advise that the ordinary course of education should be completed, rather than that a lad should be articled early in life, or passed through a technical college.

The system of pupilage is in my opinion well adapted to its ends; nor do I think the strictures passed by some of your correspondents on those who take pupils are, at least on the civil side of the profession, as a rule deserved. In my experience an engineer does not take pupils unless he has work. It is clearly the master's interest that the pupil should become useful as soon as possible. To do this he must go through the drudgery of the profession, that is, tracing and drawing, before going on works. One must walk before one runs, and although such work as an ordinary pupil does for the first year of his articles could be better and more expeditiously done by a low paid draughtsman, the pupil's time is by no means thrown away. With the knowledge gained in office, a pupil will be able to appreciate what he sees in practice, to learn field work, and to become useful as an assistant. What a pupil learns during articles must depend on himself. No engineer can be expected to act as a crammer. All that can be done is to give opportunities and instruction when required. If a well-educated man—and no other to my thinking should set up as an engineer—goes through articles without obtaining a fair professional knowledge, it is probably his own fault.

But after passing articles, what chance is there of obtaining work? Small, I fear, if a man is dependent on his earnings; to such I should say, eschew engineering! Engineers seldom want high-class assistants. They want accurate surveyors, levellers, and good draughtsmen, and such can be got in plenty for from £60 to £100 yearly, or, taking board into account, at about a cook's wages. For a clerk of works' post, which is excellent training, there are always many applicants; for town surveyorships, with salaries ranging from £100 to £250 yearly, applications are received, I am told, literally by the hundred. It is generally also a condition of these appointments that private work should not be taken, and for a man who has received a costly and protracted education it is certainly not an alluring prospect to accept £100 yearly, and to look to a borough engineership, if he is lucky, as his highest possibility. If, however, a man has private means, I think the profession a fine one, and given the requisite brains, one that is certain to yield a fair pecuniary return. I may offer my own experience for the benefit of your readers. Educated liberally, and articled to a young engineer, on the expiration of my time I joined him as partner. We have for some years carried on a fairly successful practice, paving the way for better things. I have so far no reason to regret the money invested nor to doubt our ultimate success. I had capital, and have an income independent of my profession; but even with these aids advancement is slow. The difficulty of getting work is extreme. An engineer of some eminence once told me that he spent three-fourths of his time finding the work to fill the remaining fourth; and I do not think this statement exaggerated. Work naturally gravitates to the well-known firms; but if a man will work hard, and is not absolutely dependent on his receipts for a living, but can take up anything that comes to hand and seems to promise an opening, I think, provided his health stands, that success is certain. No barrister expects to make a living for some years after he is called; and an engineer, unless he means to be content with a very modest competency, cannot do so either. Many men, it is true, accept small appointments as a means of gaining experience, or while looking round for an opening; but this does not militate against my general argument. I cannot too strongly emphasise what I believe to be the fact—that unless a man has means and can afford to do unremunerative work, or is connected with engineers of position who will push him, or is a genius—which is not a complaint that many of us suffer from—he has little chance of attaining an independent position or an income at all proportionate to that earned by educated men in other professions.

To check the overcrowding and competition existing in the profession various remedies have been suggested—restrictions as to pupils, examinations by the Institution, &c. It seems to me, however, that the laws of supply and demand and of survival of the fittest, will meet the case without the introduction of artificial restrictions, which are nearly sure to prove inefficacious and to break down in practice. We must remember also that competition and cheap labour benefit the community, though they may press hardly on individuals. W.

London, August 25th.

SIR,—I think that the controversy first begun on this matter by Mr. Audain and the able leading articles of which it formed the subject will not remain useless, and have for effect a radical reform in the training of future engineers. Further interest would have been added to the discussion now going on, if we had had the opinions of some well-known foreign engineer communicated in these columns. When I was abroad, I discussed this matter with some engineers I came in daily contact with. It is impossible to come to an agreement if we do not once for all state what an engineer should be. Under this term I understand a man whose profession is to design machinery and to supervise the construction thereof. We are not at all behind other countries, as far as inventiveness and good work are concerned. But we risk still to be beaten. The continental engineer is better educated; his theory suggests him ready means to solve questions, and opens vast fields of discoveries. It is, however, impossible to think of learning theory and practice at once. A good many years are often spent for the former, and then there remains no time to serve in the workshops. This is the bad side of the foreign system. But, again, our young English engineer has only a partial knowledge of every branch he has been through. He is neither a founder, nor a turner, nor a draughtsman. Who is the worst off? evidently the latter. The former can more easily find employment, as he has a diploma which entitles him to act as engineer. Should there be no suitable place to begin with, he must be contented to work as a draughtsman. It must be understood here that nobody can be an engineer who is not a first-rate draughtsman. That is but logical. Would one of our young English engineers find a situation abroad with the singular training he has received here? I am afraid that he would find nowhere such a situation as would be worth having, after having lavished so much money on his education.

I feel certain that the criticisms which our engineering training is now undergoing in your valuable paper will lead to the adoption of the mixed system I have advocated, some three years ago, in a letter to you on the "Education of Engineers." You cannot really expect that a man who is to become an engineer should be perfect in all sorts of work. Let him learn *de visu* how things are done. This I understand to be the reasonable course to be followed. You cannot expect an engineer to scrape a slide valve face as perfectly as the man who has done but this work in his life. I am sorry to say that "Young Engineer" is far from being mistaken. I had to go abroad to learn something practical about locomotives in the way which you recommend. It is with much pleasure, therefore, that I read "C.'s" letter. He is right; the engineer's calling is a liberal profession and not a mere trade.

How many times have I had to deplore the ignorance of my superiors on some scientific points? There are some English engineers who are perfect "ignoramuses," although good practical men. They are often the laughing-stock of foreign engineers, who become thus acquainted with the system of education still prevalent in England.

"Pater's" letter is also very good; but I cannot agree with him concerning foreign locomotives. He is evidently blind, and is one of those who think that nothing good can be made outside England. This indomitable home pride will ruin us. Foreign locomotives are as good as ours, but they are established under different conditions, one of which is that they shall be easily repaired and inspected.

I do not think I shall be wrong in saying that the necessity of an ever-increasing traffic will compel us to adopt one of those locomotive types which do not "please the English eye." Englishmen want always to be judges in everything. There are, however, abroad engineers of great talent, who have not served their apprenticeship in "the shops," and who do not hesitate about adopting the Westinghouse brake instead of sticking, as our "practical" engineers do, to worthless ones, which are too often powerless to avert the frightful consequences of an accident, which might otherwise have been but an incident. Nobody need be a great engineer to recognise that the Westinghouse brake is the best and most perfect.

"Pater" is mistaken about the best locomotive firm in Austria. When I was there I heard say that George Sigl was the best locomotive builder. As a matter of fact, an express locomotive built by Haswell, and illustrated in your paper, required half of the boiler renewing after only four years' work. It is not, therefore, the English firm who enjoys the best reputation.

In conclusion, I beg to say that our English engineers ought to be trained more scientifically in the future—there are schools enough for this purpose—the paid apprenticeship abolished; and a chance given to every intelligent young man to come forward. But this will only occur when masters themselves are persuaded that scientific knowledge is a powerful help to the engineer when used in the right direction. I trust the practical good sense of Englishmen to bring about these reforms. Then we shall not fail to hold our first rank in the engineering world; and there will be then fewer engineers, but more men worthy of the profession, for it is an easy thing for everybody to learn theory and practice within the limits of what will really be needed. E. GOBERT.

26, South-street, Longsight, Manchester,
August 25th.

NEW SOUTH-EASTERN ENGINES.

SIR,—Attention has often been directed to the absurd statements which appear in daily newspapers with regard to railway matters. A few weeks ago a report went the round of the papers that the new South-Eastern engines were to run from London to Folkestone, seventy miles, in considerably under the hour. Now the general public is favoured with the following extraordinary statement with regard to these engines:—"According to the *Times*, 'the principal peculiarities in their manufacture are that they have larger inside cylinders than any other engines made in this country, and that the leading end of the locomotive is carried on a four-wheeled bogie, an arrangement originally introduced from the United States.' By means of this bogie, it seems, the action of the engine when running round curves is considerably modified, and it is rendered 'almost impossible' for it to leave the rails."

It will be interesting to sift the matter and see what are the facts. Mr. Stirling has lately built for the South-Eastern some express engines, upon a very similar design to those he constructed about ten years ago for the Glasgow and South-Western Railway. Doubtless he has introduced improvements and adopted larger cylinders. It is reported that his cylinders are 19in. diameter; but even if this be so, they are certainly no larger than those on the Midland Railway—19in. by 26in. There is nothing very peculiar in the leading end of a locomotive being carried upon a four-wheeled "bogie." Such engines are to be found upon very many English railways. This "bogie" was not originally introduced from the United States. On the contrary, it was taken from England to America, and has now returned. With regard to the last paragraph, there can be no doubt that the action of an engine on a curve is, as the *Times* says, considerably modified; but as the South-Eastern locomotives have bogies of the same construction as those on other lines, it is somewhat difficult to understand why it should be more impossible for them to leave the rails than for engines upon any other railway in the kingdom.

CLEMENT E. STRETTON.

40, Saxe-Coburg-street, Leicester, August 23rd.

RAILWAYS IN NEW SOUTH WALES.

SIR,—I am pleased to learn that the term jobbery used by "C.E." in a former letter was not applied to the Commissioner of Railways, Mr. Charles Goodchap. It is only just that this should be clearly understood, as this gentleman's name was mixed up with terms which were very reprehensible and serious to a public man. I have no personal interest in discussing this or any political questions regarding free or fair trade as affecting the colony, but leave that to the anonymous gentleman who, after "having resided some weeks in Sydney," is fully informed as to the desires and wants of one of our most important colonies.

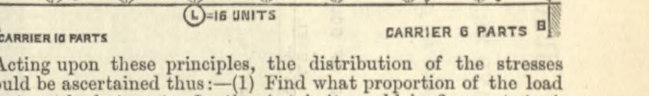
I wrote of Sir H. Parkes, not as the chief of the Government now in power, but as the best known representative of colonial integrity, and am not surprised that "C.E." leaves the leading question to inform you of that which is generally well-known. That leading question is this—Is the colony of New South Wales so degraded as to officially countenance jobbery and incompetence? which is said by "C.E." to exist. Those who are truthfully informed on colonial matters will, I feel sure, answer unanimously in the negative, and thus give the deserved quietus to scandal. The colony of New South Wales is a better judge than any individual of its own affairs. As far as I am concerned I have finished, as I do not desire to carry on a correspondence which is met by such a letter as is that in your last week's issue, and which, written under the *nom de plume* of "C.E.," is lacking in that courtesy usually exercised by those entitled to such honourable distinction. H. KENNETH AUSTIN.

104, Cato-street, Birmingham, August 26th.

STRESS DIAGRAMS.

SIR,—The letter of your correspondent "A. H." on this subject, which appears in your paper of the 22nd inst., is a step in the right direction in solving the problem of the distribution of stress amongst two sets of diagonals in a girder. Undoubtedly the distribution will depend on the workmanship and amount and quality of material in the girder; but it is certainly more reasonable to assume that these are the same throughout the girder, than that certain parts are defective, and that therefore the whole stress must go through the other parts—which is practically what is done in the two systems which your correspondent condemns.

I think we may go a step further, and say that, generally, any load in passing through the members of a girder to the abutment, will pass through the shortest aggregate length of struts and ties reaching from the point where it is placed to the abutment. Thus the portion of the load L—see diagram below—which passes to the abutment A, would pass partly through the bars *a*, *b*, *c*, and *d*, and partly through *e*, *f*, *g*, and *h*, but none of it through the line *e*, *k*, *c*, *l*, *g*, *h*. This idea follows from the fact that the greater the length of a bar subjected to a given stress may be, the greater will be the amount of alteration in form; and the alteration of form in the longer route of struts and ties would cause the load to come upon those bars forming the shorter route.



Acting upon these principles, the distribution of the stresses should be ascertained thus:—(1) Find what proportion of the load goes to each abutment. In the sketch it would be five parts to A and three parts to B. (2) Assume that half the load goes up *a* and down *b* and *m* in the proportion of 5 and 3, and so on to the abutments. (3) Assume that the other half of the load passes up *e* and *n* in the same proportions. This gives the natural distribution of the stresses, and is that which should be acted upon if it is intended to design the most economical girder of this type. Some engineers, however, not only assume that the stresses go in other directions, but force them to do so, by making the verticals only of a section suitable for struts, and by making the diagonals of such a form that they can only sustain a tensile stress. This course does not result in producing an economical girder.

Palace-chambers, 9, Bridge-street, CHARLES LEAN.
Westminster, Aug. 25th.

TOOL STEEL.

SIR,—Your Sheffield correspondent has been good enough to inform you—and the world of engineering—that for many generations no improvements have been made in the process of steel melting under Huntsman's splendid invention, and he gives some singularly inaccurate figures to support his view.

Your readers may be assured that there is no melter living who would burn 40s. worth of coke if he could attain the same positive result for burning 5s. worth of coal.

The demands of the engineer upon the makers of tool steel are more severe than ever before, and I venture to think that it was fortunate for the old melters that they knew nothing of turning and slotting steel castings, and hammered steel shafting, and they certainly never were expected to produce a steel capable of turning a 6ft. long bar of hard Bessemer steel, 5in. diameter, down to 4in. diameter at one cut, and with one grinding, the tool sliding 1in. for sixteen revolutions; and we hold that steel, to do this, is worth all the trouble and expense it costs to produce it.

Sheffield, August 27th. CLAYPOT AND COKE.

MECHANICAL STOKERS.

SIR,—In your article on "Hodgkinson's Mechanical Stoker," in THE ENGINEER of August 1st, you mention "an ingenious contrivance" in use with the stoker for regulating the steam pressure, by acting on the flue damper, and for stopping and starting the stoker according to the pressure of steam. Also in your August 22nd number, Mr. Copland describes how seven years ago he applied "Cuthell's Patent Steam Regulator" with perfect success to regulate the feed of a mechanical stoker, as well as acting on the damper, so that his man could leave the boilers for half-an-hour at a time and steam always at a steady pressure. Will you allow us to say that we are the makers of "Cuthell's Patent Steam Regulator," and that the "ingenious contrivance" you noticed was supplied by us? Their are over 2000 at work acting on the damper alone, and their use is largely extending in connection with mechanical stokers. Their cost is small.

SHARPE, SIMPSON, AND CO.

Phœnix Foundry, Lancaster, August 27th.

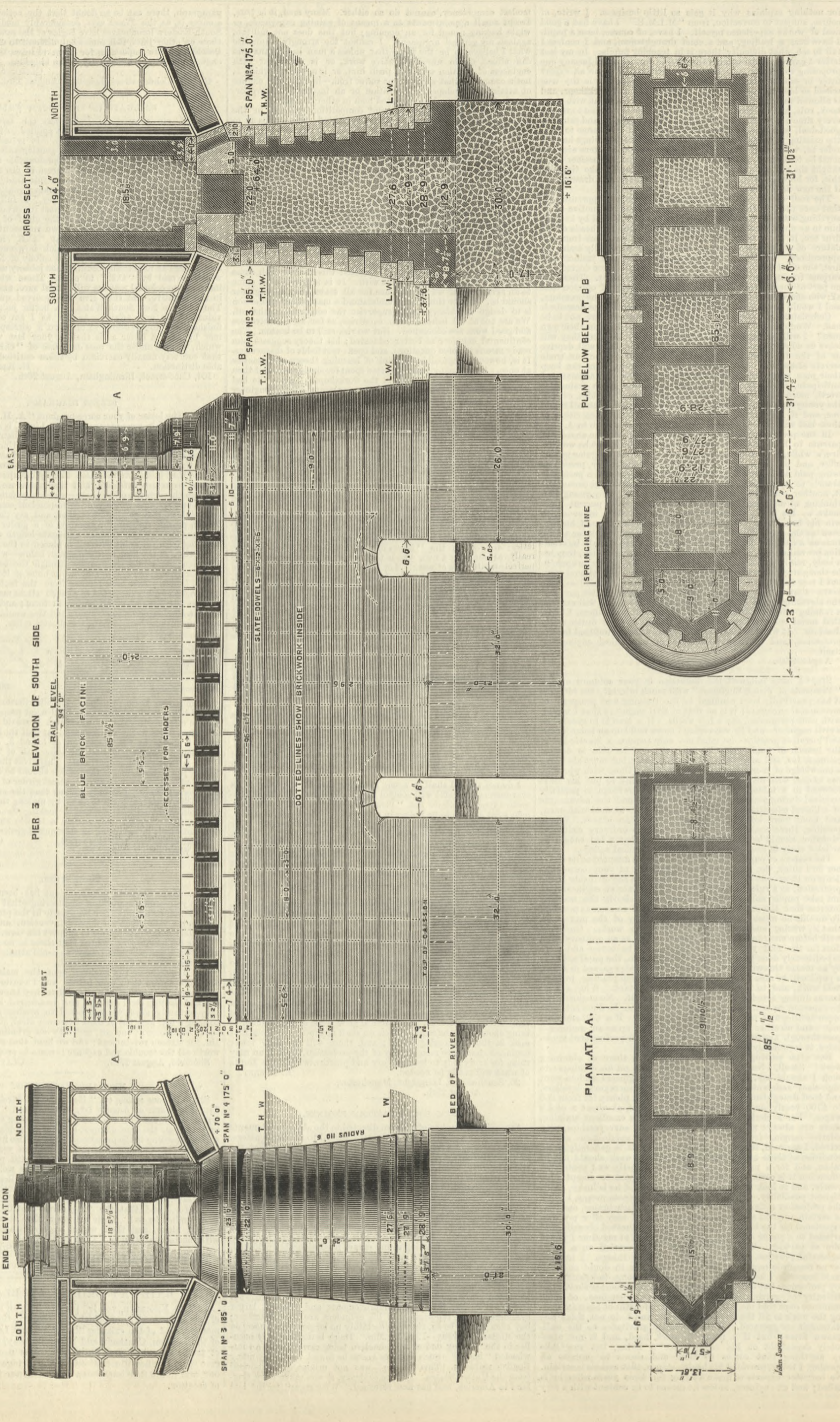
NEW RAILWAY BRIDGE AT BLACKFRIARS.

IN THE ENGINEER, vol. lv., pp. 318-322, an account was given of the new bridge, of which the construction had been commenced, east of the existing Blackfriars and Ludgate-hill Bridge of the London, Chatham, and Dover Railway, the great increase of traffic on which has made extensions necessary. We now give some further illustrations of the bridge as being carried out, and in another impression shall return to it and to the mode of erection.

LONDON, CHATHAM, AND DOVER RAILWAY, BLACKFRIARS BRIDGE.

MR. W. MILLS, MR. JOHN WOLF BARRY, AND MR. H. M. BRUNEL, MM.I.C.E., ENGINEERS.

(For description see page 159.)



FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a 1d. postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

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

J. R.—*Mr. Bourne's address is College of Engineering, Muswell-hill, London.*

W. J. P.—*In New Zealand there is no opening for engineers. Whether your son can, or cannot, get employment in Australia, is a question of the interest you can bring to bear and the introductions you can give him. Without these he has no chance.*

R. M.—*There is no advantage gained by turning the exhaust of a donkey engine into the suction pipe, except that the water is heated a little. Tank locomotives are safe on any gradients you can get them to ascend, so long as the speed is not high.*

E. R.—*There is no more chance of employment without interest in Australia than there is here for engineers. If you are a "handy man," who can do a little carpenter's work, a little smithing, paint a fence, glaze a window, milk a cow, and so on, you can earn from 7s. to 10s. a day. Professional information is at a discount there.*

J. N.—*The apparatus consists of a long trough containing water, and into which a trunk curved forward from the tender dips or touches. This trunk can be lowered a little when the trough is reached, and raised when the end of the trough is approached. When the engine is running fast the water rushes up the trunk. See "Record of the Exhibition, 1862."*

BOOKS ON BLEACHING AND BLEACHING MATERIALS.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers tell me where to obtain a moderate-priced book on some such subjects as bleaching cloth, bleaching or boiling yarns; also a book on chemistry which deals largely with the properties and analysis of such substances as soda ash, bleaching powder, sulphuric and muriatic acids, &c.? AMATEUR.

SUBSCRIPTIONS.

ADVERTISEMENTS.

DEATHS.

On the 18th inst., in his 65th year, FREDERICK AUGUSTUS SHEPPARD, A.M. Inst.C.E., of 46, Angel-road, Brixton, S.W., after a lingering illness. Cape, Straits Settlements, and China papers, please copy.

On the 12th inst., suddenly, at Port Said, on board the P. and O. Company's s.s. Ravenna, homeward bound, Major-General JULIUS GEORGE MEDLEY, R.E., late Consulting Engineer to the Government of India for Guaranteed Railways, Lahore, aged 55.

THE ENGINEER.

AUGUST 29, 1884.

AERIAL NAVIGATION.

THE world is bid to understand that August 9th, 1884, is to be "for ever memorable in the annals of discovery." Such was the announcement made the other day by M. Hervé Mangon, in presenting a report to the French Academy of Sciences concerning a balloon voyage conducted by Captain Renard and Captain Krebs, the former being the director of the Balloon Works at Meudon, and the latter his assistant. The voyage was not a long one, but it was remarkable as beginning and ending at the same spot. The balloon went from Meudon, and it returned thither, the point reached in going out being the Hermitage of Villebon, about seven miles distant. On the outward trip the wind had a rate of 18ft. per second against the balloon, but the aerial ship was propelled in the teeth of the current by the action of a screw, rotated by means of certain electric accumulators, capable—it is stated—of supplying the power of ten horses for the space of four hours. The balloon was elliptical in form, having in its car the electrical apparatus. A rudder projecting outside, like that of a boat, sufficed to steer the machine. Captain Renard attended to the propeller, while his companion took the part of steersman. The time occupied in going out and getting home again was about forty minutes. The altitude maintained is reckoned at 180ft., and the balloon went straight for Villebon, as intended beforehand. On reaching the goal Captain Krebs waved a flag as a signal that he was going to turn, and astonished everybody who was looking on by forthwith doing so. Describing a curve of 300 metres radius, the balloon sailed back to Meudon, where it quietly descended, the machine being "eased, reversed, stopped," and hauled down to earth by a rope, touching the ground without the slightest shock. Such, in substance, is the story of this adventure; but it is stated that certain technical details have been kept secret by the inventors, except from the Minister of War. Captain Renard fully believes that he has solved the problem of aerial navigation, and he looks forward to the time when the balloon will become "a formidable engine of war." But there are doubters in some quarters. Mr. Henry Coxwell signifies that he has on certain occasions managed to go out and come back again in a balloon; but he has accomplished the feat solely by taking advantage of conflicting currents, and he seems to conceive that something of the kind occurred at Meudon. Colonel Beaumont, having considerable experience in military ballooning, has been "interviewed" on the subject, and being asked what he thought of the French achievement, replied, "What do I think of it? Nothing!" Admitting that Captain Renard had once steered his balloon for a short distance, "let him do it again," said the English Colonel. The enormous power necessary to navigate a balloon is clearly apprehended by Colonel Beaumont, as also by Mr. Coxwell, and those who know most of aeronautics are least likely to be captivated by the French report.

