CHILLED CASTINGS.

No. II.

In resuming this subject, it must be remarked that it is not sufficient that the founder should find a good mixture for producing castings with a required depth of chill, as so many conditions and circumstances operate to affect that depth. It is very necessary to test the mixture frequently by casting test pieces, and examining not only the chill but the character and quality of that part which is not really chilled. For many purposes it is desirable that a strongly-marked chill should be obtained, having the inner part of the casting as soft or as tough as possible. Many mixtures may be easily made which will give a sufficient or a very deep chill by increasing the quantity of white iron used, but this may be at the expense of the strength of the casting, and hence such changes in the mixture must be made as will secure a chill of the required depth and still leave that part of the casting which it is not desired should be chilled in a normal state, so that the strength of the casting is not sacrificed. Most irons will on the other hand take a surface chill, but this is rarely of any use, and as all irons are susceptible of variation in character both in the blast furnace and in the cupola, it is highly desirable that great care should be taken in making frequent tests of the iron as it is used from the cupola in making the castings. When any considerable quantity of scrap from various sources is used this is especially necessary, as the castings which have formed scrap will probably have been made from very numerous brands of pig.

Chilled wheels for railway rolling stock are not very often made in this country, but very large quantities are made for contractors' wagons and for colliery purposes. In making these very great care is necessary to secure the proper mixtures of iron. There are several, perhaps many, firms in the kingdom who pay the necessary attention to the many points involved in success in this work, but there are some who evidently do not think that any particular attention is necessary. Some evidence of this transpired in a recent action by an ironfounder at Wigan against Messrs. Gripper and Bayless, contractors, having in hand the construction of a promenade at Southport. The ironfounder, whose name it is not necessary to mention here, supplied to Messrs. Gripper and Bayless, a number of wheels supposed to be chilled wheels in the usual sense of the term, but as these wheels wore out very rapidly and appeared not to have any chill worth mentioning, Messrs. Gripper and Bayless refused to pay for them or for the whole of them. An action brought by the ironfounder to recover the amount claimed was tried in the early part of last month, and according to the evidence, as reported in the *Wigan Observer* of the 3rd and other days of last month, the wheels were certainly not chilled wheels. The servants, including the foreman, for the ironfounder, moreover, seemed to have very little knowledge of the mixtures of iron and the precautions necessary for producing chilled castings, and hence the iron used was totally unfit for making chilled wheels. According to the evidence of the foreman, the iron used was Glengarnock No. 3, Wigan Coal and Iron Company's No 3, and machine scrap, in equal proportions. Such a mixture, it will be seen from what has already been said and that which follows, is useless for the purpose to which it was put, although several witnesses whom it might be supposed would possess some knowledge on the subject considered the mixture satisfactory. The evidence on the part of the plaintiff was not, however, calculated to support the claim that the iron employed was such as should be used in making chilled wheels. For the defendants several witnesses were called who have undoubtedly had considerable experience in making chilled castings. Among these were Mr. R. C. May, C.E., and Mr. R. C. Rapier, C.E., both of whom gained their early experience with Messrs. Ransomes and May—now Ransomes, Head, and Jefferies—a firm which was one of the earliest makers of chilled wheels and other chilled castings, while Mr. Rapier's firm—Ransomes and Rapier—are now large makers of chilled castings—amongst others, the chilled points and crossings originally made under Mr. G. A. Biddell's patent, and in which a deep and uniform chill must be combined with strength in the casting as a whole. Both these gentlemen gave evidence of the unsuitable character of the mixture mentioned above for making chilled wheels, though when asked what iron should have been used with that mixture, Mr. Rapier was obliged to say that he preferred not to answer the question, as only years' of experience and constant attention would enable anyone to learn that, and consequently by those who at considerable expense had gained the necessary information it was held a trade secret. Mr. Samuelson, of Darlington, also gave evidence, stating that 35,000 wheels had been made under his supervision, he having patented the form of wheel used by the contractors in 1855. The negative evidence in the case was very full, but no information was given of what would be the most useful mixture for such wheels as those forming the subject of the action. Some idea of the importance of the trade in chilled wheels for contractors' use may be gained from the statement in Mr. Gripper's evidence, that in the eighteen months his firm had been at Southport 500 wheels had been broken, and

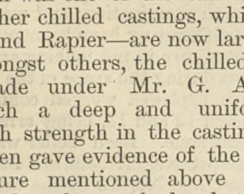


FIG. 6

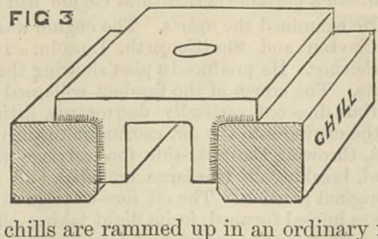
he thought they had been moderately fortunate. He considered the average life of a wheel on contractors' wagons to be about eighteen months, but a good wheel, if it did not meet with accident, would last ten years. The wheels supplied by the plaintiff had lasted but a very short time, and beside being without chill, or nearly so, were in many cases defective castings.

For heavy wagon wheels cast upon a chill as indicated in Fig. 6, the following mixture has been found to give a chill of about $\frac{3}{4}$in., but from what we have said the necessary changes for producing a chill of less depth will be readily gathered :—

Blaenavon or Pontypool	1 part
Cleator or Brymbo	1 ,,
Hematite 5	1 ,,
Selected scrap	2 ,,

For motion blocks, such as that indicated by Fig. 3, in

FIG 3

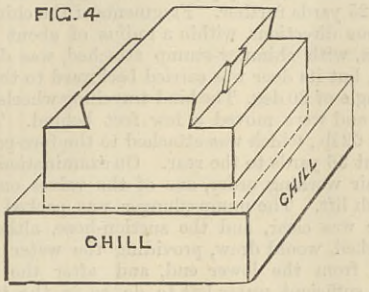


which the chills are rammed up in an ordinary mould, and for which a chill of about $\frac{1}{4}$in. is required, a mixture consisting of the following has, it is said, been found suitable :—

Madeley Wood	3 parts
Goldendale 5	$1\frac{1}{2}$,,

To this may be added, for deeper chill, some white iron, and if scrap is used it must be of grey iron, and some white iron will generally be required. For making hammer blocks, such as that indicated in Fig. 4, the following

FIG. 4



mixture has been found satisfactory in producing a chill of about $1\frac{1}{2}$in. :—

Lilleshall	5 parts
Madeley Wood	$2\frac{1}{2}$,,
Cleator	5 ,,
Hematite	$2\frac{1}{2}$,,

For a chill of about $\frac{3}{4}$in. in depth, the following has been used :—

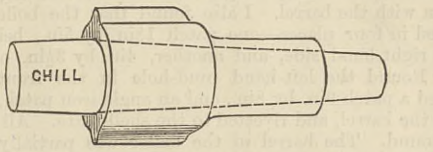
Cleator	2 parts
Hematite No. 5	5 ,,

and for a chill of about 1in. :—

Cleator	5 parts
Hematite	5 ,,
Lilleshall C.B.	2 ,,
Madeley Wood	2 ,,

For making axle-boxes upon a turned chill, as indicated

FIG. 5



in Fig. 5, the following mixture has been found to chill about $\frac{1}{4}$in. :—

Goldendale No. 5	1 part
Blaenavon No. 5	2 ,,
Glengarnock No. 1	1 ,,

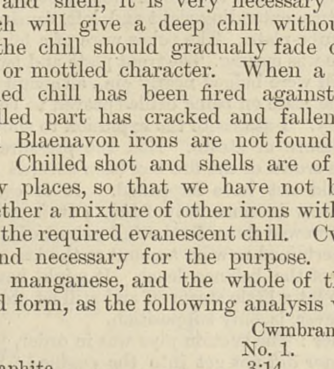
The chill, if thinly coated with plumbago, will readily come out with a slight blow from a copper hammer.

For chilled castings exposed to impact shock, such as chilled shot and shell, it is very necessary to secure a mixture which will give a deep chill without a sharply defined line, the chill should gradually fade off or merge into the grey or mottled character. When a shot with a sharply defined chill has been fired against an armour plate the chilled part has cracked and fallen off, so that hematite and Blaenavon irons are not found suitable for this purpose. Chilled shot and shells are of course only made in a few places, so that we have not been able to ascertain whether a mixture of other irons with the following will effect the required evanescent chill. Cwmbran iron has been found necessary for the purpose. This iron is very rich in manganese, and the whole of the carbon is in a combined form, as the following analysis will show :—

	Cwmbran pig iron No. 1.	Cwmbran pig iron White.
Carbon, graphite...	3·14	—
Combined carbon...	·55	3·50
Silicon	2·22	1·15
Sulphur	·02	·48
Phosphorus	·16	·17
Manganese	·88	·88

These shells are cast in heavy chills, as indicated in Fig. 7, and the following mixture has been found to effect

FIG 7



the required chill, while retaining the necessary strength in the unchilled portions :—

Cwmbran	5 parts.
Scrap from castings of shot and shell...	$2\frac{1}{2}$,,
Old cast iron guns	$2\frac{1}{2}$,,

For the surface of the chill such as that used in Fig. 4, a correspondent recommends the use of oil and plumbago, while he also commends the use of plumbago, No. 1450, Battersea, for the chills and for finishing the mould surface for small castings. In making chilled ploughshares, a section of one of which is indicated in Fig. 8, a chill mould of

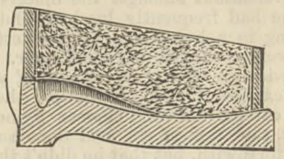


FIG. 8

considerable thickness may be used to secure strength, and a mixture similar to that used for axle-boxes may be used. For this purpose a clean, somewhat sharply defined chill is desirable, while the unchilled part should be soft, so that the lower surface retains its form, the upper part wearing off most rapidly and preventing the share from wearing out of ground or out of land. Other mixtures than that mentioned may be employed, and from what has now been said any founder will be able to adapt the irons generally at command in all foundries to the purpose. In making small chilled castings on chill moulds of closed forms it is necessary to observe that the casting be not of such a form that it so overlaps the outer parts of the mould as to be strained by its own contraction and the expansion of the chill, as this, even when the overlap is only of the nature of an over-run, is likely to break the casting. In making small castings of varying thickness for conversion into malleable iron, chills are sometimes used not to act as chills, white iron being used for the purpose, but to carry away heat from the thick parts and so inducing approximate uniformity in the rate of cooling of the casting, and preventing the fractures which sometimes otherwise occur in cooling owing to differential contraction. The iron for such purposes is best melted in cruibles and in a furnace such as that known as Fletcher's, in which a high temperature and regularity are easily obtained.

THE ATALANTA.

With the circumstances connected with the loss of the Atalanta our readers are no doubt familiar to a certain degree. It is known that she was a training ship, and that she has been lost at sea. The history of the ship may thus be briefly stated.

The Juno, afterwards called the Atalanta, was a sixth-rate of 923 tons, built at Pembroke dockyard, after the designs of the late Rear-Admiral Sir William Symonds, then Surveyor of the Navy. She was launched in 1844, and, having been fitted for sea service, was in September of the following year commissioned for the Pacific station by Captain—now Admiral—Patrick J. Blake. After a commission extending over three-and-a-half years, she was paid off in February, 1849 at Chatham, and remained in "ordinary" until September, 1853, when she was refitted for sea service, and commissioned by Captain Stephen G. Freemantle for the Australian station. On her return to England, after a commission of about four years, she was paid off, and put into "ordinary," and in 1861 was fitted as a water police vessel at Portsmouth, where she remained until 1877. In that year the Admiralty, for reasons stated by Vice-Admiral A. W. A. Hood, C.B., decided that a sailing ship without steam would be the best provision for training the young "ordinary" seamen, who were accumulating in considerable numbers in the depôt ships; and accordingly orders were sent to Portsmouth to have the Juno examined, she being the only available vessel of the size and class considered suitable for the purpose. On the completion of the repairs, she was sent to Devonport to be fitted out, her name was changed from Juno to Atalanta; and on the 17th Sept., 1878, she was commissioned by Captain Francis Stirling, with a crew of 113 officers, seamen, and artificers, besides 170 young "ordinary" seamen for training, and sailed on the 17th of October in that year. After a cruise in the West Indies and on the coasts of Ireland and Scotland, she returned to Portsmouth in September, 1879. On this cruise she experienced no bad weather, but on her return 10 tons of ballast were, at Captain Stirling's renewed request, added to the 30 tons already on board, the ballast being filled in with 3 tons of cement. Some alterations having been made in the internal fittings on the recommendation of Captain Stirling, at a cost of £886, the vessel sailed from Portsmouth on the 7th November, 1879, with orders to cruise in the West Indies, and to return to England in the following April, but owing to the occurrence of two cases of yellow fever on board, Captain Stirling, in the exercise of his discretion, left the West Indies, in January, for Bermuda and England. He arrived at Bermuda on the 29th of January last, and having completed with provisions and water, sailed with her for this country on the 1st February, since which time nothing has been seen or heard of her.

In order to arrive at the cause of her loss, a Committee of Investigation was appointed, consisting of Admiral Ryder, Captain Randolph, Mr. H. C. Rothery, Mr. R. B. Batt, and Mr. Waymouth. The report of the committee has been sent in, and is in many respects favourable to the ship. The most important question raised was, however, was she likely to capsize in a gale, and on this point we give the report of the committee in full as follows :—

(23) The next question which we propose to consider is the vessel's stability. All the witnesses who served in her, whether as a ship of war or training ship, speak of her as a safe and stable ship; at the same time they all agree in saying that she lurched and rolled very deeply. We have no record of the extent of these lurches during the time that she was in commission as the Juno, but we have entries in Captain Stirling's reports, and in the ship's log books, and statements in the evidence, that after her conversion into a training ship she lurched from 40 deg. to 45 deg., and rolled to windward from 22 deg. to 25 deg., that she put her lee nettings into the water, and that she made from twelve to thirteen oscillations in a minute.

(24) It seems that the pendulum which they had on board was indexed only to 30 deg., and that they had no battens for taking the angles of heel from the horizon, and no facilities for using

them, if they had had any. We were told by Lieutenant the Honourable A. Bethell, who had served in her during her first two cruises as a training ship, that the way in which they estimated the lurches was by observing a barometer, which, when it had gone through an arc of 40 deg., was brought up by a bulkhead; and he stated that if the bulkhead had not been there the barometer would often have shown a larger angle. He also stated that the entries in the log-book as to the extent of the vessel's lurches had been made after conversations amongst the officers; that his impression was that she had frequently lurched 40 deg. and over; and that when running in a heavy gale the lee nettings would be in the water on an average once in every half-hour. On the other hand, we have the evidence of several officers of very large experience who have expressed doubts whether the vessel ever lurched to such an extent, and Sir Thomas Symonds, G.C.B., Admiral of the Fleet, said that if she had done so she ought to have been broken up forthwith, but that he didn't think she had.

(25) There can be no question that the mode of estimating the extent of the vessel's lurches was very likely to mislead; and whilst we are not in a position to say positively that she lurched as much as 45 deg., or even 40 deg., yet the fact of her having frequently brought her bilge keels out of water even in a moderate sea, and the statement of Lieutenant Bethell that in a gale the lee nettings were in the water about once every half-hour, satisfy us that after her conversion into a training ship she must have lurched and rolled very deeply. This character for very deep rolling had been reported in her former commissions, vessels of her design being known to have that defect; and it was to remedy this that on her being fitted for a training ship bilge keels were affixed to her. The experience, however, of her first cruise was unsatisfactory, Captain Stirling reporting at its conclusion that she had lurched 40 deg. and rolled 25 deg. to windward.

(26) It is probable that if the extent of the rolling had been borne in mind the bilge keels would originally have been fitted lower down so as not to have been brought out of the water except in extreme cases, instead of being as they were frequently out of water even in ordinary weather. And it may well be a question whether it would not have been better to have placed them lower down after the first cruise instead of removing them altogether, as they might have added to the easiness of the ship, although, at the same time, it cannot be said that they would have increased her stability.

(27) Admiral Sir George Wellesley, K.C.B., the Lord of the Admiralty, whose province it was to inquire into the matter, stated that his attention had not been called to the fact of the vessel's deep lurching and rolling, and that even if it had been he should not have deemed it of any consequence, thus differing from Sir T. Symonds. Of so little importance do the reports of the vessel's heavy lurching and rolling on her first cruise as a training ship appear to have been considered, that when Captain Stirling asked to have the bilge keels removed owing to the severe shocks which they gave to the ship, his application was at once complied with by the Admiralty, and the four 64-pounder guns on the main deck were at his request removed, and two 9-pounder guns substituted for them on the upper deck. On his return from his next cruise Captain Stirling reported that the removal of the bilge keels had made the ship more easy, although she rolled more deeply, and he repeated his application for 10 tons more ballast, which was thereupon supplied to him, the ballast at the same time being filled in with three tons of cement.

(28) No doubt the shortening of the lower masts, the reduction of the armament, and the removal of the bilge keels and the four 64-pounder guns, as well as the addition of the ballast and cement, would tend to increase the ship's uneasiness, by causing her to roll and lurch more deeply; but the fact of the ship having lurched and rolled deeply is no proof that she was not a stable ship; on the contrary, taking Mr. Barnaby's definition, "that the stability may be said to be the force with which she tends to right herself after she has been inclined, or resists inclination from any position in which she is," it would seem that heavy lurching and rolling may be quite consistent with stability.

(29) We have ascertained from the Admiralty that the centre of gravity of the Atalanta was lowered, from what it had been in the Juno, ·75 of a foot, and that after her first cruise it was further lowered ·10 of a foot, and after her second cruise still further lowered ·10 of a foot, making altogether ·95 of a foot. And the conclusion, therefore, at which we have arrived is that, if she lurched and rolled very deeply when fitted as a ship of war, it may fairly be presumed that, but for the presence of the bilge keels, she would have lurched and rolled more deeply as a training ship, still more so on the second cruise, and most of all on her last cruise.

(30) Amongst the documents for which we asked, and which were supplied to us from the Constructors' Department of the Admiralty, was the Atalanta's curve of stability. Thinking, however, that it would be more satisfactory if this were also calculated by some one not connected with the Admiralty, we requested Mr. William John, an assistant to the Chief Surveyor at Lloyd's Registry, to make the necessary calculations, and to furnish us with the result. Mr. John's qualifications for the work were undoubted, as it was he who, while in the service of the Admiralty, had calculated the stability of the Captain and other vessels. A copy of the curves furnished by the Constructors' Department and by Mr. John will be found in the appendix.

(31) On comparing their results it will be seen that there is not much difference between them, and that whilst the Atalanta, from her great beam and the peg-top shape of her midship section, had very large initial stability, the amount and distribution of her weights, and the small quantity of ballast which she carried gave her a vanishing stability, according to Mr. John at 85 deg., according to the Constructors at 96 deg., the difference being due to the latter having been made for the normal condition of the ship, in agreement with her equipment as first completed for sea, and subsequently modified to include the change in armament and the increase in ballast, whereas the former was in agreement with the reported weights, and deduced from the draught of water at the date of sailing on her last voyage.

(32) From these considerations, and from a comparison of the Atalanta's curve of stability with those of well-designed merchant vessels, Mr. John was led to think that the vessel had an insufficient righting moment at large angles, and that it was by no means improbable that she would capsize, if caught in a squall of wind, unless very skilfully handled. Mr. N. Barnaby, C.B., the Director of Naval Construction, appeared to share Mr. John's preference for a design with less beam and more ballast, and thought that for a vessel of her displacement about 90 tons of ballast would be preferable to the 30 to 40 tons which the Atalanta carried, provided that she had less beam and a different midship section.

(33) In comparing, as Mr. John has done, the Atalanta's curve of stability with those of the merchant vessels to which he referred, it must be borne in mind that the qualities required in a ship of war are in many respects very different from those needed for a merchant vessel. Amongst these may be mentioned the power of fighting her guns in a fresh breeze, for which great initial stability is required, which it is admitted that the Atalanta had. How far it might be possible in a ship of war to combine sufficient initial stability with great righting moment at large angles of heel, such as appears to be possessed by well-stowed merchant ships of good design, is a question of the greatest importance, and upon which there is doubtless room for considerable difference of opinion; but this, as it appears to us, is not a question on which we are asked to report.

(34) What we are required to say is, whether the Atalanta, when she left England in November, 1879, was a stable ship; and the conclusion to which we have come, after a full consideration of all the facts of the case, is that she was on the whole a very stable ship, except at large angles of heel; that she was more stable than when first commissioned as a training ship, and much more so than in her previous commissions as a man-of-war.

BOILER EXPLOSIONS AT HUGHENDEN AND RUABON.

On the 16th of December, a portable engine exploded at Mr. Lee's farm, near Hughenden, Berks, killing one man and injuring the driver very seriously. The adjourned inquest was opened on last Wednesday week and concluded the same day. The most important evidence was that given by Mr. Spencer Jackson, of Chinnor, who said that he visited Mr. Lee's farm on the 17th December, where a portable agricultural engine had exploded on the 16th. He examined the *débris*. The engine was of very old make—by Clayton and Shuttleworth, Lincoln. It had burst with great violence. He produced a plan showing the positions of the fragments. The crown of the fire-box collapsed bodily, the force being thus directed vertically downwards, lifting the fire-box end of the engine into the air, causing it to turn a complete sommersault, throwing the near-side fore-carriage wheel into a tree overhead, breaking off two large branches, and falling 10ft. behind its original position. The off fore-carriage wheel, weighing 2 cwt., was hurled forward, in its flight taking off the top of a tree about 60ft. from the ground, and embedded itself in the turf at a distance of about 120 yards. The boiler in its first bound alighted 22ft. off, on the top edge of its shell, ricocheting forward 9ft., on to the bottom edge of the fire-box, again turning a sommersault, and, being relieved of the cylinder, fly-wheel, travelling wheels, &c., and having gained momentum, it bounded 33ft. more, again taking leaps of 19ft. and 24ft. It was finally deposited in the stream on its right-hand side, and 35 yards from its starting point. The cylinder was thrown 62 yards, and was surrounded by the driving belt, portions of the pump, piping, &c. A piece of the exhaust pipe, 2ft. in length, was embedded in the ground 25 yards further. Fragments of the chimney were driven in various directions, within a radius of about 60 yards. The smoke-box, with chimney-stump attached, was driven forward 41 yards, but its door was carried backward to the right 20 yards, at an angle of 80 deg. The hind travelling wheels remained on their axles, and were moved a few feet behind. The drag-shoe, weighing 62 lb., which was attached to the fore-part of the engine, was sent 36 yards to the rear. On examination he found the pump in fair working order, one of the valves only having rather too much lift. The pump-plunger was packed air-tight. The feed-pipe was clear, and the suction-hose, although considerably perished, would draw, providing the water covered a fracture 11in. from the lower end, and after the explosion there was still sufficient water left to do so in the tub, which had not been disturbed. The hose was well bound to the union, and the union joint air-tight. The pressure gauge was damaged by its fall, but on taking it to pieces he found the sensitive plate had burst in an upward direction. The syphon pipe was clear. he could not find the safety valve.

Two witnesses were here re-called, one of whom said the safety valve was on when he worked the engine, while the other stated that he searched for the safety valve after the explosion, and could not find it.

Mr. Jackson continued—I, however, made a new one, fitting it to the original seat, and tested the spring balance, which was marked up to 45 lb., but it blew off at the valve at a pressure of 43 lb. to 44 lb. The water gauge was gone, the taps being broken short off, but the steam and water holes in the brass nipples left in the plate were clear. On examination of the boiler I found it different in construction from the present make, as the two barrel-plates were rivetted longitudinally, and instead of the shell-plate being flanged it had a rivetted angle-iron connection with the barrel. I also found that the boiler had been repaired in four places—one patch 18in. by 5in., being studded to the right-hand side, and another, 4in. by $3\frac{1}{2}$in., on the same side. Round the left-hand mud-hole in the front plate was rivetted a patch 9in. by 8in., and an angle iron patch, 14in. long, under the barrel, and rivetted to the shell-plate. All the patches were sound. The barrel of the boiler was partially rent from the shell of the fire-box, evidently caused by the boiler pitching on end. On looking into the interior of the fire-box, I observed that the fusible plug was gone. On close examination it was evident that no iron plug had been substituted for lead. The iron bolt which lay inside had fallen from the boiler stay-joint. He mentioned this because the iron bolt was about the same size as the hole, and it might be supposed it came from it. The crown plate of the fire-box was a quarter of an inch in thickness and had every appearance of having been red hot. The top flange of the back-plate, to which the crown was rivetted, had first given way, the fracture extending right and left, causing the crown to lap over the tube-plate. The tubes were of a fair thickness, but the tube-plate was sprung. The front plate and two side plates of the boiler shell were bulged nearly $\frac{1}{2}$in., although the stays were sound, and the plate on being drilled proved to be $\frac{5}{16}$in. thick and of good quality. I attribute the explosion to shortness of water, and over-pressure of steam. Had the pressure not exceeded 60 lb. and the crown of the fire-box been covered with water the accident would not have happened. It is evident that the safety valve was in some way fixed. It is possible that the balance was screwed down to the full extent of the spring, but it cannot be ascertained now on account of the loss of the valve and the bending of the balance lever. It might have been screwed down so as to let a little steam off and still let steam accumulate. All this, however, is only supposition.

The Coroner: The suction pipe was in order, you say. How was it the water did not get into the engine? Witness: If the engine had been standing some little time and the pump not going it would soon run short of water. These engines will not inject water unless they are running.

You mean standing still while the strap was being put on?—Yes; or it might not have been full when they stopped. I cannot tell that.

You mean that the water would be made into steam?—Yes, and cause pressure to accumulate.

Isn't it the duty of a fireman to see that his boiler is full of water?—Yes, sir. It is evident there was immense strain on the boiler. That was evinced by the bulging of the front and side plates.

Do you suppose there was more than 80 lb. of pressure to cause the explosion?—There was certainly 80 lb. if not more. I should not be surprised if there were more.

The Foreman: That of course you can only conjecture?

The Coroner: But you can say for certain that there was 80 lb.?—Oh, yes. I have had 80 lb. on engines myself with front plates as thick and they never bulged.

And should you think with that old engine 80 lb. of pressure would be a bursting-charge?—Yes. It would burst at the weakest place—the flange—provided it was hot.

But was it hot?—The crown was hot.

And you say this engine was only calculated for 60 lb.?—Yes. The breaking strain of a new engine is far higher than the working strain.

What would be the breaking strain?—60 lb. would be the working strain of this when it was new, not the breaking strain.

Can you explain why 200 lb. is marked on the dial?—That has been used for a higher pressure engine.

To an ignorant man what would that mean?—They all know who go with these engines that 60 lb. is about the working point. They are not fit to drive an engine if they do not.

The jury, after hearing some further evidence, retired for fifty minutes, and on coming into court the foreman said:—

We find (1) that William Coleman, though not an educated engineer, was as generally competent as most men employed to drive agricultural engines. We find (2) that the engine burst from want of water, but owing to the frequent stoppages which had occurred in the working, and the present defective state of the suction pipe; we are unable to attribute criminal blame to William Coleman.

The Coroner said that was hardly an answer to his last question—whether there was stoppage of the supply of water?

The Foreman: The evidence will not show it, in the opinion of the jury.

The Coroner: Then you return an open verdict?—that there is not sufficient evidence to show from what cause the bursting took place.

The Foreman: There is not sufficient evidence to show criminal neglect on the part of William Coleman.

The Coroner: Nor of any other person?

The Foreman: No. He was the only one responsible, I suppose.

The Coroner: Well, I'll take your verdict. It is simply an open verdict.

The Foreman: I don't see how it is possible to come to any other. The jury have very carefully considered the evidence, and many of the jury are practically acquainted with the working of these engines.

The Coroner took a note of the verdict of the jury and read it out.

The Foreman asked that the exact words he had read should be inserted in the verdict. The Coroner had asked three categorical questions, and they had given three categorical replies.

The Coroner said the replies were hardly as he wished them to have been—Yes or no.

After some conversation, the foreman and jury agreed to their verdict in the following form (the word "present" being inserted at the special request of Mr. Blagden):—"That the portable engine owned by William Lee burst from want of water, and the present faulty state of the suction pipe, and caused the death of the said William Harris, but there is not sufficient evidence before the jury to show that there was any criminal neglect on the part of William Coleman, the driver, in the working of the said engine."

The Coroner: I can only say that I can hardly agree with your open verdict, but probably it may be a caution to farmers and others using these portable engines to have competent men to work them. You see the result of this.

The Foreman: We could say a great deal, but we had to go on the evidence before us, and on that I believe we have honestly and faithfully returned our verdict.

The Coroner: I think it my duty to say so. Addressing Coleman, the Coroner added—I must say you have had a very lenient jury. I am decidedly of opinion that you are responsible, but the jury consider there is not sufficient evidence to make you so. You have had a very narrow escape, I think. You should not have undertaken things you have not been brought up to. And I think the owners would do well to look to their engines and see that they are in proper order, and not have suction pipes in a state like this.

Our readers will not be slow to trace an analogy between this case and the explosion at Maidstone.

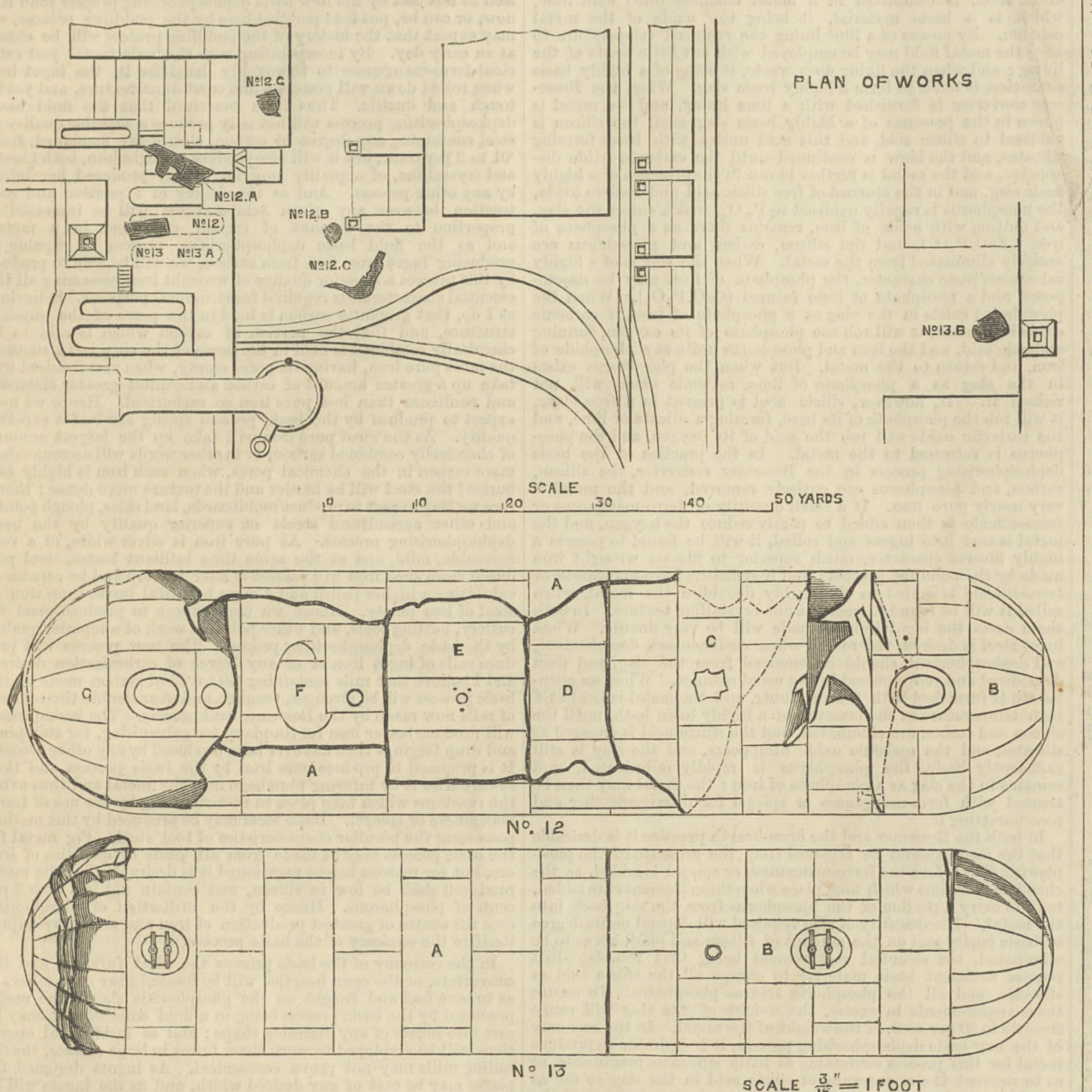
A very serious double explosion of two externally fired boilers recently took place at Ruabon.

The adjourned inquest upon the bodies of the six men who died from injuries received from this boiler explosion, which occurred at the New British Ironworks, Ruabon, on November 20th, was resumed on Tuesday the 4th inst., before Mr. B. H. Thelwall, coroner, assisted by Mr. Samson, of the Board of Trade, when the following verdict was returned:—"The death of the six men was caused through injuries received by the explosion of two boilers in the works of the New British Iron Company; that the said explosion was caused by the thinning of the plates of No. 12 boiler, owing to corrosion within the brickwork; that we, the jurors, find there has been an error of judgment on the part of the New British Iron Company in not having had the boilers stripped for the purpose of thorough examination; and we, the said jurors, also find that the Midland Company have been guilty of considerable negligence and want of care in not making an internal examination of the said boilers during the space of the last five years."

The two boilers which exploded worked connected with ten others, and were numbered 12 and 13, being arranged as shown in the sketch on the next page. Each boiler was about 32ft. in length, and they were respectively 7ft. 3in. and 6ft. 4in. diameter. No. 12 was fired by hand, and No. 13 by the waste heat from a puddling furnace. Both boilers had flash flues, and were supported by brackets secured to the sides. The date of make was unknown, though it is evident they were of considerable age. They were made of $\frac{3}{8}$in. plates, and the seams were single rivetted by hand. The plating was extremely irregular, about a half of No. 12 being placed lengthways of the boiler, and the remainder in the opposite direction. The plates had also been repaired and patched in many places. The boilers were exposed to the weather, the side brickwork covering them in coming to about 18in. from the centre-line. They were fitted with the mountings common to this class. The pressure at which they were worked was 27 lb. to 30 lb. The highest pressure the gauges—which have been tested since the explosion by Mr. Samson, and found correct—were seen at any time to indicate was 31 lb. per square inch. The plates of both the boilers internally were reduced by corrosion in places from $\frac{1}{16}$in. to fully $\frac{1}{8}$in. depth, and externally, where the brickwork over the flues rested on the sides—from 2ft. to 3ft. in width—they were deeply corroded, especially along the left side of No. 12, where the thickness was not more than $\frac{1}{32}$in.

The explosion took place at 7.15 a.m., when the workmen were changing shift, the engine standing at the time, and it was considered there was about 30 lb. pressure. Rupture evidently commenced at the deeply corroded part at the left side, about the middle of No. 12, the crown portion of this boiler (from the corroded part on one side to that on the other) being blown out, while the shock of the explosion apparently caused rupture of No. 13 at a circular seam about the middle of its length, opposite to where the rupture of No. 12 began, and the portions of both boilers were scattered as shown in the accompanying sketch.

The manager, engine-drivers, and engineer of the works, as well as the chief engineer and inspectors of the Midland Boiler Insurance Company were examined, the most important evidence being that given by Mr. Marten, who said that he was chief engineer to the Midland Steam Boiler and Insurance Company, and that he had occupied that position since 1862. The two boilers that exploded were not working in March, 1871, when they were placed under that company's inspection. The inspectors were instructed to examine the boilers as far as possible. The last internal examination of No. 12—the firing boiler—took place in 1875, and of the other boiler in 1872. It was their system to send their inspectors over without notice. He thought an improvement might be made in that system. He thought the boiler exploded because the plate was worn thin by external corrosion, and had grown too weak to bear the ordinary working pressure. The plates of boiler No. 13 were nearly their full thickness, but the boiler was seam-ripped, which was a common way of exploding. Some parts of the plate of No. 12 boiler, produced, were $\frac{1}{32}$ in in thickness, and there were other parts $\frac{1}{8}$in. There was a short length of that plate—2ft.—which was specially thin and which would account for the explosion. In reply to Mr. T. B. Acton, he said when boilers were insured, and not merely inspected as those were, they examined the boiler thoroughly every year. A letter from the witness, dated May, 1871, asking for an opportunity for an internal inspection, was put in on behalf of the New British Iron Company by Mr. Acton, and in reply to which the witness said an examination was made. The inspection company had not asked for an opportunity of thoroughly examining the boilers for the last five years. They had internally examined about sixteen boilers on an average annually. Witness said that their responsibility was that they guaranteed inspection by qualified inspectors,



THE RUABON EXPLOSION.

and sent a faithful report of the result of such examination to the owners. Charles Jefferies, inspector to the Midland Steam Boiler and Insurance Company, said he had not the rule for finding the strength of a boiler at hand. The exploded boilers should have been examined once or twice a year. The plate produced was not fit for a pressure of 30 lb. It was only fit for a water tank. Both this witness and Coulson, his successor, thought they would have discovered the condition of the plates twelve months before the explosion, and they thought the condition of the plate sufficient to cause the accident. Mr. Courtney Osborne Weeks, engineer to the Board of Trade, also read a report containing a statement of the condition of the boiler, and the cause of the accident, as described above. The opponents of boiler insurance will scarcely be able to find an argument against insurance in this case; the boilers having been under the inspection of the Midland Boiler Insurance Company, but were not insured by them.

PETERBOROUGH CORPORATION SEWERAGE WORKS.

THE sewerage works now completed for the Corporation of the city and borough of Peterborough, involved the construction of thirteen miles of brick and pipe sewers, with the necessary manholes, ventilators, flushing arrangements, and penstocks; the construction of duplicate tanks for the straining of the sewage at the outfall and two miles of concrete carrier; the preparation of 96 acres of land out of a farm of 300 acres purchased by the Corporation for the utilisation of the sewage by irrigation; the erection of two pumping stations, with the necessary machinery; and the erection of two cottages.

The sewage from all parts of the borough is brought together and discharged at one outfall. It is conveyed by the water-carriage method on the separate system. As about seven-eighths of the entire population of the borough dwell on the north side of the river Nene, it is consequently in this portion that the largest and most costly sewers are constructed; but the peculiar situation of the southern district renders the conveyance of the sewage to a suitable outfall a matter of considerable difficulty. The borough on the south side of the river is drained by three and a-quarter miles of stoneware pipe sewers, and the sewage brought to the river side, whence it is carried in an iron pipe sewer under the river and across the wash lands. After passing under the protection bank of the north level it is emptied into a tank sewer, devised for the reception of the sewage during the time the pumping engines are at rest. It then flows into the wells of the southern outfall pumping station, and is pumped into the gravitation main close to the outfall.

The borough on the north side of the river is drained by nine and three-quarter miles of brick and pipe sewers. The northern arterial main is a brick sewer, egg-shaped in section, of 3ft. by 2ft. internal diameters, and 3670 yards long. The main intercepting brick sewer is 1235 yards long, and comprises 149 yards of 3ft. by 2ft. egg-shaped, 612 yards of 2ft. 9in. by 1ft. 10in. egg-shaped, and 474 yards of 2ft. barrel sewers. These sewers discharge into a barrel culvert 3ft. 4in. in diameter, and 508 yards long which empties into a penstock chamber; from thence the sewage is taken by two 24in. iron pipes, laid side by side and for the most part in embankment to the straining tanks at the outfall. The sewage from the districts north of the river flows directly on to the irrigation area by gravitation. The geological formations through which the trenches were excavated are principally members of the Oolitic group, but in the southward gravels of the post-tertiary period overlay the Jurassic rocks. The thick beds of hard stone met with in nearly all parts of the north and eastward have caused the excavations to be difficult and costly; but the stone was utilised in the construction of the roads and the concrete carriers on the sewage farm.

The pumps by which the sewage at the southern outfall is lifted into the gravitation main are two duplicate three-throw lift pumps, driven by two high pressure non-condensing horizontal engines of six horse-power. The normal speed of the engines when working with a boiler pressure of 45 lb. is 100 revolutions a minute; and each pump working at twenty double strokes a minute will lift four hundred thousand gallons in twelve hours. The sewage on arriving at the outfall is discharged into settling tanks, built in duplicate, and provided with wrought iron strainers; passing from thence the liquid sewage is conveyed in a concrete carrier to the land prepared for irrigation. On arriving at the land prepared for the reception of the sewage the carrier divides into two smaller ones from which the sewage is distributed over the irrigation area by land carriers. The larger concrete carrier is 1098 yards in length, and has a water-way of 6·5 superficial feet. The two smaller carriers are 2159 yards long, and have a sectional area of 4·8 superficial feet. The irrigation channels are 12in. wide at the top, 6in. at the bottom, and are 6in. deep. All the carriers are laid in horizontal lengths with sluices and drops at every change of level. The soil on the irrigation area is of a light alluvial character overlying silt, and has a natural filtration and drainage of 4ft. As the farm is situated near the Bedford Level, and within the protection bank of the North Level Commissioners, the effluent water is not allowed to be carried off by their drains, except in dry seasons, and must consequently be lifted over the North Bank into the New Cut of the river Nene. This is effected by two 12in. centrifugal pumps, driven by two 25-horse power high pressure condensing engines. The normal speed of the engines is sixty revolutions per minute, with a boiler pressure of 60 lb. The cylinders are 1ft. 4in. diameter, and the stroke, 2ft. The fly wheels are 10ft. in diameter, and weigh two tons. Each pump when making 400 revolutions per minute will deliver over the bank one million six hundred thousand gallons in six hours. The boilers are Galloway's patent with shells 18ft. long by 6ft. diameter.

The works were designed and carried out by Mr. John Addy, Assoc. Memb. Inst. C.E., of Peterborough, with Mr. John C. Gill, Assoc. Memb. Inst. C.E., as resident engineer. The contractors for the buildings were Messrs. S. and W. Pattinson, of Ruskington, near Sleaford; and for the engines, pumps, boilers, and machinery, Messrs. Seeking and Ellery, of Gloucester. The works on the main drainage and irrigation farm were partly executed by Messrs. J. S. Cooke and Co., and partly by the Corporation.

CONVERSION TABLES.

THE large table which we publish this week is the first of a series which we hope to publish by degrees, for enabling French measures to be turned into English, or English into French, at a glance, and without any calculation whatever. Our reason for publishing these tables in this particular form rests on two convictions: (1) that a very large amount of work is done by engineers and manufacturers in converting French and English measures into each other, economy in which work is therefore of value; (2) that the strictest scientific accuracy in such work is very seldom required, and therefore the long and cumbersome array of figures necessary for such accuracy may very well be dispensed with.

The arrangement rests upon this basis, and may be explained in a very few words. The present table concerns measures of Length, and gives the means of converting metres into feet, centimetres into inches, and kilometres into miles, and *vice versâ*. Thus, supposing we wish to know the number of feet in 233 metres, we say, "233 metres = how many feet?" We glance over the page till we find the number 233 in the number column, and opposite to this we find in the "Metres = Feet" column the number 764·4. We then simply write down for our 233 metres, 764·4ft. It will not be once in a hundred times that we shall want to get a more close equivalent than this, but, if needed, we can still use the tables for the purpose. Thus we see that 200 metres = 656·2ft.; also that 300 metres = 984·3ft., and therefore 30 metres = 98·43ft., and 3 metres = 9·843ft. Adding these three figures together, we get for our result, 233 metres = 764·473ft., which is the same result as we should have obtained by laboriously multiplying 3·281—the equivalent of 1 metre—by 233.

If a number does not lie within the limits of 100 to 1000, given in the table, it is still easy to apply the tables to it. Thus if the No. of metres be 23, instead of 233, we look at the No. 230, or move the decimal point one place to the left in the equivalent No. of feet, giving No. 75·46ft. If, on the other hand, the No. be 2335 metres, we first look at 233, we move the decimal point in the equivalent one place to the right, giving 7644ft., we then look at No. 500, and move the decimal point in the equivalent two places to the left, giving as the equivalent to 5 metres, 16·40ft. Adding these together we get 7660·4 as the No. of feet we require. If the original number is not a whole number, but partly a decimal, as 23·35, all that is necessary is to alter the decimal point in the result to correspond, giving 76·604ft. Similarly the third and fourth columns can be used for the conversion of millimetres instead of centimetres and so forth.

We have only to add that the table has been compiled with great care by Herr C. Capito, graduate of Copenhagen, and now assistant to Professor Ayrton, and that we shall be glad to receive any hints which may render this and future tables more complete and valuable.

TENDERS.

SOUTHAM SEWAGE OUTFALL WORKS.

E. PRITCHARD, engineer, 27, Great George-street, Westminster, S.W., and 37, Waterloo-street, Birmingham. Quantities supplied by engineer.

	£	s.	d.
Ottaway, F., Sandford Thames, Oxford	3226	14	2
Dovener and Quisnel, Stoke, Staff.	2115	5	5
Rowson and Co., Stoke, Staff.	1719	10	11
Smith, J. W., Westminster-chambers	1600	0	0
Smith, G. F., Milverton, Warwick	1404	0	0
Watson, G., Southam	1390	0	0
Cunall and Lewis, Birmingham	1246	0	0
Dewill, J., Harbury	1198	0	0
Green and Son, Warwick	1177	12	0
Law, Geo., Kidderminster	1139	0	0
Burkett and Co., Birmingham	1045	0	0
Palmer, A., Birmingham—accepted	979	0	0
Engineer's estimate	1188	0	0

THE STEEL TRADE.—The great increase in the manufacturing capacity both of Europe and America has alone prevented that return to high prices which the present demand would have caused; and as, on both sides of the Atlantic, factories are being still further extended, the same counteracting cause will have effect for some time to come. A year ago, the total output capacity of steel rails in England was rather more, and in America rather less, than 750,000 tons per annum, while now, with the works already in operation or ready to commence at short notice, the total in each country is about a million tons. In America the present demand for steel rails is so considerable as to tax severely the supplying power available, and the product for at least six months forward is already sold. A deficiency does not at first result in the importation of rails from Europe, but in the supplementing of that department of manufacture which falls behind. Thus, while the demand for raw material is generally sufficiently met by Italian or Spanish ores, Bessemer pig iron has to be imported when the local blast-furnaces prove insufficient, and, in other cases, when the blooming mills cannot keep pace with the converters or with the rail mills, a considerable import of blooms from Europe takes place. This is the case at present, not only for rail making, but also for supplying those smaller steel works which make plates, wire, and other miscellaneous goods, with the blooms and billets the large converting works are at present too busy to supply. If the rail mills in America cannot meet the demands of purchasers during the coming year, it is yet an open question whether the deficiency will be made up by imported steel rails, or by home-made iron rails, or by iron rails from Europe. Both in Europe and America the different modes of making steel are finding their proper place. The Siemens process, with all its acknowledged merits, cannot compete with the quicker Bessemer converters for so cheap a commodity as steel rails. In England, steel works constructed with the Siemens open-hearth plant are not working on rails, but are making ship plates, railway tires, axles, and other similar articles, or are stopped altogether; while in America the Siemens process has hardly been applied at all to rail making, and the Siemens furnaces, with or without the Pernot modification, are confined entirely to the smaller industries, and are found extremely convenient for using up the Bessemer scrap. Both in England and America the circumstances of locality and transport are acquiring enhanced importance in the competition of trade; but while in England even a short land carriage is a disadvantage, in America works unfavourably situated for material are compensated by their contiguity to local consumers. —*Matheson and Grant's Engineering Trades' Report.*

THE BASIC DEPHOSPHORISING PROCESS; WHAT IT IS, AND WHAT MAY BE EXPECTED FROM IT.*

By Mr. JACOB REESE.

A SLAG is said to be basic when it is composed of metallic oxides; or, in other words, when the base of the slag is a metal, the slag is said to be basic. Oxide of iron, and oxide of calc .um, are true basic oxides, and form highly basic slags. A slag is said to be acidulous when it is composed of a metalloid, such as silicon, phosphorus, or sulphur, oxidised to silicic acid, phosphoric acid, or sulphuric acid, and these acids combine with ase forming silicates, phosphates, or sulphates. When these compounds are present in a slag in a large degree, it is said to be of a highly acid character. When a metallic process is conducted n presence of a highly basic slag, it is called a basic process; and when it is conducted in the presence of a highly acid slag, it is called an acid process. The process by which the ancient Romans and Britons made their iron is known as the Catalan process. It was conducted in an open chamber surrounded on all sides and the bottom with a lining of charcoal dust. The fuel was used in this metal chamber admixed with the iron ore and metal. The slag present in this metal chamber and produced by this process was principally composed of oxide of iron; hence the Catalan was and is a basic process.

The blast furnace is lined with stone or brick, both of which are highly acidulous; and although limestone is used as a flux, owing to the silicious character of the ore and ash of fuel, the slag is of an acid character, as will be seen by the following analysis :—

Silicic acid	58
Lime	23
Alumina	8
Magnesia	2
Manganese	—
Oxide of iron	9

Hence, the blast furnace process is an acid process. Henry Cort, who invented the puddling process, was the first to separate the fuel from the metal chamber; he lined his metal chamber with sand—silicic acid—the slag was highly acidulous, and Cort's puddling process was an acid process. Dr. Roebuck, the inventor of the refinery fire, lined the metal chamber with cast iron water boshes. The fuel was admixed with the metal. The refinery slag was highly basic, as is shown by the following analysis :—

Oxide of iron	85·0
Silicic acid	14·0
Alumina	0·5
Magnesia	0·5

Hence the refinery process was a basic process.

Samuel Rodgers improved Cort's puddling process by putting an iron bottom and iron plates into the puddling furnace, and lining the metal chamber with oxide of iron instead of sand. The following analysis of the slag shows it to be highly basic :—

Oxide of iron	89·0
Silicic acid	9·0
Alumina	1·5
Magnesia	0·5

Hence Rodger's puddling process is a basic process.