History is said to repeat itself; but we are not going to be quite so sceptical as to suggest that the Meudon voyage is to take rank with the still more wonderful affair narrated in a Paris journal in the year 1857. It was then announced that M. Gavarni, an artist, after studying the subject for six years, had succeeded in completing a machine at a cost of 300,000f., by means of which he hoped to be able to sail in the air in all directions. Proof that he could do this had already been given. His machine consisted of two spherical balloons fastened together. "The propelling power," said the record, "is obtained by a peculiar sort of screw, reaching as far as the car, which is provided with a rudder of whalebone." Preparations for the voyage were made "in as private a manner as possible," and only four persons were allowed to be in the secret. These four were Le Comte de Pleuvier, M. Edward Migeon, professor of the physical and mathematical sciences; M. Jules Falconer, an aeronaut; and M. Henri Page. These, with M. Gavarni, made the ascent from the park of the Comte de Pleuvier. After rising to a great height, M. Gavarni said to his companions, "We have the wind against us; now or never is the moment to try my screw. Gentlemen, I mean to steer for Algiers, where Marshal Gaudon impatiently looks out for our arrival." The Loire was passed at twelve o'clock. At two o'clock Gavarni saw the sea. In half an hour more Nismes was passed, leaving Marseilles on the left and Toulon on the right. Ultimately the double balloon descended about a mile from Algiers, where a cordial reception was given to the party by "His Excellency, Marshal Gaudon." The return voyage was soon afterwards accomplished, and a safe descent was effected in the park of the Comte de Pleuvier. This was published, with an abundant garniture of details, and probably a good many people believed the story. The narrative of Meudon has the merit of being more modest, and the voyage is a very brief one. But the account is received on this side the Channel with a considerable degree of caution. The numerous schemes of aerial navigation which have come to nothing, have made the British public slow to believe in aeronautic triumphs. About two years after the alleged voyage to Algiers and back, the *Times* devoted nearly two columns of large type to a letter signed "Vespertilio," the subject being entitled "How to Navigate the Air." The writer wound up his dissertation by saying, "The problem of aerial navigation will be easily solved whenever the progress of science shall place us in command of a motive power considerably lighter, in proportion to its capacities, than the steam engine, and not till then."

This conclusion has much to recommend it, and yet it may be doubted whether the problem will be found easy of solution, even when the world has the benefit of a motor "considerably lighter" in proportion to its power than the steam engine. The idea of navigating a balloon is easily conceived, but there are difficulties in the way which are generally underrated. As for the Meudon experiment, it certainly requires further explanation. The distance traversed was fourteen miles, and the time occupied about forty minutes. This alone would indicate a power of propulsion in the machinery of the balloon equal to a speed of 21 miles per hour. But the outward journey was made against the wind, which had a velocity of about 12 miles per hour. We may reckon that the outward journey would take half-an-hour. This would correspond to a velocity of 14 miles per hour, irrespective of the wind. But in order to counteract the effect of the aerial current, we must add 12 miles per hour to the propelling power exercised on the balloon, thus making a total of 26 miles per hour. On the return the wind would be favourable, thus adding 12 miles per hour to the self-created velocity of the balloon, and making a total of 38 miles per hour. The seven miles homeward would thus be accomplished in 11 minutes, making 41 minutes in all, the reported time being "about 40 minutes." The calculation we have made is therefore sufficiently accurate. It will be seen that if the observations made on the occasion were correct, the propelling power exercised by the screw must have been such that in a dead calm the balloon would travel at the rate of 26 miles per hour. But this is equivalent to a brisk gale with a pressure of more than 3 lb. per square foot. The elongated form of the balloon would diminish the resistance to be encountered; yet this would still be very considerable. Granting that the performance was really as it appears, the speed proper to the balloon was extraordinary. Even if there were no wind at all, the machine must have driven the balloon at a rate exceeding 20 miles an hour; and this of itself is enough to excite surprise. Such a velocity is the milder form of the brisk gale, and is equivalent to a pressure of 2 lb. on the square foot. The French narrative is therefore very wonderful, if, indeed, there is no mistake about it.

What we may term the "inherent velocity" given to a balloon by means of propelling machinery is of service, not only for the sake of the speed thus obtained, but because without such power of motion there can be no steering. Some curious ideas have been mooted on this point. It has been said that anybody can steer a balloon in the direction of the wind, and that nobody can steer a balloon in a calm. The truth is that a balloon, *per se*, knows nothing about the wind, and is always in a calm. When a balloon comes to be propelled by some internal motor, it encounters atmospheric resistance, solely due to its own motion. Having motion of its own, it can then be steered. But while it is thus travelling in the region of the air, it is subject to all the movements of the atmosphere, and its geographical course is a combination of its own motion and that of the current in which it travels. If a dead calm prevails, then the propelled balloon takes its course over the earth in exact accordance with its own inherent speed and direction. The effect of the wind on a propelled balloon is fairly illustrated by a boat rowed across a running stream, especially if we can conceive of the boat as entirely submerged, like a torpedo propelled under water. The motion produced by the wind in respect to a balloon is that of drifting, somewhat as a ship may be affected in its course by tides and currents. Propelling power would enable a balloon more or less to maintain its own course, as directed to any particular part of the earth. That a balloon may be propelled at a low velocity, and steered accordingly, is conceivable; but an artificial speed of twenty or thirty miles an hour is more than we can at present understand. Granting that any such speed has been obtained, the difficulties in the way of a substantial addition to that velocity appear insuperable. If ever aerial navigation is to be accomplished in a practical form, it is scarcely likely that the balloon will have much to do with it. The bag of silk inflated with gas is far too bulky and flimsy for the work that has to be done. A motor so powerful in proportion to its weight as to be available for navigating a balloon would be better employed in connection with some aerial machine unencumbered with gas.

ENGINEERING PAPERS.

IN recent impressions we devoted a portion of our space to articles treating of the prospects of young engineers, and in these articles we, of course, referred to the existing systems of education in engineering. We do not now propose to comment again directly on the same topic, but we feel that some remarks on a certain means of education in which the youngest as well as the oldest member of the profession can participate may be appropriate. It has been well said, that if a man desire thoroughly to inform himself upon a given subject, the best method to attain his object is that he should write a paper upon it. Of course this applies with most force to young men. To men past middle life, who from their earliest youth have been engaged in the pursuit of some special branch, it might be held almost inapplicable. We say almost; it is not quite inapplicable, because the oldest and most experienced may still learn something. The preparation and reading of papers, as well as the discussions thereon, constitute a leading feature in the proceedings of many other learned bodies besides engineers' societies, and may form a means of diffusing a great deal of valuable information. As regards the leading engineering societies and scientific bodies akin to them, some of the papers read and the discussions thereon, will bear comparison with similar productions emanating from other societies having on their members' list the most distinguished names in science or art. This means of education, however, is capable of further development, and such development we wish to see brought about. Secretaries of societies repeatedly complain of the difficulty they experience in obtaining papers; and it is now a usual thing about the commencement of the sessions of scientific and engineering bodies to see lists of subjects for papers published in the columns of this and other journals, these being suggestions to members of topics on which they might contribute papers. The difficulty of getting papers is due to more than one cause. Three, at least, may be enumerated, want of time; shyness of publicity and dread of adverse criticism; and in the case of young men, want of money; these all do much to deter writers. The first cause—want of time—operates with the men qualified by the extent of their knowledge and practical familiarity with their own specialities to contribute the best and most instructive papers. Such men's time is in constant demand; it is seldom at their own disposal, and their brief periods of leisure, when such do come, must almost of necessity be devoted to rest and renewal of their mental as well as physical energies. Other men have an idea, erroneous it is true, but still deep-rooted, that they really have nothing to write about. Like the knife-grinder, they say, "Story! Lord love you, sir, I've none to tell." The daily routine of their work, whether it be in the girder-yard, the ship-yard, or the workshop, has become so familiar to them that they cease to see anything in it that is not, in their opinion, commonplace. A feeling of shyness, a dread of adverse criticism, is present sometimes, too, and hence it is difficult to coax or influence such men to write papers. Younger men, having less experience, probably have more time at command, but then they also dread publicity and criticism even more than do those older men to whom we have already adverted. With young men just out of their articles, in many cases shyness forms an almost insuperable barrier against their writing papers. A feeling must exist in their minds that if they read a bad paper it may possibly injure all their future prospects. Poverty, too, militates against some young men; they may find time to write the paper itself, but possess no means of preparing the large diagrams usually necessary to illustrate it. Technical societies might form an excellent means of education of one kind, even on their present basis; their Transactions might be valuable books of reference, and possess the additional utility over and above that of books written by individual authors, that whereas the latter are usually simply the exponents of the views of their writers, the former embody not alone the opinions of the authors of the papers published in them, but also those of all who took part in the discussions upon these papers, so that the reader has means of forming his own judgment. All advocates of the extension of education in this country, as well as those desirous of improving the means of training young engineers, must desire to see the educational influences of our technical societies extended and developed to the utmost. The development of the system of reading papers might, perhaps, be encouraged with advantage. The system of prize-giving should be taken into consideration by committees of the several societies appointed for the purpose, they being instructed to inquire into the working of the prize system in foreign societies, as well as in ordinary educational institutions at home and abroad. Men of eminence, not merely as theorists, but men who are heads of large establishments, as well as men heads of small places, but engaged in special classes of work, should be invited, and every means used to induce them to contribute papers describing their experience. Men whose time is of great value, and who could be induced to write even short papers—and, as a rule, short papers are preferable to long—should feel that they would be remunerated for their trouble. Men who could not be induced to write papers ought, whether members or not, to be influenced to join in discussing them. As it is, however, papers are by no means what they ought to be, and the discussions on them seldom possess a great deal of value. The whole system wants reorganising, and little can be hoped until men who are able to write really good papers can be persuaded that it is right and proper that they should prepare them. The paramount tendency in the present day is to use paper reading for advertising purposes, and this, if it extends, will prove fatal to the whole system.

One of the complaints made against books, papers read before societies, and articles in scientific journals, is that they are usually too highly scientific, or else of too abstract a nature to be of practical value. There is, perhaps, foundation for the complaint, but practical men are as much to blame in the matter as any others, because, as we have said, it is difficult, if not almost impossible, not merely to get them to write, but even to attend the reading of papers, or to join in the discussion thereon. The growing fierceness of foreign competition, the great attention bestowed in other countries on all branches of technical education, must never be lost sight of; and we will sum up our remarks by saying that we are convinced that the development of the system of reading and discussing technical papers, as well as the extension of the lecture system, might be made to conduce to the preservation of English engineering in its proper place as foremost in the world.

MECHANICAL POWER ON TRAMWAYS.

So far as can be ascertained, steam seems to be used with a fair amount of success on North-country tramways. The word success in this connection refers to the pecuniary conditions under which such lines, for example, as the Manchester, Bury, and Rochdale lines are worked. It has long been known that steam engines could be made to haul tram-cars; but until recently steam has always proved itself much more expensive than horse-power. The engines which have apparently solved the problem are those of Messrs. Merryweather and Sons and Mr. Wilkinson. The cost of fuel has never constituted a formidable item; the repairing shops have run away with the money, and this has been the case principally because the machinery was close to the ground, and no adequate provisions were made for excluding dust from bearings and guide bars. Tramways are comparatively rough roads, and they soon knock to pieces any engine not made with a special care. Mr. Wilkinson builds a strong engine, with the machinery well up out of the dirt, and this is the secret of his success. It cannot be said that the problem, how to get rid of the waste steam, has yet been solved completely. In hot dry weather, such as that of the present summer, steam is practically invisible as it issues from the funnels of locomotives. In cold damp weather, however, neither Mr. Wilkinson nor anyone else can prevent the evolution of visible vapour from the engine chimney unless a condenser is used. This condenser has, however, to a large extent been abandoned. About the year 1871, Messrs. Moreland, of Old-street, constructed a steam road roller for use in St. James's Park, where it may still be seen at work. This machine has a Field boiler, and to render the exhaust steam invisible it is led down to a hollow baffler inside the furnace, and there superheated, and so rendered invisible before it leaves the chimney. This is the plan generally pursued now, and worked with a fair degree of success in the Wilkinson tramway engine. It only answers, as we have explained, to a certain extent; for in cold weather the steam quickly loses its superheat, and condenses into a white, cloudy vapour. With coke as fuel there is, of course, no smoke, and the good people of the North are too much accustomed to smoke and steam to be much, if at all, put out by a little vapour hanging for a few moments in the highway. What will answer in Rochdale or Oldham, however, would not be tolerated in London, and there is little chance that steam will find a place on metropolitan tramways.

We have often pointed out that, unless the permanent way of tramways was improved, steam engines could not be made to run on them and pay. Recent successes, so far from contradicting our statements, strongly confirm them. The Manchester, Bury, and Oldham steam tramway may be taken as an example of the most recent practice. The lines are about six miles long, 4ft. 8½in. gauge. The rails are throughout of steel, and are for the most part deep girders laid on concrete, on Gowan's system, a part of the line being on Barker's system. These girder rails are quite heavy enough to carry a railway locomotive; to support the tram engines is mere child's-play. The cars have each six wheels set on radiating axles, the arrangements being patented by Mr. Grover. The cars are 24ft. long and have a wheel base of 12ft., which makes them run more steadily and safely than four-wheel cars, which have a base of not much more than 6ft. The Wilkinson engines are said to give no trouble of any kind. As the lines have only been worked by steam for the last few months it is, of course, impossible for us to say yet whether they show a profit or not. On this important point, however, information will be available ere long.

That it is desirable to adopt mechanical instead of horse power for hauling tram-cars few will be found to dispute. There is reason, however, to believe that steam will never find favour in London, and the objections to it are so many that other expedients have much in their favour. The other modes of propulsion are two in number—namely, electricity and gas. The former cannot possibly be used in London streets as it is, let us say, at the Giants' Causeway, or on the beach at Brighton. Insulation could not in any way be maintained. The only method of using electricity, available with tram-cars, is embodied in putting storage batteries into the cars, and working, in fact, on the same principle as the Yarrow electrical launch, which has been described and illustrated in our pages last April. The Dowson gas engine is a far more promising motor, and we venture to think that if Mr. Dowson and Mr. Holt turned their attention in this direction they would succeed without much difficulty in devising an engine and generator which would take up but little space—not more, at least, than a steam engine and boiler. The consumption of fuel would be very much less than that of a steam engine of the same power; the weight would not be greater, and there would be no trouble whatever from smoke or steam.

The Hallidie system of traction by rope has attained a certain measure of success in the United States. A modification of the method has been got to work, after several mishaps, on the Highgate line. It is too soon yet to speak of its success. There is a method of using rope traction which was proposed in the comparative early days of railways which might, perhaps, be revived with advantage. By a very simple expedient the car can be made to travel five or six times as fast as the rope, and this without the use of toothed wheels or gearing of any kind. It would, we fancy, be found far more easy to work a line in which the rope ran at half a mile an hour than one in which the rope runs at five miles an hour. Some ingenuity would be needed to make the arrangement of which we speak applicable to tram-cars; but there are, we imagine, no difficulties in the way that a clever engineer could not overcome. Those who are interested in the matter will find the system of rope traction to which we refer illustrated in Law's "Civil Engineering," first edition, Weale's Series.

A CHANGE IN SHIPBUILDING.

It has not yet been generally noticed that in the stagnation that has settled upon the industry of shipbuilding there is change—probably a temporary one—in progress. The latest list of the monthly additions to the registry of British vessels shows that change. It is evinced in the fact that the vessels that are now being added to the registry are of very small tonnage compared to those which were added a year ago. In the month reported on last by the registrar, sixty-two iron and steel steamers were added to the registry of the United Kingdom, but the net registered tonnage of these was only 28,693 tons—not 500 tons each on the average, which is far below that usual at the time we have referred to. Of wood steamers, four were added in the month, the net tonnage being 53 only, whilst of iron sailing vessels, the five that were added were of 5521 tons net, and the wooden sailing vessels added were of 1683 tons net. It is clear from these figures, that whilst the iron and steel and wood steamers included many of very small tonnage—river tugs and similar vessels—the tonnage of the sailing vessels was larger. Hence the deduction is fair, that the vessels which are now being built are small steamers for special purposes and large iron sailing vessels. It is a fact that gives ground for the belief that there will be soon a revival in the demand for steamships, because the loss is going on, and practically the building of large steamships has for the present ceased. The vessels which are idle must by-and-bye be called into requisition, and then we shall find that there will be orders for new ones to meet the loss that seems to be increasing with the increase of the fleet of steamers, and with the transfer of a considerable part of the tonnage from sailing vessels to steamers.

PROGRESS OF BASIC STEEL.

Our correspondent in the Midlands informs us this week of the stage which the manufacture of steel upon the Thomas-Gilchrist principle has at present reached in that part of the kingdom. In this there is much that is satisfactory. It is clear that an important new market has been found in that process for the cheap pigs of the Staffordshire district. The opinion of some of the leading practical ironmakers there is that the Basic Steel Works now established in their midst is a mere child to the steel works that will be eventually developed. We note that Mr. R. Smith Casson, the general manager of the celebrated Round Oak Works of the Earl of Dudley, firmly holds this view. No wonder that, speaking at the close of last week in Wolverhampton, he should have been loud in his praises of the great services which the inventors have rendered. Messrs. Thomas and Gilchrist are not, however, content with the degree of success at which they have already arrived. They are not prepared to rest upon their oars and be idle. Mr. Gilchrist freely asserts that there is a great deal yet to be done to bring the process to a still greater state of perfection. He is bold to hope that in a few years, with the assistance and knowledge of practical ironmakers who are in increasing numbers taking a lively interest in this cheap steel-making, far more than now will have been accomplished. He has the confident anticipation of being able by-and-bye to produce basic steel that shall answer every purpose now served by good quality Staffordshire iron. A few figures given by Mr. Gilchrist are suggestive upon the international competition question. Last year the total output of Thomas-Gilchrist steel was 640,000 tons. Of this, our greatest competitor, Germany, produced 419,000 tons; England 121,000 tons; and other countries 100,000 tons. This year the aggregate production will be much larger; and the new Midland Works will have played a commendable part in swelling the quota.

The cartridge factory in Quebec, established by the Canadian Government for the supply of the militia of the Dominion, having proved very satisfactory, it is in contemplation to add a gun factory to the establishment, and Captain Edward Palliser has been requested to furnish all the information in connection with the subject.

LITERATURE.

Electricity: Its Theory, Sources, and Applications. By John T. Sprague. Second edition, greatly enlarged. E. and F. N. Spon, 1884.

[First Notice.]

Nine years have elapsed since the first edition of this work was published, and probably these years will prove to have been the most eventful in the whole history of electrical science. The telephone and the microphone have been made practical, even if we do not insist upon their discovery during that period. Telephony, indeed, has made such rapid strides that it is fast becoming an acknowledged competitor of the telegraph, which, in many cases, it is destined to supersede. Then we have, during these nine years, seen the Paris International Exhibition, where we had the first glimpse of the commercial practicability of the electric light, the rapid development of which has caused even the wonders of telephony to suffer partial eclipse; also the Paris Electrical Exhibition, followed by scores of minor electrical exhibitions, in which the electric light played a most, or the most prominent part. Added to these youthful but already lusty developments of electricity, we have in an embryonic stage—but still, fitly belonging to this period—the transmission of power, and the storage of electrical energy, in the discussion of which problems our author has taken no mean position.

The first edition of this work stamped Mr. Sprague as an independent and deep thinker, it showed him to be free of the trammels of scholasticism, and took an unique position in the literature of electricity. Standing, then, almost alone—so far as published opinions were concerned—in opposition to many of the received theories of the day, attacked by critics whose slavish attachment to authorities merited and has reaped its just reward, the author has lived to record "that recent text-books are gradually adopting and teaching doctrines which were accounted utter heresies when this book first appeared."

The work has grown from 384 pages to 650 pages—a sufficient proof of the author's appreciation of the developments of the science. Many will remember Macaulay's remarks on Dr. Nares' memoirs of Burleigh and his times. After reciting the number of pages, cubical contents, weight, and so forth, the reviewer says, "Such a book might before the deluge have been considered as light reading by Hilpa and Shalum. But unhappily the life of man is now three score years and ten; and we cannot but think it somewhat unfair in Dr. Nares to demand from us so large a portion of so short an existence." Macaulay objected to the book not so much because of its bulk as because of its tediousness—its verbosity, its pomposity, and repetition. Macaulay could condemn in strong language. He could as well commend; yet we doubt if his command of critical language was sufficient to express the difference between the book he reviewed and the one before us. In this scientific work we have condensation of thought—condensation in many parts carried to extremes. We have sentences that could easily be developed into pages, pages that would not be thought long if extended into chapters, and chapters that would easily form the text for moderately-sized books. It is impossible, then, to notice such a work fully in a review of ordinary length. We therefore claim indulgence to select for more detailed comment a few—and a few only—of the parts of the work which seem to us to call for particular notice. Broadly speaking, we agree with Mr. Sprague's theories; yet the exigencies of the occasion may cause us so to write that the opposite may seem to be the case. Mr. Sprague, however, would be the first to admit that while on the whole we may approve of a piece of architecture, it does not follow that every detail is necessarily approved. The plan adopted is to discuss "static," then "dynamic" electricity—a plan which should be reversed. The author objects to cram books and cramming; and yet of all the subjects in the domain of physical science, static electricity lends itself most to cramming. The amateur and the student can experiment far more freely in dynamic than in static electricity; and as the former is the more generally applied, it seems to us to demand first attention. Or it might be reasoned that a knowledge of the circuit being of the utmost importance in both cases, and being more easily explained and verified in the one than in the other, that most easily explained should come first.

An introductory chapter briefly discusses certain chemical theories, the notation used, and the text upon which the work is founded. The text is thus formulated:—"According to the theory adopted in these pages, electricity is not material or a *quasi* material fluid, nor is it a special force; it is a form of motion—energy charged in a special manner upon ordinary matter, and developing special relations among its molecules. Since the first edition of this work was published this view has gained much ground, and many things which were then regarded as heresies are now generally adopted as true scientific principles."

Elsewhere, as Mr. Sprague points out, Clerk-Maxwell acknowledged that during his later years he inclined to the physical rather than the mathematical method of investigation and description; but so far as we know, Maxwell had not changed his opinion that electricity, whatever it is, "is not, like heat, a form of energy." The difference is fundamental, yet easily explained, as may be illustrated by a water analogy. One man says the water turns the mill, another man says gravitation turns the mill. The former gives a special name to the water, the latter gives the same name to gravitation. Now of course we all agree that the action of gravitation imposes motion upon the water, that water has no more tendency to go down hill of itself than an unsupported stone has to fall to the earth. Gravity is the acting cause in both cases, and if we object at all, it is that writers are not sufficiently careful to explain exactly what they mean. Mr. Sprague has explained his position, but we think insufficiently. In the paragraph preceding the text he says, "We not uncommonly hear of the conversion of electricity into light, heat, or mechanical energy." This is an absolute error, originating in the confusion of the two factors of electricity. Electricity regarded as a quantity calls for two distinct expressions, Q and Q*. The first is strictly a quantity, and is that which the old theories considered to be material or analogous to matter, and represented to the mind by the expression imponderable fluid; but which the new theory considers to be numerical, the action of definite material quantities or molecules. This, which is properly the "electricity," can no more be converted into heat or anything else than can the water in a steam boiler or hydraulic engine. The second, Q*, is the electric energy, which is the true cause of electric phenomena, and which may be converted into heat and work, because it answers exactly to the mechanical energy—also convertible—carried by the water as steam from a boiler, or under pressure in the hydraulic engine. From this it will be seen that the author gets rid entirely of "electricity," which he assumes to be matter, and confines himself to the something connected with matter which is called "electrical energy."

Mr. Sprague will forgive us if we do not interpret him aright, but it seems we may put his theory into other words with the advantage of simplicity. It is as if we have a conducting chain—say, a chain of molecules capable of revolution about an axis. This chain of molecules is, of course, material, and answers to the expression Q above. The chain, however, is constructed so that each molecule is capable of impressing its motion upon the next molecule. If, then, the molecule or molecules at one end of the chain be given a motion of rotation, the motion will be impressed onwards along the chain; and, further, the greater the velocity of rotation imparted to the end molecules the further along the chain will the rotation be carried. The theory would tell us that the degradation of this velocity of rotation is the means by which we obtain our work. We do not mean to say that Mr. Sprague's theory necessarily involves molecular rotation; the motion may be of some other kind, or may resolve itself into a pressure, or pull, or vibration in definite directions.

A large number of scientific men hold this theory that electricity is a mode of motion, but we do not know how far their views agree the one with the other, or whether the ideas are sufficiently advanced to enable anything more definite than a mode of motion to be stated. A very pretty superstructure could be built up upon the rotational hypothesis. Potential would depend on the circumferential velocity of the originally impressed molecules. Current would be velocity transmitted, polarity would depend upon direction of rotation, and so on.