The Bessemer process, invented by Henry Bessemer, is conducted in a converter which is lined with ganister—a highly silicious substance. The slag produced is composed of the following :—

Silicic acid	44·30
Lime	·65
Protoxide of manganese	24·55
Alumina	10·80
Magnesia	·25
Oxide of iron	19·45

It is a silicious slag because there is not sufficient basic material to engage all the silicic acid as silicates. And the Bessemer process is an acid process. In the open-hearth process the metal chamber is lined with sand. When metal and scrap are used the slag is highly acidulous, and the metal and scrap open-hearth process is an acid process. When iron ore is used in the open-hearth in considerable quantity, the slag is neutral; and the ore and metal open-hearth process may be classed with the basic processes. We therefore have as

Basic Processes.	Acid Processes.
Catalan	Blast furnace
Refinery	Cort's puddling
Rodgers' puddling	Bessemer
Open-hearth ore and metal	Open hearth metal and scrap

The dephosphorising problem may be summed up in these words: The phosphorus must be oxidised to phosphoric acid $P_2 O_5$, in the presence of a basic slag, in order that the acid so formed may unite with and be held by a metallic base as a phosphate of lime or a phosphate of iron. And as silicic acid decomposes a phosphate of lime or a phosphate of iron, and carbonic oxide decomposes a phosphate of iron, the slag must be of a highly basic character in order that all the silicic acid formed by the oxidation of silicon shall combine with and be engaged in the slag as silicates. And in order to avoid the reduction of the phosphate by carbonic oxide, the dephosphorisation must take place in the presence of a highly basic slag, and in the absence of carbonic oxide. In the acid processes before mentioned, as the blast furnace, Cort's puddling, Bessemer converter, and the open-hearth with metal and scrap, the silicie acid and carbonic oxide reduce the phosphate to a phosphide; and as a phosphide has a greater affinity for the metal than for the slag, the phosphorus is returned to the metal. In the blast furnace, however, an additional reaction takes place under the following conditions:—Carbonic oxide being always present at the zone of reduction, where the ores are deoxidised, the phosphorus accompanies the metal as a phosphide of iron. In case where the slag in the hearth does not contain over 40 per cent. of silicic acid, and does contain 60 per cent. of basic material, the silicic acid being held as silicates, the oxide of iron contained in the slag in the free state will oxidise a portion of the phosphorus, which, uniting with oxide of iron or lime, will form a phosphate of iron, or a phosphate of lime, and exist in the slag in the hearth of the furnace below the zone of carbonic oxide; under these conditions a partial dephosphorisation of metal takes place in a blast furnace working on black cinder. The degree of phosphorus thus taken up by the slag will depend upon its basic character and its ability to hold the phosphorus as a phosphate.

In the old basic processes—the Catalan process and the refinery process—the fuel being admixed with the metal, carbonic oxide was always present; hence the phosphate could not exist, even in the highly basic slag, and dephosphorisation was impossible. In the basic open-hearth dephosphorisation takes place before the elimination of carbon commences, if the phosphoritic slag is removed, and also after the carbon has been consumed and carbonic oxide disappears. In Rodgers' basic puddling process the chemical reactions are divided into three periods: first, the melting period; second, the boiling period; third, the solidifying period. During the first period the metal is melted and the oxide of iron is admixed and melted. The chemical reactions which occur in this period are the oxidation of phosphorus, and of silicon and their removal from the metal to the slag. As there is no gas evolved from the oxidation of these elements the metal remains in a state of rest, except so far as agitated by the puddler's tools. If the slag be tapped off just before the close of this period, it will be found to contain from 70 to 80 per cent. of the phosphorus previously contained in the pig metal. But if the slag remain with the metal until the silicon is reduced down to ·02, the second period commences, the carbon is oxidised to carbonic oxide, which, passing upward through the slag, attacks the phosphate and reduces it to a phosphide, and, as a consequence, all the phosphorus removed from the metal during the first period, and permitted to remain in the slag, is returned to the metal during the second period. As the chemical reaction during the second period is the oxidation of carbon to carbonic oxide (C.O.), ebullition takes place, and the metal boils. When the carbon has been reduced down to ·08, the ebullition ceases, the cinder or slag "drops," and the metal solidifies, and, as the puddlers term it, "is brought to nature" during the third period. During the first part of the third period the damper is raised, and the metal which extends above the slag is exposed to an oxidising flame. The phosphorus is either sweated out of the metal by liquidation or is oxidised by the fluid cinder; in either case, it being oxidised to P_2O_5, it again enters the slag as a phosphate of iron ($_2FeO.P_2O_5$). There being no free silicic acid or carbonic oxide in the slag during this third period, the phosphorus remains in the slag until the metal is withdrawn; hence Rodgers' puddling process, when properly conducted, is a true basic dephosphorising process, being conducted in the presence of a highly basic slag, and in the absence of C.O. or free silicic acid.

As phosphorus, silicon, and carbon tend to reduce the fusion point of iron in degree to the amount of these elements which the metal contains, it follows that the fusion point of iron is greatly raised by the diminution of these elements, and this is the reason that the iron solidifies during the third period of the puddling process. In the Bessemer and open-hearth processes the temperature is kept high enough to hold the metal in a fluid condition after the elimination of phosphorus, silicon, and carbon, but at the high temperature required, Rodgers' basic lining—oxide of iron—is fused also, and for this reason the Bessemer converter and the open-hearth have heretofore been lined with a silicious material. The new basic dephosphorising process, by which iron and steel may be desiliconised, decarbonised, and dephosphorised, and yet be retained in a fluid state, so as to cast it into ingots of iron, or of steel, is conducted in a metal chamber lined with lime, which is a basic material, it being the oxide of the metal calcium. By means of a lime lining the required temperature to keep the metal fluid may be employed with but little waste of the lining; and when the lining does waste, it being of a highly basic character, it tends to form a highly basic slag. When the Bessemer converter is furnished with a lime lining, and the metal is blown in the presence of a highly basic slag until the silicon is oxidised to silicic acid, and this acid unites with bases forming silicates, and the blow is continued until the carbonic oxide disappears, and the metal is further blown in the presence of a highly basic slag, and in the absence of free silicic acid and carbon oxide, the phosphorus is rapidly oxidised to $P_2 O_5$, which enters the slag, and uniting with oxide of iron, remains there as a phosphate of iron ($_2FeO.P_2O_5$), and the silicon, carbon and phosphorus are entirely eliminated from the metal. When the slag is of a highly calcareous basic character, the phosphate of iron may be decomposed and a phosphate of lime formed ($CaO.P_2O_5$). When the phosphorus exists in the slag as a phosphate of iron, if carbonic oxide be present, it will rob the phosphate of its oxygen, forming carbonic acid, and the iron and phosphorus unite as a phosphide of iron, and return to the metal. But when the phosphorus exists in the slag as a phosphate of lime, carbonic oxide will not reduce it. If, however, silicic acid is present in a free state, it will rob the phosphate of its base, forming a silicate of lime, and the carbonic oxide will rob the acid of its oxygen, and the phosphorus is returned to the metal. In the practice of the basic dephosphorising process in the Bessemer converter, the silicon, carbon, and phosphorus are entirely removed, and the metal is very nearly pure iron. If a small quantity of ferro-manganese or ferro-silicide is then added to partly reduce the oxygen, and the metal is cast into ingots and rolled, it will be found to possess a highly fibrous character, much superior to fibrous wrought iron made by the puddling process; and if sufficient ferro-manganese or ferro-silicide is added to thoroughly deoxidise the metal, when rolled it will be found to possess a fine crystalline texture. In both these cases the ingot iron so made will be very ductile. When ingot steel is desired, the metal, when desiliconised, decarbonised, and dephosphorised, should be removed from the slag, and then deoxidised and recarbonised in the usual manner. When an open-hearth is furnished with a lime lining, and the metal is held at a high temperature in the presence of a highly basic bath, until the silicon and carbon are eliminated, and the silicic acid is engaged as silicates, and the carbonic oxide disappears, and the slag is still sufficiently basic, the phosphorus is rapidly eliminated, and remains in the slag as a phosphate of iron; the metal may then be treated with ferro-manganese or spiegel for deoxigenisating and recarburetting it.

In both the Bessemer and the open-hearth practice it is desirable that the metal should be removed from the presence of the phosphoritic slag before the ferro-manganese or spiegel is added, as the chemical reactions which take place when these elements are added, tend to carry a portion of the phosphorus from the slag back into the metal. The quantity of slag required will depend on its degree of basic purity and on the amount of silicon and phosphorus to be eliminated, the essential requirement being that the slag shall possess sufficient basic material to engage all the silicic acid as silicates, and all the phosphoric acid as phosphates. To secure these requirements in excess, the weight of the slag will range from 25 to 30 per cent. of the weight of the metal. In the economy of the new basic dephosphorising process, it is desirable to produce metal for this process containing as little silicon as practicable, so as to prevent the appearance of silicic acid in the slag so far as possible. And as the reduction of silicon is a reduction of the source of heat, it is desirable to increase the percentage of phosphorus in the metal in proportion to the heat units withdrawn by the reduction of silicon. Therefore the most desirable metal for the new basic dephosphorising process is that which is low in silicon, and containing from 2 to 3 per cent. of phosphorus.

When metal containing 2 per cent. of phosphorus is treated in a lime-lined converter, and in the presence of 25 per cent. of a highly calcareous basic slag, the slag when withdrawn will be found to contain 18·32 per cent. of phosphoric acid to weight of slag, or 4·58 per cent. of weight of the metal. In order to obtain a metal from any class of ores, suitable for the new basic dephosphorising process, containing a minimum of 2 per cent. of phosphorus, and to economise the cost of the basic calcareous slag, it is proposed to use this calcareous phosphoritic slag as a flux in the blast furnace in place of so much limestone. When this slag containing 18·32 per cent. of phosphoric acid is used in a blast furnace in proportion to ¼ ton of slag to 1 ton of metal produced, the phosphate is reduced by the carbonic oxide and silicic acid to a phosphide, and the metal produced will contain 2 per cent. more phosphorus than was obtained from the ores from which the metal was smelted. Thus the phosphorus which is utilised by oxidation for the development of caloric essential to keep the metal in a highly fluid condition in the basic converter, is again utilised by its reduetion in the blast furnace, securing economy and an absolute control of the production of a minimum of 2 per cent. of phosphorus in the metal made from any class of iron ores; which is desirable, as it is more convenient and practicable to elimininate 2 per cent. of phosphorus from the metal by the basic process than it is to dephosphorise a metal containing but one-tenth of that amount of phosphorus and 2 per cent. of silicon. The essential requirements of dephosphorisation having been determined as set forth, *i.e.*, the oxidation of phosphorus in the presence of a highly basic slag, and in the absence of free silicic acid and carbonic oxide, it is proposed to dephosphorise molten metal flowing from a blast furnace by treating it at a low temperature in the presence of a highly basic slag, and withdrawing the metal from the slag after it is dephosphorised and before the oxidation of the carbon takes place, and running the oxidised metal into pigs, or taking the metal and treating it in the acid Bessemer converter, or in an acid-lined open hearth. It is also proposed to dephosphorise molten metal direct from the blast furnace as before described, then running it, minus the slag, into an open hearth, and there desiliconise it down to ·025, and then withdrawing the dephosphorised metal and running it into pigs. Such a metal would be low in phosphorus, high in carbon, and practically free from silicon, and would be a superior chilling iron for the production of chill rolls, car wheels, and most excellent for gun metal, and malleable castings, and all foundry purposes. It is also proposed to desiliconise and decarbonise metal in the acid Bessemer converter, and then run it minus the silicious slag into a basic-lined converter or open hearth and there dephosphorise and refine it, and then run the metal, minus the phosphoritic slag, into a ladle and deoxigenise and recarbonise it in the usual manner, and cast it into ingots. Having explained the distinguishing characteristics of the old processes, and the essential requisites to dephosphorisation possessed by the new basic process, I will now venture a few predictions as to "what we may expect from it." The basic dephosphorising process will eliminate all the silicon, carbon, manganese, and phosphorus contained in the metal and produce nearly pure wrought iron. As the fibrous character of wrought iron is caused by oxide of iron being inter-stratified in alternate lamina with the iron, and as the molten metal in the basic converter will, at the end of the blow, be somewhat oxidised, if a small quantity of ferro-manganese be added to it, but not in sufficient quantity to reduce all of the oxygen, the ingot iron produced by the basic dephosphorising process when rolled down will exhibit a highly fibrous texture and possess in a superior degree the properties of ductility, malleability, and welding, which are possessed by the best Swedish or Norway iron—therefore the importation of such irons will cease when the basic wrought iron is put upon the market, as the latter will be better and cheaper. And as pig metal designed for the basic dephosphorising process may be made from the cheapest class of ores, smelted in a blast furnace in which a hot blast of the highest volume and temperature is employed, the metal will be of the cheapest class produced; and as such metal, whether white, mottled, or grey, can be put into fibrous wrought iron at less cost by the new basic dephosphorising process than it is now, or can be, put into puddled bars by the puddling process, we may expect that the history of the puddling process will be closed at an early day. By incorporating with the basic metal just sufficient ferro-manganese to thoroughly deoxidise it, the ingot iron when rolled down will possess a fine crystalline texture, and yet be tough and ductile. Thus it is conceived that the fluid basic dephosphorising process will not only produce a superior quality of steel containing any degree of carbon, chemically combined, from ·01 to 2 per cent., but it will also produce wrought iron, both fibrous and crystalline, of a quality superior to any produced heretofore by any other process. And as the degree of expansion and contraction between any given temperatures will be increased in proportion to the amount of carbon contained in a metal, and as the fluid basic dephosphorising process is capable of producing ingot iron free from carbon, we will be able to produce by this process a superior quality of wrought iron possessing all the essential characteristics required for structural purposes. Believing, as I do, that graphitic carbon is held in the pores of the physical structure, and that the portion of carbon which is said to be chemically combined is held in the pores of the chemical structure, the most pure iron, having its pores empty, when recarbonised will take up a greater amount of carbon and exhibit greater elasticity and resilience than less pure iron so carburised. Hence we may expect to produce by the basic process spring steel of a superior quality. As the most pure iron will take up the largest amount of chemically combined carbon, or in other words will accommodate more carbon in the chemical pores, when such iron is highly carburised the steel will be harder and the texture more dense; therefore we may expect to produce moldboards, land sides, plough points, and other agricultural steels of superior quality by the basic dephosphorising process. As pure iron is silver white, of a very agreeable, mild, and at the same time brilliant lustre, steel produced from such iron will possess a finer texture and be capable of exhibiting a higher polish and a more beautiful lustre than iron or steel of less purity. Hence we may expect to produce steel for cutlery, cutting tools, and other polished work of a superior quality by the basic dephosphorising process. The new process will produce rails of ingot iron or of any degree of carburisation desired, and I believe that rails containing ·60 to ·75 of carbon made by the basic process will be stronger, tougher, and wear double the tonnage of rails now made by the Bessemer acid process. The basic process will produce better iron for tin-plate, for galvanising, for stamping, and drop forgings than has ever been produced by any other process. It is proposed to produce pure iron by the basic process and then re-carburise it by infusing plumbago into the metal and thus avoid the reactions which take place in re-carburising by the use of ferro-manganese or spiegel. Basic steel may be produced by this method possessing the peculiar characteristics of tool steel. Pig metal for the basic process may be made from all kinds or qualities of iron ore, but for reasons before mentioned it is desirable that the metal produced shall be low in silicon, and contain not less than 2 per cent. of phosphorous. Hence by the utilisation of phosphoritic ores the centre of greatest production of iron and steel may adjust itself to the economy of the basic process.

In the economy of the basic process the blast furnaces and the converters, or the open hearths, will be located near each other, so as to save fuel and freight on the phosphoritic slag. The metal produced by the basic process being in a fluid condition, it may be cast into ingots of any desirable shape; and as mechanical operations will be employed to work these forms in large masses, the old rolling mills may not prove economical. As ingots designed for plates may be cast of any desired width, and as the ingots will be reduced to plates principally by automatic process of rolling, nail plates, tank and ship plates, will be produced at less cost than such are now produced by the old processes. In conclusion, I believe that the fluid process, *i.e.*, the Bessemer and open hearth, with the basic dephosphorising improvement, will, in time, supersede all others for the production of iron and steel, and will ultimately enable the United States to become the greatest exporter of iron and steel in the world.

As the priority of invention relating to all the essential features requisite to the new basic dephosphorising process is now in litigation in the cases known as "Reese *v.* Thomas," until the priority of invention is determined it will not be known whether myself or Thomas and Gilchrist will control the new basic dephosphorising process in the United States. For this reason I have given this paper a general charcacter, and have carefully avoided reference to the claims of invention.

* Paper read before the Engineers' Society of Western Pennsylvania, U.S.A., December 21st, 1880.

YORKSHIRE FREEMASONRY.—At a monthly meeting, on Thursday last, of the General Committee of the Royal Masonic Institution for Girls, Florence, daughter of the late Brother James, of Ripon, was placed on the list of candidates for election in April next. At this election there will be 28 candidates, of whom only 15 can be elected.—See ENGINEER, 11th May, 1877.

THE INSTITUTION OF CIVIL ENGINEERS.—On the 30th of November, 1862, this society consisted of exactly 1000 Members of all classes, now there are on the books eighteen Honorary Members, 1231 Members, 1335 Associate Members, and 569 Associates, besides 686 Students, in all 3839. Two years ago the bye-laws were so amended as to allow of the separation of the professional from the non-professional Associates, the former being designated Associate Members, and the latter retaining the simple title of Associate.

SOCIAL GATHERING OF SCOTCH ENGINEERS.—A social gathering of Scotch foremen and marine engineers, representing the principal firms at the East-end of London, and the various mail companies, took place on Thursday evening at the Old Commodore, High-street, Poplar. The chair was taken by Mr. Ferrie, the vice-chair being occupied by Mr. Macfarlane, between forty and fifty gentlemen sitting down to supper. The various loyal and patriotic toasts were heartily responded to, but that of "Absent friends" was received with especial favour. During the evening a selection of Scottish and humorous vocal and instrumental music was given by various gentlemen.

RAILWAY MATTERS.

The tax on railway fares in Roumania, which was 15 per cent., has been repealed.

The section of the Northern Punjab State Railway from Rawul Pindee to Attock has been opened for traffic.

The Dundee Chamber of Commerce has agreed to support the North British Railway Company's Bill for the reconstruction of the Tay Bridge at as low a level as can be sanctioned.

Reporting on a collision on the Highland Railway, Major-General C. S. Hutchinson says, "It is to be regretted that the Highland Company have hitherto done so little in improving their signal arrangements."

A meeting was held in Halifax, Nova Scotia, on the 28th ult., in opposition to the Pacific Railway scheme brought forward by the Government, at which it was resolved to call a mass meeting in order to elicit a decided expression of popular opinion against the measure.

A contract has been entered into with Messrs. Mousley and Lovatt, No. 1, Westminster-chambers, for the construction of three and a-quarter miles single line tramway from Warwick to Leamington. Mr. E. Pritchard, of Westminster and Birmingham, is the engineer.

In a report on the collision on the 23rd of November last, at Woodside Station, Birkenhead, on the London and North-Western and Great Western Joint Railway, Colonel F. H. Rich says, "If the train had been fitted with continuous brakes, and the guard as well as the driver had been able to work them, the collision would probably have been prevented."

Of the total car movement on the Philadelphia and Erie Railway in 1879, 30 per cent. was empty, and of the total tonnage, 37·2 per cent. was west-bound. On the Susquehanna Division, 14·3 per cent. of all the cars moved were empty, and 17·15 per cent. of loaded cars were west-bound. It should be added that the mileage of cars for 1879 was as follows:—Loaded: eastward, 29,396,802; westward, 17,684,656; empty: eastward, 4,459,240; westward, 15,752,215. Total mileage on basis of loaded cars, 59,208,331.

Great activity has for the greater part of the past year characterised the American railway world. 5839 miles of new railways were constructed in the United States, costing £35,000,000. The new railways are chiefly west of the Mississippi River. It is estimated that next year over 7000 miles will be constructed, as the capital is ready for extending all the south-western lines, and also the Northern Pacific Railway. The earnings and profits of the American lines generally exceeded those of any previous year.

The Bury and Tottington District Railway, which was promoted and the money found by the owners of the mills and manufactories on the line of route, so as to give them a communication by rail the whole way from their works to Manchester, *viâ* Bury, and so avoid the carting they had to employ before, is drawing towards completion. The line is about three and a-quarter miles in length, with branches to the various works. Messrs. Wells, Owen, and Elwes, of Westminster, are the engineers, and Mr. J. Welland Smith, of Westminster, contractor for the line, and it is expected to be open for traffic very shortly.

The effective service in tons of paying freight moved by each engine on the Susquehanna Division of the Philadelphia and Erie Railway was, in 1874, 197·5 tons; in 1875, 222·98; in 1876, 234·66; in 1877, 257·47; in 1878, 289·5; and in 1879, 310·15 tons. On the Philadelphia and Erie road proper it was, in 1879, 226·48 tons. This includes the mileage of pushers or helping engines on grades, of switching engines and the proportion of distributing service. The actual distance from Sunbury to Erie is 288 miles, the actual mileage of engines, however, including pushers on the grades, to haul these trains, is 352 miles.

A report on Mr. Cockburn Muir's "block-sleeper" track for tramways has lately been received from Mr. Henry W. Ford, manager of the City of Buenos Ayres Tramways. From this report we learn that even where laid upon very indifferent foundations the tramway has proved remarkably efficient, and has in every way satisfied the authorities. As the earliest laid has been down about ten years, ample time has elapsed to enable them to know all that can be known of the defects of the system. They complain, however, of none, but acknowledge its efficiency and the advantage of fewness of parts, and the rigidity of the rail joints or connections.

The Hounslow and Metropolitan Railway, the purpose of which is to take the District Railway Company's trains, *viâ* Mill Hill Park and on their Ealing line, to Spring Grove and Hounslow, both of which places are most inadequately supplied with railway accommodation, was, after many years' opposition, passed this last session. The engineers—Messrs. Owen and Elwes—are proceeding with the working plans, and it is stated that the contractors—Messrs. Eckersley and Bayliss—are prepared to commence work as soon as they can get possession of any land. The line is about five and a-half miles in length, and is of great importance to the whole of the Hounslow district.

The average freight train for the whole of the Philadelphia and Erie Railway during 1879 was equivalent to 32·9 loaded cars. For the Susquehanna Division it was 51 loaded cars. This includes only paying freight; 3·33 per cent. of that carried was for use of the company, or carried free. In this estimate five empty cars are taken as equal to three loaded cars. On the latter division this year, says the *Railroad Gazette*, the average train-load for January was 50·3 cars; for February, 51·5; for March, 58·4, for April, 57·0; for May, 56·1; for June, 57·6; for July, 56·9; for August, 57·9; for September, 62·6. The average lading of loaded freight cars for 1879 was 11·12 tons. This year it is expected to approximate very closely to 15 tons.

Express trains are now running between Paris and Bordeaux at 66 kilometres per hour, or 40·92, say 41 miles per hour, which is only about 2½ miles per hour less than the speed of the Flying Scotchman on the long journey of 397 miles, from London to Edinburgh, which is done in nine hours including stops, or at about 43·4 miles per hour. Some of the French writers are saying that there is no reason why this difference should exist. The journey between Paris and Bordeaux is shorter than some English runs at a much higher speed than 43 miles per hour, and they say that the French permanent way, rolling stock, and engines are as good as English, and why not then the speeds. The railway authorities answer that English travellers pay about or nearly one-third higher fares.

The numerous and large orders for locomotives which have been given out during the last few months have animated a branch of trade which had been unduly depressed. In the keen competition which has taken place during the last five years, the advantage which some manufacturers have over others in their better plant and organisation has been plainly demonstrated, for profits have been earned out of prices which barely pay cost to makers less favourably situated. The improvement is not confined to this country, but on the Continent also the railway companies have ordered largely, while in America the principal firms, though making more engines than ever before, are unable to keep pace with the orders offered to them. In regard to wagons and carriages, so many are built by the principal English railway companies themselves, and the new factories since 1870-3 are so numerous, that notwithstanding the large quantities of new stock now being built, the prices obtainable by private firms are still very low. The use of iron and steel in the underframes, and even in the bodies of railway wagons, seems, Messrs. Matheson and Grant say in their "Engineering and Trades Report," to be extending, and the American method, which has been adopted by some of the leading English companies, of supporting long passenger carriages on bogie-trucks, is likely to become more general, even though in regard to the bodies of the carriages the English type is retained.

NOTES AND MEMORANDA.

An instrument for measuring the amount of electric current flowing through a circuit, or the number of webers that have been supplied, is the subject of a recent patent by Mr. Edison.

According to the records of the rainfall in the Severn valley for the last twenty-two years, it appears that there has been a progressive increase; in the first five years the mean was 24in., in the last over 29in.

In making some experiments on the compressibility of oxygen gas, M. Amagat used mercury for transmitting the pressure, and found that the absorption of the gas by the mercury even at high pressures and temperatures is almost insensible.

Munich has now a population of no fewer than 228,000 inhabitants. In 1875 the number was 193,000. In 1801 it amounted to 40,000 souls. In 1830 the number was 77,000; in 1840, 95,000; in 1852, 106,000; in 1861, 148,000; and in 1871, 169,000.

M. Colladon has pointed out that a poplar or other tall tree may, if its roots strike into damp soil, serve as a lightning-conductor to protect a house; and he thinks he has verified this conjecture by examination of a number of individual cases of lightning-stroke. In the case, however, where the house stands between the tree and a piece of water, a pond or a stream, the shortest path for the lightning from the tree to the wet conductor may be through the house.

The annual rate of mortality, according to the most recent weekly foreign returns, was per 1000 in Calcutta 41; Bombay, 30; Madras, 39; Paris, 26; Geneva, 16; Brussels, 21; Amsterdam, 23; Rotterdam, 22; The Hague, 24; Copenhagen, 24; Stockholm, 31; Christiania, 11; St. Petersburg, 38; Berlin, 21; Hamburg, 26; Breslau, 23; Munich, 25; Vienna, 23; Buda-Pesth, 30; Rome, 34; Naples, 24; Turin, 27; Venice, 27; Lisbon, 33; Alexandria, 46; New York, 32; Brooklyn, 23; Philadelphia, 23; and Baltimore, 24.

M. de Mollins, of the Société Industriélle du Nord de la France, has communicated a paper on the means of purifying the rivers now polluted by the acid refuse thrown into them from factories in which wool and hair are treated, by diluting and passing the diluted refuse through lime and sulphate of iron, through lime and the ferric solution obtained by the action of dilute acid on old iron, or through lime alone. From one dye works alone in Frankfort-on-the-Maine from 100 to 1000 kilos. of sulphuric acid, at 66 deg., pass into the river per day.

The Austrian Metallurgical Department has recently published the statistics of production of mines and metallurgical works for 1879. The greatest yield in mining matters has been in lignite, which amounted to 79,059,352 cwt.; coal, to 53,786,040 cwt.; iron ore, 6,282,469 cwt.; manganese, 34,333 cwt.; graphite, 114,909 cwt. The production of metals in metric cwt. was as follows:—Pig iron, 2,559,531; foundry pig, 298,864; silver, 295,350; lead, 59,803; litharge, 32,012; zinc, 32,807; quicksilver, 4285; copper, 2582; tin, 332; antimony, 846.

The first Englishman known to have been a bell-founder by trade lived in 1284, when he made four bells for the cathedral church of Exeter, none of which remain; and one which is dated 1296 is the most ancient identified in England. A very old bell is still hanging in the steeple of Cold Ashby Church, which bears the date of 1317. In Leicestershire, 140 of the early period have been found; so that there is only a difference of three old bells between the two counties. Northamptonshire does not seem to have boasted of a bell-founder till the end of the sixteenth century, being thus about one hundred years later than Leicestershire. Many of the Northamptonshire bells were made by Newcombe, of Leicester, the two which hang beside "Maria," at Cold Ashby, being by him, with the inscription, "Newcomb," of Leicester, made me, 1606."

Mons. A. Angot proposes a new formula for calculating altitudes from barometric observations. The existing method is found to be defective, since its results exhibit an uncertainty that varies with the season, an elevated station appearing to be higher by day and in summer than at night or in winter. The formula proposed by M. Angot gives the difference in altitude by calculating directly the height of each station above an imaginary plane at which the barometric pressure is 760 millims. No empirical coefficients are needed in this case, the standard constants of Regnault and others for air and aqueous vapour being taken. M. Angot has, says *Nature*, recalculated from his formula a new set of tables, involving all the corrections that must be applied to the older tables of the Bureau des Longitudes.

According to Herr W. Birsch, a German process of enamelling cast iron vessels is as follows:—After pickling and cleaning the vessels, they are covered with a ground made as follows: Quartz 50, fluorspar 7·5, and borax 22·5 parts fused together. Of this, 16 parts, 6·5 to 12·5 of quartz, 4 to 6·5 of clay, and ·5 of borax are ground in a wet mill, with an addition of 2·5 clay and ·66 borax. This is laid on and burned, forming a yellowish-brown mass. For the outer coating 2·5 powdered fluorspar, 1 zinc-white, 4·75 tin oxide, ·75 bone ash, and ·03 to ·5 smalt are well mixed. Of this 9 kilos. are mixed with 16 of fine-ground fluorspar, 9·5 borax, 3·25 soda, and 1·25 to 1·5 nitre, and the whole fused together. The product is powdered, and 30 kilos. of it are wet ground with six cups of about 140 c.c. of white clay, and ·3 of zinc oxide. This is laid on and burned, completing the work.

In the course of further correspondence on semi-distillation of coal in gas making, so as to provide a smokeless fuel for London, as described in this column in our last impression, Mr. Scott-Moncrieff says that the scheme has been carried out in practice at a gas work to which he refers. When it was found that the apparatus for making gas on an extraction of six hours was insufficient for supplying the wants of the long winter evenings, the distillation was stopped when gas had been removed to the extent of 5000 cubic feet per ton. The larger quantities obtained from the coal per unit of time, and the superior illuminating power obtained per unit of volume tided over the difficulty and rendered the existing plant sufficient. No practical obstacles were discovered in discharging the retorts. He does not think the difference between an extraction of 5000 and 3333 cubic feet per ton would make a material change in this respect. The fuel resulting from a uniform extraction of 3333 cubic feet per ton is practically smokeless if it is taken hot from the retorts and immediately quenched with water.

In duplexing long submarine cables it is found, says the *Electrician*, that one great point to be aimed at is to carefully reproduce in the artificial cable which balances the working cable an exact imitation of the first three hundred miles or so at each end of the working cable, both as regards the resistance and electrostatic capacity of each consecutive mile of cable in its proper relative position; and for this purpose the "section books" containing the tests of each mile of cable before it is added to the cable are consulted, and the artificial resistances and inductive resistances forming the artificial one made to correspond, the remaining portion of the working cable being represented in the artificial cable more in the gross than in exact detail. This shows that the labour expended on the careful compilation of exact tests during manufacture is not thrown away, but is becoming of increased importance. So sensitive is the balance to this exact representation of the first few hundred miles of cable that even a slight decrease in insulation at one spot within that distance can only be rebalanced by a similar decrease of insulation at exactly a corresponding spot along the artificial cable, and this seems to open out a new and accurate method of determining the distance and magnitude of a small fault of insulation. In fact, for finding the distance of a fault in a cable we should have for one side of the bridge an artificial cable having electrostatic capacity and resistances exactly similar to the cable under test when perfect.

MISCELLANEA.

A useful index to the technical literature of each month is published in Glaser's "Annalen fuer Gewerbe und Bauwesen."

The Royal Agricultural Society proposes to hold its annual show at Reading in 1882. Reading is considering and encouraging the idea.

The engines of the cable-laying steamship Kangaroo recently ran the 9500 miles from New Zealand to St. Vincent without stopping.

The Hydraulic Engineering Company's offices in London and Paris have been removed to more convenient premises, as follows: London, Palace-chambers, 9, Bridge-street, Westminster; Hull, Machell-street; Paris, 10, Rue Laffitte.

Messrs. Ransomes, Sims, and Head, the well-known agricultural engineers, Orwell Works, Ipswich, announce that, from the 1st inst., the style and title of their firm will be Ransomes, Head, and Jefferies, the partnership of Mr. W. D. Sims having expired, by effluxion of time, on December 31st.

The Skeldergate Bridge at York, which was illustrated in our impression for the 11th May, 1877, has been opened to foot passengers, and the opening for general purposes will take place in the present month. The foundation stone was laid in June, 1878, and the cost of the bridge and approaches will be between £50,000 and £60,000. Mr. Geo. Gordon Page, C.E., is the engineer.

On Monday evening last the workmen of the Streethouse Colliery of the firm of Hy. Briggs, Son, and Co., together with a few other friends, assembled in the Streethouse day-school, where Mr. James Tears, on behalf of 164 subscribers, presented Mr. Alexander Alexander with a handsome address and a purse containing £30 in gold, as a small expression of their esteem and affection, and their regret at his removal from the colliery where he has during the past eight years occupied the position of colliery engineer.

The first application in Glasgow of electricity to street lighting in a permanent form took place on the evening of the 3rd inst. at the new *Herald* buildings, Buchanan-street. The proprietors have also contracted with Messrs. Anderson and Munro, electric engineers, Glasgow, to light up the public offices and the composing rooms of the *Herald* and the *Evening Times* by electricity. The Gramme machines are used, driven by a gas engine. The electric lamps are those invented by Mr. Brockie, formerly of Glasgow. They were described in our Abstract of Patent Specifications No. 3771, 1879.

The Custom-house returns show that during last year the shipment of pig iron from the port of Middlesbrough amounted to 960,744 tons, or 145,181 tons in excess of the quantity shipped in the previous year. Out of this quantity not less than 285,259 tons were shipped to Scotland, while the amount sent to the United States of America for the whole of the year was only 90,087 tons. The shipments to France, Germany, and Belgium were much above the average last year; and the total quantity sent out of the port is the highest by far that has been shipped in any one year in the history of the trade in the north.

What will Mr. Standfield and others say about the oppressed inventors, when they read that the applications for patents for inventions during 1880 were more numerous than in any previous year, having reached 5517. In 1879 the number was 5338, while in 1878 they amounted to 5343. With a few slight fluctuations, there has been a steady increase of business since the passing of the Patent Law Amendment Act in 1852, when a very sudden and extensive upward tendency manifested itself. In 1850 the number of patents granted reached 523 only; in 1860 the applications were 3196, and in 1870 they had increased to 3405.

The changes which are gradually taking place in the mode and direction of thought of the natives of some parts of India is perhaps indicated by the appearance in Marathi language of a small "Treatise on the Locomotive in Theory, History, and Practice." It is by Vishnu Chimnaji Karve, the station-master at Sanawad, of the Holkar State Railway, and he modestly only claims for his work that it is a compilation. He has written it for the advantage of the Marathi members of the Railway Service, and it will no doubt find many readers. It is fully illustrated with engravings and etchings sufficiently well executed, and the author deserves every encouragement.

A company is being formed to work the marble deposits at Caswell Sound on the west coast of Otago, New Zealand. The marble is said to exist in practically inexhaustible quantities, and consists of the purest white and of the dove-coloured varieties, the two kinds being found on opposite sides of the Sound at a distance of about a mile and a-half from each other. As specimens from these quarries obtained the first prize and medal at the Sydney Exhibition, and as vessels can anchor in perfect safety close alongside the workings, there appears to be every hope of the enterprise proving successful. The company proposes also to manufacture lime, Portland cement, &c.

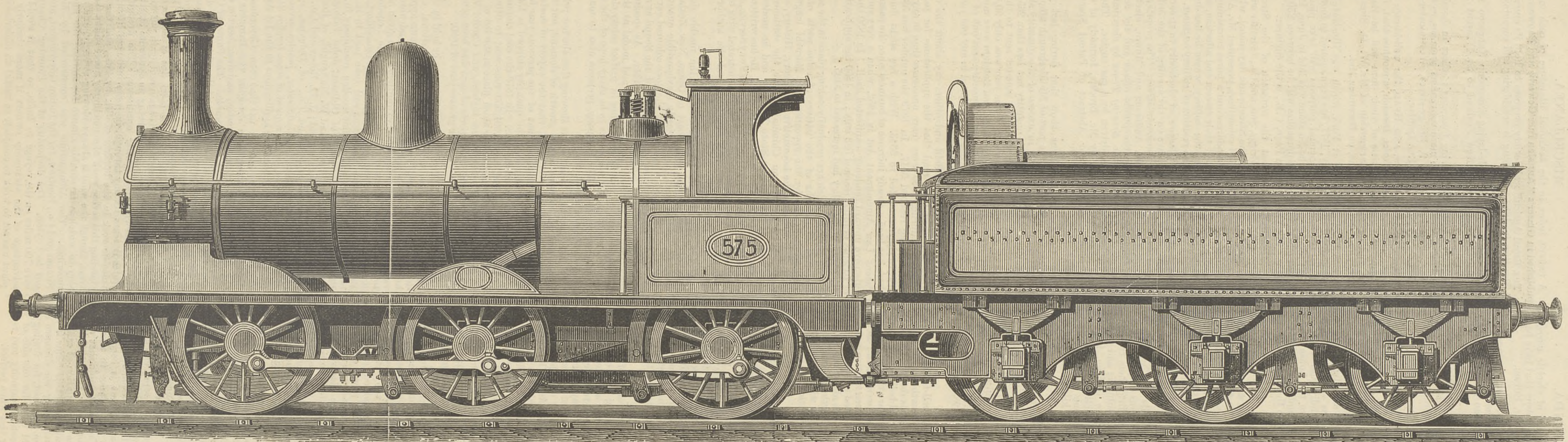
It is interesting to notice, as showing that the low price of coal is not due to decrease in the growth of demand, but to greatly increased means of production, that the export of coals from the river Wear in 1880 exceeded that of the previous year by not less than 300,000 tons, and that the quantity shipped is 150,000 tons above that of any previous year. In 1879 the coal shipments were 1,015,928 tons foreign, and 2,091,559 tons sent to other British ports. The Wear occupies the third place in the list of coal-shipping ports, Newcastle taking the highest, and Cardiff the second place. The increase in the exports of coal has been general at all the north-eastern ports over the greater part of 1880.

The International Woollen Exhibition—to be held in the Crystal Palace—is one of the series of annual international exhibitions determined on by the directors, has met with warm approval and hearty response from manufacturers at home and abroad. The various continental and colonial exhibitions have given an impetus to the subject. Many of the exhibitors at the Leipsic Woollen Exhibition, and the exhibitors at Vienna, Dusseldorf, Brussels, Brisbane, Sydney, and Melbourne will take part in it. All the best machine makers will exhibit woollen machinery in motion—Platts Brothers and Company, of Oldham; John Tathan, Edward Leach, John Batree, and J. and W. McNaught, of Rochdale; J. Sykes and Sons, of Huddersfield; J. H. Robey and Co., of Bury; Hutchinson, Hollingsworth, and Co., of Dobcross, near Manchester; Koerting Bros., of Manchester, besides several foreign makers. The directors, at the request of some foreign States, have extended the time for receiving applications to the 1st April.

A correspondent informs us that the Government screw dredger Albuquerque has been dredging the Paumber Channel, Ceylon, for the last eighteen months, and describes the difficulties being met with as very considerable. The Paumber Channel is about 100 miles north of Colombo, and the object is to deepen the channel to 18ft. at spring tides. The soil is very tenacious, and frequently rocks of volcanic formation are being met with. While encountering these the powerful dredger is frequently brought to a standstill, and the steel lips of the buckets torn away. Notwithstanding this it is again and again put to it till the obstructions are removed, there being no dynamite blasting as customary elsewhere in similar operations. The dredging master states it tears its way through, in some instances lifting pieces of volcanic rock in the buckets of 3ft. by 4½ft., and that notwithstanding this severe work the machinery never shows signs of distress, though the wind is always blowing strongly, and it is necessary to watch a favourable chance for shifting the anchors and moorings. The Albuquerque was constructed by Messrs. W. Simons and Co., Renfrew, for the Indian Government, and steamed out to Ceylon. The deepening of the Paumber Channel would save 700 miles on the voyage to India, so that it would be to the advantage of the steamship owners if more similarly powerful plant was set to work to complete so useful an undertaking.

SIX-COUPLED GOODS ENGINE, LANCASHIRE AND YORKSHIRE RAILWAY.

CONSTRUCTED BY THE VULCAN FOUNDRY COMPANY, NEWTON-LE-WILLOWS, FROM THE DESIGNS OF MR. W. BARTON WRIGHT, LOCOMOTIVE SUPERINTENDENT, LANCASHIRE AND YORKSHIRE RAILWAY.

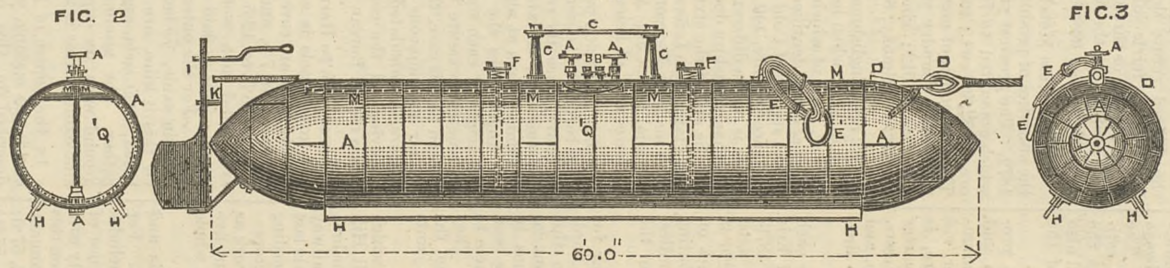


We illustrate above one of fifty goods engines recently ordered by the Lancashire and Yorkshire Railway Company. We shall publish working drawings of this engine in an early impression, and meanwhile content ourselves with stating that the cylinders are 17½in. diameter, with a stroke of 26in. The wheels are 4ft. 6in. diameter and the wheel base 15ft. The grate surface is large—19½ square feet. The heating surface of the tubes is 943½ square feet, and that of the fire-box 90½ square feet—total, 1034 square feet. In sixteen engines the boiler is to be of Lowmoor, and in sixteen engines of Bowling iron, and the remainder may be made of either one or other. The inside fire-box and the stays to be of copper; the tubes are to be of iron with 6in. of solid copper tube brazed on at the fire-box ends. The tender is peculiar; it is fitted at the front end with Sharp's patent arrangement of cab, tool box and filling hole combined. The wheels are 3ft. 1⅞in. diameter; the engine and tender will be fitted with Hardy's vacuum brake.

THE CONVEYANCE OF SEA WATER TO LONDON.

Many of our readers are no doubt aware that several schemes have been proposed for conveying sea water to London, and during last summer a considerable quantity was so conveyed in tanks by the Great Eastern Railway Company. Mr. John Hayes, of 27, Leadenhall-street, proposes to convey water from the North Sea in a specially constructed floating tank, resembling the vessel which conveyed Cleopatra's Needle to this country. The features of this plan will be readily understood from the engraving. Figs. 1, 2, and 3 represent views of the sea water vessel, the dimensions of which are 60ft. by 10ft. diameter, and in which A A is the plating or shell of wrought iron ⅜in. in thickness, A A are the inlet valves placed on the bottom of the vessel, and opened by a screw and wheel at the top of the same, B B are two air outlets which allow egress for air displaced by the sea water, C C are wrought iron columns supporting the guard rail also marked c, D D is a strong iron framework for attaching the tow rope and hook to, E¹ is a life-buoy, F F are two valves secured or kept on their seats by spiral springs. A water-tight bulkhead divides the vessel at the centre; H H are two strong plate-iron keels 18in. by 1in., secured by angle-irons 5in. by 5in. by ⅝in. to the shell, which latter, at the bottom or between the keels, is for the entire length of the vessel ½in. thick. I is the rudder, and K the steersman's platform; it is expected, however, that this would seldom be required, if at all, as the double mode of towage would require a steersman only on the tug-boat. M M M M are the spaces at the top side of the vessel reserved as air spaces, and in which water would be never permitted to enter. These are formed of ¼in. iron plates, supported and strongly attached to wrought iron frames, and stayed where necessary to resist a test pressure of 20 lb. to the square inch, applied externally by means of hydraulic power. This air chamber is divided longitudinally into two separate compartments, the intervening space being left for the valve spindles A A, &c., to pass through. Figs. 4 shows the mode of handling the sea water on arrival at the wharf in the Thames, when the water would be pumped up into suitable tanks, and from which it would have ample fall for filling the water carts. On the ground floor, Mr. Hayes's design includes an additional feature in the form of a sea-water swimming bath, measuring 100ft. by 25ft., and of a suitable depth. The sea-water vessels, also the tanks for storage of the water, will be carefully lined with a special composition capable of withstanding the action of the sea water, and at the same time preventing it from getting discoloured by contact with iron or any other material. It is proposed to send two of these tanks out to the North Sea, one lashed at each side of the steamer. E is a hose with a buoy at the end. Should one of the tanks be sunk air could be forced in through this hose, the upper end of which floats, and the vessel could thus be raised.

FIG. 2 FIG. 1 FIG. 3



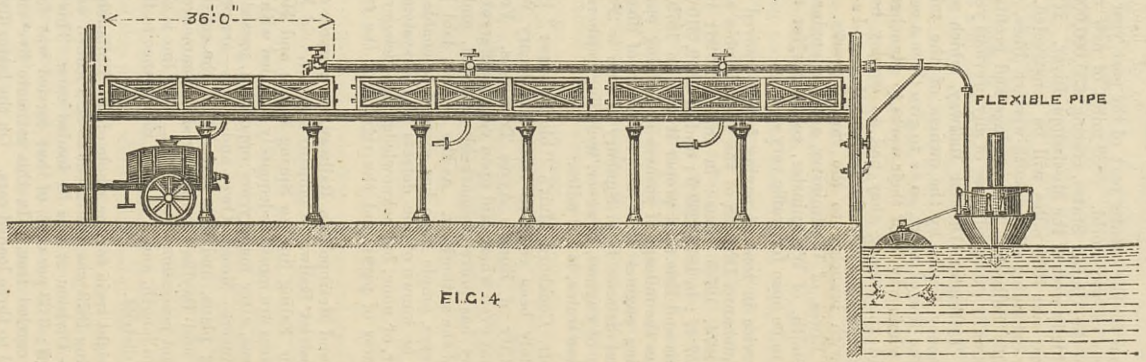
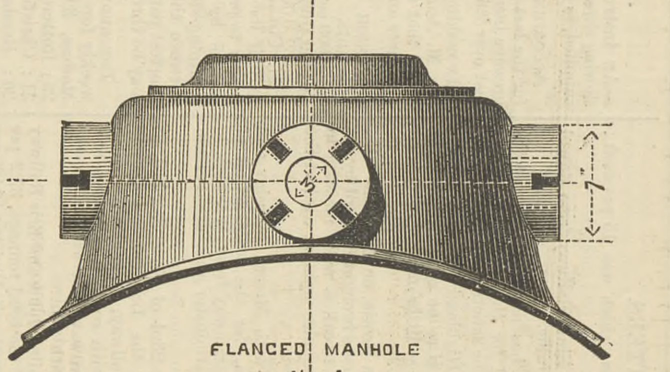


FIG. 4

AN IMPROVED MANHOLE.

The accompanying engraving illustrates an improved manhole cover, manufactured by Messrs. Garrett and Sons, of Leiston. It will be seen that this manhole cover carries all the principal openings into the boiler,



FLANGED MANHOLE
SCALE 1" = 1 FOOT

and possesses several advantages in this respect over the ordinary system. Thus two 7in. seats are provided for steam or coupling pipes, and two 3in. openings for safety valves. The whole cap can be stamped up of steel in the Piedbœuf press.

Torpedo Boats.—Two torpedo boats of the Batoum type, built for the Argentine Government by Messrs. Yarrow and Co., have just been tested at the measured mile on the Thames, when their respective speeds in fighting trim were found to be 19·9 and 19·8 knots. These boats are of special design, and have been constructed under the superintendence of Captain Hunter Davidson. They are 100ft. in length, and will shortly start across the Atlantic for South America.

RAILWAY BRIDGE OVER THE RIVER OHIO, BEAVER, PENNSYLVANIA.