But to proceed. The next chapter deals with static electricity, and should come later on, or preferably not at all, because the static circuit is merely a modification of the dynamic circuit. In the latter case the circuit is wholly conductive; in the former partly conductive and partly non-conductive. As Mr. Sprague says — static electricity "has no existence." The older knew, and many of the more modern writers knew, little of the inductive circuit, although Mr. F. C. West twenty years ago entered very fully into the matter in his little book on accumulation. We are glad to note that the death-knell of repulsion is sounded. We read, "The repulsion is only apparent; the real cause of the motion is to be found in the attraction exerted by the surrounding bodies." If this is correct, it will be seen that formulæ relating to repulsion can hardly be accepted as more than approximately accurate, the action really depending upon the disposition of surrounding conductors. There is hardly a paragraph in this chapter that does not call for comment. The whole should be carefully read and digested, and we are fain to believe that it will repay all the thought bestowed upon it. It may be well to mention here that we have reason to know that almost every experiment described in this book has been verified by the author; and it may be taken for granted that if the use of any material is suggested, or any machine preferred, it is because after due trial the results were found to be satisfactory.

A short chapter comes next discussing the polar theory of magnetism, methods of magnetisation, certain phenomena of natural magnetism, &c. The last paragraph of this chapter combats the absurd idea that a magnet is the source of an inexhaustible supply of force. This popular fallacy, like many others, is too firmly rooted to be easily displaced, yet the student who has but a smattering knowledge of conservation of energy is able to see how ridiculous it is.

The following chapter deals with batteries, primary and secondary. The consideration of the action of batteries brings us into the domain of elementary chemistry. We have often considered how, in modern science, it happened that terms and phrases entered into common use, as it seemed there could have been no real thought upon the subject. Take, as an example, the idea of a "nascent" atom. Has the idea been introduced without due consideration, or is there really a physical conception behind the phraseology? Mr. Sprague accepts, say, the idea of nascent hydrogen without question, and in the usual manner explains the theory of the Daniell cell, symbolising the action thus:—

We have	Zinc.	$H_2 SO_4$	$H_2 SO_4$	$Cu SO_4$	$Cu SO_4$	Copper.
polarised		$SO_4 H_2$	$SO_4 H_2$	$SO_4 Cu$	$SO_4 Cu$	
breaking up		$Zn SO_4$	$H_2 SO_4$	$H_2 SO_4$	$Cu SO_4 Cu$	

By the way, by a printer's error, the first formula is printed $H_2 SO_4$, which is evidently incorrect. The chemical exchanges are not sufficiently explained by the polarisation theory. The nascent hydrogen does replace the copper of the sulphate of copper; but further we cannot go. It may be said that the graphic representation of the polarised molecules is not intended to represent more than this, nor the symbols as given above. The general idea, however, is that the hydrogen driven off by the zinc is nascent, its action being to drive off the hydrogen already combined with the next acid radical, the last hydrogen molecule driving off the copper of the sulphate of copper. The idea may thus be symbolised:—

Zn	$H_2 SO_4$	$H_2 SO_4$	$Cu SO_4$	$Cu SO_4$	Cu
Zn	$SO_4 H_2$	$SO_4 H_2$	$SO_4 Cu$	$SO_4 Cu$	Cu

In the same chapter, p. 186, Kaboth should be Kabath. The end actions are easily admitted. It is the action of molecule to molecule in the chain of $H_2 SO_4$ and $Cu SO_4$—molecules, that is, not so readily explained. The symbols above introduced by Hoffman and others relating to valency is adopted by Mr. Sprague, who shows that the method is capable of explaining electrical as well as chemical phenomena. There is, perhaps, no work in which the theory and practice of the ordinary Daniell and other cells, taken as typical cells, are more fully and more ably discussed. The information given is exhaustive. Secondary batteries receive considerable attention, the conclusions of the author being against their extensive use, inasmuch as the use of such batteries means a loss of 50 per cent. of the energy compared with direct working. The reasons are given why so great a loss is sustained, but against this we have the records of experiments that the loss is much less—in some cases not more than 20 or 25 per cent.—and that the main factor against the use of such batteries is in their want of durability.

MAJOR MARINDIN ON THE PENISTONE ACCIDENT.

MAJOR MARINDIN'S report to the Board of Trade on the Penistone accident has just been published. We append the conclusions at which he has arrived. It will be seen that they bear out fully the views we have previously expressed on the subject. Nothing can well be stronger than the language used by Major Marindin in speaking of the Smith vacuum brake; and we venture to commend Major Marindin's words to the shareholders of the London and North-Western, South-Eastern, and other lines. If juries once get into the habit of regarding the absence of automatic brakes as evidence of neglect on the part of railway directors to provide for the safety of passengers, the prejudices of railway officials will prove extremely costly—so costly, we hold, that few shareholders will care to incur the expense. The whole drift of opinion is in favour of automatic brakes, and such men as Sir Edward Watkin and Mr. Moon can no more prevent their ultimate adoption than Mrs. Partington could keep out the Atlantic Ocean with a mop. Major Marindin's conclusions run as follows:—

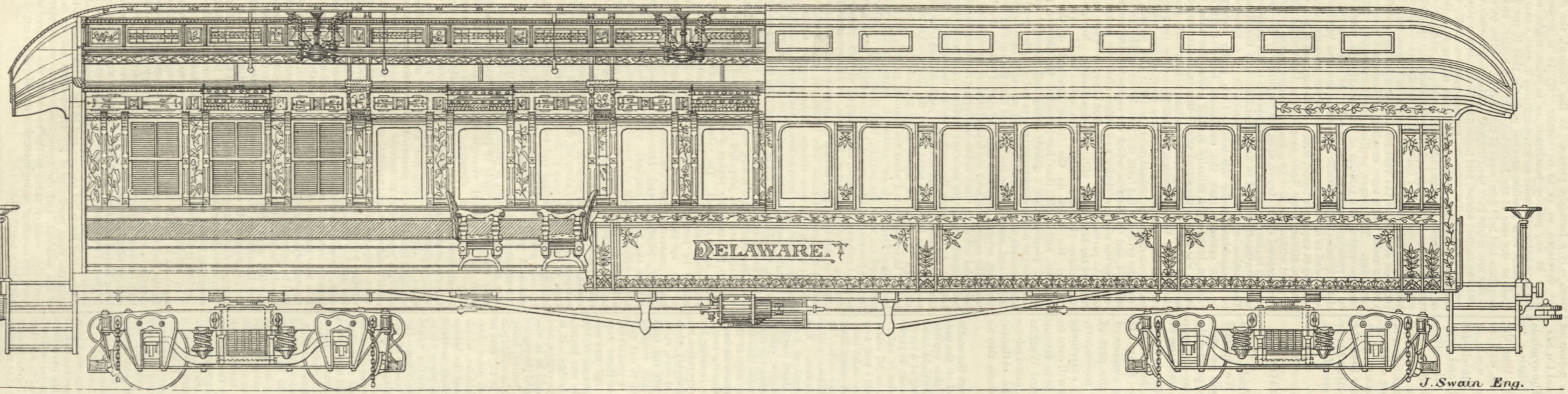
It is clear from the evidence detailed above, and from the result of a personal examination of the engine and train, and of the permanent-way at Bullhouse, that the primary cause of this terrible disaster was the breaking of the outside web of the right-hand crank on the driving-axle, while the engine was running at a speed of something under 50 miles an hour, at or near a point 66 yards west of Bullhouse signal-cabin. The fracture of axles is unfortunately not a very uncommon occurrence, as many as 247 crank or driving-axles having been broken in the year 1883; but, as a rule, no serious consequences have followed when these axles have failed in running, and the trains have in many cases been brought to a stand without any vehicle leaving the rails. In this case, however, owing to the peculiar conditions under which the fracture took place, it was far otherwise. The train was running at high speed, on a falling gradient of 1 in 124, and on a curve of 40 chains radius, and was just about leaving a cutting to enter upon an embankment across a narrow valley, with an under-bridge near the middle of it, so that, when the road was broken up behind the engine, it was almost inevitable that the carriages should run off at a tangent, and fall over the edge of the embankment. The left driving wheel of the engine seems to have mounted the outside rail of the curve immediately after the crank broke, but to have dropped into its place again after running for 18in. on the top of the rail, and to have repeated this operation six times at nearly equal intervals of about 18ft. 6in., probably when the two broken parts of the crank came into contact at each revolution of the wheel; the left driving wheel then left the rails altogether, and when passing the check rail of the crossing opposite to the signal-box, on the left side, wrenched it out and threw it back into the bottom of the tender, which it penetrated to a considerable depth; from this point eastwards there were several chairs broken along the left side, but the left rail was not actually torn up until the engine had run for a distance of 168 yards from the place where the first mark on the rails was found, and was within 75 yards of the centre of the under bridge. It is probable that, from this point, the driving wheels of the engine, and all the wheels of the tender, and of the leading vehicle in the train—a horse-box—ran over the sleepers and ballast until the engine came to a stand 274 yards east of the centre of the bridge, being kept in line by the bogie of the engine, which was running forward upon good rails, and that upon the parting of the coupling at the rear of the horse-box, which, as far as can be ascertained, took place close to the bridge, the two or perhaps three leading vehicles, which must have been already off the rails, ran over the side of the bridge and the east abutment of the bridge. Each successive carriage must have run off at a tangent upon arriving at the place where the outer rail of the curve was torn up, and the marks would indicate that the six or seven rear vehicles ran obliquely down the embankment, from a point 75 yards west of the centre of the bridge, or thereabouts, into a position shown on the attached plan, and with the result recorded above. It is difficult to account for the sudden fracture of the crank; for, although there was undoubtedly a small growing flaw in the web close to the end of the big-end bearing or journal, the dimensions of the flow did not exceed 4½in. in length, and 2in. in depth at the deepest part. There does not appear to have been any sudden or violent shock; the permanent-way was in good order; the curve was true and even, with a sufficient amount of superelevation of the outer rail; and the engine was in proper condition, and is stated to have been running smoothly and well; while the absence of any marks upon the permanent way on the right-hand side, and the nature of the fractures of the side rod and outside crank arm on this side, which were found broken after the accident, negative the theory which was advanced, that the side rod broke first, and that the striking of the end of the broken part against the permanent way gave a sufficiently violent shock to the engine to cause the crank to give way. Although, therefore, this disaster is to be attributed to a pure accident, and to one of a character not uncommon, it becomes material to inquire:—(1) Whether this accident might have been prevented by any human foresight; (2) whether there were any contributing causes which were preventible; (3) whether the effects might have been mitigated by the use of any safety appliances in common use; (4) what precautions it would be advisable to adopt to prevent such accidents in future. Taking these considerations *seriatim*:—(1) I have no hesitation in stating my conviction that the accident to the crank was one which could not have been foreseen or prevented. The growing flaw in the web of the crank was one which could not possibly have been seen, unless the big end of the connecting rod had been taken down from the bearing or journal; and as I am not prepared to say that the flaw extended through the outer surface of the metal up to the very last moment before the web broke, it is quite possible that it might have escaped detection even under these circumstances. The rule of the company that the cranks are to be critically examined by a competent person once a week, and monthly with the big ends taken down, seems to have been adhered to; and it is, in my opinion, quite credible that at the time the big end was last taken down and the whole surface of the crank exposed to view, only a fortnight previous to the accident, the flaw had not developed so as to be visible. (2) It is impossible to arrive at any positive conclusion as to what might or might not have happened under certain conditions in such a case as this, but I think it is possible, or even probable, that if the draw-bar hook at the rear of the horse-box had not broken, and all the couplings had held firm, some of the leading vehicles in the train at any rate might have been dragged safely along the line, together with the engine, tender, and horse-box; but I do not think that, even under these circumstances, the rear vehicles could, with the brake-power available, have escaped from falling over the bridge or embankment, considering the speed at which they were running when they arrived at the point where the outer rail of the curve had been torn up; indeed, it is possible that the draw-bar hook broke only under the enormous strain thrown upon it by the very fact of some of the vehicles behind it falling over the bank, a strain under which some coupling or headstock was certain to give way. The proper position for horse-boxes, fish-trucks, carriage-trucks, and vehicles of this description, when attached to a passenger train is, undoubtedly, at the rear of it. But the exigencies of the traffic often cause them to be placed otherwise; and as in this case the horse-box was properly equipped for running in passenger trains, with a draw-bar hook of the approved pattern, although not quite so strong as those which have been adopted within the last two years, in consequence principally of the increased strain thrown upon the couplings by the use of continuous brakes, I consider that the position of the horse-box in this train can hardly be held to have contributed to the disaster. (3) The action of the continuous brake is the principal thing to be considered under this head. It is pretty clearly proved by the evidence that the continuous brake—Smith's simple vacuum brake—was actually applied about the time that the engine was passing the signal cabin—that is, about two and a-half seconds after the crank broke, and at a point 177 yards from the centre of the over bridge, and 102 yards from the point where the line was first torn up, and where most of the vehicles afterwards ran down the embankment; and it is also certain, not only from the evidence, but from the manner in which the train was wrecked, and the distance which the engine, tender, and horse-box ran over the sleepers, chairs, and ballast after the brakes came off upon the parting of the coupling, that the speed when the engine reached the bridge was still very considerable. Now, while I do not believe that any brake which exists could have actually stopped the train on the falling gradient in the distance available, and could thus have averted the disaster, yet it is beyond question that a quickly-acting and powerful continuous brake ought in this distance to have so reduced the speed that the consequences of the accident would probably have been far less fatal; and, assuming for the moment that the vacuum-brake pipes were not severed until the coupling parted behind the horse-box when the engine was near the bridge, it must be conceded that this brake did not do as much towards stopping the train as might have been expected from its recorded performances with experimental trains. Again, when the engine was at the centre of the bridge, the rear vehicle in the train was 139 yards distant from this point, and 75 yards from the point where the line was broken up, and, although the vehicles immediately behind the horse-box could hardly have been saved when the coupling parted, yet, if the train had been fitted with an automatic brake, which would have remained on when the parting took place, it is probable that the four or five rear vehicles would, by its continued action and the consequent reduction of speed, have escaped with comparatively little damage. The explanation, however, of the apparent inefficient action of this brake may be that one or more of the brake pipes were broken or damaged some time before the engine arrived at the bridge; and if this were the case, the automatic action, had such existed, would have been so much the sooner brought into play. It is quite impossible to say when the pipe under the tender was broken, whether in the act of getting it on the rails or before; but it was found broken when the tender was examined, and it is far from improbable that it was cut by the check rail, when this rail was thrown out and propelled through the bottom of the tank; and in this case the brakes would hardly have been in action before being released. The value of a brake having rapid action, and, above all, automatic action, in such a case as this can hardly be contested; and although the Board of Trade has, as yet, no power to insist upon the adoption of a continuous brake possessing these qualities, yet I would remind the Manchester, Sheffield, and Lincolnshire Railway Company that this is the second emphatic warning which has been given to them within the last six months as to the need for automatic action in the brakes used on their line; the previous instance being on the 6th February, 1884, when, after a carriage had left the rails when running at high speed near Dinting station, the vacuum brake was severed, the brake became useless, and the carriage was dragged along off the rails for over 350 yards further than it would have been if the brakes had remained on, at the imminent risk of falling and taking with it the carriages behind it, over a viaduct 100ft. in height. (4) As to the precautions which it would be advisable to take in order to prevent a recurrence of such an accident, I would remark that the giving way of a crank which is proved by the evidence and tests to have been properly made of steel of good quality, and to have been of exceptional strength and weight, and which had only run for a distance of 50,776 miles, should lead locomotive engineers to consider carefully the relative advantages of engines with inside cylinders and crank axles, as compared with engines with outside cylinders and straight axles; of steel axles as compared with iron axles; and of cranks hooped with wrought iron bands, as compared with cranks having the additional strength provided by an increase of metal in the webs of the crank itself; and as it might assist them in their deliberations if a return were prepared showing the proportion of crank axles and of straight axles which have failed during a given period, relatively to the number of such axles in use upon engines throughout the kingdom, I would recommend that such a return, distinguishing also between iron, steel, and hooped axles, should be prepared and issued. It is also manifest that the more frequently cranks are examined thoroughly, the greater probability there will be that growing flaws will be detected, and I would therefore recommend that the big ends should be taken down at the weekly examinations, instead of only monthly as at present; and as regards the Manchester, Sheffield, and Lincolnshire Railway Company in particular, I would observe that there must be considerable and unjustifiable risk in running a suspected axle under observation, when an apparent flaw has not been extended by the test to which it has been subjected, which, according to the evidence of the superintendent of the works at Gorton, is the present practice upon this line.

In conclusion, I would call attention to what cannot but be regarded as satisfactory features in connection with this sad affair. In the first place there is not the smallest fault to be found with the manner in which the servants of the company performed their duties both before and after the accident; and I wish especially to record my opinion that there are no grounds whatever for supposing, as has been hinted and even published, that the signalman at Bullhouse neglected to place his signals at danger until warned by a passenger to do so, or that there was any unreasonable delay in the despatch of the relief trains; and in the second place it is probable that the close proximity of Mr. Hinchcliffe's colliery to the scene of the accident, and the promptitude with which the workmen from this colliery came to the rescue of the injured passengers, were the means of saving more than one life which might otherwise have been sacrificed.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—William Barclay, chief engineer to the Asia for the Dreadnought; and Robert J. Barker chief engineer to the Canada.

AMERICAN PALACE CAR.

THE JACKSON AND SHARP COMPANY, WILMINGTON, DEL., ENGINEERS



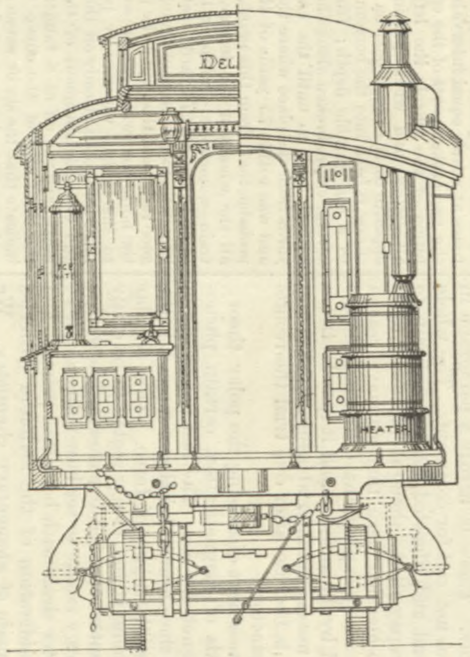
THE CHICAGO RAILWAY EXPOSITION.

No. XIV.

A LARGE number of passenger cars were exhibited at Chicago, and nearly every variety of car used in America was well represented. Many of these very handsome and luxurious vehicles have been already briefly alluded to in these articles, and it is a matter of regret that the limited space at our disposal does not permit of a more detailed description. The sleeping and dining-room car has been received with a great deal of favour in Great Britain, and it is to be hoped that their use will become more general. The company that will run dining cars between London and Perth or Edinburgh, or sleeping cars between, say, Newcastle and Bristol, will, or should, earn the gratitude of the frequent traveller. The Jackson and Sharp Company, of Wilmington, Del., exhibited a first-class car, which was awarded the gold medal. This car is illustrated above, but it is impossible in an engraving to give an adequate idea of the beauty and taste displayed in the internal decorations. This car is intended to carry ordinary passengers at the usual fare—about 1½d. per mile, or slightly less than our parliamentary fare of 1d. per mile, when the difference in the purchasing power of money in America as compared with this country is taken into consideration.

The car seats fifty-eight passengers, and the maker's price is 8000 dols., or £1600. It is not, therefore, more expensive, for the number of passengers conveyed, than an ordinary English first-class carriage, but probably equals the most costly saloon in the convenience of its appointments, and surpasses it in the artistic beauty of its interior. No expensive inlaid woods or veneers are used, but the sides, ends, partitions, &c., are lined with light-coloured mahogany, divided by elaborate mouldings into panels, which are decorated by graceful and artistic specimens of hand carving, natural leaves, flowers, &c., being the objects represented, each panel being of a different design. One panel represents a spider's web, in which a fly has been caught, the insects and the fine lines of the web being all carved with great delicacy and skill. Over every third window is a little ornamental balcony, two turned pillars supporting a carved mahogany shelf, the background being painted with various designs of birds, flowers, natural leaves, &c. As such carving can be produced at less cost than the hideous and shapeless top-knots with which many of our railway carriages are adorned, it is to be hoped that some enterprising carriage builder will try some artistic wood carving. As the carving is simply lightly cut into a flat surface, little manual labour is involved, and one skilful carver will decorate all the cars built by several hundred men. South Kensington has widely spread the necessary art training, and once the outlined design is sketched on the surface of the wood, the requisite precision and delicacy in carving are soon acquired by practice.

The seats are arranged in the manner usual in American cars, and have reversible backs. The arms are of carved mahogany, and the backs and seats are covered with crimson and old gold



CROSS SECTIONS OF PALACE CAR.

plush. The parcel racks, doorlocks, window and seat fittings are all of polished brass of very tasteful design, and gold lacquered. The windows are of thick French plate-glass, and are shaded by double slat blinds of bass wood—an even-grained white wood much used for this purpose in the States. The ceiling is lined with birdseye maple veneer, painted with decorative designs. The floor is covered with a bright-coloured Wilton carpet. At one end of the car is a sort of ante-room, fitted as a lavatory, with a marble basin, into which cold water can be pumped from a tank underneath, and in winter hot water can be drawn from the pipes heating the car.

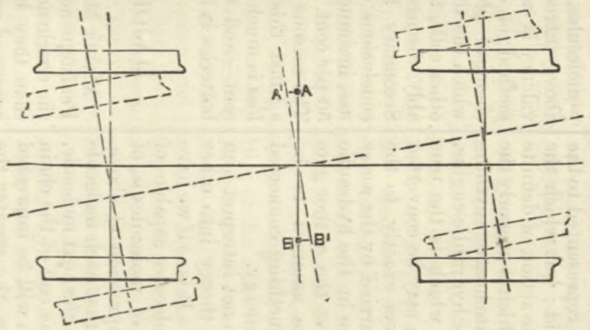
The outside of the car is painted in a very elaborate manner, as will be seen on referring to the illustration. The major part of the body is painted a light canary yellow, the longitudinal panel above the windows and the corner posts being lake. A large amount of gilding is used, and though the whole effect is very rich, and possibly well suited to the bright, clear, sunny American climate, it hardly produces the same pleasing effect as the extremely tasteful and beautiful carvings in the interior of the car. It may be mentioned that bright yellow and straw colour are by some American authorities considered the more durable colours for car painting. The hand and platform railings are all silver-plated.

The car was lit by the Foster compressed gas—an American system of lighting railway carriages which somewhat resembles the well-known Pintsch and Pope systems in use in England. The gas is made from crude petroleum or naphtha, and is compressed to a pressure of 40 atmospheres, and carried in lap-welded cylinders, 15in. diameter, fixed underneath the floor of the car. A governor, or reducing valve, diminishes this pressure to seven-tenths of an inch of water at the burners. The compression is effected in two stages, by two single-acting plungers of different diameters. The cubic, but not the lineal, amount of clearance is reduced by the admission of water between the plunger and cylinder end. The amount of water admitted can be varied so as to regulate the amount of clearance. Five lights of four burners each were used, giving a total light equal to 260 candles. The lights are lit simultaneously by an electric spark, rendering it unnecessary for the attendant to touch, or even go near, a burner in order to light it.

The car is heated by Searle's patent heater. Fresh water circulating through pipes in a stove radiates its heat, and is re-heated by passing through a vertical coil of pipe. The hot water passes from the stove through straight pipes on both sides of the car to the end furthest from the stove, and there distributes its heat by means of a radiator, thus thoroughly warming the cold end of the car before permitting the water to return by means of bent pipes under the seats to the stove again. An even temperature is thus secured, which is a matter of some difficulty in car heating.

The car is supported on two four-wheeled bogies, made by the Suspension Car Truck Manufacturing Company, of Mills-building, New York. The principle on which this truck works is novel, and has excited much attention in America. At the Master Car Builders' Convention, held at Chicago during the Exposition, many of the speakers regarded the suspension principle as likely to be adopted on the standard truck for the United States and Canada. As is well known, the Master Car Builder's standard car axle, axle-box, and brass are widely adopted throughout North America, and the convenience and economy in effecting repairs on foreign cars at a distance from their own line has been so great that the adoption of standard trucks for passenger and freight service respectively is under consideration.

The weight of the car is placed upon the truck or bogie by means of frames resembling the letter A placed upside-down, the feet or serriffs of the letter being attached to the under-side of the main framing of the car. The lowest points of the A frames are connected



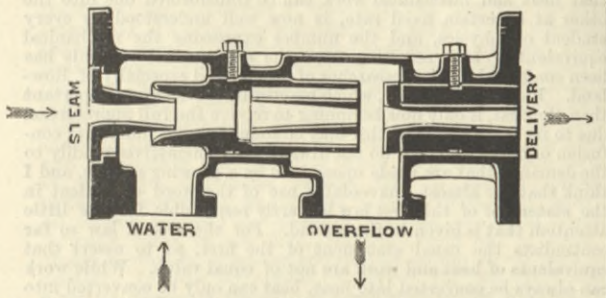
by means of a long horizontal pin, its length being at right angles to the longitudinal axis of the car. This pin bears on the lower ends of two links, the upper ends of which embrace pins which bear on the cross frames of the bogie. The weight of the car, therefore, is suspended from the bogie by these two links, which form the only connection between bogie and car, centre pins and side bearings being alike dispensed with. This absence of any rigid connection is in itself an advantage, independently of the question of rounding curves, as any obstacle struck by the wheels, such as the nose of a crossing, &c., simply retards the truck, the car continuing to move forward until the inclination of the links overcomes the effect of the shock and restores the normal mutual position of the car and truck. As the links are in tension, any inclination tends to lift the car and increase the vertical distance between it and the bogie. The weight of the car, therefore, always tends to keep the links in a vertical position.

When the bogie enters a curve, the links become inclined in opposite directions, the side of the truck nearest the outside of the curve moving forwards, and correspondingly inclining the link. The link nearest the inside of the curve is similarly inclined in the opposite direction. This is clearly shown in the annexed diagram, in which the full lines show the position on the straight, and the dotted the position the truck assumes on a curve. The full longitudinal centre line represents the longitudinal centre of the car itself. It will be seen that the point A, or the upper end of the outside suspension link, is moved forward to A^1, and that the inner link is similarly moved back from B to B^1. The inclination of the links tends to pull the body of the vehicle round the curve, and at the same time tends to restore the bogie to its normal position when it reaches a piece of straight road. It may be mentioned that the suspension links are a loose fit on the pins, and thus allow the necessary swivelling motion.

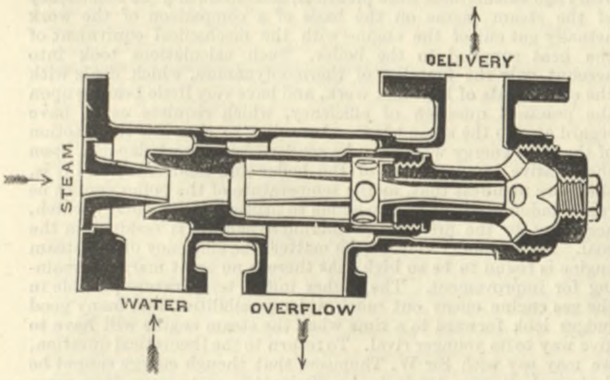
The bogie shown in our illustration has a further application of the suspension-link principle in the manner in which the side play of the axle-boxes is regulated. On referring to the engraving, it will be noticed that the spring beam does not, as usual, rest on the top of the axle-box, but is suspended beneath the box by links which embrace the spring beam and are connected together at the top, forming a rounded bearing which spans the top of the axle-box. Each axle, therefore, has independent side play, governed only by the inclination of the links. A model bogie shown at Chicago ran over an extremely crooked piece of line with great smoothness, though the rails were purposely bent and deformed in a manner which would render it impossible to move an ordinary stiff wheel-base vehicle at all.

GRESHAM'S PATENT IMPROVED SELF-ACTING INJECTOR.

WE illustrate below an injector patented by Mr. Gresham, of the firm of Gresham and Craven, Manchester. This injector has the important advantage that if "knocked off" by a jerk, as when an engine is running over points or crossings, it will automatically re-start itself instead of having to be re-started



by hand. The receiving or delivery cone is made to slide freely in its bearing, so that when steam is turned on it passes through and around the combining cone, thus creating a partial vacuum in the water pipe, and so lifting the water. Immediately the water comes in contact with the steam condensation takes place, thus centralising the jet of steam and water, which then passes through the combining cone only, and then on into the receiving cone, creating sufficient pressure below the latter to force it up until it comes in contact with the bottom of the



combining cone. Should the injector cease to work from shortness of water, or any other cause, the steam forces the receiving cone away from the combining cone, when the same action takes place as before, and the injector re-starts itself without any manipulation whatever, and is thus perfectly automatic.

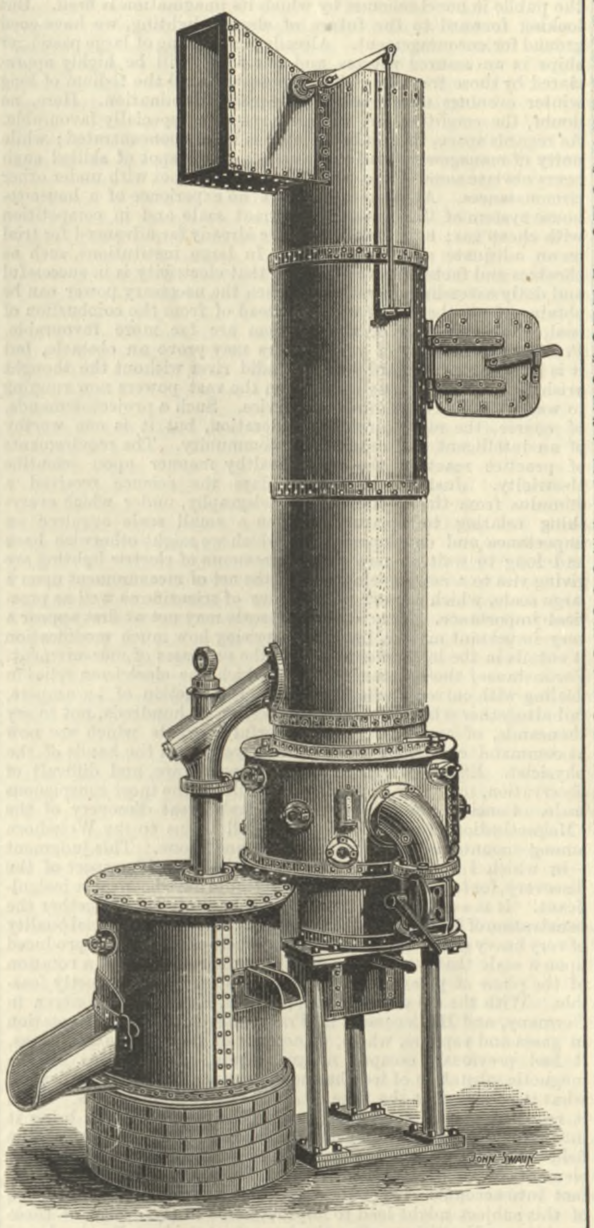
The sealing of the overflow from the atmosphere is a great advantage, as it enables the injector to work freely with hot water, without the necessity of closing the overflow by mechanical means, as is done in many injectors, in which, when from any cause they cease to work, the steam rushes up the water pipe and warms the water, without calling the attendant's attention to the fact of the injector having ceased to work. This injector will lift 15ft.

THWAITES' "RAPID" CUPOLA.

THE cupola illustrated by the accompanying engravings is made by Messrs. Thwaites Brothers, of Bradford, under Stewart's patent. It will be seen that it is of the receiver class, and, unlike the Kreuger furnace used in Germany and illustrated in THE ENGINEER, Vol. L., 1880, the receiver is separate from the cupola.

The shell of the cupola is of plate iron with butt joints, covered with strips and rings, and rivetted together with cup head rivets outside, the heads inside being flattened to allow the brick lining to fit close to the shell, which is of one diameter and parallel inside. There are several rings of angle iron inside shell in the length of the cupola to support the lining. To the shell is attached an annular air belt. Referring to the engravings, it will be seen that on each side of the air belt is secured a cast iron quarter-bend blast pipe, and to each bend is connected a turned shut-off valve. Inside the shell and communicating with the air belt, are three rows of cast iron tuyeres. The two bottom rows each consist of three tuyeres, and the top row of six tuyeres. All the tuyeres are fastened to the shell with bolts and an asbestos ring. Opposite each of the top tuyeres in the air belt is fixed a cast iron shut-off turned plug valve. The plugs of these valves come through cover plates fixed upon the top of belt. All the plugs are fitted with small spocket wheels, and are connected to each other with Ewart's malleable chain, so that all can be controlled from one handle at any convenient position. Opposite each tuyere is fixed a seat with sliding door, fitted with blue-tinted glass peep-holes. In front of each glass is a mica disc. Upon the air belt is a blast pressure gauge to indicate the pressure of air in cupola. The upper part of cupola above the belt is provided with charging door—fire-brick lined—and with damper door and shield at the top, on one side. The cupola stands upon a cast iron base plate. This base plate is fitted with a wrought iron hinged drop bottom door, in halves, opening from the centre. Each half of the bottom is connected to a shaft, on which is fixed a wrought iron hand lever. A strong wrought iron bolt is shot across the door when closed, securely retaining it in position. A fettling door is provided at the back of the cupola. The base plate of the cupola is supported by four cast iron pillars upon a strong cast iron bed-plate. The receiver shell is also made of plate iron, with angle iron ring, top and bottom, and cover plate on top; and provided, as shown, with tapping hole, spout and fettling door, slag hole and spout, and hot-air pipe and plug to convey hot air from the top of the receiver into cupola.

Several advantages as attending the use of this cupola are claimed by the makers, not the least important of which is its speed. According to the experiments of Dulong, 1 lb. of carbon combining with the necessary quantity of oxygen to form carbonic acid, developes 12,906 units of heat. The specific heat of cast iron being about ·13, the melting point 2190 deg., and the coke containing 82 per cent. of carbon, then to heat a ton of



cast iron of a temperature of, say, 40 deg., to a temperature of 2190 deg. would require

$$2190 - 40 = \frac{\overset{\text{Heat}}{2150} \times \overset{\text{Iron}}{2240} \times \overset{\text{Sp. heat}}{\cdot 13}}{12906 \times \cdot 82} = 59{\cdot}1 \text{ lb. coke.}$$

This is supposing that the whole of the carbon is converted into carbonic acid, but if by any means carbonic oxide is formed a very different result is obtained. Then 1 lb. of carbon burning to carbonic oxide only evolves 4453 units of heat. If, however, by admitting air above the zone where the oxide is formed, we recover 4478 units, this + 4453 gives 8931. This is a little over two-thirds of the available heat to be got out of 1 lb. of carbon, allowing 10 per cent. for moisture in the coke, 10 per cent. for radiation, or 40 per cent. in all. The amount of coke per ton of metal should not exceed 112 lb., although the actual consumption is usually much higher. On this point we may quote the following result of a blow made on the 8th March last at Messrs. Rushforth and Co.'s St. James's Foundry, Bradford, with a cupola 4ft. in diameter and 19ft. length of shell:—

	Time.	Charge of coke in lb.	Charge of iron in lb.
Time of lighting fire	10.0 a.m. ..	Bed 336 ..	1792
Put in coke for bed of cupola	10.30 ,, ..	,, 112 ..	2016
Making up of door	11.0 ,, ..	,, 112 ..	2016
Commenced charging	11.5 ,, ..	,, 112 ..	2016
Filled up cupola	12.30 p.m. ..	,, 112 ..	2016
Commenced blasting	1.5 ,, ..	,, 112 ..	2016
Metal running down	1.15 ,, ..	,, 112 ..	2016
Took away first metal in		,, 112 ..	2016
35 min. after blasting ..	1.40 ,, ..	,, 112 ..	2016
2nd metal taken	2.15 ,,		
3rd do. do.	2 30 ,,	1232	17920
4th do. do.	2.35 ,,		
Finished charging	2.15 ,,		
Finished blasting	2.35 ,,		
Fuel used for bed coke			336 lb.
Fuel used for fusion coke			896 lb.
Total consumption of fuel			1232 lb.
Amount of iron melted in cupola			17,920 lb.

The speed of the blower was from 425 to 430 revolutions per minute, and the pressure varied between 29in., 32in., and 37in. of water. The above figures show that 8 tons of iron were melted, with 1232 lb. of coke in one hour and a-half, time from starting to finishing blowing. The time taken to melt the iron after having taken away the first ladleful of metal from the receiver to taking away last metal was 55 minutes. This gives 14·54 lb. of iron to 1 lb. of coke, or, taking the coke used, exclusive of the bed coke, namely, 896 lb., and weight of iron melted, 17,920 lb., we have 1 cwt. of coke per ton of iron, and the makers say that the cupola will never "make up" if care is taken in charging 1 cwt. of coke per 18 cwt. of iron.

It is unnecessary to say anything further as to the economy of the cupola in working, but it may be mentioned that it is claimed that less blast is used, as it has not to traverse so heavy a mass as in the ordinary cupola, that the wear and tear is less, and that the melted metal is obtained freer from impurities, while it is made hotter.

In their description, the makers observe that the bottom of the cupola is raised up to the tuyeres, so that the metal as fast as melted runs straight into the receiver. "The hot blast also enters receiver at the same pressure as the inside of cupola furnace. This blast agitates and mixes the metal in receiver, and then the hot air from receiver is carried back through a vertical pipe into the cupola, above the belt, and is by this means utilised in heating up the iron in upper part of cupola. The receiver, which is applicable to new or existing cupolas, enables such a quantity of molten metal to be stored up and kept to a proper temperature, that with an ordinary-sized cupola large steam hammer blocks may be cast with the same ease and certainty as smaller castings, and at the same time the metal may be held in reserve for any required length of time whilst the moulds are being prepared. It will be noticed that as the blast is diverted in its course, and does not entirely pass through the charge, the coke or fuel is not consumed before it is required for melting the metal, and hence a much smaller quantity of fuel is required to melt a given quantity of metal." Some of the cupolas are being fixed in France for the Thomas-Gilchrist steel process, and they have also been introduced for smelting copper ores. The metal, in the latter case, is run into large portable receivers, and is then taken to other refining furnaces, or run into the ingot direct.

The following, on introducing fine slack coal in the blast as mentioned by the makers, is of interest:—In the United States pulverised coal and fine slack have been used in cupolas. The practicability of this utilisation of a comparatively waste product was discovered in the following manner: There had been some trouble through scaffolding in the cupolas, and to melt down the "salamander" the manager withdrew the tuyere pipes, rammed in a lot of small coal through the tuyere holes, and again put on the blast. The scaffolding was removed in a very short time, and the work proceeded as usual. The blast pipe was then perforated, and a small quantity of fine coal was supplied to the cupola through the tuyeres, which it was found not only prevented scaffolding, but caused the cupola to work much more rapidly. The great waste in melting iron in a cupola usually occurs at the zone of the tuyeres on account of the large quantity of air blown in, and the absence of carbonic oxide at that point. What little carbon the air comes in contact with at this point forms carbonic acid, which is almost as destructive to the iron as free oxygen. The principal waste of the metal occurs after its fusion, and in its passage through this carbonic acid and atmosphere. By the injection of the fine coal with the blast its combustion is secured at the zone of the tuyeres, producing carbonic oxide, and thus preventing the oxidation of the descending metal. Beyond saving the waste of iron by this improvement, a much larger percentage of the carbon which the pig contains is transmitted to the converter, an advantage which would also be of great value in all cupolas for melting iron for castings; as the chief difficulty in that line is that the carbon is burnt out of the metal, and metal thus prepared is said to run more fluid and to produce finer and tougher castings than that melted in the ordinary manner.

The following from the directions for lining is also worth quoting:—"The durability of fire-bricks depends largely upon the amount and quality of the fire-clay used in laying them, and the way they are fitted together. If wide spaces are allowed, and too much fire-clay used, there is shrinkage in the first heat, the bricks are attacked on all sides, and the key or wedge of the brick is lost. Only use the best fire-clay; thin it with water to the consistency that will allow the brick to be dipped; fit the bricks so closely that, being dipped, they will take up sufficient slip to make the joint when rubbed together; fill all spaces with the thin slip, and dry with a slow fire."

AN EXTRAORDINARY MODEL.—Dr. Freire, of Rio Janeiro, describes in a recent number of the *Scientific American* some of the handiwork of a man named Yeo, of Thirkwood, near St. Louis, who carves all manner of things with a pocket-knife. "At this writing," says Dr. Freire, "he is engaged upon a momentous undertaking, which, if successful, he believes will be the masterpiece of his life—an automaton water and landscape of nearly 300,000 pieces and 1100 movements, to be put in motion by means of an overshot wheel driven by a stream of sand falling from a hopper. This will occupy a space of 48ft. by 16ft., is already more than half completed, and embraces windmills, lighthouses, towers, bridges, railways and trains, canal boats, steamers and sailing crafts, hills, dwellings, &c., besides a Noah's ark, a copy of the Strassburg Cathedral and its wonderful clock, model of the New York, West Shore, and Buffalo Railway Depôt at Buffalo, and a host of moving and performing figures. Of these, a brig weighing less than ½ lb. and complete in all details, containing 1800 distinct pieces; Noah's ark, 40in. long, 3400 pieces; the depôt, 11 by 14 and 9ft. high, is a wonderful piece of work, out of which trains will dart at intervals, the same movement putting in motion some ninety figures on the platform and in and about the building. Besides the ordinary features of the Strasburg clock, the chimes in the spire, on striking, cause the Virgin to appear before the cross on the altar of the cathedral in a supplicating attitude; two hundred figures leave the choir, and moving down the main aisle pause for a moment contemplating her, and then disappear behind the altar piece. At stated periods, also, the inhabitants of the ark sally forth by a gangway, and defiling down the side of the hill, return by a circuitous route, entering in the same way at the opposite side. Canal boats pass up the river; vessels in harbour toss upon the water; figures in door yards pursue their usual vocations, while in one instance a man constantly saws wood, while another as monotonously plies the axe. One of the peculiar features of the work is that each subject is complete in itself, and independent of the others—may be used separately or connectedly at the will of the operator. Again, aside from paint and cloth, nothing but wood enters into the construction, saving the chimes of the cathedral and the iron shaft of the main wheel. When I saw the affair, I was told that it had proceeded to the extent of 2500 cigar boxes and 800ft. of pine and white wood, and would require as much more, and more than a year's hard labour, before arriving at completion. It would appear too ponderous for removal or exhibition, but the builder asserts his ability to take down and pack in small compass, suitable for transportation, in less than three hours, and again to unpack and put together again in less than half a day.

THE BRITISH ASSOCIATION.

On the 27th instant the first meeting of the British Association at Montreal took place. The Council of the Association met in the morning and completed its report, which was submitted to the General Committee. The report of the Council states that a new section has been formed for anthropolgy; various matters will be deferred until the general committee meets in London on November 11th. Then also the president, officers, and council for the next year will be chosen, the date of the 1855 meeting decided on, and the place of meeting for 1886.

The members of the Association assembled at Queen's Hall in the afternoon, when the mayor and aldermen of Montreal presented an address. Appropriate replies were made by Sir William Thomson and Lord Rayleigh. The first general meeting of the Association was held in the evening, in Queen's Hall, which accommodates about 1600 people, and was crowded. This meeting was confined to British, Canadian, and American members, it being found impossible to admit the public, there was such great pressure for admission. Lord Lansdowne, the Governor-General, Mayor Beaudry, of Montreal, Lord Rayleigh, and other officers of the Association, filled the platform. In the absence of Professor Cayley, the outgoing president, Sir W. Thomson temporarily occupied the chair. Lord Lansdowne made a short speech, which he concluded by saying: "As representative of the Crown in this part of the Empire, it is my duty and pleasure to bid you, in the name of our people, a hearty welcome to the Dominion." Sir W. Thomson—representing Professor Cayley, absent—said a few words in resigning, on the part of Professor Cayley, the presidential chair, and introduced Lord Rayleigh, who then delivered the following presidential address:—

"It is no ordinary meeting of the British Association which I have now the honour of addressing. For more than fifty years the Association has held its autumn gathering in various towns of the United Kingdom, and within those limits there is, I suppose, no place of importance which we have not visited. And now, not satisfied with past successes, we are seeking new worlds to conquer. When it was first proposed to visit Canada, there were some who viewed the project with hesitation. For my own part, I never quite understood the grounds of their apprehension. Perhaps they feared the thin edge of the wedge. When once the principle was admitted, there was no knowing to what it might lead. So rapid is the development of the British Empire, that the time might come when a visit to such out-of-the-way places as London or Manchester could no longer be claimed as a right, but only asked for as a concession to the susceptibilities of the English. But seriously, whatever objections may have at first been felt soon were outweighed by the consideration of the magnificent opportunities which your hospitality affords of extending the sphere of our influence and of becoming acquainted with a part of the Queen's dominion which, associated with splendid memories of the past, is advancing daily by leaps and bounds to a position of importance such as not long ago was scarcely dreamed of. For myself, I am not a stranger to your shores. I remember well the impression made upon me, seventeen years ago, by the wild rapids of the St. Lawrence and the gloomy grandeur of the Saguenay. If anything impressed me more, it was the kindness with which I was received by yourselves, and which I doubt not will be again extended not merely to myself but to all the English members of the Association. I am confident that those who have made up their minds to cross the ocean will not repent their decision, and that, apart altogether from scientific interests, great advantage may be expected from this visit. We Englishmen ought to know more than we do of matters relating to the Colonies, and anything that tends to bring the various parts of the Empire into closer contact can hardly be overvalued. It is pleasant to think that this Association is the means of furthering an object which should be dear to the hearts of all of us; and I venture to say that a large proportion of the visitors to this country will be astonished by what they see, and will carry home an impression which time will not readily efface. To be connected with this meeting is, to me, a great honour, but also a great responsibility. In one respect, especially, I feel that the Association might have done well to choose another President. My own tastes have led me to study mathematics and physics rather than geology and biology, to which naturally more attention turns in a new country, presenting as it does a fresh field for investigation. A chronicle of achievements in these departments by workers from among yourselves would have been suitable to the occasion, but could not come from me. If you would have preferred a different subject for this address, I hope, at least, that you will not hold me entirely responsible."