(*For description see page 16.*)

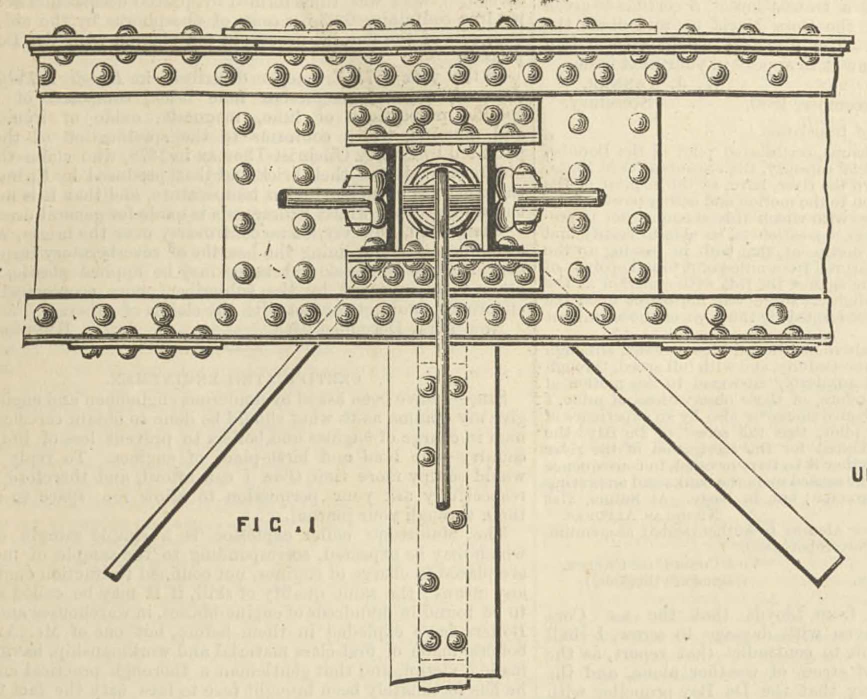


FIG. 1

UPPER CHORD

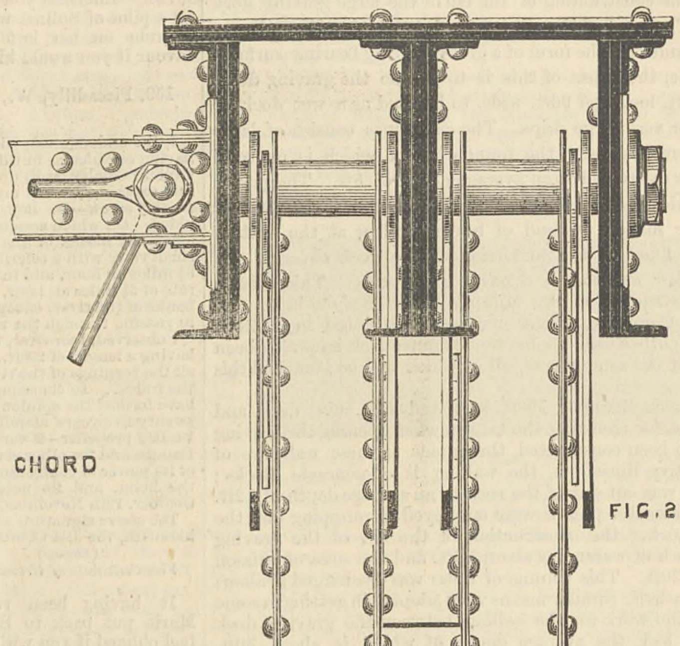
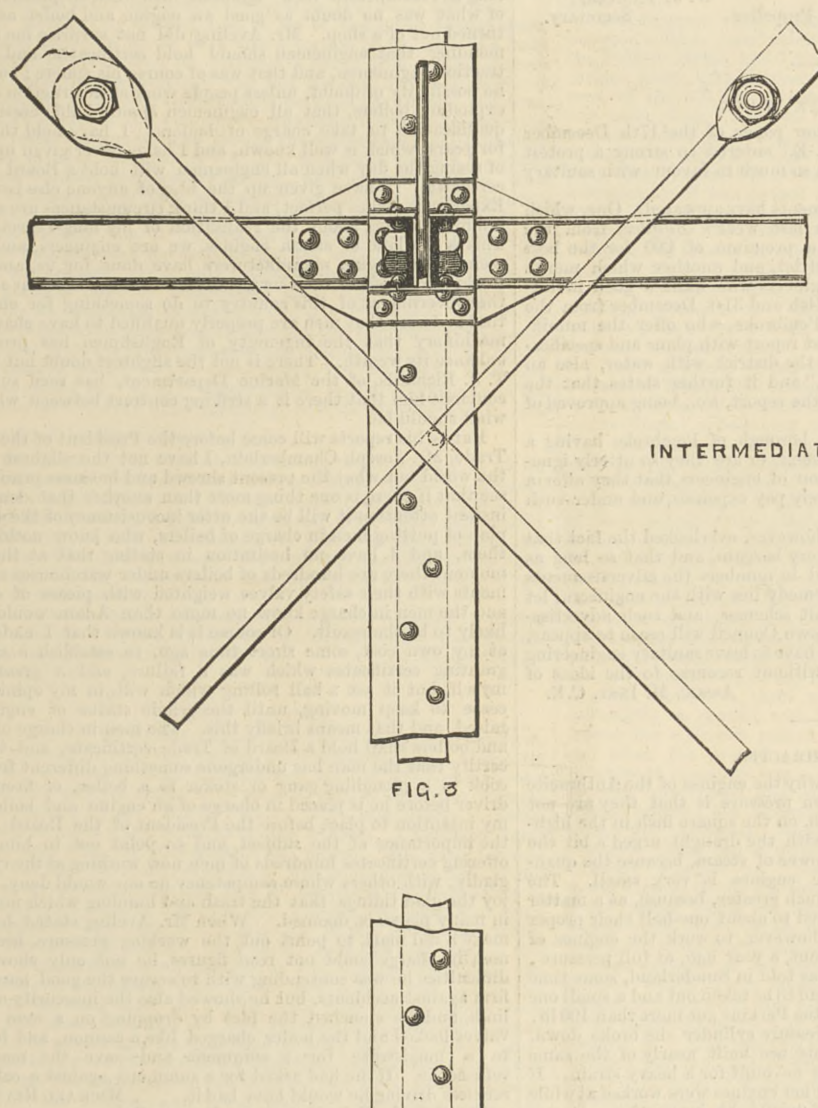


FIG. 2



INTERMEDIATE BRACING

FIG. 3

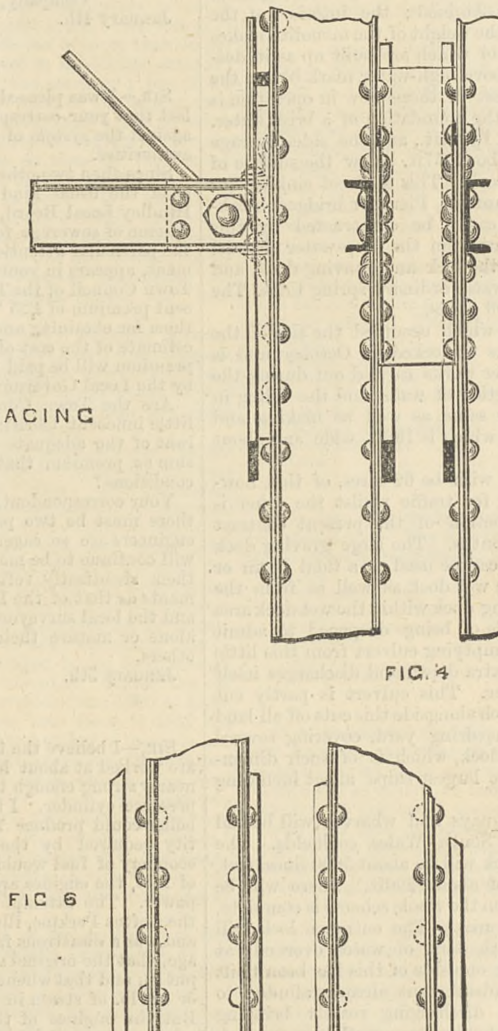


FIG. 4

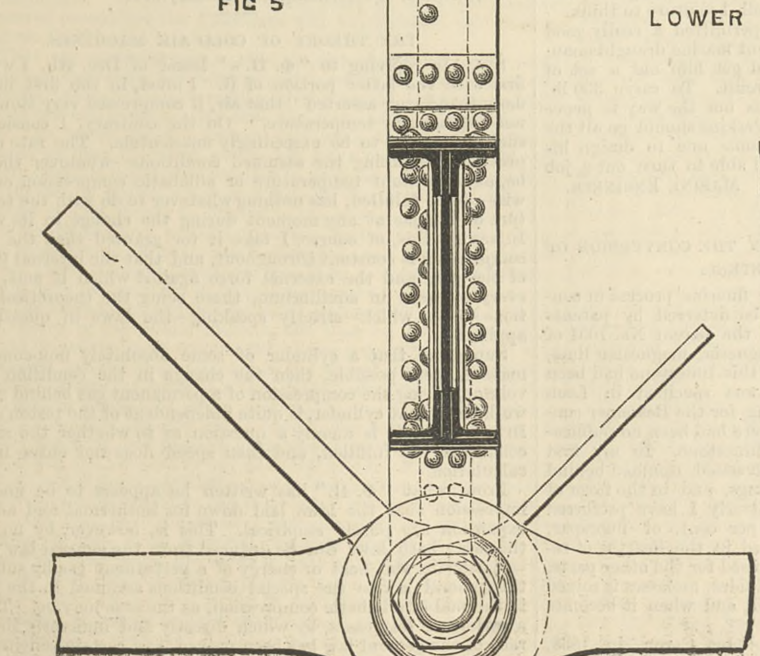


FIG. 5

LOWER CHORD

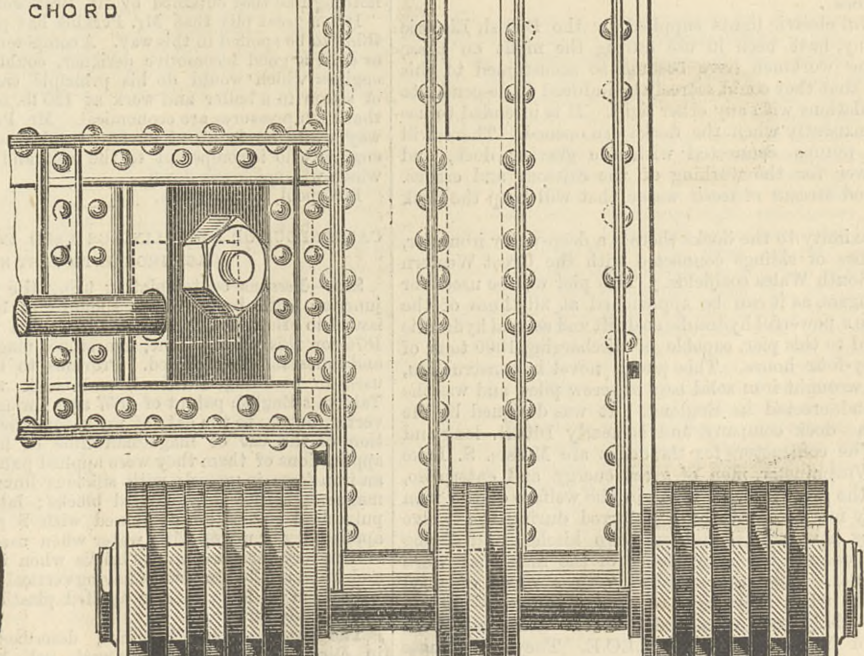


FIG. 6

MILFORD DOCKS.

CONSIDERABLE progress has been made with these docks during the last year. Some of the deepest tidal work, many feet below low water, has been carried out by means of a large iron caisson framing, in the construction of the cill of the large graving dock entrance. The level of the cill is 34ft. below high water ordinary spring tides, and is in the form of a groove having bearing surfaces on either side, the object of this is to enable the graving dock, which is 710ft. long and 96ft. wide, to be used as a wet dock or tidal basin for very large ships. The cill stones consist of large blocks of Cornish granite, the foundation of which is on solid rock, and was excavated to an average depth of 8ft. The gate or caisson for this entrance is a floating caisson, and the largest of its kind ever made. Instead of having rollers at the bottom they will be fixed to the underside of the deck covering the caisson chamber, and this is a novel contrivance. This caisson has been constructed at the Milford Haven Shipbuilding and Engineering Company, whose works are situated in Milford Haven. Two other caissons for the entrance lock have also been constructed at the same works, all of which will be launched this month.

A large caisson chamber, 100ft. long and 45ft. 6in. deep, and 15ft. 6in. wide, for receiving the caisson when opening the graving dock, has also been constructed, the quoins to these walls are of blocks of native limestone, the walling is of concrete blocks; this chamber was cut out of the rock to an average depth of 12ft. Six large Pulsometer pumps were employed in pumping out the tidal water during the construction of the cill of the graving dock, the depth of water was about 25ft. and the area of caisson was 60ft. by 30ft. This volume of water was discharged in about one hour and a-half. Similar means were adopted in getting in some deep foundation work for the walling between the graving dock and entrance lock, the average depth of which is about 30ft. below low-water ordinary spring tides, this wall is of Ashlar limestone masonry obtained from quarries situate on the shores of Milford Haven.

Some deep foundations were obtained by means of monoliths constructed and built in concrete on the surface of the ground where the foundation is to be obtained; the interior of the monolith is then excavated, and the weight of the monolith makes the whole mass to sink, the sides of which are built up as it descends, or this may be built up above high-water mark before the interior is excavated. The largest of these now in operation is at the entrance of the lock, for the foundation of a breakwater. The size of this monolith is 36ft. by 24ft., and the sides average about 6ft., and has to go down about 57ft. below the surface of the ground before reaching the rock. This mode of sinking for foundations is novel in this country. Piers for bridges, breakwaters, and lighthouses could easily be constructed by this method. A channel has been cut from the deep-water channel of the Haven to the entrance of the lock and graving dock, and this gives 34ft. of water at high-water ordinary spring tides. The width of this channel is about 100 yards.

The Great Eastern steamship, which occupied the site of the large graving dock for repairs, was undocked in October, and is now lying off Milford. The other works carried out during the past year are chiefly the construction of walls, and the filling in and forming backing behind the same, as well as making and completing the sea embankment, which is 100ft. wide and about 800ft. long.

The dock area when completed with be 62 acres, of this, however, the first half will be opened for traffic whilst the other is under construction. The first section of the present contract will be completed in about six months. The large graving dock having an entrance at either end can be used as a tidal basin or lock, and can be entered from the wet dock as well as from the Haven. There exists a small graving dock within the wet dock area of about 300ft. long and is capable of being deepened to admit ships drawing 20ft. of water; an emptying culvert from this little dock has been laid down to the extra depth and discharges itself outside the dock wall at low water. This culvert is partly cut out of the rock and a puddle trench alongside this cuts off all land springs. There will be a large repairing yard, covering several acres alongside the large graving dock, which is of such dimensions that it will accommodate the largest ships afloat including her Majesty's ironclads.

Sidings and coaltips along the quays and wharves will be laid down in connection with the South Wales coalfields. The frontage of the 30 acres of the dock will be about 5000 lineal feet, with an average depth of quay of about 200ft. There will be additional 7000ft. of wharfage when the whole scheme is complete, with 26ft. of water over the dock area. The entrance lock will be 500ft. long and 70ft. wide, with 34ft. of water over cill at high-water ordinary spring tides; one side of this has been built during the last year. The sea embankment already alluded to is used on the the sea-side in discharging vessels bringing material to the docks. A breakwater has been partly constructed, and will be extended to its full length on the south-western side of the dock, for the protection of the entrance to the lock and graving dock.

Two powerful electric lights supplied by the British Electric Light Company, have been in use during the night on these works, and the workmen have become so accustomed to this splendid light that they could scarcely be induced to descend into the deep foundations with any other light. It is intended to use this light permanently when the docks are opened. There will be powerful pumps connected with the graving dock, and hydraulic power for the working of the caissons and cranes. There is a good stream of fresh water that will keep the dock well supplied.

In close proximity to the docks there is a deep-water iron pier, with three lines of sidings connected with the Great Western Railway and South Wales coalfields. This pier will be used for landing passengers, as it can be approached at all times of the tide. There are a powerful hydraulic coal-lift and several hydraulic cranes attached to this pier, capable of discharging 1000 tons of coal in twenty-four hours. This pier is novel in construction, being built of wrought iron solid bars or screw piles, and was the first of its kind erected in England. It was designed by the engineer of the dock company, and is nearly 1000ft. long and 40ft. wide. The contractors for the docks are Messrs. S. Lake and Co., of Westminster, men of great energy and enterprise, and owing to the great interest taken in the welfare of the men employed, very few accidents have occurred during the twelve months. They have erected a large soup kitchen and drying room on the docks for the convenience of the men that work during the tides. They are supplied with a quart of good wholesome soup when they leave off work. Between 400 and 500 men have daily been employed. These docks are from the designs of Mr. J. M. Toler, M.I.C.E. They are situate near the old town of Milford, and are about four and a-half miles from the entrance of the harbour. The Milford Haven dock and railway run parallel to the dock walls for nearly half a mile.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE DE BAY PROPELLER.

SIR,—Enclosed you will find a translation of a certificate given by a pilot of Sulina, who took the Cora Maria up and down the Danube on her last voyage. The directors would esteem it a favour if you would kindly allow it to appear in your next issue.

W. J. TANNER,
159, Piccadilly, W., 29th December, 1880. Secretary.

[Copy of translation.]

I, the undersigned, Nicholas Aleuras, certificated pilot of the Danube, having conducted, in this my special capacity, the steamboat Cora Maria, Captain Cawley, both up and down the river, have, at the request of the said captain, directed my attention to the motion and acting power of the De Bay screw—De Bay propeller—with which this steam vessel is provided. On which account I am in a position to be able to certify and affirm, by means of the present document, that both in passing up the small river with a celerity—if measured from mile-point to mile-point—of 8¾ miles an hour, and in struggling against the tide with a motion at the rate of 2½ miles an hour, not the slightest surge was noticeable upon the banks of the river, except the wave formed by the bows of the steamboat in passing through the water.

I observed, moreover, that the above-mentioned steam vessel, although having a length of 230ft., passed successfully, and with full speed, through all the turnings of the river, as it admirably answered to the motion of the rudder. In consequence, therefore, of these observations of mine, I have formed the opinion, strengthened moreover also by an experience of twenty-five years' standing as a pilot, that the screw of De Bay—the De Bay propeller—is very well adapted for the navigation of the river Danube and for other service, whether it be ferry or canal, in consequence of its power of controlling the surge caused upon the banks and answering the helm, and its noiseless character; but in haste. At Sulina, 31st October, 12th November, 1880. NICHOLAS ALEURAS.

The above signature of Nicholas Aleuras is authenticated as genuine herewith, the 31st October, 12th November, 1880.

(*Stamp*) VICE-CONSUL OF GREECE.
Vice-Consulate of Greece in Sulina. (Signature illegible.)

It having been reported from Lloyds that the s.s. Cora Maria put back to Bremerhaven with damage to screw, I shall feel obliged if you will allow me to contradict that report, as the vessel put back on account of stress of weather alone, and the captain has since written to say that the De Bay propeller with which this vessel is fitted is entirely uninjured though severely tested by the gale. W. J. TANNER,

De Bay's Patent Direct-Acting Propeller Secretary.
Company, Limited.
January 4th.

COMPETITIVE PLANS.

SIR,—I was pleased to see in your paper of the 17th December last that your correspondent "C. E." entered so strong a protest against the system of competition so much in favour with sanitary authorities.

Since then two other advertisements have appeared. One, which is of the usual kind appears in last week's *Builder*, from the Hindley Local Board, who offer a premium of £60 for the best scheme of sewerage for their district, and another which merits the particular attention of all engineers who want a good investment, appears in your papers of 24th and 31st December from the Town Council of the Borough of Pembroke, who offer the munificent premium of £25 "for the best report with plans and specifications for obtaining and supplying the district with water, also an estimate of the cost of the same," and it further states that the premium will be paid "only" on the report, &c., being approved of by the Local Government Board.

Are the Town Council of the borough of Pembroke having a little innocent Christmas amusement, or are they so utterly ignorant of the adequate remuneration of engineers that they offer a sum as premium that would barely pay expenses, and under such conditions?

Your correspondent, "C. E.," however, overlooked the fact that there must be two parties to every bargain, and that so long as engineers are so eager to respond in numbers the advertisements will continue to be made. The remedy lies with the engineers; let them steadfastly refuse to submit schemes, and such advertisements as that of the Pembroke Town Council will cease to appear, and the local surveyors will either have to leave sanitary engineering alone or mature their schemes without recourse to the ideas of others. ASSOC. M. INST. C.E.

January 5th.

THE ANTHRACITE.

SIR,—I believe the true reason why the engines of the Anthracite are worked at about half the given pressure is that they are not nearly strong enough to bear 350 lb. on the square inch in the high-pressure cylinder. I fancy that with the draught urged a bit the boiler could produce 160-horse power of steam, because the quantity required by the Anthracite engines is very small. The economy of fuel would then be much greater, because, as a matter of fact, the engines are only worked to about one-half their proper power. The attempt was made, however, to work the engines of the Loftus Perkins, illustrated about a year ago, at full pressure, and was a disastrous failure. I was told in Sunderland, some time ago, that the original steam pipe had to be taken out and a small one put in, and that whenever the Loftus Perkins got more than 100 lb. or 120 lb. of steam in the high-pressure cylinder she broke down. But the engines of the Anthracite are built nearly of the same relative proportions, and are just as unfit for a heavy strain. If Mr. Perkins could say at what power her engines were worked at while she was crossing the Atlantic, it would be interesting. It was nothing like that obtained by Mr. Bramwell, I venture to think.

It is a great pity that Mr. Perkins has permitted a really good thing to be spoiled in this way. A competent marine draughtsman, or even a good locomotive designer, could get him out a set of engines which would do his principle credit. To carry 350 lb. of steam in a boiler and work at 120 lb. is not the way to prove that high pressures are economical. Mr. Perkins should go all the way while he is about it, and employ some one to design his engines who is competent to the task, and able to turn out a job which will not break down. MARINE ENGINEER.

Liverpool, January 4th.

CALCAREOUS OR BASIC LININGS USED IN THE CONVERSION OF CAST IRON INTO CAST STEEL.

SIR,—Persons contemplating using the fluorine process in conjunction with basic linings should not be deterred by patents issued to other inventors since 1870, as in the patent No. 1051 of 1870 for this process lime, limestone, magnesia, magnesian lime, and limestone are specified. Previous to this limestone had been used in puddling furnaces, and chalk was specified in Leon Talabot's English patent of 1857 as a lining for the Bessemer converter, but up to the date of my patent there had been no publication of the use of magnesian lime or limestone. In my first applications of them they were applied pulverised, rammed behind an iron form in vessels with silicious linings, and in the form of magnesia bricks and quarried blocks; latterly I have preferred pulverised raw dolomite mixed with 2 per cent. of fluorspar, applied dry or mixed with water when used in the hearths of reverberatory furnaces, and as bricks when used for the other parts, and when applied in vessels having vertical sides, molasses is mixed with them to form mortar applied plastic, and when it becomes dry is ready for use.

The magnesia burnt bricks, described by Caron, in 1868, in *Dingler's Polytechnic Journal*, vol. 189, pp. 110 and 111, were used in the beginning of the year 1872 in the Bessemer process, in conjunction with the re-agents of the Henderson fluorine process, by Tessie du Motay in his horseshoe-shaped converter. In June, 1872, whilst the writer was showing the process in the puddling furnaces of the Bowling Iron Company, their superintendent, Mr. J. E. Goldwyer, sent a considerable quantity of their usual quality of pig iron to France to be converted in du Motay's apparatus. Mr. Goldwyer assisted at the trials, and reported on his return that the phosphorus was all removed and most of the carbon. Steel was thus formed by partial decarbonisation from pig iron containing 0·65 per cent. of phosphorus by the aid of the re-agents of the fluorine process in conjunction with the Bessemer process.

In the year 1873 Erdmeyer described, in *Dingler's Polytechnic Journal*, a burnt magnesian lime brick, composed of certain specific proportions of lime, magnesia, oxide of iron, silica, and alumina, which conforms to the specification of the brick patented by Sidney Gilchrist-Thomas in 1878, who claim that the difference between their brick and that produced by Erdmeyer is that theirs is burnt at a higher temperature, and that it is made for the steel process, whilst Erdmeyer's is made for general uses.

There need, however, be no controversy over the bricks, as they are unnecessary for lining the hearths of reverberatory furnaces or converters, as the basic substance may be applied plastic, and in other ways invented by the subscriber, more economically and effectively, and not conflict with the claims of others.

New York, December 24th. JAMES HENDERSON.

CERTIFICATED ENGINEMEN.

SIR,—I have been asked by numerous enginemen and engineers to give my opinion as to what should be done to obtain certificates for men in charge of engines and boilers to prevent loss of life in this country—the land and birth-place of engines. To reply to all would occupy more time than I can afford, and therefore I most respectfully ask your permission to allow me space to answer them through your journal.

The Maidstone boiler explosion is a simple sample of that which may be expected, corresponding to the sample of men who are placed in charge of engines, not confined to traction engines by any means; the same quality of skill, if it may be called skill, is to be found in hundreds of engine-houses, in warehouses and mills. Boilers have exploded in them before, but one of Mr. Aveling's boilers, made of first-class material and workmanship, having been made a victim, and that gentleman a thorough practical engineer, he has fortunately been brought face to face with the fact that all his attention and anxiety to produce a safe boiler avails nothing so long as incompetent men—ignorant men—can be placed in charge of what was no doubt as good an engine and boiler as was ever turned out of a shop. Mr. Aveling did not surprise me in recommending that enginemen should hold certificates, and specially traction enginemen, and that was of course his sphere; but there is no possibility of doubt, unless people wink at destruction of life by exploding boilers, that all enginemen should hold certificates of qualification to take charge of boilers. I have held the opinion for years, which is well known, and I have never given up the idea of seeing the day when all enginemen will hold a Board of Trade certificate. I have given up the idea of anyone else issuing one. Experience makes perfect, and I think circumstances are every day tending to bring about the realisation of my long-expected hopes. This is the land of steam engines, we are engineers, and I think, seeing what engine manufacturers have done for us, and for the world—done out of their own pockets—that the time has arrived for the Government of this country to do something for enginemen, that is to see that men are properly qualified to have charge of the machinery that the ingenuity of Englishmen has produced to enhance its wealth. There is not the slightest doubt but what Mr. T. J. Richards, of the Marine Department, has seen sufficient to convince him that there is a striking contrast between what is and what should be.