After speaking of the great loss the Association had sustained by the death of Sir W. Siemens, and in very high terms of his great work, the President continued:—"It is now several years since your presidential chair has been occupied by a professed physicist, and it may naturally be expected that I should attempt some record of recent progress in that branch of science, if indeed such a term be applicable. For it is one of the difficulties of the task that subjects as distinct as mechanics, electricity, heat, optics and acoustics, to say nothing of astronomy and meteorology, are included under physics. Any one of these may well occupy the life-long attention of a man of science, and to be thoroughly conversant with all of them is more than can be expected of any one individual, and is probably incompatible with the devotion of much time and energy to the actual advancement of knowledge. Not that I would complain of the Association sanctioned by common parlance. A sound knowledge of at least the principles of general physics is necessary to the cultivation of any department. The predominance of the sense of sight as the medium of communication with the outer world brings with it dependence upon the science of optics; and there is hardly a branch of science in which the effects of temperature have not—often without much success—to be reckoned with. Besides, the neglected borderland between two branches of knowledge is often that which best repays cultivation, or, to use a metaphor of Maxwell's, the greatest benefits may be derived from a cross fertilisation of the sciences. The wealth of material is an evil only from the point of view of one of whom too much may be expected. Another difficulty incident to the task, which must be faced but cannot be overcome, is that of estimating rightly the value, and even the correctness of recent work. It is not always that which seems at first the most important that proves in the end to be so. The history of science teems with examples of discoveries which attracted little notice at the time, but afterwards have taken root downwards and borne much fruit upwards. One of the most striking advances of recent years is in the production and application of electricity upon a large scale—a subject to which I have already had occasion to allude in connection with the work of Sir W. Siemens. The dynamo machine is indeed founded upon discoveries of Faraday now more than half a century old; but it has required the protracted labours of many inventors to bring it to its present high degree of efficiency. Looking back at the matter, it seems strange that progress should have been so slow. I do not refer to details of design, the elaboration of which must always, I suppose, require the experience of actual work to indicate what parts are structurally weaker than they should be, or are exposed to undue wear and tear. But with regard to the main features of the problem it would almost seem as if the difficulty lay in want of faith. Long ago it was recognised that electricity derived from chemical action is—on a large scale—too expensive a source of mechanical power, notwithstanding the fact that—as proved by Joule in 1846—the conversion of electrical into mechanical work can be effected with great economy. From this it is an evident consequence that electricity may advantageously be obtained from mechanical power; and one cannot help thinking that if the fact had been borne steadily in mind, the development of the dynamo might have been much more rapid. But discoveries and inventions are apt to appear obvious when regarded from the standpoint of accomplished fact; and I draw attention to the matter only to point the moral that we do well to push the attack persistently when we can be sure beforehand that the obstacles to be overcome are only difficulties of contrivance, and that we are not vainly fighting unawares against a law of nature. The present development of electricity on a large scale depends, however, almost as much upon the incandescent lamp as upon the dynamo. The success of these lamps demands a very perfect vacuum—not more than about one-millionth of the normal quantity of air should remain—and it is interesting to recall that, twenty years ago, such vacua were rare even in the laboratory of the physicist. It is pretty safe to say that these wonderful results would never have been accomplished had practical applications alone been in view. The way was prepared by an army of scientific men, whose main object was the advancement of knowledge, and who could scarcely have imagined that the processes which they elaborated would soon be in use on a commercial scale, and entrusted to the hands of ordinary workmen. When I speak in hopeful language of practical electricity, I do not forget the disappointment within the last year or two of many over-sanguine expectations. The enthusiasm of the inventor and promoter are necessary to progress, and it seems to be almost a law of nature that it should overpass the bounds marked out by reason and experience. What is most to be regretted is the advantage taken by speculators of the often uninstructed interest felt by the public in novel schemes by which its imagination is fired. But looking forward to the future of electric lighting, we have good ground for encouragement. Already the lighting of large passenger ships is an assured success, and one which will be highly appreciated by those travellers who have experienced the tedium of long winter evenings unrelieved by adequate illumination. Here, no doubt, the conditions are in many respects especially favourable. As regards space, life on board ship is highly concentrated; while unity of management and the presence on the spot of skilled engineers obviate some of the difficulties that are met with under other circumstances. At present we have no experience of a house-to-house system of illumination on a great scale and in competition with cheap gas; but preparations are already far advanced for trial on an adequate scale in London. In large institutions, such as theatres and factories, we all know that electricity is in successful and daily extending operation. When the necessary power can be obtained from the fall of water, instead of from the combustion of coal, the conditions of the problem are far more favourable. Possibly the severity of your winters may prove an obstacle, but it is impossible to regard your splendid river without the thought arising that the day may come when the vast powers now running to waste shall be bent into your service. Such a project demands, of course, the most careful consideration, but it is one worthy of an intelligent and enterprising community. The requirements of practice react in the most healthy manner upon scientific electricity. Just as in former days the science received a stimulus from the application to telegraphy, under which everything relating to measurement on a small scale acquired an importance and development for which we might otherwise have had long to wait, so now the requirements of electric lighting are giving rise to a new development of the art of measurement upon a large scale, which cannot fail to prove of scientific as well as practical importance. Mere change of scale may not at first appear a very important matter, but it is surprising how much modification it entails in the instruments, and in the processes of measurement. For instance, the resistance coils on which the electrician relies in dealing with currents whose maximum is a fraction of an ampère, fail altogether when it becomes a question of hundreds, not to say thousands, of ampères. The powerful currents which are now at command constitute almost a new weapon in the hands of the physicist. Effects which in old days were rare, and difficult of observation, may now be produced at will on the most conspicuous scale. Consider for a moment Faraday's great discovery of the 'Magnetisation of Light,' which Tyndall likens to the Weisshorn among mountains, as high, beautiful, and alone. This judgment—in which I fully concur—relates to the scientific aspect of the discovery, for to the eye of sense nothing could have been more insignificant. It is even possible that it might have eluded altogether the penetration of Faraday, had he not been provided with a special quality of very heavy glass. At the present day these effects may be produced upon a scale that would have delighted their discoverer, a rotation of the plane of polarisation through 180 deg. being perfectly feasible. With the aid of modern appliances, Kundt and Röntgen in Germany, and H. Becquerel in France, have detected the rotation in gases and vapours, where, on account of its extreme smallness, it had previously escaped notice. Again, the question of the magnetic saturation of iron has now an importance entirely beyond what it possessed at the time of Joule's early observations. Then it required special arrangements purposely contrived to bring it into prominence. Now in every dynamo machine, the iron of the field magnets approaches a state of saturation, and the very elements of an explanation of the action require us to take the fact into account. It is indeed probable that a better knowledge of this subject might lead to improvements in the design of these machines. Notwithstanding the important work of Rowland and Stoletow, the whole theory of the behaviour of soft iron under varying magnetic conditions is still somewhat obscure. Much may be hoped from the induction balance of Hughes, by which the marvellous powers of the telephone are applied to the discrimination of the properties of metals, as regards magnetism and electric conductivity. The introduction of powerful alternate currents in machines by Siemens, Gordon, Ferranti, and others, is likely also to have a salutary effect in educating those so-called practical electricians whose ideas do not easily rise above ohms and volts. It has long been known that when the changes are sufficiently rapid, the phenomena are governed much more by induction, or electric inertia, than by mere resistance. On this principle much may be explained that would otherwise seem paradoxical. To take a comparatively simple case, conceive an electro-magnet wound with two contiguous wires, upon which acts a given rapidly periodic electro-motive force. If one wire only be used, a certain amount of heat is developed in the circuit. Suppose now that the second wire is brought into operation in parallel—a proceeding equivalent to doubling the section of the original wire. An electrician accustomed only to constant currents would be sure to think that the heating effect would be doubled by the change, as much heat being developed in each wire separately as was at first in the single wire. But such a conclusion would be entirely erroneous. The total current, being governed practically by the self-induction of the circuit, would not be augmented by the accession of the second wire, and the total heating effect, so far from being doubled, would in virtue of the superior conductivity be halved. During the last few years much interest has been felt in the reduction to an absolute standard of measurements of electro-motive force, current, resistance, &c., and to this end many laborious investigations have been undertaken. The subject is one that has engaged a good deal of my own attention, and I should naturally have felt inclined to dilate upon it, but that I feel it to be too abstruse and special to be dealt with in detail upon an occasion like the present. As regards resistance, I will merely remind you that the recent determinations have shown a so greatly improved agreement, that the Conference of Electricians assembled at Paris, in May, have felt themselves justified in defining the ohm for practical use as the resistance of a column of mercury of 0 deg. C., one square millimetre in section, and 106 centimetres in length—a definition differing by a little more than 1 per cent. from that arrived at twenty years ago by a committee of this Association. A standard of resistance once determined upon can be embodied in a 'resistance coil,' and copied without much trouble, and with great accuracy. But in order to complete the electrical system, a second standard of some kind is necessary, and this is not so easily embodied in a permanent form. It might conveniently consist of a standard galvanic cell, capable of being prepared in a definite manner, whose electro-motive force is once for all determined. Unfortunately, most of the batteries in ordinary use are, for one reason or another, unsuitable for this purpose, but the cell introduced by Mr. Latimer Clark, in which the metals are zinc in contact with saturated zinc sulphate and pure mercury in contact with mercurous sulphate, appears to give satisfactory results. According to my measurements, the electro-motive force of this cell is 1·435 theoretical volts. We may also conveniently express the second absolute electrical measurement necessary to the completion of the system by taking advantage of Faraday's law, that the quantity of metal decomposed in an electrolytic cell is proportional to the whole quantity of electricity that passes. The best metal for the purpose is silver, deposited from a solution of the nitrate or of the chlorate. The results recently obtained by Professor Kohlrausch and by myself are in very good agreement, and the conclusion that one ampère flowing for one hour decomposes 4·025 grains of silver, can hardly be in error by more than a thousandth part. This number being known, the silver voltameter gives a ready and very accurate method of measuring currents of intensity, varying from $\frac{1}{10}$ ampère to four or five ampères. The beautiful and mysterious phenomena attending the discharge of electricity in nearly vacuous spaces have been investigated and in some degree explained by De la Rue, Crookes, Schuster, Moulton, and the lamented Spottiswoode, as well as by various able foreign experimenters. In a recent research Crookes has sought the origin of a bright citron-coloured band in the phosphorescent spectrum of certain earths, and after encountering difficulties and anomalies of a most bewildering kind, has succeeded in proving that it is due to yttrium, an element much more widely distributed than had been supposed. A conclusion like this is stated in a few words, but those only who have undergone similar experience are likely to appreciate the skill and perseverance of which it is the final reward. A remarkable observation by Hall, of Baltimore, from which it appeared that the flow of electricity in a conducting sheet was disturbed by magnetic force, has been the subject of much discussion. Mr. Shelford Bidwell has brought forward experiments tending to prove that the effect is of a secondary character, due in the first instance to the mechanical force operating upon the conductor of an electric current when situated in a powerful magnetic field. Mr. Bidwell's view agrees in the main with Mr. Hall's division of the metals into two groups according to the direction of the effect.

"Without doubt the most important achievement of the older generation of scientific men has been the establishment and application of the great laws of thermo-dynamics, or, as it is often called, the mechanical theory of heat. The first law, which asserts that heat and mechanical work can be transformed one into the other at a certain fixed rate, is now well understood by every student of physics, and the number expressing the mechanical equivalent of heat resulting from the experiments of Joule has been confirmed by the researches of others, and especially of Rowland. But the second law, which practically is even more important than the first, is only now beginning to receive the full appreciation due to it. One reason of this may be found in a not unnatural confusion of ideas. Words do not always lend themselves readily to the demands that are made upon them by a growing science, and I think that the almost unavoidable use of the word equivalent in the statement of the first law is partly responsible for the little attention that is given to the second. For the second law so far contradicts the usual statement of the first, as to assert that equivalents of heat and work are not of equal value. While work can always be converted into heat, heat can only be converted into work under certain limitations. For every practical purpose the work is worth the most, and when we speak of equivalents, we use the word in the same sort of special sense as that in which chemists speak of equivalents of gold and iron. The second law teaches us that the real value of heat, as a source of mechanical power, depends upon the temperature of the body in which it resides; the hotter the body in relation to its surroundings, the more available the heat. In order to see the relations which obtain between the first and the second law of thermo-dynamics, it is only necessary for us to glance at the theory of the steam engine. Not many years ago calculations were plentiful, demonstrating the inefficiency of the steam engine on the basis of a comparison of the work actually got out of the engine with the mechanical equivalent of the heat supplied to the boiler. Such calculations took into account only the first law of thermo-dynamics, which deals with the equivalents of heat and work, and have very little bearing upon the practical question of efficiency, which requires us to have regard also to the second law. According to that law the fraction of the total energy which can be converted into work depends upon the relative temperatures of the boiler and condenser; and it is, therefore manifest that, as the temperature of the boiler cannot be raised indefinitely, it is impossible to utilise all the energy which, according to the first law of thermo-dynamics, is resident in the coal. On a sounder view of the matter, the efficiency of the steam engine is found to be so high that there is no great margin remaining for improvement. The higher initial temperature possible in the gas engine opens out much wider possibilities, and many good judges look forward to a time when the steam engine will have to give way to its younger rival. To return to the theoretical question, we may say with Sir W. Thomson, that though energy cannot be destroyed, it ever tends to be dissipated, or to pass from more available to less available forms. No one who has grasped this principle can fail to recognise its immense importance in the system of the universe. Every change—chemical, thermal, or mechanical—which takes place, or can take place, in nature, does so at the cost of a certain amount of available energy. If, therefore, we wish to inquire whether or not a proposed transformation can take place, the question to be considered is whether its occurrence would involve dissipation of energy. If not, the transformation is, under the circumstances of the case, absolutely excluded. Some years ago, in a lecture at the Royal Institution, I endeavoured to draw the attention of chemists to the importance of the principle of dissipation in relation to their science, pointing out the error of the usual assumption that a general criterion is to be found in respect of the development of heat. For example, the solution of a salt in water is, if I may be allowed the phrase, a downhill transformation. It involves dissipation of energy, and can therefore go forward; but, in many cases it is associated with the absorption rather than with the development of heat. I am glad to take advantage of the present opportunity in order to repeat my recommendation, with an emphasis justified by actual achievement. The foundations laid by Thomson now bear an edifice of no mean proportions, thanks to the labours of several physicists, among whom must be especially mentioned Willard Gibbs and Helmholtz. The former has elaborated a theory of the equilibrium of heterogeneous substances, wide in its principles, and we cannot doubt far-reaching in its consequences. In a series of masterly papers Helmholtz has developed the conception of free energy with very important applications to the theory of the galvanic cell. He points out that the mere tendency to solution bears in some cases no small proportion to the affinities more usually reckoned chemical, and contributes largely to the total electro-motive force. Also in our own country Dr. Alder Wright has published some valuable experiments relating to the subject. From the further study of electrolysis we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. I am not qualified—I wish I were—to speak to you on recent progress in general chemistry. Perhaps my feelings towards a first love may blind me, but I cannot help thinking that the next great advance, of which we have already some foreshadowing, will come on this side. And if I might, without presumption, venture a word of recommendation, it would be in favour of a more minute study of the simpler chemical phenomena.

"Under the head of scientific mechanics it is principally in relation to fluid motion that advances may be looked for. In speaking upon this subject I must limit myself almost entirely to experimental work. Theoretical hydro-dynamics, however important and interesting to the mathematician, are eminently unsuited to oral exposition. All I can do to attenuate an injustice, to which theorists are pretty well accustomed, is to refer you to the admirable reports of Mr. Hicks, published under the auspices of this Association. The important and highly practical work of the late Mr. Froude in relation to the propulsion of ships is doubtless known to most of you. Recognising the fallacy of views then widely held as to the nature of the resistance to be overcome, he showed to demonstration that, in the case of fair-shaped bodies, we have to deal almost entirely with resistance dependent upon skin friction, and at high speeds upon the generation of surface waves by which energy is carried off. At speeds which are moderate in relation to the size of the ship, the resistance is practically dependent upon skin friction only. Although Professor Stokes and other mathematicians had previously published calculations pointing to the same conclusion, there can be no doubt that the view generally entertained was very different. At the first meeting of the Association which I ever attended, as an intelligent listener, at Bath in 1864, I well remember the surprise which greeted a statement by Rankine that he regarded skin friction as the only legitimate resistance to the progress of a well-designed ship. Mr. Froude's experiments have set the question at rest in a manner satisfactory to those who had little confidence in theoretical prevision. In speaking of an explanation as satisfactory in which skin friction is accepted as the cause of resistance, I must guard myself against being supposed to mean that the nature of skin friction is itself well understood. Although its magnitude varies with the smoothness of the surface, we have no reason to think that it would disappear at any degree of smoothness consistent with an ultimate molecular structure. That it is connected with fluid viscosity is evident enough, but the *modus operandi* is still obscure. Some important work bearing upon the subject has recently been published by Professor O. Reynolds, who has investigated the flow of water in tubes as dependent upon the velocity of motion and upon the size of the bore. The laws of motion in capillary tubes, discovered experimentally by Poiseuille, are in complete harmony with theory. The resistance varies as the velocity, and depends in a direct manner upon the constant of viscosity. But when we come to the larger pipes and higher velocities with which engineers usually have to deal, the theory which presupposes a regularly stratified motion evidently ceases to be applicable, and the problem becomes essentially identical with that of skin friction in relation to ship propulsion. Professor Reynolds has traced with much success the passage from the one state of things to the other, and has proved the applicability under these complicated conditions of the general laws of dynamical similarity as adapted to viscous fluids by Professor Stokes. In spite of the difficulties which beset both the theoretical and experimental treatment, we may hope to attain before long to a better understanding of a subject which is certainly second to none in scientific as well as practical interest. As also closely connected with the mechanics of viscous fluids, I must not forget to mention an important series of experiments upon the friction of oiled surfaces, recently executed by Mr. Tower for the Institution of Mechanical Engineers. The results go far towards upsetting some ideas hitherto widely admitted. When the lubrication is adequate, the friction is found to be nearly independent of the load, and much smaller than is usually supposed, giving a coefficient as low as $\frac{1}{1000}$. When the layer of oil is well formed, the pressure between the solid surfaces is really borne by the fluid, and the work lost is spent in shearing—that is, in causing one stratum of the oil to glide over another. In order to maintain its position, the fluid must possess a certain degree of viscosity, proportionate to the pressure; and even when this condition is satisfied, it would appear to be necessary that the layer should be thicker on the ingoing than on the outgoing side. We may, I believe, expect from Professor Stokes a further elucidation of the processes involved. In the meantime, it is obvious that the results already obtained are of the utmost value, and fully justify the action of the Institution in devoting a part of its resources to experimental work. We may hope indeed that the example thus wisely set may be followed by other public bodies associated with various departments of industry. I can do little more than refer to the interesting observations of Professor Darwin, Mr. Hunt, and M. Forel on Ripplemark. The processes concerned would seem to be of a rather intricate character, and largely dependent upon fluid viscosity. It may be noted indeed that most of the still obscure phenomena of hydro-dynamics require for their elucidation a better comprehension of the laws of viscous motion. The subject is one which offers peculiar difficulties. In some problems in which I have lately been interested, a circulating motion presents itself of the kind which the mathematician excludes from the first when he is treating of fluids destitute altogether of viscosity. The intensity of this motion proves, however, to be independent of the coefficient of viscosity, so that it cannot be correctly dismissed from consideration as a consequence of a supposition that the viscosity is infinitely small. The apparent breach of continuity can be explained, but it shows how much care is needful in dealing with the subject, and how easy it is to fall into error. The nature of gaseous viscosity, as due to the diffusion of momentum, has been made clear by the theoretical and experimental researches of Maxwell. A flat disc moving in its own plane between two parallel solid surfaces is impeded by the necessity of shearing the intervening layers of gas, and the magnitude of the hindrance is proportional to the velocity of the motion and to the viscosity of the gas, so that under similar circumstances this effect may be taken as a measure, or rather definition, of the viscosity. From the dynamical theory of gases, to the development of which he contributed so much, Maxwell drew the startling conclusion that the viscosity of a gas should be independent of its density—that within wide limits the resistance to the moving disc should be scarcely diminished by pumping out the gas, so as to form a partial vacuum. Experiment fully confirmed this theoretical anticipation—one of the most remarkable to be found in the whole history of science, and proved that the swinging disc was retarded by the gas, as much when the barometer stood at ½in. as when it stood at 30in. It was obvious, of course, that the law must have a limit, that at a certain point of exhaustion the gas must begin to lose its power; and I remember discussing with Maxwell, soon after the publication of his experiments, the whereabouts of the point at which the gas would cease to produce its ordinary effect. His apparatus, however, was quite unsuited for high degrees of exhaustion, and the failure of the law was first observed by Kundt and Warburg, as pressures below 1 mm. of mercury. Subsequently the matter has been thoroughly examined by Crookes, who extended his observations to the highest degrees of exhaustion as measured by MacLeod's gauge. Perhaps the most remarkable results relate to hydrogen. From the atmospheric pressure of 760 mm. down to about ½ mm. of mercury the viscosity is sensibly constant. From this point to the highest vacua, in which less than one-millionth of the original gas remains, the coefficient of viscosity drops down gradually to a small fraction of its original value. In these vacua Mr. Crookes regards the gas as having assumed a different, ultra-gaseous, condition; but we must remember that the phenomena have relation to the other circumstances of the case, especially the dimensions of the vessel, as well as to the condition of the gas. Such an achievement as the prediction of Maxwell's law of viscosity has, of course, drawn increased attention to the dynamical theory of gases. The success which has attended the theory in the hands of Clausius, Maxwell, Boltzmann, and other mathematicians, not only in relation to viscosity, but over a large part of the entire field of our knowledge of gases, proves that some of its fundamental postulates are in harmony with the reality of Nature. At the same time, it presents serious difficulties; and we cannot but feel that while the electrical and optical properties of gases remain out of relation to the theory, no final judgment is possible. The growth of experimental knowledge may be trusted to clear up many doubtful points, and a younger generation of theorists will bring to bear improved mathematical weapons. In the meantime we may fairly congratulate ourselves on the possession of a guide which has already conducted us to a position which could hardly otherwise have been attained.

"In optics attention has naturally centred upon the spectrum. The mystery attaching to the invisible rays lying beyond the red has been fathomed to an extent that, a few years ago, would have seemed almost impossible. By the use of special photographic methods Abney has mapped out the peculiarities of this region with such success that our knowledge of it begins to be comparable with that of the parts visible to the eye. Equally important work has been done by Langley, using a refined invention of his own based upon the principle of Siemens' pyrometer. This instrument measures the actual energy of the radiation, and thus expresses the effects of various parts of the spectrum upon a common scale, independent of the properties of the eye and of sensitive photographic preparations. Interesting results have also been obtained by Becquerel, whose method is founded upon a curious action of the ultra-red rays in enfeebling the light emitted by phosphorescent substances. One of the most startling of Langley's conclusions relates to the influence of the atmosphere in modifying the quality of solar light. By the comparison of observations made through varying thicknesses of air, he shows that the atmospheric absorption tells most upon the light of high refrangibility; so that, to an eye situated outside the atmosphere, the sun would present a decidedly bluish tint. It would be interesting to compare the experimental numbers with the law of scattering of light by small particles given some years ago as the result of theory. The demonstration by Langley of the inadequacy of Cauchy's law of dispersion to represent the relation between refrangibility and wave length in the lower part of the spectrum must have an important bearing upon optical theory. The investigation of the relation of the visible and ultra-violet spectrum to various forms of matter has occupied the attention of a host of able workers, among whom none have been more successful than my colleagues at Cambridge, Professors Liveing and Dewar. The subject is too large both for the occasion and for the individual, and I must pass it by. But, as more closely related to optics proper, I cannot resist recalling to your notice a beautiful application of the idea of Doppler to the discrimination of the origin of certain lines observed in the solar spectrum. If a vibrating body have a general motion of approach or recession, the waves emitted from it reach the observer with a frequency which in the first case exceeds, and in the second case falls short of, the real frequency of the vibrations themselves. The consequence is that, if a glowing gas be in motion in the line of sight, the spectral lines are thereby displaced from the position that they would occupy were the gas at rest—a principle which, in the hands of Huggins and others, has led to a determination of the motion of certain fixed stars relatively to the solar system. But the sun is itself in rotation, and thus the position of a solar spectral line is slightly different according as the light comes from the advancing or from the retreating limb. This displacement was, I believe, first observed by Thollon; but what I desire now to draw attention to is the application of it by Cornu to determine whether a line is of solar or atmospheric origin. For this purpose a small image of the sun is thrown upon the slit of the spectroscope, and caused to vibrate two or three times in a second, in such a manner that the light entering the instrument comes alternately from the advancing and retreating limbs. Under these circumstances a line due to absorption within the sun appears to tremble, as the result of slight alternately opposite displacements. But if the seat of the absorption be in the atmosphere, it is a matter of indifference from what part of the sun the light originally proceeds, and the line maintains its position in spite of the oscillation of the image upon the slit of the spectroscope. In this way Cornu was able to make a discrimination which can only otherwise be effected by a difficult comparison of appearances under various solar altitudes. The instrumental weapon of investigation, the spectroscope itself, has made important advances. On the theoretical side we have for our guidance the law that the optical power in gratings is proportional to the total number of lines accurately ruled, without regard to the degree of closeness, and in prisms that it is proportional to the thickness of glass traversed. The magnificent gratings of Rowland are a new power in the hands of the spectroscopist, and as triumphs of mechanical art seem to be little short of perfection. In our own report for 1882, Mr. Mallock has described a machine constructed by him for ruling large diffraction gratings, similar in some respects to that of Rowland. The great optical constant, the velocity of light, has been the subject of three distinct investigations by Cornu, Michelson, and Forbes. As may be supposed, the matter is of no ordinary difficulty, and it is therefore not surprising that the agreement should be less decided than could be wished. From their observations, which were made by a modification of Fizeau's method of the toothed wheel, Young and Forbes drew the conclusion that the velocity of light *in vacuo* varies from colour to colour to such an extent that the velocity of blue light is nearly 2 per cent. greater than that of red light. Such a variation is quite opposed to existing theoretical notions, and could only be accepted on the strongest evidence. Mr. Michelson, whose method—that of Foucault—is well suited to bring into prominence a variation of velocity with wave length, informs me that he has recently repeated his experiments with special reference to the point in question, and has arrived at the conclusion that no variation exists comparable with that asserted by Young and Forbes. The actual velocity differs little from that found from his first series of experiments, and may be taken to be 299,800 kilometres per second. It is remarkable how many of the playthings of our childhood give rise to questions of the deepest scientific interest. The top is, or may be understood, but a complete comprehension of the kite and of the soap-bubble would carry us far beyond our present stage of knowledge. In spite of the admirable investigations of Plateau, it still remains a mystery why soapy water stands almost alone among fluids as a material for bubbles. The beautiful development of colour was long ago ascribed to the interference of light, called into play by the gradual thinning of the film. In accordance with this view the tint is determined solely by the thickness of the film, and the refractive index of the fluid. Some of the phenomena are, however, so curious, as to have led excellent observers like Brewster to reject the theory of thin plates, and to assume the secretion of various kinds of colouring matter. If the rim of a wine-glass be dipped in soapy water, and then held in a vertical position, horizontal bands soon begin to show at the top of the film, and extend themselves gradually downwards. According to Brewster these bands are not formed by the 'subsidence and gradual thinning of the film,' because they maintain their horizontal position when the glass is turned round its axis. The experiment is both easy and interesting, but the conclusion drawn from it cannot be accepted. The fact is that the various parts of the film cannot quickly alter their thickness, and hence when the glass is rotated, they re-arrange themselves in order of superficial density, the thinner parts floating up over, or through, the thicker parts. Only thus can the tendency be satisfied for the centre of gravity to assume the lowest possible position. When the thickness of a film falls below a small fraction of the length of a wave of light, the colour disappears, and is replaced by an intense blackness. Professors Reinold and Rücker have recently made the remarkable observation that the whole of the black region, soon after its formation, is of uniform thickness, the passage from the black to the coloured portions being extremely abrupt. By two independent methods they have determined the thickness of the black film to lie between seven and fourteen millionths of a millimetre; so that the thinnest films correspond to about one-seventieth of a wave length of light. The importance of these results in regard to molecular theory is too obvious to be insisted upon.