But as his reports will come before the President of the Board of Trade, Mr. Joseph Chamberlain, I have not the slighest doubt in the world but what the present shrewd and business president will see that if there is one thing more than another that demands his instant attention it will be the utter inconsistency of the dangerous plan of putting men in charge of boilers, who know nothing about them, and I have no hesitation in stating that at the present moment there are hundreds of boilers under warehouses and pavements with their safety valves weighted with pieces of cast iron, and the men in charge know no more than Adam would what is likely to be the result. Of course it is known that I endeavoured, at my own cost, some short time ago, to establish a system of granting certificates which was a failure, and a great one to myself, but it set a ball rolling which will, in my opinion, never cease to keep moving, until the whole status of enginemen is raised, and that means briefly this. The men in charge of engines and boilers shall hold a Board of Trade certificate, and that shall certify that the man has undergone something different from being cook to a ploughing gang or stoker to a boiler, or fireman to a driver before he is placed in charge of an engine and boiler. It is my intention to place before the President of the Board of Trade the importance of the subject, and to point out to him that by offering certificates hundreds of men now working at the vice would gladly, with others whose competency no one would deny, hail with joy the glad tidings that the trash and humbug which now prevail in many places is doomed. When Mr. Aveling stated he had to make a red mark to point out the working pressure, because the men in charge could not read figures, he not only showed what difficulties he was contending with to secure the good name of his firm against accidents, but he showed also the insecurity of life and limb, and he clenched the fact by dropping on a man with his valves locked and the boiler charged like a cannon, and he applied to a magistrate for a summons and—save the mark!—was refused it. If he had asked for a summons against a cabman for reckless driving he would have had it. MICHAEL REYNOLDS.

Standeford, Wolverhampton, January 3rd.

THE THEORY OF COLD AIR MACHINES.

SIR,—In replying to "Φ. Π.'s" letter of Dec. 4th, I will dea first with the latter portion of it. I must, in the first instance, deny that I ever asserted "that air, if compressed very slowly, will not augment in temperature." On the contrary, I consider any such statement to be exceedingly unscientific. The rate of compression, supposing the assumed conditions—whatever they may be, as to constant temperature or adiabatic compression or otherwise—to be fulfilled, has nothing whatever to do with the temperature of the gas at any moment during the change in its volume. In saying this, of course I take it for granted that the rate of compression is constant throughout, and that the internal pressure of the gas, and the external force against which it acts, are at every moment in equilibrium, these being the theoretical conditions under which—strictly speaking—the laws in question are applicable.

Supposing that a cylinder of some absolutely non-conducting material were possible, then the change in the condition at any volume, during the compression of a permanent gas behind a piston working in that cylinder, is quite independent of the piston's speed. In every case it is merely a question as to whether the assumed conditions are fulfilled, and then speed does not enter into the calculation.

From what "Φ. Π." has written he appears to be under the impression that the laws laid down for isothermal and adiabatic expansion are purely empirical. This is, however, by no means the case; both laws can be deduced from the general law for the variation in the heat or energy of a permanent gas by subjecting this general law to the special conditions assumed in the case of isothermal or adiabatic compression, as the case may be. There is a variety of test cases, by which directly and indirectly the accuracy of the general law has been proved, and certain conclusions to which theory has pointed have been verified by direct experiment. Admitting, therefore, that the general law is accurate, there is no reason for doubting the special conclusions derived from it by mere mathematical processes, provided the limits within which the gases

—to which the law applies may be considered permanent—are not exceeded. The general law referred to is, like every other in physics, based partly on theory and partly on well authenticated experiments, and the number and variety of cases in which it has been found to agree with practice leave no doubt as to its accuracy within the specified limits.

With regard to "Φ. Π.'s" denial of my former statement, that when 1 lb. of air is compressed isothermally the energy contained in it is the same as before compression, my answer may be taken from "Φ. Π.'s" own statements. He says: "According to M. Mallard the air will fall in temperature"—when allowed to expand adiabatically after having been isothermally compressed to half its original volume—" about 108 deg. . . ." Now this fall in temperature represents the work done in expanding from a pressure of 29·4 lb. per square inch to the original volume, and the energy contained in the gas after this expansion is less than its original energy by exactly this amount; the work done by expansion in this case is all derived from the energy contained in the air before compression, and is therefore not gained, as "Φ. Π." supposes, in a scientific sense; it is merely made available for external work. We have in principle a parallel in the case of the application of a condenser to a steam engine; by using a condenser more work than otherwise is obtained from a given weight of steam, but it cannot be asserted that the equivalent amount of energy does not in any case exist in the steam, or that the extra work due to the use of a condenser is only equal to that required for working the latter. The energy, both in the case of the air and steam, exists previously, but is only made available for useful work, in the one case by compression, in the other by the use of a condenser. If the process of compressing isothermally and expanding adiabatically were repeated, with every repetition the temperature would, at the end of the expansion, be lower than previously, the energy exerted in expansion being not a part of the energy expended on compression—all of which goes, for instance, to heat the water used to maintain a constant temperature—but that originally contained in the pound of air compressed at atmospheric pressure, temperature, and volume.

It would, under certain circumstances, be possible to utilise a part of the energy contained in 1 lb. of air at atmospheric pressure, temperature, and volume, without first compressing it isothermally, and if the energy thus utilised be the same in amount as that represented by the adiabatic expansion of the air as assumed above, then its condition, after it has parted with that quantity of energy, will be identical with what would have resulted from isothermal compression and subsequent expansion as previously assumed.

For instance, by causing 1 lb. of air of the given temperature, volume, and pressure to part with a portion of its heat to a body of lower temperature; for example, a bar of iron of such dimensions that the temperature will fall 108 deg. before equality is established, as regards temperature, between the air and the iron, then we shall—if the volume be maintained constant—have the same resultant condition as though the compression and expansion in the manner assumed by "Φ. Π." had taken place, *i.e.*, atmospheric volume, temperature 46 deg., and pressure 11·7 lb. This is a sufficient proof that no energy is gained by isothermal compression apart from that which is converted into heat. In a former communication, "Φ. Π." expressed a doubt as to the correctness of the formula used for determining the work necessary for adiabatic compression. It is only necessary to remark with regard to this point, if "Φ. Π." accepts the usual law as to pressure and volume for adiabatic expansion—*i.e.*, $p\,v^{1\cdot41} = p_1\,v_1^{1\cdot41}$ where $p\,v$ are respectively pressure and volume at any moment during expansion, and p_1 and v_1 initial pressure and volume; hence for the terminal pressure, where $v_1 = \frac{1}{2}v$—, $p = 29\cdot4\,(\frac{1}{2})^{1\cdot41} = 11\cdot06$ lb., as against 11·7 as stated by "Φ. Π."—there cannot be two opinions as to the formula for the work done, resulting from the law referred to, and determined by the expression $\int p\,d\,v$.

In conclusion, I repeat that the energy contained in 1 lb. of air after isothermal compression to half its natural volume is precisely the same as previously, and the fact, that if the same amount of energy developed by adiabatic expansion after such compression be given up as heat at atmospheric pressure, temperature, and volume—without compression—the resultant condition of the air is the same as after compression and expansion, is evidence of the truth of this assertion.

For the work done in adiabatic expansion, formula (22), p. 903 of D. K. Clarke's "Rules, Tables, and Data," should be used instead of formula (24) as quoted by "Φ. Π." G. R. Bodmer.

January 3rd.

CHEAP PATENTS.

Sir,—Mr. F. W. Grierson's excellent paper on the above subject, read recently before the Society of Engineers, calls, I think, for a wider discussion than that allowed for on that occasion, and as one who was privileged to be present, and to hear the remarks made thereon by Mr. Hinde Palmer, M.P., and others, I would venture to make a few remarks on the subject. I cordially agree in the main with the substance of the paper. This said, I would point out that the mere reduction of fees or stamps in itself would not, in my opinion, stem the tide of American encroachments in the home and colonial markets, and I think the statement made by a speaker—and embodied in principle in Mr. Anderson's Bill—that "half a loaf is better than none," does not hold good in this case. I mean that no compromise or half legislation will do the inventor—or the public, which in the end is the same thing—any good in the long run. It is now more than twenty-eight years since the present patent law was passed, and if a half measure were to be passed now we may have to wait another thirty years or more before we get its defects remedied, the truth of the matter being that few statesmen in this country are alive to the importance of the subject, and fewer still are conversant with the requirements. While we wait thirty years or more for another improved patent law the Americans will have gained such a start that we shall be too late again.

What our statesmen, as a rule, do not understand, but what American statesmen are alive to, is, it seems to me (1) that the material prosperity and progress of the nation hangs on a good patent law and practice; (2) that the more patents there are in force the better for the nation—*vice versâ*, the more "orphan" patents we have the worse we are off, for a patent come to an untimely death it is nobody's interest to push, and hence no one man nor the whole nation reaps any benefit therefrom; (3) that the greatest facility should be offered to the poorest to make it worth his while to improve existing processes and apparatus, and to invent better ones; (4) that public morality and the true interests of the nation demand that there should be a rigid but fair examination as to the novelty of inventions sought to be patented; (5) that the inventor should not be taxed because he spends his time and money in the public interest, but that he, on the contrary, should be assisted and encouraged in every possible way, and that he should pay the State no more in the way of stamps or fees than is found needed for defraying the Patent-office expenses, and that any surplus should be solely devoted to model museums or any other things that directly might benefit the inventor. I need not waste words on the present unrighteous and foolish practice of compelling the inventor to pay £140,000 into the Exchequer yearly.

But I would again urge that a proper examination as to the novelty of the inventions sought to be patented is a *sine quâ non* in any new Bill that shall have the effect of bringing this country back to its leading position as to material progress. I do not say that the examiners shall have the right to deny any one a patent if he, in spite of their distinct advice, persists in it; but I do say that the patentee shall be required to put in such disclaiming clauses as the examiners, on appeal to chief examiners, if need be, may advise, in order that the public may have the fullest and fairest guidance in the matter. I believe in having the whole thing above board, and that the whole correspondence between the patent examiners and the patentee or his agent respecting the grant of the patent shall be accessible to any one on payment of a small inspection fee.

As to the keeping in force of patents by means of yearly progressive payments, we find such yearly payments troublesome, and I should rather advocate a third year's stamp of say at most £5; a sixth year's stamp of £10, and a tenth year's and fifteenth year's stamp of £20 each.

As long as some of our leading statesmen look upon the inventor as a nuisance, merely to be tolerated and kept under and heavily taxed, I do not hope for a very good patent law; and I say, let us rather go on as we are than unsettling without permanently helping the matter. I believe that it is of the greatest importance in any future Patent Bill to insist upon distinct provisions as to the examiners being practical engineers and chemists, so that the legal element be kept out almost entirely. In fact, I submit that we shall do well to strive for a patent practice such as is now developing in Germany, but in an improved form, especially by making the examiners more of a consultative body than in Germany and the United States.

All who take an interest in the matter would do well to get information on the spot, or from patent agents here, as to how the American and German patent laws really work, that they might learn the *pros* and *cons*, for merely studying the patent laws themselves will be of little use.

I trust this may open a discussion that shall prove useful.

33, Chancery-lane, W.C. P. J.

Sir,—I have no inclination to enter into an irksome newspaper discussion on the very broad subject of cheap patents, and therefore content myself with the following remarks in reply to the two letters which appeared on this subject in your number for the 17th ult. I may, however, first remark that in your leading article of the 10th ult. you have unwittingly misrepresented some of my statements and opinions, as you will see on reference to the complete paper when printed.

I carefully guarded myself from using any combination of words which could be fairly interpreted as a statement that in the United States an inventor can actually obtain a patent for £7, any more than that he can in Great Britain obtain a full patent for £175. These amounts are the bare stamp duties in each case, and the patentee is almost necessarily put to some additional expense; but on the average an unopposed fourteen years' British patent costs the inventor ten times as much as an unopposed American patent lasting seventeen years. For confirmation of this statement, see Mr. W. P. Thompson's letter in The Engineer of 10th September, 1880.

I cannot agree with "Patentee" that there is any fair comparison between a three years' patent here and a seventeen years' patent in the United States, and I doubt if any person can. Of course, I cannot prove that "money is being made out of more than 10 per cent. of the 200,000 patents now in force in the United States," any more than "Patentee" can prove the contrary; but if his implied statement that as many as 10 per cent. of the said patents—that is, as many as 20,000—are now making money, can be taken as a fact, he has furnished a very powerful argument for the assimilation of our patent stamp duties to those of the United States, as nothing like that number of British patents are now making money, for there are not 16,000 in force. If "Patentee" is pleased to take as an evidence of defeat my inability to anwer a question that is incapable of being answered, I have no objection to offer to his so doing, but I regret he did not favour me by drawing attention to "the wild and illogical assertions" he believes to have been made in the paper, when he had the "misfortune" to hear it read.

I have nowhere stated that "this country annually sustains a drain of 9000 skilled artisans of the highest class, who emigrate to America solely on account of the beneficent patent law which reigns there," or anything tantamount thereto, but I pointed out that cheapness of patent grants in the United States is a great inducement to our mechanic inventors to go there.

There being no record of "the names and circumstances" of our emigrating inventors, "giving particulars of the numbers and dates of their patents," the information that "Senex" asks for cannot be had, but many employers of skilled labour know of instances of English artisans taking their inventions to the United States to develope and bring them out there, under their own supervision. The mere possession of an American patent would not benefit the English mechanic without opportunity of pushing its introduction into use, but when he has gone to the States and obtained a patent, he is in a position safely to make as public as possible his invention, and to negotiate with any manufacturers and capitalists that he pleases, whereas a three years' patent here is not long enough sufficiently to protect and benefit the inventor. Under the old patent law a British patent cost the inventor from £300 to £350, and when the present patent law came into force in 1852 the stimulus to invention was so great that the number of patents was at once quadrupled, and our manufactures consequently obtained a great benefit; but although they have made great strides since then, the American manufactures have made comparatively greater. There can be no doubt that our manufactures are very seriously affected—or "partly ruined," as, perhaps, "Senex" would express it—by our present expensive patent law, the stamp duties under which are the most oppressive in the world; our watch, clock, stove, organ, piano, and small tool and ironmongery trades are notorious instances.

As an example of the latent invention of the workmen of this country, which latent invention is practically kept down by our present stamp duties, the result of the award system now in force in the shipbuilding yard of Messrs. Denny, of Dumbarton, may be pointed to. This scheme has been in force for less than four months, and the highest award that can be granted is only £10, and yet they have already received twelve claims, of which only three have been rejected, seven have been found valid, and two are not yet decided upon; on the seven valid claims £16 have been awarded. Considering the novelty of this scheme, and the very short time during which it has been in operation, this result must be considered highly satisfactory. Were all large establishments to adopt some such system, the number of beneficial labour-saving inventions brought into use in the course of a year would doubtless be considerable.

At present Great Britain is, beyond question, the greatest manufacturing country of the world, which fully accounts for the number of patents taken out here by foreigners; she is, however, not so great comparatively as she used to be, and the United States are so quickly rising to a first place as a manufacturing nation that her competition with the mother country is being more and more seriously felt. The Americans attribute their rapid success to their efficient patent system—*vide* their numerous trade journals, and even the official reports of their Patent Commissioner. Surely it will be readily admitted by all that the country is dependent upon invention for advancement in prosperity and wealth, and that a reduction of our exceptionally high patent stamp duties would greatly stimulate invention, and is therefore to be sincerely desired.

In conclusion, permit me to state that my only object is seriously to draw as much attention as possible to what I firmly believe to be the very hurtful action of our exorbitant patent stamp duties upon the prosperity of the country, and therefore I do not think it worth while to bring in irrelevant matters, such as "Senex's" or "Restless, unsteady men who go to America for a change," or "the persuasive eloquence of the Mormons."

January 1st. Frank W. Grierson.

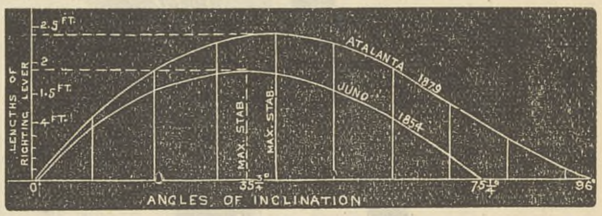
THE ATALANTA.

Sir,—It is only in a scientific paper that a point of much public interest in the Report of the Atalanta Committee can be brought out clearly.

The Committee reports—p. 8, par. 34—"What we are required to say is, whether the Atalanta, when she left England in November, 1879, was a stable ship; and the conclusion to which we have come, after a full consideration of all the facts of the case, is that she was on the whole a very stable ship, except at large angles of heel; that she was more stable than when first commissioned as a training ship; and much more so than in her previous commissions as a man-of-war."

It has been publicly stated, on the other hand, by a writer having apparent access to all the documentary and other evidence, that there is agreement between Mr. John and Mr. Barnaby that the alterations made had increased stability at small angles and diminished it at the large angles more likely to be reached by heavier rolling.

These two opposing statements have been regarded in some quarters as consistent with each other. I enclose a copy of the curves of stability of the Atalanta and of the Juno before the alterations as they were sent to the committee and accepted by them, as approximately correct representations of the conditions of the lost ship, in the two distinct periods of her history. The ordinates of these curves represent, at every angle of inclination the comparative righting force at that angle.



From this you will see that the stability was increased by the alterations at all angles of inclination, and that whereas the Juno would have had no righting power at 76 deg. of inclination from the upright, the Atalanta had as much righting power at 76 deg. as the Juno had at 10 deg. The committee state the facts as to this comparison, the writer quoted states what is manifestly inconsistent with them.

The force of the words of the committee, "except at large angles of heel," is that some merchant ships with deep holds and heavy cargoes stowed low down have considerable righting power at 90 deg. of inclination, if things do not shift their places, and if the water does not enter the ship. Ships of war do not possess this quality, whatever it may be worth, and the Atalanta did not. It is this fact to which they draw attention. It will be interesting to your readers, probably, to have the means afforded them of correctly appreciating such force as there is in it. Nathl. Barnaby.

Admiralty, December 30th.

BYE-PRODUCTS OF THE IRON MANUFACTURE.

Sir,—With the view of ascertaining whether the fluorine contained in the fluorspar used in conjunction with oxides in the manufacture of steel is evolved as gas or passed into the cinder, the cinder was analysed by Mr. E. Riley. Titaniferous iron ore was used mixed with the fluorspar, and titanic acid was thus insured in the slags, by which means it was readily identified as being the slag of this process, as it is never present in the cinder from ordinary puddling; this and the presence of lime, and the small percentage of phosphoric acid, are due to this process.

The trial of the process was made at the Bowling Ironworks, treating cinder pig iron in a furnace that was fitted with slags accumulated from puddling the refined metal made at these works. The fluorine in the mixed fluorspar and iron ore was about 15 per cent. by weight. The analysis is :—

Silica	9·4	per cent.
Titanic acid	6·89	,,
Protoxide of iron	64·7	,,
Sesqui-oxide of iron	10·4	,,
Alumina	1·4	,,
Oxide of manganese	·72	,,
Phosphoric acid	·52	,,
Lime	4·4	,,
	99·26	

The bar iron made from this pig iron contained 0·012 per cent. of phosphorus. The slag from puddling the refined metal by their usual process, according to analysis by Riley, contains :—

Silica	12·8	per cent.
Protoxide of iron	55·7	,,
Sesqui-oxide of iron	26·6	,,
Oxide of manganese	·51	,,
Alumina	1·3	,,
Sulphur	·12	,,
Phosphoric acid	3·27	,,
	100·30	

It is thus shown that the cinder from this process does not contain the fluorine, and that the fluorine—which has never yet been isolated—must have absorbed silicon and phosphorus and carried them away as vapour, as they are not found in the slag from inferior pig iron in but small proportion to slags from superior cast iron, which had been previously refined before it was puddled. The slags of this process are thus also shown to be as useful as iron ore for smelting with pig iron of the best quality.

New York, December 17th. James Henderson.

THE BRISTOL STEAM TRAMWAYS.

Sir,—In your last edition an anonymous correspondent asks me a question concerning the Bristol Steam Tramway. If he will give me his name and address, I shall be glad to give him an answer. Henry Hughes.

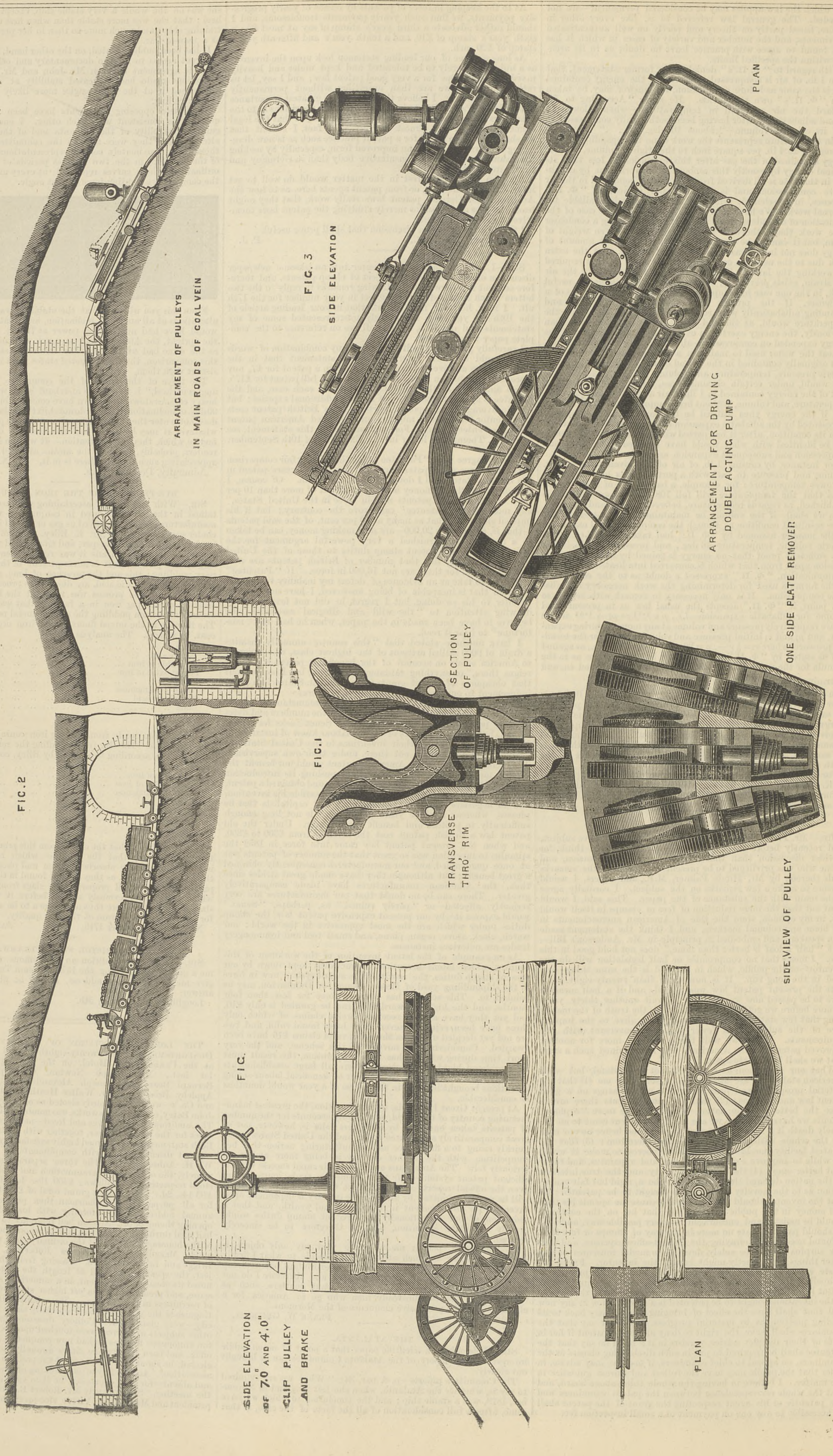
Loughborough, January 5th.

The London Association of Foremen Engineers and Draughtsmen. — The twenty-eighth annual meeting was held at the Cannon-street Hotel, on the evening of Saturday, the 1st inst., Mr. Joseph Newton, C.E., presiding. Messrs. Bernard Beard, and Joseph Alexander—of the firm of Messrs. Appleby Bros.—and Mr. Walter Heath—of Messrs. Hall, Beddal and Co.'s—were unanimously elected as ordinary members, and Mr. John Batey, of Mr. Esson's works, was nominated in the same category. The auditors—Messrs. Ives and Reed—next produced the balance sheet for the past half year, together with their report thereupon. Both statements were deemed highly satisfactory, and were accepted without discussion, and with compliments to the secretary—Mr. W. H. Aubrey, C.E. The three separate and distinct funds, namely, the ordinary, superannuation, and widows' and orphans', stood respectively as follows: £460 19s. 4d.; £2149 18s. 5d.; and £93 14s. 2d.; thus giving a grand total of £2704 11s. 11d., invested for all purposes. The chairman then proceeded to deliver his annual address. In conformity with his ordinary practice the opening theme of Mr. Newton had reference to those members who had died during the past year, and of whom there were four—two of the honorary, and two of the ordinary class, viz.:—Messrs. Alexander Macgillivray and James Robertson, and Messrs. John Briggs and Leonard Carden. Passing from this melancholy subject, the speaker reviewed at length the history of the society, noted its steady advancement, in a numerical, social, and financial sense, and predicted for it a yet higher stage of development and of usefulness in time to come. The scientific discoveries which distinguished the year 1880—and especially those in respect of electricity—were glanced at. Colliery disasters, gas purification, and other subjects of interest were touched upon, and finally Mr. Newton announced that, as he had now completed twenty-two years of office, and been twenty-one times annually and unanimously re-elected, he should not again accept the position of president of the association. Accordingly after thanking all the members—present and absent—for past courtesies, he then vacated the chair and left the meeting. Subsequently Mr. Robert B. Vinicombe was elected president and Mr. William Virtue vice-president for 1881.

WIRE ROPE GEAR AT PENRUIFUFER, LLWRYNYPIE, AND LOCHELLY COLLIERIES.

MESSRS. F. HURD AND CO., WAKEFIELD, ENGINEERS.

(For description see page 15.)



FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame Boyveau, *Rue de la Banque.*
BERLIN.—Asher and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. Gerold and Co., *Booksellers.*
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NEW YORK.—The Willmer and Rogers News Company 31, *Beekman-Street.*

PUBLISHER'S NOTICE.

*** *With this week's number is issued as a Supplement, A Conversion Table for French and English Measures of Length. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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 2d. 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.*

*** *All letters intended for insertion in* The Engineer, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

J. H.—*Messrs. Siebe and Gorman, Neptune Works, Westminster.*

J. R.—*The last dozen volumes of* The Engineer *all contain descriptions of various brakes. You can consult the volumes at the Patent-office Library.*

H. M.—*The sectional area of the wire is* 0·001963 *of a square inch. Of the* 42 *wires it is* 0·082467 *of a square inch. This area at* 150 *tons per square inch will support* 12·37 *tons, or* 27,708·8 *lb. The breaking strain on each wire = the strain on each wire =* 659·7 *lb., supposing the material of the wire to be capable of supporting* 150 *tons per square inch as you suggest. Send addressed stamped envelope for other figures, &c.*

A Constant Reader.—*We can give you no trustworthy formula to determine the smallest size of pulley that it is possible to use with a leather belt. But the following rule may answer your purpose in other respects:—To find the width of a single belt for any given horse-power, multiply the horse-power by* 33,000, *and divide the product by the length in inches of periphery of the smaller pulley covered by the belt, and by the speed of the belt in feet per minute. The quotient is the width in inches. This will give the belt very easy work.*

R. F. (Edinburgh).—*We have already replied to questions similar to yours more than once. The action of steam on the piston of a steam hammer only supplements gravity. If you know the weight of the mass moved—that is to say, of the piston, rod, and tup, and the length of the stroke, then the final velocity may be found by the formula* $v = 8\sqrt{\frac{f\,s}{w}}$, *where v is the velocity, s the space, f the force, and w the weight. The force means the weight of the mass moved, and the total effective pressure on the piston added together.*

Erratum.—*In our notice of Young's "Ball Vale" in last week's impression of* The Engineer, *for Mr.* Dovell *Young read Mr.* David *Young.*

BARTON'S FEED-WATER HEATER.

(*To the Editor of The Engineer.*)

Sir,—Can any of your readers inform me who are the makers of Barton's self-acting feed-water heater? J. C.

London, January 6th.

RESTORING BURNED STEEL.

(*To the Editor of The Engineer.*)

Sir,—Can any correspondent kindly inform me where I can get the composition for restoring burnt steel? I saw it advertised in The Engineer by a Glasgow firm about twelve months ago. G. C. B.

Hereford, January 4th.

REGENERATORS.

(*To the Editor of The Engineer.*)

Sir,—Can any of your readers give me any information as to the relative heating powers of regenerators on the Siemens system and on the system of alternate flues for air and waste heat, the chambers being in both cases the same size, but in the former filled with a honeycomb of ordinary-sized quick fire-bricks, and in the latter with flues, say 6in. wide, separated by 2½in. tiles? There is no doubt the Siemens regenerator, so far as brickwork goes, is the cheaper and probably the more efficient, but I particularly wish to avoid the reversing necessary with them. Would there be a probability with a flue chamber, as described, 50 per cent. larger, of getting something like the same heat as from the smaller Siemens chamber? B.

St. Helens, December 31st.

MEETING NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, Jan. 11th, at 8 p.m.: Inaugural address of Mr. Abernethy, President, and monthly ballot for members.

DEATH.

On the 28th Dec., in the 45th year of his age, Joseph Watson, for eighteen years the trusted and valued friend and foreman engineer of the firm of James Harby and Co., Chrisp-street, Poplar, E.

THE ENGINEER.

JANUARY 7, 1881.

1881.

The depression against which almost all industries have been struggling for several years has been steadily decreasing since the commencement of the past year. When writing our customary review, retrospective and prospective, there seemed some promise of coming prosperity. A great advance had been made in the values of iron and steel, and though that advance in the values of the products of our most important industries had been too rapid and too great to indicate the stable improvement in trade, which had been so long looked for in vain, it indicated a return of the confidence of capitalists in the value of public works for investment. The early improvement in demand came from America, and though it was seen to be but of limited duration from that country, it was nevertheless urged that the improvement would become general as it has so often commenced in the West. The demand has spread as predicted, and work of all kinds is becoming daily more plentiful the world over. Accumulated capital is finding application, and, until the re-accumulation of an excess, work will probably not be lacking. Not that the accumulation reduces the work to be done, but much of it is generally expended in times of great prosperity in increasing the means of supply until this exceeds the demand. Capital then has little to do until demands equal that increased power of production, and so activity and inactivity follow each other in not very dissimilar periods. That the depression is not so much the result of greatly decreased production, but of cessation of material increase, may be illustrated by the fact that all through the past few stagnant years the production of iron and steel has been but little less than in the busy years 1870-3, the average production in these four years being 6·474 million tons, while in the years 1874-9 it was 6·335 millions. The exports, however, dropped considerably from 1873, but nearly re-reached the 1873 total in 1879. Prices are now considerably higher than in 1878 for iron and steel, but the effect of the enormous expenditure of capital in developing our coal stores is still seen in the very low prices which still rule for fuel of almost all sorts, though the exports are as great as ever. There is, however, now some evidence that the existing means of production will gradually become much more fully employed, and, amongst other reasons for looking forward to prosperous times, is the appearance and support of large numbers of engineering projects at home and abroad.

The year 1880 has carried with it the records of the completion or progress of several important engineering works. It also carries the records of the failure of a piece of engineering construction which has detracted much from the almost universal praise which English bridgework has acquired for its strength and quality, if not for its architectural fitness. The investigation into the causes of the failure of the Tay Bridge, on the 28th December, 1879, occupied several months of the past year, and brought to light some almost incredible instances of want of ability or judgment, and supervision; and evidence of workmanship that any country would be ashamed to acknowledge. The bridge was blown down in a heavy gale, against the stress of which its weak-legged piers were incompetent to do battle. The investigation into the failure showed that the assumed maximum pressure of wind employed in calculating the stability of the structure was much too low for exposed situations, such as that of the Tay Bridge; and that the customary allowances for wind pressure had in very few cases been sufficient to ensure the stability of such structures had they not possessed a considerable margin of strength allowed by reason of other considerations. It further showed that our knowledge of the dynamic value of air moving at high velocities is insufficient; and that the influence of the form of surfaces in modifying the effective action of wind on structures needs to be ascertained. A recommendation that these points should be cleared up by a committee to be appointed by the Board of Trade, and a regulation of wind pressures to be assumed and included in the Board of Trade rules as to structures, was appended to the report of Messrs. W. H. Barlow and Colonel Yolland, but though this will probably not be done by any such authority, and there are obvious objections to the imposition of a rule bearing on a question which must always be subject to variation, according to the circumstances of each application, it will, without doubt, be taken up by some private investigators. It is a most important question, and one which might fitly occupy one of our technical societies. Designs for a new bridge have some time since been sent in by Mr. Barlow, who was appointed engineer for its reconstruction, but the Scotch authorities are now objecting to a bridge about 20ft. in height less than the old one. They are now asking for the low level which the railway company would have adopted at first, but were prevented by the very authorities who now see the necessity for it.

The completed works of the civil engineer include the Royal Albert Dock, formerly known as the Victoria Docks Extension, and the Holyhead harbour and docks of the London and North-Western Railway Company. Both these were opened with great ceremony—the Holyhead on the 17th of June, and fully described in our impressions of the 25th June and 30th of July last; and the Albert Dock opened on the 24th June, and fully described in our impressions for the 25th June and 2nd of July last. This is the largest dock in the world, and is a remarkable instance of the application of concrete on a very large scale. Extensive dock improvement works were opened in October at Sunderland, the works consisting chiefly of a new lock and deep-water channel, connecting the Hudson Dock with the sea, the lock being 480ft. in length, and 95ft. wide. Very extensive dock accommodation has been added to that previously existing at the Hartlepools, over half a million sterling having been expended upon them. A dock area of 176½ acres is now possessed by these places, and this accommodation, when taken with the deep water channel which runs between the two towns, places Hartlepool amongst the most accessible and commodious of eastern ports; and in heavy storms Hartlepool will probably be now more readily accessible than any port between Grangemouth and the Humber. The works were described in our impression of the 2nd of July last. The handsome Skeldergate Bridge at York, erected from designs of Mr. Geo. Gordon Page, and illustrated in our impression of the 11th May, 1877, has just been completed. Abroad the most important work which has for some time been in progress is the St. Gothard tunnel, the advance heading of which was completed by the accurate meeting, without deviation, of the two parts on the 30th of April last. The tunnel was illustrated and described in our impression of the 5th of March last. The progress of this work was very rapid, and much is claimed for the top heading or Belgian system of tunnelling adopted by the late able engineer and contractor M. Louis Favre. The rapidity was also due to the adoption of the best rock drills and improvements as they became known, and to the very large employment of compressed air for working drills, locomotives, and ventilation. Shortly previous to the meeting of the headings, however, the temperature became so high as to be almost unbearable. Men were rapidly disabled, and horses killed off very quickly. Very great trouble was experienced in two cases from great influxes of water and the existence and passage through a bed of semi-plastic material consisting of decomposed or disintegrated feldspar with alumina and gypsum, which on exposure to the atmosphere swelled with almost irresistible force and threatened at one time to crush every lining that could be built in. The pressure due to the enormous masses of superincumbent rock moreover caused the extrusion of this soft material as soon as freedom of motion was given to it, and with such force that heavy granite lining of 5ft. in thickness was in some parts crushed, and had to be renewed and supported by side walls also of granite 6ft. 7in. in thickness. These difficulties have, however, been overcome, and the tunnel will, it is expected, be completed in April next. The differences between the contractor and the St. Gothard Railway Company have yet to be settled, but the justice of the Federal Council will undoubtedly make the full allowance for the lengthy delays caused by the difficulties thrown in the contractor's way, and the delay caused thereby. It may be here mentioned that a scheme is proposed for connecting Andermatt with the St. Gothard main line by means of a sloping tunnel 700 metres in length. Andermatt is directly above the great tunnel, and almost exactly midway between Göschenen and Airolo; and it is thought that by the adoption of this expedient the company would not only increase their receipts, but secure the effectual ventilation of the tunnel, while facilities for direct communication with Andermatt would be extremely useful in case of an accident in the tunnel. The Paris, Lyons, and Mediterranean Railway Company began last year the construction of a new length of tunnel on the Replat Section of the Mont Cenis line, not far from Modane, to replace an open cutting, which, owing to the nature of the stratum through which it passes, which is the same as the soft stratum encountered in the St. Gothard, is continually giving way, and for years past has been kept open only by great watchfulness and at immense cost. The new Replat tunnel is being bored by the compressed air machinery and perforators invented by Professor Colladon. The head of it is about 1000 metres from the portal of the great Fréjus tunnel, into which it will run 600 metres inside the mountain. Its total length will be 1583 metres, of which upwards of 900 are already executed. Another tunnel through the Arlberg of the Rhaetian Alps is now in progress, the object being to connect the Swiss railway system with that of Austria by a line running along the right bank of the Inn between Innsbruck, Landeck, and Bludenz. By this means the two countries will be rendered independent of the German railways over which the traffic is now directed. The tunnel will be about six and a-half miles in length. It will be made for a double line, and it is intended to sink a shaft 1540ft. in depth to accelerate the work and assist ventilation.

Some important dock and harbour works have been for some time in progress at Milford. Considerable progress has been made during the past year with the docks, which are constructed from the designs of Mr. J. M. Toler, C.E., and will have an area of 62½ acres, including a graving dock 710ft. in length and 96ft. in width. Some of the deepest tidal work ever carried out has been necessary in this work, but of its progress and chief features we give an account in another page.

The most important and longest new line which has for some time been constructed in this country is the Hull and Barnsley Railway, of which Mr. W. Shelford is the engineer. The first sod is about to be turned with great ceremony, and work will be commenced at once. The line is designed chiefly to give a much wanted means of direct communication between the Barnsley coal-field and the sea. As we gave a full account of it in our impression for the 13th of August, we need not describe it here.

A railway which will attract much attention is about to be commenced in Malta, the first railway in an island the population of which is more dense than that in any other portion of the world. A company has lately been formed, and a concession granted for the construction of a line about 6¾ miles in length, from Valetta, the capital of the island, to Notabile or Citta Vecchia, the ancient capital, and a place of considerable importance, taking several small towns and villages in its route. Messrs. G. Wells-Owen, and Elwes are the engineers, and the contractor, Mr. Geneste, is in Malta making arrangements for the commencement of the work. The Bury and Tottington District Railway, constructed under the same engineers, is nearly completed.

The most costly and attractive work which it is proposed to commence this year is the Panama Canal. The indomitable energy and perseverance of M. Ferdinand de Lesseps seems to have overcome all the American objections to the scheme, and it is said that all the shares have been taken up, the applications for shares being much more than the whole number of 590,000, amounting to eleven and a-half millions sterling. The benefits to be derived from the completion of the canal are generally conceded, but as it will probably take much more than the estimated twelve years to complete it, there is plenty of time to count upon the advantages. As between England and the antipodes these will be nearly *nil*, for the distance between London and Sydney through Panama will be nearly the same as through Suez. Our West Indian colonies will no doubt profit by the undertaking, but the chief gainers will be the Americans when it is completed.

At home there is much work to be done by the civil engineer, but for some of the most important, namely, works for the prevention of floods, and river regulation, much opposition will have to be overcome. For the efficient grappling with the Thames floods, for instance, the whole river from source to sea must be under one authority, otherwise the contending interests, or supposed interests, of each district will prevent the execution of works in every other district. There are many small towns yet without any, either qualitatively or quantitatively efficient water supply, and the supply of such places leaves much work to be done by the combined assistance of the civil and mechanical engineer. To the London water supply question we have several times referred, and it is satisfactory to see that the water doctors have so long cried wolf that Londoners begin to see that the bad water neither summer nor winter comes from the water mains, but from the house cisterns, and that what is required to put the water supply question on a satisfactory basis is a system of regulation similar to that which has answered so successfully with the gas companies.

The success with which the electric light has now been adapted to lighting public buildings and thoroughfares, and the probability of its being made applicable for domestic purposes, suggests the desirability of turning attention to the utilisation of the power now running to waste from many rivers in the United Kingdom. Electricity might be generated near rivers and waterfalls, and transmitted direct to the neighbouring town, or air might be compressed there at a very low cost and transmitted to towns to work air engines for driving dynamo-electric machines. In not few cases the rise and fall of the tide might be economically utilised for lighting towns by electricity, as by means of suitable reservoirs and constantly acting turbines, power could be obtained much more cheaply han by means of steam engines. There are few places on our coast where the tide rises less than 10ft., and from one-half to three-fourths of this might be utilised in working turbines continuously.

Tramway enterprise needs very little encouragement; but there is much room for light local railways, such as that which the Great Eastern Railway is about to try between Wisbeach and Outwell, about six miles.

The Southampton and Isle of Wight Railway is another project of considerable importance. It comprises a tunnel under the Solent near Cowes and Beaulieu on the mainland, where the Solent is only a mile and a-half wide. The stratum through which the tunnel would pass is composed of a sound clay, which would greatly facilitate its construction. There exists a strong feeling of insecurity in crossing the Solent by steamers, the danger of collision, particularly during fogs, increasing the fear of accident from the constant traffic of steamers and sailing vessels passing at right angles to the track of the Isle of Wight steamers. Great delay, sometimes of days, arises, owing to the impossibility of getting safely across in the fogs, and there is no doubt that a railway connecting the mainland and island would secure the traffic rather than by the Portsmouth, Southampton, and Ryde steamers. The South-Western and Brighton and South Coast Railway Companies have jointly spent nearly half a million in the Ryde district in improving the pier and making a short railway across the esplanade, without, up to the present time, causing any very sensible addition to the traffic of the Isle of Wight Railway. The result would probably have been very different if this capital had been expended in constructing the proposed Solent Tunnel Railway. It is estimated that the saving of time between London and Ventnor in fine weather would be one and a-half hours. Its completion has been delayed by the depression which has stopped so many projects. The cost as estimated by Mr. Hamilton Fulton, C.E., is £500,000. The proposed Manchester and Salford Tidal Canal is again forming the subject of discussion in the district. The project comprises the deepening, straightening, and widening of the rivers Irwell and Mersey between Manchester, Salford, and Runcorn, so as to enable steamers to reach Salford and to discharge their cargoes direct from the ship, thus saving the consequent delay and expense incidental to the transhipment at Liverpool. The Irwell would then become a tidal navigation, and the oft-occurring and damaging floods in the low-lying districts of Manchester, Salford, and elsewhere would be entirely obviated. The bed of the river would be deepened and cleansed by scour, and docks, warehouses, and factories would spring up on its banks. The estimate of the cost of carrying out this proposal, as made by Mr. Hamilton Fulton, would not exceed an outlay of £3,500,000. It is stated that those interested propose to establish an association, which would be armed with the necessary parliamentary powers, and an adequate capital for the construction of the necessary works. The Corporation of Salford, it is believed, thoroughly approves the measure, and is prepared to render every assistance within the limits of its statutory powers. As will be seen by reference to the letter of our Manchester correspondent, Salford is now suffering severely from the floods which this work would prevent. There are always many difficulties to be evercome in important undertakings such as this, and more particularly during a period of a depressed condition of trade such as has lately prevailed; but it is thought, and there is every reason to believe, that before long, under the more favourable auspices of the Salford Corporation and other influential interests, the matter will be brought to a successful issue.

The metropolitan water companies may be supposed to be looking forward with some anxiety to the events which await them in the present session of Parliament. The Irish agitation will probably serve to take off a little of the keen edge of the Damoclean sword which has been so long hanging over their heads; but the companies know full well that they have no particular friend in Sir W. Harcourt. Political events may befriend them, but some kind of legislation is imminent with respect to the London water supply. According to the official notification of the Government Bill, a Water Authority is to be created, with power to go into the whole question, and deal with it as may appear best, though we may expect that Parliament will reserve to itself a pretty tight hold on this Authority. If any scheme of purchase is carried out, it has to be remembered that the cost will fall on the metropolis exclusively. It is a local question of the largest magnitude, and its settlement is committed to the wisdom of the Legislature. If it should happen that nothing more than a Regulation Bill is passed, the question of purchase will be removed to a date so remote as to put it almost out of men's minds. This is just a possible issue, though appearances look rather in the direction of purchase or competition. In a short time something more will be known on this point, and it is perfectly certain that the Government are pledged to propose some kind of scheme. In the meantime the companies are proceeding with the constant supply, and are also improving in their financial position. London is even threatened with a new company in connection with the South Metropolitan Spring Water scheme, which is to reappear this session. Although having no relation to the drinking supply, perhaps we ought to mention the resuscitated project for laying on a supply of sea-water to London from the coast of Sussex. On the part of the provinces no startling scheme of water supply presents itself for the attention of Parliament this year. The famous Vyrnwy project was carried in the session of 1880, and the Water Bills now forthcoming are small affairs, excepting as concerns the metropolis.

Disastrous floods from the overflowing rivers may be said to form a sort of connecting link between the water and the sewage questions. The proper management of a river requires that it shall neither receive any damage nor inflict any. According to the Queen's Speech, the Government will immediately proceed to take up the subject of river management in a practical and comprehensive spirit. So far as concerns the present outlook of the sewage question, it is pretty much what it was. The drainage of the towns of the Lower Thames Valley, of which group Kingston is a conspicuous member, is still an unsettled subject, but the Local Government Board have pretty plainly intimated their readiness to approve of Sir Joseph Bazalgette's plan for carrying the sewage round the southern outskirts of the metropolis into the West Kent system. If this method be adopted, it will be to the grief and trouble of the Thames Conservators, who have an idea that sewage creates shoals and thereby interferes with the navigation. Earl Fortescue has declared the intercepting sewer and outfall system of the metropolis to be a mistake, the right principle being that of "the rainfall to the river, the sewage to the soil." There is, however, very little prospect of that principle being made generally available, though it may be employed advantageously in certain cases. Respecting the pollution of rivers, the law which was to prevent that evil appears to produce very little effect at present. Sir Robert Christison declares it to be rendered in a great degree inoperative by the saving clauses which are designed to protect the manufacturers. Dr. Stevenson Macadam asserts that the law is good enough "provided it were put in force." Seemingly it remains more or less in abeyance, owing to the lack of power on the part of inspectors to originate proceedings, so as to take the burden off from private individuals. With regard to processes for the treatment of sewage little is heard just now.

The New Year opens with pleasing prospects for the gas consumer, and with very fair encouragement for the companies, although the interests of the latter may seem to be threatened by the electric light. In London, the progress of amalgamation has gone so far, that only four companies exist, where formerly there were thirteen. Another absorption cannot be far off, by which the London Company will be divided between the Chartered and the South Metropolitan. It is true that at present there are no positive signs of such a change being at hand, but there has been a recent attempt to bring it to pass, and we may presume that so reasonable a reform can only suffer a short postponement. Nothing is said as to an absorption of the Commercial Company, although in some respects that is even more to be desired than the partition of the London, seeing that the Commercial district renders the Chartered mains unproductive during their course through a crowded and extensive district. This is, perhaps, primarily a question for the gas companies themselves, whereas the exclusive position occupied by the London Company deprives the consumers in that district of the benefit of the new system of gas legislation. Still, to the credit of the London Company it is to be said that they are offering cheap gas in common with the other companies. The price of gas in London from the commencement of the present year is 2s. 10d. per 1000ft. in the South Metropolitan district, including that which was recently the Phœnix and Surrey Consumers', 3s. in the Commercial district, and 3s. 2d. in the district of the Chartered Company, which extends over nearly two-thirds of the metropolis. Under the sliding-scale, the South Metropolitan Company may now pay dividends at the rate of 12 per cent. per annum, and of course they will exercise their privilege. Still more enviable is the position of the Commercial Company, which will be allowed to go as high as $12\frac{1}{4}$ per cent. The maximum dividend of the Chartered Company will be $11\frac{3}{4}$ per cent., while the London, being under the old system, will be limited as before to 10 per cent. It is to be observed that this last-named company is not placed under the same surveillance as the other companies in respect to illuminating power and quality, though there is no positive reason to suppose that its gas is in any way inferior. A guarantee, however, is worth something, and this does not exist in the case of the London. One feature in the gas question during the coming year not to be overlooked will be the Bill of the South Metropolitan Company for the construction of enormous gasworks in the Greenwich marshes. In the provinces there is a continuance of the process by which the local authorities acquire the property of gas companies, and thereby constitute themselves the owners and masters of the gas supply. But there can be no doubt that the electric light is rendering the municipal bodies rather less anxious than formerly to occupy the place of the gas companies. As a convenient agent for the production of heat, we find gas becoming increasingly popular, though it is obvious that gas which has been prepared for illuminating purposes is a somewhat costly article to employ as fuel. The use of gas to supersede coal with a view to the reduction of the fog nuisance, is one of the ideas now promulgated. In some shape or other we may expect gas will still be wanted, let the electric light prosper as it may. Even the electric light itself is often dependent on the motive power furnished by a gas engine, a class of machine for which there is now a very large demand. On the whole we expect gas to become better, cheaper, and more skilfully applied. Palpably in the year on which we have just entered, gas will pay such dividends as it never paid before.