"The beautiful inventions of the telephone and the phonograph, although in the main dependent upon principles long since established, have imparted a new interest to the study of acoustics. The former, apart from its uses in every-day life, has become in the hands of its inventor, Graham Bell, and of Hughes, an instrument of first-class scientific importance. The theory of its action is still in some respects obscure, as is shown by the comparative failure of the many attempts to improve it. In connection with some explanations that have been offered, we do well to remember that molecular changes in solid masses are inaudible in themselves, and can only be manifested to our ears by the generation of a to-and-fro-motion of the external surface extending over a sensible area. If the surface of a solid remains undisturbed, our ears can tell us nothing of what goes on in the interior. In theoretical acoustics progress has been steadily maintained, and many phenomena, which were obscure twenty or thirty years ago, have since received adequate explanation. If some important practical questions remain unsolved, one reason is that they have not yet been definitely stated. Almost everything in connection with the ordinary use of our senses presents peculiar difficulties to scientific investigation. Some kinds of information with regard to their surroundings are of such paramount importance to successive generations of living beings, that they have learned to interpret indications which, from a physical point of view, are of the slenderest character. Every day we are in the habit of recognising, without much difficulty, the quarter from which a sound proceeds, but by what steps we attain that end has not yet been satisfactorily explained. It has been proved that when proper precautions are taken, we are unable to distinguish whether a pure tone—as from a vibrating tuning fork held over a suitable resonator—comes to us from in front or from behind. This is what might have been expected from an *à priori* point of view; but what would not have been expected is that with almost any other sort of sound, from a clap of the hands to the clearest vowel sound, the discrimination is not only possible, but easy and instinctive. In these cases it does not appear how the possession of two ears help us, though there is some evidence that it does; and even when sounds come to us from the right or left, the explanation of the ready discrimination which is then possible with pure tones is not so easy as might at first appear. We should be inclined to think that the sound was heard much more loudly with the ear that is turned towards than with the ear that is turned from it, and that in this way the direction was recognised. But if we try the experiment, we find that, at any rate with notes near the middle of the musical scale, the difference of loudness is by no means so very great. The wave lengths of such notes are long enough in relation to the dimensions of the head to forbid the formation of anything like a sound shadow in which the averted ear might be sheltered.

"In concluding this imperfect survey of recent progress in physics, I must warn you emphatically that much of great importance has been passed over altogether. I should have liked to speak to you of those far reaching speculations, especially associated with the name of Maxwell, in which light is regarded as a disturbance in an electro-magnetic medium. Indeed, at one time, I had thought of taking the scientific work of Maxwell as the principal theme of this address. But, like most men of genius, Maxwell delighted in questions too obscure and difficult for hasty treatment, and thus much of his work could hardly be considered upon such an occasion as the present. His biography has recently been published, and should be read by all who are interested in science and in scientific men. His many-sided character, the quaintness of his humour, the penetration of his intellect, his simple but deep religious feeling, the affection between son and father, the devotion of husband to wife, all combine to form a rare and fascinating picture. To estimate rightly his influence upon the present state of science, we must regard not only the work that he executed himself, important as that was, but also the ideas and the spirit which he communicated to others. Speaking for myself as one who in a special sense entered into his labours, I should find it difficult to express adequately my feeling of obligation. The impress of his thoughts may be recognised in much of the best work of the present time. As a teacher and examiner he was well acquainted with the almost universal tendency of uninstructed minds to elevate phrases above things; to refer, for example, to the principle of the conservation of energy for an explanation of the persistent rotation of a fly-wheel, almost in the style of the doctor in 'Le Malade Imaginaire,' who explains the fact that opium sends you to sleep by its soporific virtue. Maxwell's endeavour was always to keep the facts in the foreground, and to his influence, in conjunction with that of Thomson and Helmholtz, is largely due that elimination of unnecessary hypotheses which is one of the distinguishing characteristics of the science of the present day. In speaking unfavourably of superfluous hypothesis, let me not be misunderstood. Science is nothing without generalisations. Detached and ill-assorted facts are only raw material, and in the absence of a theoretical solvent, have but little nutritive value. At the present time, and in some departments, the accumulation of material is so rapid that there is danger of indigestion. By a fiction as remarkable as any to be found in law, what has once been published, even though it be in the Russian language, is usually spoken of as 'known,' and it is often forgotten that the rediscovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory. In this matter we are greatly dependent upon annual reports and abstracts, issued principally in Germany, without which the search for the discoveries of a little-known author would be well nigh hopeless. Much useful work has been done in this direction in connection with our Association. Such critical reports as those upon hydro-dynamics, upon tides, and upon spectroscopy, guide the investigator to the points most requiring attention, and in discussing past achievements contribute in no small degree to future progress. But though good work has been done, much yet remains to do. If, as is sometimes supposed, science consisted in nothing but the laborious accumulation of facts, it would soon come to a standstill, crushed, as it were, under its own weight. The suggestion of a new idea, or the detection of a law, supersedes much that had previously been a burden upon the memory, and by introducing order and coherence, facilitates the retention of the remainder in an available form. Those who are acquainted with the writings of the older electricians will understand my meaning when I instance the discovery of Ohm's law as a step by which the science was rendered easier to understand and to remember. Two processes are thus at work side by side—the reception of new material and the digestion and assimilation of the old; and as both are essential, we may spare ourselves the discussion of their relative importance. One remark, however, should be made. The work which deserves, but I am afraid does not always receive, the most credit, is that in which discovery and explanation go hand in hand, in which not only are new facts presented, but their relation to old ones is pointed out. In making oneself acquainted with what has been done in any subject, it is good policy to consult first the writers of highest general reputation. Although in scientific matters we should aim at independent judgment, and not rely too much upon authority, it remains true that a good deal must often be taken upon trust. Occasionally an observation is so simple and easily repeated, that it scarcely matters from whom it proceeds; but as a rule it can hardly carry full weight when put forward by a novice whose care and judgment there has been no opportunity of testing, and whose irresponsibility may tempt him to 'take shots,' as it is called. Those who have had experience in accurate work know how easy it would be to save time and trouble by omitting precautions and passing over discrepancies, and yet, even without dishonest intention, to convey the impression of conscientious attention to details. Although the most careful and experienced cannot hope to escape occasional mistakes, the effective value of this kind of work depends much upon the reputation of the individual responsible for it. In estimating the present position and prospects of experimental science, there is good ground for encouragement. The multiplication of laboratories gives to the younger generation opportunities such as have never existed before, and which excite the envy of those who have had to learn in middle life much that now forms part of an undergraduate course. As to the management of such institutions there is room for a healthy difference of opinion. For many kinds of original work, especially in connection with accurate measurement, there is need of expensive apparatus; and it is often difficult to persuade a student to do his best with imperfect appliances when he knows that by other means a better result could be attained with greater facility. Nevertheless it seems to me important to discourage too great reliance upon the instrument maker. Much of the best original work has been done with the homeliest appliances; and the endeavour to turn to the best account the means that may be at hand developes ingenuity and resource more than the most elaborate determinations with ready-made instruments. There is danger otherwise that the experimental education of a plodding student should be too mechanical and artificial, so that he is puzzled by small changes of apparatus much as many school-boys are puzzled by a transposition of the letters in a diagram of Euclid. From the general spread of a more scientific education, we are warranted in expecting important results. Just as there are some brilliant literary men with an inability, or at least a distaste practically amounting to inability, for scientific ideas, so there are a few with scientific tastes whose imaginations are never touched by merely literary studies. To save these from intellectual stagnation during several important years of their lives is something gained; but the thorough-going advocates of scientific education aim at much more. To them it appears strange, and almost monstrous, that the dead languages should hold the place they do in general education; and it can hardly be denied that their supremacy is the result of routine rather than of argument. I do not, myself, take up the extreme position. I doubt whether an exclusively scientific training would be satisfactory; and where there is plenty of time and a literary aptitude, I can believe that Latin and Greek may make a good foundation. But it is useless to discuss the question upon the supposition that the majority of boys attain either to a knowledge of the languages or to an appreciation of the writings of the ancient authors. The contrary is notoriously the truth; and the defenders of the existing system usually take their stand upon the excellence of its discipline. From this point of view there is something to be said. The laziest boy must exert himself a little in puzzling out a sentence with grammar and dictionary, while instruction and supervision are easy to organise and not too costly. But when the case is stated plainly, few will agree that we can afford so entirely to disregard results. In after life the intellectual energies are usually engrossed with business, and no futher opportunity is found for attacking the difficulties which block the gateways of knowledge. Mathematics, especially, if not learned young, are likely to remain unlearned. I will not further insist upon the educational importance of mathematics and science, because with respect to them I shall probably be supposed to be prejudiced. But of modern languages I am ignorant enough to give value to my advocacy. I believe that French and German, if properly taught, which I admit they rarely are at present, would go far to replace Latin and Greek from a disciplinary point of view, while the actual value of the acquisition would, in the majority of cases, be incomparably greater. In half the time usually devoted, without success, to the classical languages, most boys could acquire a really serviceable knowledge of French and German. History and the serious study of English literature, now shamefully neglected, would also find a place in such a scheme. There is one objection often felt to a modernised education, as to which a word may not be without use. Many excellent people are afraid of science as tending towards materialism. That such apprehension should exist is not surprising, for unfortunately there are writers, speaking in the name of science, who have set themselves to foster it. It is true that among scientific men, as in other classes, crude views are to be met with as to the deeper things of Nature; but that the life-long beliefs of Newton, of Faraday, and of Maxwell, are inconsistent with the scientific habit of mind is surely a proposition which I need not pause to refute. It would be easy, however, to lay too much stress upon the opinions of even such distinguished workers as these. Men, who devote their lives to investigation, cultivate a love of truth for its own sake, and endeavour instinctively to clear up, and not, as is too often the object in business and politics, to obscure a difficult question. So far the opinion of a scientific worker may have a special value; but I do not think that he has a claim, superior to that of other educated men, to assume the attitude of a prophet. In his heart he knows that underneath the theories that he constructs there lie contradictions which he cannot reconcile. The higher mysteries of being, if penetrable at all by human intellect, require other weapons than those of calculation and experiment. Without encroaching upon grounds appertaining to the theologian and the philosopher, the domain of natural science is surely broad enough to satisfy the wildest ambition of its devotees. In other departments of human life and interest, true progress is rather an article of faith than a rational belief; but in science a retrograde movement is, from the nature of the case, almost impossible. Increasing knowledge brings with it increasing power, and great as are the triumphs of the present century, we may well believe that they are but a foretaste of what discovery and invention have yet in store for mankind. Encouraged by the thought that our labours cannot be thrown away, let us redouble our efforts in the noble struggle. In the Old World and in the New, recruits must be enlisted to fill the place of those whose work is done. Happy should I be if, through this visit of the Association, or by any words of mine, a larger measure of the youthful activity of the West could be drawn into this service. The work may be hard, and the discipline severe; but the interest never fails, and great is the privilege of achievement."

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

(*From our own Correspondent.*)

There was no falling off on 'Change in Wolverhampton yesterday and in Birmingham to-day—Thursday—in the encouraging tone of the reports recently presented by the thin—best—sheet makers. These manufacturers made known that they were still busy. Certain of the makers of black sheets for the galvanisers also announced increased sales alike for early and forward delivery. On the whole, therefore, trade this week wears a rather more cheerful appearance.

A few sheet makers have not had so many forward orders on their books for several months past. These are quoting up prices nominally 5s. per ton upon the late minimum. Doubles become £7 10s. to £7 12s. 6d.; lattens, £8 10s. to £8 12s. 6d.; and the same people ask £7 5s. for singles. Other firms who are not so well off are still prepared to accept orders at the low prices of £6 15s. to £7 for singles, £7 5s. for doubles, and £8 5s. for lattens. Numbers of firms have orders on their books placed by the galvanisers a considerable while ago, when prices were much higher than now. But they cannot obtain specifications for the execution of these, buyers preferring to draw upon the orders placed more recently at easier rates. Some improvement is reported in the galvanised corrugated sheet trade chiefly on account of India and America, but prices in this branch are still unsatisfactory.

Orders for plates and bars are irregularly distributed, and while some firms whose brands are especial favourites have more to do than certain of the sheet makers, other firms, on the contrary, are less active. Angles and plating bars are in demand by local bedstead, safe, and edge tool manufacturers. The list price of bars is £7 10s. to £7, while medium quality bars are £6 10s., and common £6, down to in some cases even £5 10s. Hoops are £6 as a minimum, and £5 15s. is pretty much the most that can be got for common gas tube strip or for nail strip.

Pig iron shows more life, chiefly, however, in brands produced outside this district. Certain consumers believe that rock bottom has now been touched, and they are prepared to buy as forward, at present prices, as vendors will allow, and in considerable quantities. Sellers, however, are equally alive to their own interests, and will not accept contracts beyond the end of the year. Yet for 1000-ton contracts, I hear this week of some agents from Lincolnshire firms who are prepared to accept 1s. per ton below what is generally regarded as the market price for such iron. Derbyshire pigs are 40s. 6d. to 41s. 6d.; Northampton's rather less; and Lincolnshire's are quoted 46s. to 46s. 6d. Native pigs are slow of sale at 57s. 6d. to 56s. 3d. for all-mines, 42s. 6d. for part mines, and 36s. as about the minimum for cinder pigs. Messrs. G. and R. Thomas, of the Hatherton Furnaces, Walsall, have this week blown out their last all-mine furnace, having a large stock in hand.

The considerable blast furnace plant at Spring Vale of Mr. Alfred Hickman—the largest in South Staffordshire—is being augmented by the erection of two new large furnaces, each 60ft. high by 21ft. diameter in the widest part. They will make 400 tons a week each. They will have attached to them two Cowper patent hot blast heating stoves, and five stoves of the Ford and Montchur patent. Additional blast power has been laid down, including three engines of, respectively, 120, 100, and 50-horse power. At present three furnaces are blowing, producing some 900 tons a week. The arrangements are rapidly progressing for lighting up the works at night by electricity, under contract with the Wolverhampton Electric Light, Storage, and Engineering Company.

The alteration in railway rates for pig iron brought into the Staffordshire district from the Midlands, referred to in previous reports, is to be followed up on September 1st by a reduction in the rates of conveyance from Cleveland and from South Wales. The London and North-Western, the Great Western, and the Midland Companies, are all interested. The exact changes are not yet made known, but they are believed to be about 1s. 3d. per ton on Cleveland pigs, and 10d. per ton on Welsh pigs. At present the rates from Cleveland are 12s. 6d. per ton, and from South Wales they vary from 6s. 8d. to 8s. 4d. per ton. Cleveland forge pigs are quoted this week 46s. to 46s. 6d. delivered into this district; and Welsh hematites 55s. delivered. Welsh scrap iron, composed mainly of sheet shearings, is pretty firmly held at 47s. 6d., and for steel sheet shearings more money is asked than a while ago.

The Staffordshire Steel and Ingot Iron Company, Bilston, is just now producing most of its finished steel in the form of plates for bridge and roofing and boiler making purposes. Blooms and billets it is supplying to the sheet and tin-plate makers and other ironmasters for rolling down. With the view of getting the custom of this district, which is now falling to the North of England iron and steel masters, particularly in the shape of plates, the company is prepared to sell at North of England prices; and it is urged that if the quality is found to be as good—and it is claimed that it is indeed better—then the local consumers ought to give the preference over the Cleveland makers. The prices at which steel is offered are as here:—Crown plates, up to ¼in. thick, suitable for bridge and girder making, &c., £5 15s. per ton for a good specification; boiler plates, £7; best best, stated to be equal to Lowmoor, £8; plating bars, £6 5s.; sheet and tin bars, either 3in. or 5in., £5 10s.; billets, down to 2in. square, £5 5s.; and blooms, 12in. by 13in. or 6½in. by 3in., £5. The company is at present blowing one out of the three Bessemer-basic converters erected, but by-and-bye it hopes, when in full work to meet with sufficient demand to warrant four converters blowing and two others in readiness for replacement. Three hundred tons of pigs made at the adjoining Spring Vale furnaces, of Mr. Alfred Hickman, are at present being consumed every week. This pig is made from tapped cinders and Staffordshire iron ore with a little manganese, and although having a whitish appearance, is guaranteed to work grey in the puddling furnace. It contains 2½ per cent. of phosphorus, 3 per cent. of manganese, 1 per cent. of silicon, and ·05 of sulphur. These pigs take about an hour to melt down in one of the three cupolas erected, and after being poured into the converter in about 6 or 6½ tons lots, is blown during periods varying from ten to twenty minutes, according to the heat of the metal received from the cupola, the power of the blast, and the will of the operator. When the flame indicates that most of the impurities have been eliminated, the after blow takes place, varying in length from two and a-half to five minutes. The pressure of the blast is sometimes as great as 25 lb. or 27 lb., and at others it is allowed to fall to 12 lb., but if it should get below 10 lb. the metal gets into the tuyeres. Six tons of molten metal from the cupola produce about five tons of ingot steel. The company is at present making about five or six blows a shift of twelve hours. Before cogging down and rolling the ingots, the reheating furnaces are brought into operation, but when they get to about eight blows a shift or rather more, the double set of Gjers' soaking pits—eighteen in all—will be utilised.

To ensure plates of good quality the metal from every blow is carefully tested in the plate form, and if it should not come up to the required quality the plates are cut up. From oval ingots 18in. wide, 10in. thick, and 3ft. 6in. long, the members of the South Staffordshire Institute of Iron and Steel Works Managers, who on Friday last visited these works on the occasion of their annual excursion, saw plates rolled of sufficiently good quality for boiler purposes. Some of them were 26ft. long, 3ft. 4in. broad, and ⅜in. thick, and others 33ft. long, 3ft. wide, and ⅜in. thick. These ingots had not been put through the cogging mill, but after leaving the re-heating furnace were first put through the soft rolls and then through the hard rolls. The visitors afterwards tested samples cut from cold plates in the blacksmiths' shops with varying results. The company boasts that the steel has proved sufficiently good for tube welding and for heavy chain welding.

The Patent Shaft and Axletree Company, Wednesbury, has not, as I have previously announced, been successful in the manufacture of basic steel, probably because their plant was ill-adapted to this special purpose. It failed to obtain as great a uniformity as could be wished. But at the present time it is producing an excellent quality of open-hearth steel with results so satisfactory that it contemplates a further extension and developement of the system. It believes that there is an important future before cast steel as applied to anchor making. Anchors so made can be produced at two-thirds the price of forged iron, and the company holds that the new goods will perform their work quite as well as the more expensive ones.

On Monday the arbitrator to the Iron Trade Wages Board sits in Birmingham to hear the merits of the dispute concerning future wages. Considerable importance is attached to the proceedings.

There seems every probability that the disastrous results of the late North Staffordshire coal trade strike will be repeated in the south of the country. The strike has now entered upon its ninth week, and there are as yet no signs of its drawing to a close. The men are still obdurate, with the result that many thousand pounds have been sacrificed in wages.

The Associated Chambers of Commerce have intimated that they agree with the Dudley Chamber that steps ought to be taken respecting the 500 lb. scale applied to small consignments of goods. They, however, wisely suggest that they should be deferred until the powers of the Railway Commission are extended.

The London and North-Western Railway Company hopes that by Easter next year the alterations which are going on at the New-street station, Birmingham, will have been completed. A portion of the new structure will, it is trusted, be ready for use by Christmas. The Company is just now constructing a bridge over the new portion of the station and over Great Queen-street. When it is connected with the old foot-bridge it will be 580ft. long and 17ft. broad.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—There is still only a very small weight of business doing in any department of the iron trade of this district. Prices remain about stationary, very little attempt being made to press sales at the present low rates, whilst buyers simply give out orders from hand to mouth at the minimum figures as they find it necessary to cover requirements. For all descriptions of metals prices are extremely low; in fact, they are very nearly at the very lowest point touched during the depression of five years ago, but there is a want of confidence in the future which operates as a check upon speculative transactions, and there appears to be little or no disposition to take advantage of the present low rates to buy largely for the future.

The iron market at Manchester on Tuesday was an extremely dull one, with only the most limited inquiry for either pig or finished iron. Prices were no lower, sellers generally holding firmly to the minimum rates that have been quoted of late, but there was so little actual business doing that prices were scarcely tested. For local and district brands of pig iron delivered equal to Manchester 41s. to 42s. less 2½ remain the minimum figures that makers are open to take, and at these a few small orders are being booked. In outside brands such as Scotch and Middlesbrough transactions are confined to odd special lots, the much lower price of the local brands rendering any really competitive business in this market practically out of the question.

Hematites still meet with only a very slow sale, and good foundry brands delivered here are to be got at about 44s. 6d., less 2½ per cent.

In the finished iron trade rather more inquiry is reported for sheets, both for home requirements and shipment, but generally in other classes of goods the business doing continues small, and no better prices are being got. For good qualities of Lancashire and North Staffordshire bars, delivered here, £5 12s. 6d. remains the average price, with some common local makes to be got at £5 10s., and sheets at from £7 2s. 6d. to £7 10s., according to quality.

Brassfounders report trade slackening down so far as the demand for marine and engineers' fittings is concerned, and to secure new orders prices have to be cut very low.

Amongst machine tool makers I continue to hear reports that the weight of new orders is decreasing, but there is still sufficient work in hand to keep most of the principal firms fairly well employed. Mill and wheelwrights, who until recently have been fairly off for work, also report that new orders are coming forward but indifferently, and are only to be got at very low figures.

The recent railway disaster near Sheffield called attention very forcibly to the necessity of minimising as much as possible the risk of accidents incident to the possible existence of undiscovered flaws in the material used in the construction of locomotive cranks, and any improvements in the methods of manufacture which are calculated to render more readily discoverable any possible flaw in the material are consequently of importance. During the past week I was at the works of Messrs. Craven Brothers, of Manchester, who have just completed for the Midland Railway Works at Derby a specially designed machine for cutting out crank webs, which effects an important step in the direction indicated. The machine has been constructed to cut out the crank webs and round the crank pin within ½in. of the finished size. The work to be done by the machine is effected by means of a rotary cutter, 3ft. in diameter, having steel tools of ordinary shape inserted at intervals round the cutter, and so arranged as to cut alternately, so that at each revolution the cut is deepened, and the circular cutter is forced into the web by a self-acting motion. When it has advanced to within a depth of ½in. of the crank pin, a circular self-acting motion is put into gear and revolves the crank, thus making the crank pin round. The usual practice is to anneal the cranks in the solid, but by the use of the above machine the sweeps can be cut out before the annealing process is carried out, and the makers will be enabled to examine more effectually the centre of the crank webs before they leave their works, and before the annealing is done, and this will naturally afford much greater facilities for discovering any possible flaw.

Another set of special tools has also just been made by Messrs. Craven Bros. for the Great Western Railway works at Swindon. These include a series of machines for manufacturing the iron framework of railway carriages and wagons. The designing of these machines has necessitated a special arrangement of a set of fixed spindles, which are carried on five separate machines, having respectively 42, 19, 38, 35, and 43 spindles. The machine with 43 spindles is horizontal, and carries a drill at each end, with the double object of equalising the pressure and enabling the machine to drill two pieces of ironwork of the same description at the same time. The machines are arranged to work in connection with hydraulic rivetters, and with specially constructed circular saws for cutting the ironwork cold, whilst there are also rotary cutters for making the mortices. The whole of the parts of the iron frame are thus turned out ready for simply putting together by means of portable hydraulic rivetters, the entire framework being manufactured and built up comparatively little or no hand labour being required. The construction of iron framework has hitherto been chiefly confined to wagons and carriages for the Indian railways, but with plant such as the above, and with iron at a low price, it would not seem improbable that iron may largely supersede the wooden frames on the English railways.

Some time back I referred to a couple of exceptionally large gun boring machines that Messrs. Craven were constructing for the English Government. These have now been completed and delivered, and they are the largest machines of this class that have ever been made for ordnance work. Each machine weighs 165 tons, and is capable of boring 30in. diameter to a depth of 50ft. In construction they are similar to previous machines made by the same firm, the special feature being the extra length of bore required for the new guns now being built.

In the coal trade the recent cold weather has had a tendency to give a little steadier tone to the market, but in the weight of actual business doing there is no appreciable improvement, and there is still a good deal of stock lying under load for which sellers in many cases are open to entertain low offers. The actual selling prices for quantities for prompt delivery consequently continue irregular, but in the ordinary quoted rates there is no change. Best coal at the pit mouth averages 8s. 6d. to 9s.; seconds, 6s. 6d. to 7s.; common house fire coal, 5s. 6d. to 6s.; steam and forge coal, 5s. to 5s. 6d.; burgy, 4s. 6d. to 5s.; best slack, 4s. to 4s. 3d.; and common, 3s. 3d. to 3s. 6d. per ton.

In the shipping trade there is a fair amount of activity at low prices, good Lancashire steam coal delivered at the high level, Liverpool, or the Garston Docks, averaging 7s. to 7s. 3d. per ton.

Barrow.—I have still to report a dull state of affairs in North Lancashire. The iron markets are but thinly attended, and the disposition to do business has in no way improved. Makers find the greatest difficulty in obtaining orders at reasonable and remunerative prices. When business is done it is only at the very lowest prices. Stocks are light in the hands of consumers, as they are buying, so to say, simply from hand to mouth. The output is by no means so heavy as it was a few months ago. Prices this week are quotably unchanged, 46s. representing mixed parcels of Bessemer iron, f.o.b. net; foundry, 45s. net on trucks; and forge, 44s. 9d. net on trucks. Iron ore is in great demand, and the shipments show a considerable decrease. Prices remain at about 8s. 6d. to 9s. 6d. per ton net at mines. Stocks are heavy. The steel trade still lacks activity, and the prospect of a better future is anything but promising. There is no improvement in the demand for steel rails, and exports are less than they were a few months ago. Engineers, boiler makers, and ironfounders are but poorly employed. Wire is selling briskly. Shipbuilding is in a very stagnant condition. Coal and coke quiet. Shipping dull.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

In spite of the change in the weather, which has interrupted the glorious sunshine of a month, our seaside and watering-places east and west continue well filled with visitors, and there has been a fairly good business doing in season goods for lodging-house keepers, hotel proprietors, boarding establishments, &c. The Scotch demand has been exceptionally good. A capital harvest has been well secured during the past month, and the result is expected to have a beneficial effect on the rural markets generally. It must be admitted, however, that the light trades are still very dull, no ephemeral demand from the seaside being sufficient to keep the works going full time. In several leading departments there is no lack of work, chiefly in armour-plates, heavy ordnance, and similar goods. There is also an active call for solid steel castings for colliery wheels and similar purposes. The makers of propeller blades, crank shafts, axles, &c., are full of work, chiefly on home account. Very little doing in steel or steel rails.

Major Marindin's report on the Penistone accident has been received with interest. Practically, it says that no brake in the world could have prevented the accident, but that an automatic brake might have lessened the deplorable consequences by keeping several of the carriages on the lines. It exonerates the officials, but remarks that it is the second emphatic warning the Manchester, Sheffield, and Lincolnshire Company has received on the subject of brakes.

The Yorkshire papers are giving some attention to an improvement in the safety lamp which has been introduced by Mr. W. E. Garforth, mining engineer, of Normanton, for the detection of fire-damp in mines. Mr. Garforth's invention consists in the use of a small india-rubber hand-ball, without a valve of any description, but by the ordinary action of compressing the ball, and then allowing it to expand, a sample of the suspected atmosphere is drawn from the roof or any part of the mine, without the great risk which now attends the operation of testing for gas should the gauze be defective. The sample thus obtained is then forced through a small perforated tube on to the flame, when, if gas is present, it is shown by the well-known blue-cap and elongated flame. The ball is so small that it can be carried in the waistcoat pocket, so that it is evident that it must prove a valuable adjunct to the safety lamp. At the last meeting of the Midland Institute, it was stated that at the Aldwarke Main Colliery—Messrs. John Brown and Co.—a sudden outburst of gas took place with such violence that 40,000 cubic feet of air, which was passing per minute, was rendered explosive for a mile in length. Mr. C. E. Rhodes, the manager of the collieries, states that no lamp would have been safe in such a current. He therefore left his lamp in a safe place, crept on his hands and knees into the return air-way, with a ball in his pocket, which in the darkness he filled with a sample of the atmosphere. On getting back, he forced the contents of the ball on to the flame. It showed such a quantity of gas that it was declared the test was perfect, and no lamp would have been safe in such a current.

Rotherham readers will hear with regret that Messrs. Baker and Burnett, of Conisborough, state that they have no intention of commencing wagon building at Brinsworth Ironworks, Rotherham, which they recently purchased. I notice that the liquidator of the Northfield Iron and Tire Company, advertises the sale by auction of the stock-in-trade, working tools, stores, &c. All hope, therefore, of carrying on that concern, at one time so important for Rotherham, must have been abandoned. Mr. G. Walter Knox, who worked the business at a profit while he had it in charge, introduced a new tire, from which great things were anticipated. Very little has been heard of the tire recently, but it was understood to be a good invention.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

The attendance at the Cleveland iron market held at Middlesbrough on Tuesday last was again small, and there was no increase in the number or extent of business transactions. The price of No. 3 g.m.b., as quoted by merchants, was 36s. 4½d. to 36s. 6d. per ton; but only small quantities changed hands at these prices. Consumers offered 36s. 3d. per ton. They believe that by holding back their orders a little longer they will be able to place them at that figure or less. The combination makers still adhere to their agreed price of 37s. per ton, and where special brands are required that price must be paid. The demand for forge iron has lately been extremely dull, and the price required by merchants has fallen to 34s. 3d., and it is even said that orders have been placed at as low a figure as 34s. Makers, of course, ask more. The nominal price for warrants is 36s. 6d. per ton.

Messrs. Connal's stock of Cleveland pig iron at Middlesbrough declined 334 tons during the week ending Monday last, the quantity then in store being 56,100 tons. At Glasgow they hold 585,962 tons.

Shipments of pig iron from the Tees continue at a moderate rate. Up to Monday last only 61,916 tons had been sent away during August.

The demand for manufactured iron does not improve, no orders for shipbuilding iron having recently come into the market. Prices have not altered, and stand as follows:—Ship plates, about £5 per ton; angles, £4 15s.; and common bars, £5 2s. 6d., free in trucks at makers' works, cash 10th, less 2½ per cent.

It is reported that Messrs. Bolckow, Vaughan, and Co., are about to put down a steel plate mill at their works at Eston. It is said they intend to erect four Siemens steel furnaces, so that they will be able to turn out steel of every kind required by consumers, and to the aggregate extent of about 5000 to 6000 tons per week.

The new company who commenced to bore for salt at Haverton Hill, near Middlesbrough, the other day, are Messrs. Grigg and Co., of London. The Newcastle Chemical Company has also recommenced boring operations.

Messrs. E. Withey and Co., shipbuilders, of Hartlepool, who have a scheme for encouraging their workmen to submit to them inventions in tools, machinery, &c., have just awarded their foreman blacksmith, Mr. Salt, the sum of £10 for an improved ship's anchor crane.

Satisfactory progress is being made with the Scarborough and Whitby railway. Of the 20½ miles of line, 13½ miles are now laid, and it is expected that the whole will be finished by November next, and that the line will be opened for traffic early next year.

Major Marindin's report upon the Penistone disaster is meeting with adverse criticism by some who are not altogether ignorant of the principles of mechanics. The gallant major states his conviction that the breaking of the crank was an accident which could not possibly have been foreseen or prevented. He adds:—"There is not the smallest fault to be found with any of the servants of the company." It appears, then, that the public must make up their mind to travel daily subject to similar risks, and with no hope of prevention or cure. Now, this is what is being said:—"Crank axles in locomotives are barbarities which should be immediately done away with. An axle with an 8ft. diameter driving wheel on each end, and jolting round a curve at fifty miles an hour, has quite enough to do to retain its form and its weight-carrying power without being cut in two places, as it almost is when formed into a crank axle. Besides, the material forming the cranks is never so good as that forming the plain parts. What must be come to, before this danger is obviated, is plain axles throughout, outside cylinders with moving weights properly balanced, and a bogie in front. Not until such engines have superseded inside cylinder crank axle engines will Major Marindin's words become true."

NOTES FROM SCOTLAND.

(From our own Correspondent.)

There has been comparatively little animation in the warrant market this week. The tone of the market has been weak, and the amount of business done not very important. Although there has been a better demand for the first qualities of makers' iron, the volume of the trade as a whole continues unsatisfactory. The past week's shipments amounted to 9520 tons compared with 11,484 in the preceding week, and 17,009 in the corresponding week of last year. There is a rather better demand from Canada, and some inquiries on the part of Russian consumers, but otherwise the foreign demand shows no improvement. A furnace has been extinguished at the Clyde Ironworks, but one has been relighted at Gartsherrie and one at Eglinton, so that there is one more blowing than a week ago, the total number being 95. The stock of pigs in Messrs. Connal and Co.'s warrant stores has been reduced by 450 tons in the course of the week.

Business was done in the warrant market on Friday at 41s. 5½d. cash, and 41s. 7½d. one month. On Monday transactions occurred at 41s. 5½d. to 41s. 4½d. cash, and 41s. 7d. to 41s. 6½d. one month. Tuesday's market was quiet at 41s. 5½d. to 41s. 5d. cash, and 41s. 7d. one month. On Wednesday the quotations were 41s. 5d. to 41s. 3d. cash. To-day—Thursday—transactions took place at 41s. 3½d., but the quotation was 41s. 4d. sellers at the close of the market.

The prices of makers' iron are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 53s.; No. 3, 50s. 3d.; Coltness, 60s. and 51s. 6d.; Langloan, 55s. and 51s. 6d.; Summerlee, 52s. 6d. and 47s. 3d.; Calder, 52s. and 47s. 9d.; Carnbroe, 50s. and 46s. 6d.; Clyde, 48s. and 45s.; Monkland, 43s. 9d. and 40s. 9d.; Quarter, 42s. and 40s. 3d.; Govan, at Broomielaw, 43s. and 40s. 9d.; Shotts, at Leith, 52s. and 51s.; Carron, at Grangemouth, 48s. (specially selected, 52s. 6d.), and 47s. 6d.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 50s. and 43s.; Eglinton, 44s. 3d. and 41s.; Dalmellington, 47s. 3d. and 43s.

The hematite trade is quiet, and there is little or no change in the stock, which amounts to about 50,000 tons.

The total imports of Cleveland pig iron to date are 162,105 tons, showing a comparative decrease this year of 7398 tons.

Makers of malleable iron are not receiving the advance in prices which they intimated several weeks ago, when reports were circulated regarding a revival of trade. The revival is evidently still somewhat in the distance, and in the meantime business continues quiet.

In the course of the last three weeks about £150,000 worth of machinery and manufactured iron and steel articles have been exported from Glasgow Harbour, including nine locomotives, valued at £20,000, for Calcutta.

The first of four complete sugar mill plants is about to be shipped at Glasgow by Messrs. Duncan, Stewart, and Co., to Brazil, for the Bahia Central Sugar Factories Company, of London and Brazil. Along with the engines and mills, which are capable of crushing 400 tons of canes a day, the Messrs. Stewart are supplying all the pans, heaters, and other apparatus requisite to the complete furnishing of sugar factories.

The coal trade in the West of Scotland is in a fairly active state; and although merchants report that inquiries have been slower within the past few days, the shipments, as a whole, compare favourably with those of the corresponding week of last year. Prices for some sorts are just a shade easier, but the quotations remain nominally without change. The total week's shipments of coals from all the ports were 68,284 tons as against 53,165 in the corresponding week of 1883. Large quantities have been despatched from Ayr to the new cheap mineral trains from Lanarkshire, which are now running, and expected to be the means of greatly increasing the export trade in coals at the Ayrshire ports.

The members of the Mining Institute of Scotland held their annual meeting in Edinburgh a few days ago, and took occasion to visit the works of the Forth Bridge at Queensferry, now in active progress. At the meeting, which was presided over by Mr. James M'Creath, M.E., a discussion took place with regard to Harrison's mining machine, and Mr. Roxburgh, of Alloa, in whose pits it is used, said that he was enabled to deliver the coal at from 4d. to 6d. a ton better than when it was produced by manual labour. Mr. Watson, of Earnock, now president, and Messrs. Austine, Dixon, and Hamilton, were appointed to arrange for stations in Scotland where the Fleuss life-saving apparatus may be rendered available in case of accidents in the mines. A paper was read by Mr. D. Johnstone on "Some Practical Results of Hydraulic Pumping."

It is interesting to note that six of the twenty-five Whitworth Scholarships gained this year have come to Scotland, that all these have been won by Glasgow students, and that four of the six received their instruction at the Glasgow College of Science and Arts, of which Mr. Jamieson is the principal.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

It is fortunate for our ironmasters that the coal trade remains so good, as this, to a large extent, makes up for the badness of the iron and steel trade.

Conversing this week with one of the most competent managers of steel works we have, he commented upon this fact. It has enabled ironmasters, most of whom have large coal areas, to keep the mills going, and at the same time carry out extensive transformations, which will be of service when the tide turns. So far the signs of a change in the rail trade are lacking, and as bar, sheet, and rail constitute pretty well the make of the Welsh works, and the demand for these is small, there is not much doing. An impression is gaining ground amongst some of the more advanced minds that makers should go in for machinery. Present slackness is prompting the query, "What shall we do with our steel?" and I confidently expect, with the cheap labour market and appliances that abound, something will be done in that direction.

The success of Treherbert Foundry in turning out admirable work is also another fact to be considered, all pointing in the same direction, that Wales may fairly compete in machinery work.

The coal trade, though not exhibiting the dash of past months, is yet, for the season, in a satisfactory state, and the next quarter is looked forward to with every confidence as certain to bring about a firm and well sustained demand. Most of the collieries are well employed, and where there is a slight falling off, as usually occurs at this time, managers judiciously carry out needed changes and improvements.

Mr. H. Martin is doing good work at Bedlinog; Mr. Beith, at Ynysybrol; Mr. Price, at Deep Navigation, where he has succeeded Mr. T. Evans, who is now in charge of one of the Rhondda collieries. At the Dinas Colliery the 9ft. seam has been struck in the Stonehouse shaft, and an appreciable increase to our stores of 3ft. Rhondda is also announced.

The Welsh railways at present are in a flourishing condition, and even the prospects of the Cambrian may be said to be improving under its proposed reorganisation. As regards passenger traffic, it has little cause of complaint, and the service is most efficiently conducted. The drawback is the slackness of the slate trade and the sparse goods traffic. The Taff Vale, while not showing the same large totals for mineral traffic as it did, yet continues the extensions and widenings with unabated energy. Its lines to Llancaiach and Ynysybwl may be said to be in advance of the traffic, but only for a short time. Its siding to the new sinkings in the Taff Vale is a very important one. The Brecon Railway reports that the last half-year has been the most satisfactory ever had, so far as receipts were concerned. The increase was £2603, as compared with the corresponding half of last year. The doubling of the line between Machar and Bassalley, and the opening of the Newport, Pontypridd, and Caerphilly line promise great things for the Brecon, which is entering upon an era of increased vigour and, I hope, prosperity.

I must note also the enterprise of the Great Western in dovetailing wisely with the Cambrian and the London and North-Western, thus securing a fair share of tourist traffic.

Amongst the promising enterprises of the future, Milford Docks are again coming to the fore. Since the time that Mr. Fowler, the stipendiary of Swansea, drew attention to the excellence of the Haven in a work of great merit, hopes have been high in respect of the future of the Haven, but by adverse winds of circumstances these have not been realised. Now good news reaches me, difficulties are fading, powers will be forthwith handed from the Courts to the company, contracts be given out, and a fresh start made.

Lloyd's Committee have visited South Wales, and are now combining business with pleasure at Tenby. They report most favourably of Swansea, its means of access to and exit from, and the efforts to develope the natural advantages of the port.

The Bull Rock Lighthouse.—The *Times* Cork correspondent writes:—"About twenty miles to the west of Castletown, Berehaven, lately selected as a station for the British Navy, lies the Calf Rock, and three miles to the north-west is situated the Bull, where the Government is at present erecting a lighthouse to replace that of the Calf Rock which was swept away in the great storm three years ago. A steamer belonging to the Board of Lights conveys the workmen from Castletown to the Bull Rock, but so dangerous is the approach in consequence of the swift currents which prevail here, and which make the rock, even in the calmest weather, a very Scylla to modern navigators, that ordinary visitors are forbidden by a Board order from essaying the dangerous passage. By driving from Castletown to Dursey Sound—a journey of about fifteen miles—one may get a good idea of the boon the light will prove to storm-tossed mariners, by observing the inhospitable nature of the coast of which it is to serve as a beacon. The coast presents to the seaside a precipitous rocky wall, worn into strange shapes by the action of wind and wave, and broken occasionally by deep narrow gorges or bays, studded with rock islands. Three rocks—the Bull, Cow, and Calf—lie off Dursey Head, the bull situated at a distance of three miles to the north-west. The rock rises more than 300ft. above the sea, and is pierced through from side to side by an immense natural cavern. It is the home of countless sea birds—*apricis statio gratissima mergis*—which fill every nook and cranny with their eggs."

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.

19th August, 1884.

11,409. Bye-pass for Gas Taps, T. Fletcher, Warrington.
11,410. Metallic Pistons, J. S. D. Shanks, Belfast.
11,411. Pneumatic Carrying Apparatus, W. P. Thompson.—(*A. Brisbane and R. Gillham, U.S.*)
11,412. Cover of Books, W. P. Thompson.—(*J. E. and L. M. Lacoste and J. B. Geneste, Thiviers.*)
11,413. Electric Lamps, &c., W. P. Thompson.—(*T. Elcoate, Port Said.*)
11,414. Steam Boilers, J. M. McCulloch, Liverpool.
11,415. Watch Protector, A. Edmonds, Birmingham.
11,416. Trap for Vermin, J. J. Dyson, Bradford.
11,417. Stench Traps, E. G. Colton.—(*R. T. D'Heureuse, New York.*)
11,418. Connections for Braces, J. Cadbury and J. G. Rollason, Birmingham.
11,419. Attaching Lathe-chucks and Lathe-mandrels, W. D. Hasluck, Clapham.
11,420. Bicycles, B. Kelsey, Birmingham.
11,421. Railway Wagon Coupling, T. Wolstenholme, Bradford.
11,422. Bicycles, &c., W. Cordeaux, Rotherham.
11,423. Brake-block for Railway Vehicles, M. Swain, Manchester.
11,424. Life Buoys, A. and R. Strong, Barrow-in-Furness.
11,425. Scraping Rollers, J. Dent and J. Holt, London.
11,426. Steam Pumps, L. B. Carricaburu, London.
11,427. Steam Engines, L. B. Carricaburu, London.
11,428, Valve Gear for Steam Engines, L. B. Carricaburu, London.
11,429. Device for Indicating Time, T. Lewis, Birmingham.
11,430. Spikes for Securing Rails, H. H. Lake.—(*J. P. Perkins, U.S.*)
11,431. Apparatus for Playing Games, H. H. Lake.—(*J. H. Bowen, U.S.*)
11,432. Lasting Boots or Shoes, H. H. Lake.—(*H. P. Aldrich, U.S.*)
11,433. Portable Lamp, J. Sothcott, Finsbury.
11,434. Chaff-cutters, W. Sayer, London.
11,435. Attaching Buttons to Fabrics, G. Pitt.—(*G. W. Prentice, U.S.*)
11,436. Devices for Guiding the Fingers in Writing, I. Bergmann, London.
11,437. Press-screwing Lamp Furniture, J. Shelton, London.
11,438. Looms, A. G. Brookes.—(*J. D. Butler and A. F. Whitin, U.S.*)
11,439. Cane Juice Clarifiers, G. Fletcher, London.
11,440. Combined Filter Press and Monte-jus, G. Fletcher, London.
11,441. Multiple Scissors, O. Edlinger, London.
11,442. Tanning Tawed Leather, C. Kaestner, London.
11,443. Air, &c., Cooling Apparatus, H. J. Haddan.—(*G. Honerla, Kohlstadt.*)
11,444. Fireproof Floors, &c., E. Homan, London.
11,445. Nailing Machines, G. Lines and A. Bridgman, London.
11,446. Electric Bells, S. A. Varley, London.
11,447. Preventing Contact between Dress Skirts, Trousers, &c., and the Boot-heels of the Wearer, S. L. R. Spackman, London.
11,448. Galloon Trimmings, R. Renkewitz.—(*Pohlmann and Co., Berlin.*)
11,449. Distilling Urine, &c., W. R. Lake.—(*C. Brison, Mâcon.*)

20th August, 1884.

11,450. Stopping Bottles, H. Arch and C. Wozencroft, Hunslet.
11,451. Mangles or Wringers, W. P. Thompson.—(*G. Scott and T. J. Baldon, Canada.*)
11,452. Cord Holders for Blinds, &c., T. Hughes, Birmingham.
11,453. Magneto-electric Machines, &c., R. E. B. Crompton and G. Kapp, London.
11,454. Tidal Water-power, J. Dixon and J. Horrocks, Southport.
11,455. Connections for Metal Tie-rods, R. H. Evans, Manchester.
11,456. Dyeing Cotton Yarns and Fabrics, F. A. Gatty, Manchester.
11,457. Boring Wells, C. Chapman, Manchester.
11,458. Automatic Sight Feed Lubricators, W. Dixon, Ballymacarrett.
11,459. Scouring and Polishing Brass, &c., T. Kendrick, Birmingham.
11,460. Rolling or Shaping Edge-tools, &c., T. Cawthron, London.
11,461. Making Fresh Water from Salt Water, A. Chapman, London.
11,462. Packing Cases, A. W. O. Saunders, London.
11,463. Advertising, G. Holiday and J. H. U. Harris, London.
11,464. Cooking and Heating Apparatus, J. Burford, London.
11,465. Preserving the Felt of Grand Piano Hammers, F. Kaim and Sohn, Wurttemberg.
11,466. Looms, J. Hollingworth, Marsden.
11,467. Turning Over the Pages of Music, G. Brockelbank, Anerley.
11,468. Brushes, N. W. Chittenden, London.
11,469. Callipers, G. Edwards, New Thornton Heath.
11,470. Automatic Discharging and Righting Skip, J. Kitto and R. R. Nancarrow, Llanidloes, and A. Paul, Devil's Bridge.
11,471. Pencil-holders and Point Protectors, G. R. Willis, Woodford.
11,472. Increasing the Velocity of Steaming or Sailing Vessels, C. W. Dobson, Turkey.
11,473. Alarum Detector, W. Löffelhardt, London.
11,474. Sewing Machines, O. Linley, London.
11,475. Steam Engines, P. M. Justice.—(*W. H. Wilde, United States.*)
11,476. Rubber Waterproof Cloaks, A. F. L. and W. L. Hepton, London.
11,477. Ladders, H. Meyer, London.
11,478. Purifying Water, D. Nicoll, London.
11,479. Disinfecting the Contents of Dust-bins, &c., D. Nicoll, London.
11,480. Fastenings for Stay Busks, C. M'C. Symes and A. Gray, London.
11,481. Fire-escape, H. Hargreaves, London.
11,482. Spindles and Bobbins, W. R. Lake.—(*R. Wright, United States.*)

21st August, 1884.

11,483. Dobbies for Looms, W. Butterworth and J. Booth, Halifax.
11,484. Sausage Filler, &c., Machine, F. W. Follows, Manchester.
11,485. Producing Vacuum in the Evaporation of Liquids, G. Hambruch, Berlin.
11,486. Transposition of Water in Canals, H. Shaw, London.
11,487. Raising, &c., the Radial Arm of Drilling Machines, A. Earnshaw and J. H. Foster, Halifax.
11,488. Self-locking Stopper for Bottles, &c., M. Macleod, Manchester.

11,489. Non-alcoholic Beverages, T. Hogben, London.
11,490. Stands for Cruets, Bottles, &c., R. F. Mackay, Dundee.
11,491. Hydraulic Apparatus for Pumping, &c., E. Miller and T. Hewitt, Birmingham.
11,492. Flavouring Aerated Waters, T. Kerfoot, London.
11,493. Cutting Paper Rolls, W. P. Thompson.—(*C. Milchsack, Berg-Gladbach.*)
11,494. Regulating a Given Supply of Water to Closets, &c , H. Harrison, Leeds.
11,495. Combined Wheels and Axles for Rail and Tramways, W. Woodward, Manchester.
11,496. Cooking and Kitchen Ranges, W. Russel, Manchester.
11,497. Loom Pickers, H. Tetlow, Manchester.
11,498. Shelter for Certain outside Seats of Passenger Carriages, L. J. Todd, London.
11,499. Attaching Soles to Boots and Shoes, T. Laycock, London.
11,500. Joints for Flexible Pipe Hose, &c., F. R. Wildegose, London.
11,501. Electric Arc Lamps, C. Lever, London.—30*th May*, 1884.
11,502. Operating the Rising and Falling Shuttle-boxes of Looms, J. Cowburn and C. Peck, Manchester.
11,503. Bell Cranks, &c., G. Hurdle, Southampton.
11,504. Compression of Air, J. R. Cox, London.
11,505. Sleeve and Collar Links, W. B. Tracey, Manchester.
11,506. Plough, &c., Wheels, H. Lennon, Melbourne.
11,507. Fixing Coating for Moroccos, &c., W. E. Gedge.—(*J. B. Dervieux, Arcueil.*)
11,508. Velocipedes, H. Smedley and W. J. Green, London.
11,509. Monumental, &c., Work, A. J. Boult.—(*F. M. Nichols, U.S.*)
11,510. Lubricator, E. Edwards.—(*T. Delville, Arlon.*)
11,511. Indicator for Looms, E. Edwards.—(*A. Cally and R. Carrov, Elboeuf.*)
11,512. Slide Valves, &c., E. F. Piers, London.
11,513. Transverse Water-tubes for Steam Boilers, E. J. Curtin, London.—10*th June*, 1884.
11,514. Leg Rests applicable to Bicycles, R. Laurence, London.—30*th July*, 1884.
11,515. Fastening Sliding Sashes, J. Eaton, London.
11,516. Raising and Lowering Blinds, &c., J. Eaton, London.
11,517. Sashes of Railway, &c., Doors, J. Eaton, London.
11,518. Anti-incrustation Composition for Steam Boilers, A. M. Clark.—(*Van Baerle and Co., Worms.*)
11,519. Trimming Lamp-wicks, A. Martin, London.
11,520. Preparing Surface Rolls for the Manufacture of Tin-plates, &c., W. F. Lewis, London.
11,521. Electric Batteries, J. H. Johnson.—(*P. G. Skrivanow, Paris.*)
11,522. Horseshoe Nails, J. H Ehlers, London.

22*nd August*, 1884.

11,523. Mount for Mouthpiece of Pipes, B. Salmon and M. Gluckstein, London.
11,524. Gas Engine Combustion Chambers, W. Ainsworth, Penrith.
11,525. Sweat Protectors, W. P. Thompson.—(*S. J. Picard and L. Vincent, Paris.*)
11,526. Fasteners for the Hair, A. Sedgwick, Liverpool.
11,527. Wrapping, &c., Newspapers, &c., G. M. Borns, London.
11,528. Positive Let-off Motion for Looms, E. Beach, Providence, U.S.
11,529. Carding Engines, G. and E. Ashworth, Manchester.
11,530. Lamps or Lamp Holders, E. Grube and A. C. Wells, Manchester.
11,531. Fittings for Cattle on Shipboard, W. Wylie, Glasgow.
11,532. Shuttles, T. Tweedale, Manchester.
11,533. Automatic, &c., Sash Fasteners, J. Parker, London.
11,534. Horseshoes, A. G. Greenway and J. B. Adams, London.
11,535. Apparatus to Dispense with the Check Straps in Looms, R. Mercer, Halifax.
11,536. Glass Holder for Table Use, E. Fiet, London.
11,537. Cabin Lifeboats in a Ship, M. Underwood, Devonport.
11,538. Gas Meter Indices, G. Joslin, Westminster.
11,539. Springs, A. Browne.—(*J. G. Dreyfus, Paris.*)
11,540. Whiffletree, A. Browne.—(*J. G. Dreyfus, Paris.*)
11,541. Stoves, J. H. Keyser, London.
11,542. Dynamo-electric Machines, S. Williams, Newport.
11,543. Burning Naphtha for Melting Metals, T. Nordenfelt.—(*L. Nobel, St. Petersburgh, C. G. Wittenström, Motala, E. Faustman and P. Ostberg, Stockholm.*)
11,544. Revolving Shutters, H. J. Haddan.—(*J. Anderlee, Vienna.*)
11,545. Brace for Theatrical Machinery, G. Pepper, London.
11,546. Cutter Bar for Mowing Machines, A. M. Clark.—(*L. P. Roys, U.S.*)
11,547. Substitute for Fuller's Earth, W. D. Curzon and G. Jones, London.
11,548. Compound suitable for Scouring, W. D. Curzon and G. Jones, London.
11,549. Gasaliers, W. G. Kent and J. W. Sutton, London.
11,550. Wheels for Carriages, T. E. Knightley, London.
11,551. Pans for use with Buddles for Tin Mines, E. Davies and R. T. Haws, London.
11,552. Wick Raisers, M. C. Harney, London.
11,553. Lawn-tennis Stand, L. A. de Sausmarez, London.
11,554. Leak Stopper for Boiler Tubes, E. D. Barker, London.
11,555. Impressing Fiscal Stamps, W. H. Beck.—(*C. Busch, Paris.*)
11,556. Taking Photographs by Artificial Lights, E. Himly, London.
11,557. Obtaining Glucose from Wood, A. M. Clark.—(*L. J. A. Lespermont, Paris.*)
11,558. Filters, E. M. Knight, Liverpool.

23*rd August*, 1884.

11,559. Portable Front Seat for Phaeton, &c., T. R. Mountain, Ripon.
11,560. Front Seat of Reversible Stanhope Wagonette, T. R. Mountain, Ripon.
11,561. Bicycles, A. Caton, Portsmouth.
11,562. Spring Bed or Palliasse, J. Beale, Cork, and T. Dineen, Leeds.
11,563. Railway Chair, G. Paley, Manchester.
11,564. Metallic Belts for Sewing Machines, S. H. France, Hyde.
11,565. Advertising, C. S. Nelson, Manchester.
11,566. Additions Machine, M. Meyer, London.
11,567. Metal Castings, T. Nordenfelt.—(*C. G. Wittenström, Motala, E. Faustman and P. Ostberg, Stockholm.*)
11,568. Metal Castings, T. Nordenfelt.—(*C. G. Wittenström, Motala, E. Faustman and P. Ostberg, Stockholm.*)
11,569. Railway Chairs, C. H. Rosher, London.
11,570. Printing Paper Wrappers, &c., A. G. Brookes.—(*P. Büchy and J. P. Strangman, Sarno.*)
11,571. Saddle Girths, H. Westwood, London.
11,572. Rotary Engines, J. Wild, London.
11,573. Furniture Castors, A. Skinner and C. H. Thompson, London.
11,574. Baths, G. Tennant, London.
11,575. Velocipedes, J. Rettie, London.
11,576. Lubricating Engines, S. Griffin, Bath.
11,577. Rock Boring Machines, R. Harris, London.
11,578. Gas Motor Engines, F. W. Crossley, London.
11,579. Stretching Trousers, &c., Garments, W. Farmer, London.
11,580. Safety Brakes for Lifts, &c., J. C. Mewburn.—(*D. C. de la Jeannière, Paris.*)
11,581. Examining Eggs, C. Mackintosh, London.
11,582. Propelling Railway Wagons, &c., W. Heslop, London.
11,583. Removing Fluff from Threads or Yarns, R. Threlfall, London.
11,584. Padlocks, E. G. Brewer. — (*A. Schroeder, Volmarstein.*)
11,585. Clipping Horses, &c., H. H. Lake.—(*T. Bérard, Paris.*)
11,586. Extracts of Tannin, W. A. Barlow.—(*La Société Civile d'etudes sur les Procédés Nouveaux de Fabrication Perfectionnée d'Extraits Tannique, Paris.*)
11,587. Raising Sunken Ships, R. T. Turnbull.—(*G. Ross, New Zealand.*)
11,588. Producing Patterns in Cloth, W. Rigg, London.

25*th August*, 1884.

11,589. Flushing Apparatus, A. Seward and H. G. Walton, Liverpool.
11,590. Opening and Scutching Cotton, L. Hargreaves, Halifax.
11,591. Operating Rising and Falling Boxes of Looms, E. O. Taylor, Halifax.
11,592. Making Joints in Submarine Tunnels, R. Pickwell, Hull.
11,593. Looms for Weaving, R. L. Hattersley and J. Hill, Keighley.
11,594. Feeding Wool, &c., to Carding Machines, W. Cliffe, Halifax.
11,595. Line Reel, T. Nuttall, Ramsbottom.
11,596. Gas Motor Engines, G. Magee, Govan, and R. McGhee, Walthamstow.
11,597. Stopper for Bottles, &c., R. Bateman, Birmingham.
11,598. Heating Apparatus, W. Poore, London.
11,599. Rotary Engines, G T. Leitch, Glasgow.
11,600. Brushes, E. Wilson, Bradford.
11,601. Electric Railways, I. Enright, London.
11,602. Thermo-electric Batteries, G. Zanni, London.
11,603. Sketching Compass, A. Wilkinson, London.
11,604. Disinfecting, H. Taylor, London.
11,605. Road Wheels for Vehicles, T. E. Daintree and A. Greig, Leeds.
11,606. Lighting Street Lamps, J. Brown, London.
11,607. Indicating Direction Travelled by Vehicles, M. J. Rowley and C. A. Wheeler, London.
11,608. Motor Engines, E. F. Piers, London.
11,609. Marine Engines, E. F. Piers, London.
11,610. Shirt or Collar Stud, W. Sapte, jun., London.
11,611. Bottles for Aerated Liquids, I. R. Sharpe, London.
11,612. Bending and Upsetting Metals, W. R. Lake.—(*Dosme et Cie., St. Amand.*)
11,613. Axles, S. C. Joyce, London.
11,614. Wheelbarrow, A. Browne.—(*J. G. Dreyfus, Paris.*)
11,615. Animal Charcoal for Blacking, &c., J. C. W. Stanley, London.
11,616. Wheels, E. Edwards.—(*La Société Deflassieux Frères, Paris.*)
11,617. Short Circuiting Incandescence Lamps, C. D. Abel.—(*Siemens and Halske, Berlin.*)
11,618. Hand Looms, H. Dörnemann and F. A. Weil, London.

ABSTRACTS OF SPECIFICATIONS.

Prepared by ourselves expressly for The Engineer *at the office of Her Majesty's Commissioners of Patents.*

5675. Navigational Sounding Apparatus, *Sir W. Thompson, Glasgow.—8th December*, 1883. 8*d.*

Relates to improvements on patents 3452, A.D. 1876, and 781, A.D. 1880. Instead of letting the shaft or axle which carries the wire drum or wheel run round with the drum or wheel during the egress of the wire, and attaching the hauling-in handles after the sinker reaches the bottom, the shaft is kept at rest with the handles fixed to it, and the drum or wheel is let to run round by unclamping it from rigid attachment to the said axle. The moment the sinker reaches the bottom the drum or wheel is clamped frictionally to the axle, or it may be a grooved ring in place of a drum or wheel, on a disc carried by the axle, so as quickly, but not too suddenly, to stop the farther egress of the wire.

5770. Mincing Machines, *A. M. Clark, London.—17th December*, 1883.—(*A communication from Collin et Cie., Paris.*)—(*Not proceeded with.*) 6*d.*

Relates to the arrangement of perforated cutter plates and blades.

5794. Poles or Standards more Especially Useful for Wire Fencing, *W. T. C. Bruce and A. Still, Liverpool.—18th December*, 1883. 4*d.*

Relates to a pole or standard in the form of two tubes confluent or jointed together, constructed out of sheet metal.

5807. Telegraph Transmitters and Electric Circuit Controllers, *E. A. Brydges, Berlin.—19th December*, 1883.—(*A communication from W. F. C. M. McCarthy, New York, U.S.*) 6*d.*

A number of independent circuits are controlled simultaneously and automatically by means of a perforated fillet or tape of any suitable insulating material.

5820. Lowering, Raising, and Releasing Ships' Boats, *C. J. Fox, Birkenhead.—20th December*, 1883. 8*d.*

Relates to an apparatus whereby ships' boats are so carried that they can be launched from either or both sides of the ship, and they can be lowered in succession into the water by the same apparatus, such apparatus also serving for raising the boats.

5837. Knitting Machines, *T. Coltman, Leicester.—22nd December*, 1883. 1*s.*

Relates to the construction of straight bar knitting machines in which what are known as tumbler or latch needles are employed.

5839. Longitudinal Sleepers and Fastenings for Railways, *E. G. Holtham, London.—22nd December*, 1883. 6*d.*

Consists in constructing a longitudinal sleeper with an upper central part on which the rail seats, and a lower wider corrugated part bearing on the ballast, with upwardly sloping ribs arranged to enter and to be keyed in recesses formed in chair jaws.

5842. Thread-winding Machines, *J. Booth and J. T. Wibberley, Bolton.—22nd December*, 1883. 10*d.*

The object is to construct a sewing thread-winding machine having a self-adjusting reciprocating motion, or motion for guiding the threads being wound upon the bobbins, reels, or spools, which can be altered immediately to suit all kinds or sizes of bobbins, reels, or spools and sewing thread.

5871. Locomotives for Tramways, &c., *J. W. Hartley, Stoke-on-Trent.—27th December*, 1883. 6*d.*

Relates, First, to a novel form of vertical boiler, Secondly, to the driving gear; and, Thirdly, to means for rendering the escape of the exhaust steam noiseless and invisible.

5903. Obtaining Oil, &c., from Minerals, &c., *J. McCulloch and H. Macvicar, Lanark.—28th December*, 1883. 6*d.*

Relates to the process for obtaining oil and other products from minerals, and consists in subjecting the minerals in long, vertical retorts of at least 40ft. in height, through which retorts they descend slowly to gradually increasing heats, which are most intense at the lower part of the retorts, whilst steam is introduced at the lower part.

5908. Grinding Swords, &c., *A. Greenwood, Leeds.—29th December*, 1883. 8*d.*

Relates to the introduction into what are known as copying machines of emery wheels, or equivalent grinding surfaces, for reducing to shape swords, bayonets, files, or other articles of irregular form.

5909. Measuring and Continuously Recording Physical Power, *A. G. Meeze, Redhill, Surrey.—29th December*, 1883. 1*s.* 2*d.*

This relates to the application of various forms of integrating mechanism for measuring the power given out by steam or other engines, the power transmitted through belts, to measuring and recording the work done in an electrical circuit, &c.

5930. Centrifugal Governors and Expansion Gear, *W. Hartnell, Leeds.—29th December*, 1883. 8*d.*

Consists partly in the construction of a centrifugal governor with an abutment disc or surface, against which the levers carrying the governor balls thrust, whilst in diverging they compress the controlling spring.

5934. Tills, *J. L. Edwards, London.—29th December*, 1883. 8*d.*

Relates to the general construction of tills in order to prevent fraud.

5939. Electro-motor Engines for Railways, *F. H. Danchell, Maidstone.—31st December*, 1883. 6*d.*

The wheels of the vehicle are driven by being in frictional contact with the axle of the electro-motor.

5944. Combination Steam Engine, *H. Howaldt, near Kiel.—31st December*, 1883. 6*d.*

The object is to utilise in steam engines the heat and power of high-pressure steam to the best advantage, and it is carried into effect by combining two or more pairs of cylinders working according to Woolf's principle in such manner that the second and third and the fourth and fifth cylinders, and so on, will work according to the compound principle.

5952. Gas Retort, Steam Boiler, and other Furnaces for Generating Heat, *J. Dempster, Elland.—31st December*, 1883. 6*d.*

Relates to the formation of the bricks and the construction of the flues.

5964. Telegraphic and Telephonic Apparatus, *D. Sinclair and J. L. Corbett, Glasgow.—31st December*, 1883. 6*d.*

This relates to improvements on patent No. 3380, of 1883, relating to the arrangement of apparatus for enabling branch exchanges to be worked automatically; and to means for enabling a number of subscribers in a district to be connected to a central exchange by a single trunk wire.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

302,062. Armature for Dynamo-electric Machines, *Silvanus F. Van Choate, New York, N.Y.—Filed October 27th*, 1883.

Claim.—(1) In an armature for a dynamo-electric machine, transverse or lateral grooves or slots extending entirely through the armature from one side to the other, as and for the purpose described. (2) In a sectional armature, segmental sections having

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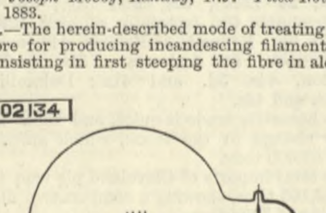

lateral or transverse grooves or slots formed in their abutting heads or ends, as and for the purpose described. (3) The combination, in a sectional armature, of sections having slots or grooves in their abutting ends, plates in said grooves, and means for securing the plates to the sections.

302,134. Incandescent Filament for Electric Lamps, *George W. Hickman, Washington, D.C., and Joseph McCoy, Rahway, N.J.—Filed November 7th*, 1883.

Claim.—The herein-described mode of treating vegetable fibre for producing incandescing filaments, the same consisting in first steeping the fibre in alcohol,

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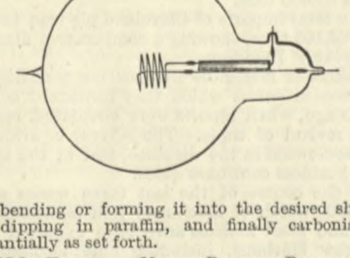

next bending or forming it into the desired shape, then dipping in paraffin, and finally carbonising, substantially as set forth.

302,296. Finishing Metal Rods in Rolling or Drawing, *William A. Sweet, Syracuse, N.Y.—Filed January 14th*, 1884.

Claim.—(1) In combination with rollers for rolling metal rods, a tube or chamber filled with steam, through which the metal rod passes while being rolled, and by which said rod is enveloped, as and for the

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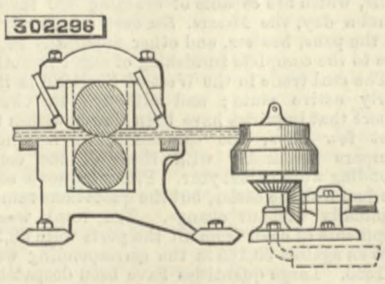

purposes specified. (2) A closed chamber into which the heated metal wire is reeled, filled with steam, which surrounds the metal wire while reeling into a coil, in the manner and for the purposes specified.

302,319. Dynamo-electric Machine, *Charles F. Brush, Cleveland, Ohio.—Filed June 30th*, 1882.

Claim.—(1) The combination, with two series of field-of-force magnets arranged with poles of opposite polarity facing each other, of two or more coils or folds having their planes substantially in the line of their movement between the poles of the field-of-force magnets, the opposite faces of each coil or fold being exposed to the poles of the field-of-force magnets, substantially as set forth. (2) The combination, with two series of field-of-force magnets arranged with poles of opposite polarity facing each other, of a revolving diamagnetic carrier provided with two or more coils or folds having their planes substantially in the line of their movement between the poles of the field-of-force magnets, the opposite faces of each coil or fold being exposed to the poles of the field-of-force magnets, substantially as set forth. (3) The combination, with two series of field-of-force magnets arranged with poles of opposite polarity facing each other, of two or more folds of ribbon conductor arranged to move in their own plane between said field-of-force magnets, substantially as set forth. (4) The combination, with two series of field-of-force magnets arranged with poles of opposite polarity facing each other, of a revolving ribbon conductor disposed in radial folds arranged to move in their own planes between said magnets, substantially as set forth. (5) The combination, with two series of field-of-force magnets arranged with poles of opposite polarity facing each other, of a revolving ribbon conductor disposed in insulated radial folds arranged to move in their own planes between said magnets, substantially as set forth. (6) The combination, with two series of field-of-force magnets arranged

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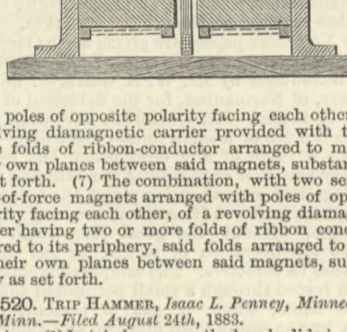

with poles of opposite polarity facing each other, of a revolving diamagnetic carrier provided with two or more folds of ribbon-conductor arranged to move in their own planes between said magnets, substantially as set forth. (7) The combination, with two series of field-of-force magnets arranged with poles of opposite polarity facing each other, of a revolving diamagnetic carrier having two or more folds of ribbon conductor secured to its periphery, said folds arranged to move in their own planes between said magnets, substantially as set forth.

302,520. Trip Hammer, *Isaac L. Penney, Minneapolis, Minn.—Filed August 24th*, 1883.

Claim.—(1) In trip hammers, the box *k*, slide *i*, centres *l*, and links *q*, combined with the beam operating the hammer, substantially as shown and described. (2) In trip hammers, the links or braces *q*, combined with

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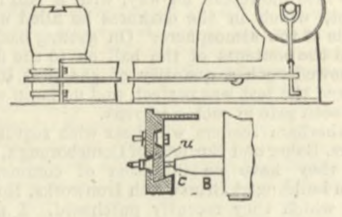

the beam C, box *k*, and slide *i*, carrying the beam centres, substantially as and for the purposes specified. (3) In trip hammers, the slides *u*, carrying centres *c*, and the adjustable operating rod *f*, combined with standards *d*, helve B, and beam C, substantially as shown and described.

CONTENTS.

The Statistics of the French Railway System for the year 1882, which have only recently been issued, show a very conspicuous improvement, from the mechanical point of view, upon the preceding year. There were in France in 1882, 26,340 kilometres of railways of public utility, worked by 7859 locomotives, aggregating 29,954,407-horse power. The local lines had a length of 2308 kilos., with 171 locomotives, of 19,415-horse power. Industrial railways extended to 629 kilos., with 238 locomotives; and there were 207 kilos. of steam tramways worked by 133 locomotives. In Algeria 172 engines were required to work 1457 kilos. of line. Compared with 1881 these figures show the very large increase of 631 locomotives in France, and 47 in Algeria. The average horse-power was greater in 1882 by 15. There were thus in that year 8401 railway locomotives at work in France and Algeria, 1020 of which were of foreign construction, while 248 were new. Upon the Chemin de Fer du Nord alone, in 1882, the consumption of fuel—coal, coke, and peat—was 536,049 tons.