It is a remarkable fact that men go on for years, if not for generations, suffering daily from particular wants and never making an effort worth the name to satisfy their want. It has been so in all ages, and will probably be so to the end of time. The proposition is true of social relations; it is true of the concerns of every-day life having nothing to do with technical matters; and what is much more to the point for our present purpose, it is particularly true when applied to the doings of mechanical engineers and that section of humanity most dependent on mechanical engineers for success and prosperity. The fact that wants remain unsupplied, wishes ungratified, hopes unfulfilled, constitutes the element of success in the inventor's career. When, however, we come to consider how it is that wants still exist, although the world was never before so able and so willing to pay for the gratification of its desires, while never before were so many individuals apparently able and certainly willing to supply the demand, we shall find that various causes exist all operating directly or indirectly to the same end. With none of these save two need we now concern ourselves. The first is that although new inventions are wanted, the men able to invent do not know what they are; and the second is that mankind very readily accepts what it holds to be inevitable, and makes no effort to avoid it. Thus for generations it was held that steel could only be made by cementation, and it does not appear that any one ever attempted to make it on a large scale in any other way, for what used to be known in times long past as puddled steel had very little in common with the stuff of which we now make rails. For example, even Mr. Bessemer, during his earlier efforts with the converter, sought to make, not steel but wrought iron. In the same way vinegar makers now convert "gyle" into a dilute acid by a long-continued process of oxidation, brought about by running the liquid in thin streams through huge fagots of twigs, so as to expose a large surface to the air, while for all that we know, or perhaps any one else, the same result might be attained in one-fourth of the time by simply blowing air through vats containing the fluid, as Bessemer blows air through the converter. It is indisputable that an enormous inventive power is wasted in every civilised country year after year by men who really do not know what is wanted, and hit on remunerative subjects, when they hit on them at all, by mere chance, if such can be supposed to exist. We can do no more than call attention to the existence of the evil—we cannot even indicate a means of remedying it, unless indeed we might suggest that those who feel that they possess the faculty of invention, and earnestly desire to exercise it, should take great pains to learn all that can be known concerning mechanical science in its various applications. They may then avoid, perhaps, much waste of precious power, even if they do not hit upon a gold mine.

A glance at the work of the past year suffices to show that mechanical engineering has very closely adhered to old grooves. We seek almost in vain for instances where the beaten track has been left, even for a tiny excursion; and nothing is more strange than the pertinacity with which men continue to try over and over again to make certain things "do" which it has been clearly proved cannot be made to answer. We could illustrate this by dozens of examples. We may use one or two which will serve at once to illustrate our proposition, and to indicate the direction which mechanical science is taking or is likely to take in certain respects the present year. Day by day accounts reach this country of the breakage of the crank or propeller shafts in sea-going steamships. No class of ship appears to escape. At one time a cargo boat, of some 500 or 600-horse power indicated, is disabled in this way. At another it is a great Atlantic steamer, worth perhaps with her cargo £150,000, and carrying many hundreds of men, women, and children, which is put in serious jeopardy. Engineers seem to have accepted this most unsatisfactory condition of affairs as inevitable; but is it inevitable? We venture to say that it is not. So long as engineers and shipowners think that the mere putting in of stronger and stronger shafts, in the sense that they are thicker and thicker, will meet the required object or supply the want—a shaft which will not break—so long will shipowners have cause to complain. The reasons why shafts break must be sought for intelligently; and when they are found they can be combated. We cannot attempt to do more than indicate here what these causes are. Crank shafts generally break because the bearings are allowed to get hot. Why this overheating should operate to the stated end, it is not quite easy to say. Enough that it is generally admitted that hot bearings and split or cracked crank shafts go together. This being known, it is obvious that precautions should be taken to keep the cranks cool. Is it quite certain that all the talent of the country is powerless to produce a marine engine shaft which will run from this country to the United States without the use of cold water, and which will not heat if left to itself for say half an hour? We hope not. If railway engineers had not been more successful with their bearings and journals than marine engineers are with theirs, then would railway travelling at sixty miles an hour or runs of an hour and a-half at a time be impossible. Again, is it quite clear that we make our crank shafts the right way? We have no doubt at all that such shafts should be built-up when of any but the smallest size. But not more than a couple of years have passed since the practice of using built-up shafts became at all popular, and it was forced upon marine engineers by the impossibility of getting single forgings large enough for such ships as the Orient. The idea once set in motion and fairly accepted, the rest follows, and built-up shafts are likely completely to displace the ordinary shaft. One of the best arrangements of the kind which we have seen is that of Mr. Turton, of Liverpool, in which the crank webs are made in halves secured together by bolts. The breaking of any portion of the shaft—say a crank pin—means a few hours' delay while it is being replaced, instead of a total and incurable breakdown. Coming now to propeller shafts, there can be no doubt that they are broken from two causes—first, the bending and springing of the ship's hull, by which they are distorted; and, secondly, by the racing of the engines. There are some excellent governors now in the market, by which racing is prevented, and we commend them to the consideration of shipowners. The desirability of adopting a plan all but universally adopted in the French navy, and introducing in two or three places universal joints, to give flexibility to the shaft and save it from undue strains. We believe we are correct in saying that the fracture of a propeller shaft, fitted with flexible unions, is a thing unknown in French ships, and we need not be too proud to learn from our neighbours. If this seems too complex and expensive, then as an alternative something akin to the breaking spindle of rolling mills might be adopted. Let us suppose that the proper diameter for a propeller shaft is 10in. Then let a short length of it be of this diameter, and all the rest 10½in. If breakage takes place, then the portion 10in. diameter is sure to fail, being the weakest portion of the shaft, and this length—say 5ft. long—could be removed in a very short time by taking out the bolts in the couplings and replaced with a new length, which could be carried as "spare gear" without trouble.

Another excellent instance of the persistence of types is supplied by the attempt made to use steam on tramways. Years ago we pointed out that extremely light engines could not be made to do this work, and experience has proved that we were right. We also indicated the propriety of not using the rails, but the common road as the place to apply tractive effort, for very obvious reasons. This latter plan, there is every probability, will be put in practice during the present year. But setting this solitary exception to the general rule on one side, we still find engineers building engines which differ in no essential particular from those which have gone before them and failed. There is of course no trouble whatever in designing a tram engine which will haul cars and not prove offensive to the public. That much has been done by half-a-dozen inventors to the satisfaction of all parties. The puzzle is to build a tram engine which can be made to pay its way; one which will not wear itself out in a very few months. Now it is well-known that the cost of repairs is heavy, enormously heavy, because the working parts become covered with dirt; because the engines blunder over wretched roads and yet are fitted with miserable springs; and because no attempt worth the name is made to keep bearings clean. Collinge, the inventor of the "patent axle," taught the world years and years ago how to make a bearing which would run over the worst roads, winter and summer, for four or five years without any more attention than was involved in pouring a teaspoonful of oil into a hole once a week. Is there a crank pin and big end now in use on a tram engine fitted up like a Collinge patent axle? That is to say, with a long, absolutely cylindrical spindle of the hardest steel outside, with a soft, tough iron core, working in a steel bush, which it fits air-tight when the surfaces are smeared with oil. There is nothing of the kind about the normal big ends which are specially designed to pick up all the mud and dust going. We need not pursue this topic further; to those of our readers who can take a hint we have said enough.

It is a part of our duty to endeavour to indicate at the beginning of each year the direction which invention should take in the immediate future. Broadly speaking, at the present moment in nothing is invention more required than in those branches of engineering science in which we compete on common ground with other nations. So far we may be said to have cotton and woollen spinning and weaving in our own hands. There is no reason to believe that any other nation possesses better machinery than we do for these purposes. The progress of recent invention in the manufacture of cotton spinning machinery has been so recently and fully set forth in our columns,* that it will suffice only to mention it here. The next great national industry is the iron trade, and it is worth while to consider how we stand here. Our great competitor is the United States. In that country iron ore and coal abound, and the production of manufactured iron and steel of all kinds has been greatly developed and fostered by protection. We regret to say that some of our own ironmasters and others prognosticate that in a comparatively short time the United States must adopt free trade; that when this is done there will be great demand for British iron and steel, and that if we can only rub along a little longer we shall yet do very well without making undue exertions. We have heard this argument used year after year for many years. It is fortunate that no matter what turn men's thoughts take in this direction, their actions do not run wholly in the same groove. There is not the slightest probability now that there will be any mitigation of the tariffs in our favour until the next presidential election, four years off. Those who hold different opinions assert that the farmers will rise against protection; but the truth is that the American farmers suffer very little if at all from high import duties. The American farmer has practically no rent to pay, and he can therefore very well afford to contribute to the prosperity of large towns by submitting to the infliction of the tariff. At this moment the United States are the most prosperous nation on the face of the earth; they are practically self-sufficing, and it is very difficult to see what they could gain yet awhile more than they have by adopting free trade principles. There is in truth no analogy at all between such a country as America and such a country as Great Britain. The facts being as they are, ironmasters in this country ought to see that no effort should be spared to put themselves on a footing of equality with their competitors. It is quite certain that at present we are not holding our own in this respect. The United States ironmasters are beating us by 100 per cent. in the output from their plant. With one pair of converters they can do as much and more than we can do with two pairs; and while our blast furnaces turn out 480 tons of pig per week, theirs, much smaller, give as much as 1100 tons a week. In the rail mills, and bar and sheet mills, matters are in much the same condition. If we are asked, To what is this superiority due? we reply that it is to be traced, to some extent, to better organisation, and in others to better plant. In the Bessemer works, for example, the drill of the men employed is perfect, and a converter is never stopped for days while being lined up and re-bottomed. The converter alone represents but a small part of the plant; but when a converter is standing, so to a certain extent do the blowing engines, the hydraulic appliances, ingot moulds, and very probably the hammer, the cogging mill, and the rail train. What would be thought of a foundry which was closed while a 5-ton ladle was being re-lined? In the United States, for a long time back, the moment a converter is burned out it is taken away, and a new one put in its place. The operation requires, we understand, about half-an-hour at the most. In how many English steel works is the same plan pursued? It has, we may say, been forced on Messrs. Bolckow, Vaughan, and Co. by the necessities of the basic process, and we hope to see it generally adopted before many months are out. There is still room for invention in this direction. Bessemer plant was regarded as perfect until the other day among ourselves. Then Mr. Holley showed the good people of the States that, excellent as it was, it could be made better. Is it to be supposed that Mr. Holley has left our own Bessemer steel men nothing to do? We think not. Mr. Windsor Richards, in his recent address to the Cleveland Institution of Engineers,* spoke in somewhat depreciatory terms of the work done by the Edgar Thomson Steel Company, suggesting that by hard driving, the furnaces were soon burned out and wanted re-lining. Even if we admit this to be quite true, it seems to be perfectly clear that the cost of re-lining must be charged as so much per ton of iron made, and that unless it can be proved that the Edgar-Thomson furnaces cost more for repairs and renewals per ton of pig than do furnaces less hard pressed, the advantage is altogether with them. To make this plain, let us say that one of our great Cleveland furnaces, with its appurtenances, costs £20,000, which is not far from the truth. It turns out, say, 450 tons of pig per week, or 23,400 tons a year. The interest on £20,000 at 5 per cent. is £1000, or 20,000 shillings; consequently each ton of pig iron must be charged with, say, 10d. for interest alone. If, however, the make of the furnace had been doubled, or 900 tons a week, then 5d. a ton would have been saved, and this sum, and less, represents in the present day a profit which is by no means to be despised. It comes to nearly £20 a week per furnace, and even this amount of clear profit, small as it is, many an ironmaster would be glad to get from each of his blast furnaces. It may be said that, after all, the rate at which a furnace is driven has very little to do with mechanical engineering. But this is not true; double production means double blowing, double feeding, double hoisting of materials, and increase in the power of various appliances, all which demand renewed exertion on the part of the mechanical engineer. And here we may refer to a somewhat novel pair of blowing engines, recently put down at Staveley, where they were constructed from the designs and under the superintendence of Mr. Charles Markham. We shall illustrate these engines in an early impression, and it will be enough now to say that they combine in an unusual degree great power with considerable economy of fuel and very small first cost. A great deal of the blast furnace plant of Great Britain is antiquated, and the sooner it is replaced with more modern plant the better. We may cite as an example hot blast stoves. It is a suggestive fact that much of the success which attends the labour of the American ironmaster is due to the efficiency of Mr. Cowper's stoves, and yet English ironmasters have been very slow to accept an invention which American ironmasters jumped at.

In rolling mill machinery there is still a great deal of room for improvement. It is very desirable to reduce the power required to produce any particular class of rail, bar, or sheet to its lowest limits, not so much because steam costs money—for its cost in most ironworks is exceedingly small—as because great power means enormously heavy and costly gearing, which again requires equally costly foundations. Indeed, the train proper of any reversing rolling mill appears ridiculously small as compared with the great mass of mechanism beside it, and intended to drive it—mechanism which is moreover constantly breaking down. To get rid of much of this gear we have on the one hand the three-high mill, which is not very popular in this country; for one reason because the middle roll wears faster than its fellows, and for another that the bars have to be lifted very high. The more popular expedient is the use of a pair of quick-speed engines fitted with link motion reversing gear, and without a fly-wheel; but even then cogged gear is required. It is by no means so generally understood as is desirable that great power is needed not so much to shape the iron as to overcome the friction of the rolls. In a sheet mill, for example, the rolls are driven asunder when the double is nearly finished with a force of about 400 tons. The roll necks will be 14in. to 18in. in diameter, but let us take the smaller dimensions. The circumference of the neck is 45in. The roll itself will be 20in. diameter, its circumference will be 63in., the doubles will be about 8ft. long; so that to pass one the rolls must make, say, 1½ revolution. The rolls will make thirty to thirty-one revolutions per minute, so that their necks will have an angular velocity of $31 \times 45 = 1345$in., or, say in round numbers, 116ft. per minute. Each roll neck will carry 200 tons, and there are four necks. Hot neck grease is not a very efficient lubricant, and it would not be safe we think to take the coefficient of friction at less than $\frac{1}{30}$ of the insistant load; but $\frac{200}{30} = 6{\cdot}6$, and we have therefore for each roll neck a resistance of 6·6 tons, or 14,784 lb., to be overcome at the rate of 116ft. per minute, which is equivalent to 52-horse power nearly, or for the four necks say, in round numbers, 200-horse power. Fortunately the sheets are not always passing through the rolls, because there is an interval while they are being returned over the top, during which the fly-wheel again picks up momentum. To drive a good double sheet mill direct requires a non-condensing engine with a 35in. cylinder, 5ft. stroke, and a 70 ton fly-wheel, the pressure being 50 lb. Doubles are very seldom going through both mills at the same time, but "stalls" are not unknown. Our readers can calculate for themselves what the power of such an engine is. A rail mill will absorb from 250 to 300-horsepower, of this 70 or 80-horse power will be required to drive the machinery light; of the remainder by far the larger proportion is expended in overcoming bearing friction. Several years ago we showed in this journal how a large proportion of this loss might be saved by the use of friction wheels to carry the lower roll necks, in a way exceedingly simple, and incapable of interfering with the ordinary housing or screw tackle. Whether this method be or be not adopted, it is at least clear that great advantages may be expected from the adoption of any system of construction which will obviate the existing loss of power. Before leaving rolling machinery we would also suggest that for certain classes of work considerable advantage would probably accrue from the use of what we may term a reciprocating mill. When rolling short plates, for example, as is sometimes done, not more than one and a-half revolutions of the rollers is required each way; much more than this is needed, however, for reversing, and much time is wasted, during which the iron is cooling. If instead of using rolls, say, 20in. or 22in. in diameter for such a purpose, rolls of three or four times the diameter were employed, then not more than two-thirds of a revolution need be made each way, and the rolls could be driven by a crank and connecting rod. In practice, the use of rolls of this size would be out of the question, but chilled segments might be attached to two suitable framings, each representing a portion of a roll some 8ft. or 10ft. in diameter, if necessary, and a swinging or pendulous motion being given to the upper or lower one, a plate once put between them could never be delivered until it had been reduced to the proper thickness. The iron could be worked very hot, and the yield of a given mill enormously augmented. The circumference of a roll 10ft. in diameter would be, say, 32ft., but the roll centres need be little more than 10ft. apart, and the housings would not need to be of unwieldy dimensions, while a reciprocation of one-third of a revolution would produce plates or bars over 10ft. long. Not in the rolling mills alone, but in many other matters with which engineers have specially to do, is improvement wanted in our ironworks. The German, French, and American ironmasters will not stand still, and it is beginning to be understood in this country that the iron or steel producer can hope for nothing in the way of profit unless he has the best plant that modern science can produce. There is still a wide field open to inventors here, and we hope that 1881 will not be suffered to pass without substantial advances having been made.

Many subjects press on us and clamour for a word of notice, but space is limited; and even if it were not so we have no desire to weary our readers, but rather to give them hints as to the directions which mechanical engineering progress ought to take, and is taking. We cannot pass in utter silence the enormous advances which are being made in ocean steam navigation. We must content ourselves, however, with giving a very few particulars of certain huge vessels which will probably make their trial trips before 1882 is upon us. There is the City of Rome, being built for the Inman Company by the Barrow Shipbuilding Company. She has been very fully described in our pages already, but it will not be out of place to say here that she will be 586ft. from figure-head to taffrail, 52ft. beam, and 38ft. 9in. deep, with a gross register tonnage of 8300. She will be propelled by three engines acting on a single crank shaft. Each will consist of a high-pressure cylinder 43in. diameter over a low-pressure cylinder 86in. diameter, the stroke being 6ft. The crank shaft is of steel, built up hollow, and 25in. in diameter, and weighing 68 tons. Steam will be supplied by eight double-ended boilers, with forty-eight furnaces. The working pressure will be 90 lb., the indicated power 8500, the speed 17 knots. The propeller will be 24ft. in diameter and 30ft. pitch. The Servia, being built for the Cunard Company, is a rival vessel. She will be 500ft. long, 50ft. beam, and 37ft. deep, and 7500 tons register. She will be propelled by a three-cylinder compound engine, the high-pressure being 72in. and each of the low-pressure cylinders 100in. in diameter, the stroke being 6ft. 6in. Concerning her boilers little information is as yet available. They will have thirty-eight furnaces. The engines are to indicate 7500-horse power, and the speed of the ship is to be over 16 knots. The Guion line, not to be outdone by the other Atlantic companies, is building the Alaska, 500ft. long, 50ft. beam, and 39ft. deep, gross register tonnage about 7700. She, too, will have three cylinders 68in. and 100in. diameter

* "Cotton Spinning Machinery," by Mr. Eli Spencer. Paper read before the Institution of Mechanical Engineers. See THE ENGINEER for November 19th.

* See THE ENGINEER for 19th November, 1880.

with a stroke of 5ft. She will have fifty-four furnaces in nine boilers, working at 100 lb. The indicated power is to be 9000, and the speed of the ship $17\frac{1}{2}$ knots. Many other great steamships have been recently finished, or are on the point of completion, but nothing so large as those we have named.

It cannot be said that in Great Britain any great change in locomotive construction is impending. The tendency is to make engines heavier and more substantial, but we see no evidence of a desire to introduce any radical change in design. On the Continent certain changes are, however, being made from time to time, which can scarcely be said to apply to matters of detail. We cannot better illustrate what we mean than by referring our readers to THE ENGINEER for September 3rd, where they will find a locomotive embodying several new features. Locomotive engineers in the United States have hitherto been intensely conservative. Whatever differences existed between the passenger engines of different American makers in other respects, in all were to be found outside cylinders with the slide valves on top of them, four coupled driving-wheels of moderate size, and a bogie. As American engineers have improved their roads, and the desire for higher speeds have sprung up, it begins to be suspected that the normal American locomotive is not quite what is wanted. Already resort is being had to single driving-wheels, and even the bogie may yet be abolished. It is beginning to be found out at last that goods stock fitted with bogies is harder to pull than four wheel trucks and wagons of the English pattern. A Mr. Fontaine has patented, and has had made and tried, an engine in which the cylinders are on top of the boiler, and the driving-wheels in the same place. They bear not on the rails but on large pulleys on the insides of the true driving-wheels, which are in their normal position. These last make consequently about $1\frac{1}{4}$ revolutions for every one of the crank shafts. This queer device is said to have made sixty miles an hour with a heavy train, and to have given great satisfaction. The same result would have been obtained, we fancy, by using driving-wheels, say, 7ft. 6in. in diameter in the ordinary way. Perhaps, however, American locomotive builders have neither the plant nor the skill to make driving-wheels much more than 6ft. in diameter. Mr. Fontaine's engine resembles an expedient to attain with imperfect means a given end. It is very much like what is called "a makeshift" in this country.

We have kept our readers so fully apprised of all that is being done in the construction of ordnance and munitions of war, that fortunately we need say little or nothing on the subject here. Compound armour plates have given victory to the ship for the time being against the gun. It remains to be seen what the new breech-loaders can do against these plates. There is at least good reason to believe that we are very far from having reached finality in the power of our guns. In a few days a competition which is expected to last a fortnight will begin with machine guns, such as the Gatling and Nordenfelt. It would seem that we have no more reached finality with these things than with big guns. Messrs. Yarrow and Company, again, are apparently determined that torpedo boats shall not sink into a second place in the race for perfection, and they have just completed two—each 100ft. long—sea-going boats to a great extent, and with a speed of $19\frac{1}{2}$ knots in fighting trim on the measured mile. The Inflexible is so far as can be seen a great success, and the Italian Duilio has made a trial trip in stormy weather, concerning which trip very contradictory reports have reached this country. The Italian Government do not propose to build more ships of such great size at present, but to lay down some comparatively small men-of-war, of which the country stands it is said in great need.

The progress in submarine telegraphy during the past year has been important. The Telegraph Construction and Maintenance Company has laid over four thousand miles of cable during the year, 1908 miles of which were laid in the Atlantic, 1132 miles forming the last section of the duplicate Australian cable; 529 miles the Hong Kong Manilla cable; 518 miles of cable from Newbiggin to Arendal and Marstrand, &c. The Silvertown Company has manufactured between two and three thousand miles of cable, 575 miles of which were for the French Government, part of the cable was used to lay a fourth line from Algiers to Marseilles; the other cable was made for the Canadian Government and for the Mexican Telegraph Company. The only cable work of importance spoken of in the immediate future is the construction of two new Atlantic cables for American speculators. At the present time the capital sunk in Atlantic cables is about eleven millions sterling, and the length of cable is about twenty thousand miles. There is not enough work to keep the existing cables employed, and the returns from any speculation in this direction must therefore be exceedingly problematical.

The postal telegraph department has during the past year erected a trunk line from London to Glasgow, 325 miles in length, carrying over 5000 miles of wire. Improvements have been made in the automatic instruments, so that a greater speed over longer distances is obtained. The Aberdeen circuit, including Leeds, Newcastle, Edinburgh, Glasgow, and Dundee, 650 miles long, with two relays, one at Leeds the other at Edinburgh, is worked at the constant rate of 200 words per minute. The average rate on the automatic system has been raised from 100 to nearly 250 words per minute during the year. The telegrams during the year show an increase of over four millions, the receipts an increase of nearly £200,000. At the end of the year the long-pending telephone trial was decided in favour of the Government, and immediately active steps were taken by the department to supply the public with the best instruments at a lower rate than was required by the Telephone Company.

The most important electrical feature of the year is the great progress made by the electric light. After a year of hesitation in 1879, the year 1880 proved exceptionally busy, and in the course of a few days most of the larger metropolitan railway stations will be illumined by means of this light. Already the Brush light can be seen at Broad-street and Paddington; it is being erected at Charing-cross. The Brockie lamp is to be used at Cannon-street, and the Crompton lamp at King's-cross. Mr. Crompton's lamp is in extensive use at Glasgow, and has been adopted in twenty or thirty different places during the year—successfully lighting railway stations, quays, collieries, water works, factories, &c. Hitherto this lamp has been used generally with the Gramme machine, and to a considerable extent under the auspices of the British Electric Light Company, the licensees of the Gramme machine in Great Britain. The British Electric Light Company has had an active year, and this company has in hand the lighting of some of the Liverpool streets, the Cannon-street Station, &c. Messrs. Siemens have applied their system to the lighting of the Parade in Blackpool, the Holyhead Harbour, and the Royal Albert Docks, with constant success. One of the signs of the times is the application of various towns to Parliament to obtain powers for lighting by electricity, and the significant fact that a general lowering of prices has been thought necessary by the gas companies. At the close of last year we were promised a public demonstration of the Edison light, but the promise has not yet been fulfilled. The latest news from that quarter announces the formation of a company with a capital of 1,000,000 dols. to light New York. The moving spirits in the company are Marvin Green, Tracy R. Edson, James H. Baker, and T. A. Edison.

Mr. Swan, of Newcastle-on-Tyne, who commenced his experiments on this particular form of lamp nearly twenty years ago, has during the year publicly explained and shown the result of his labour. His work has brought the electric light within the domain of domestic wants, and those who are willing to pay for the necessary alterations can obtain a cleaner and better light than heretofore has been possible. The progress of the electric light will, to a certain extent, be independent of cost, supposing the cost to be at all comparable with that of gas. It must be remembered that Mr. Swan has more than once stated that the light obtained by his lamps, with the electric machine driven by a gas engine, is greater than the light from the same quantity of gas burned in the ordinary manner. Digressing for a moment, attention must be directed to the admirable way in which the constructors of steam engines have supplied the requirements of electric light engineers. Previous to the advent of electric lighting, probably few except marine and pumping engines were required to run so long without a stoppage. The consensus of opinion that no difficulty has been put forward by builders of engines must be gratifying to those who regard the electric light as the light of the future. The time will come when advances having been made in thermo-electricity, the engine will be relegated to other work, and the attention of men should be turned to this almost unexplored field of investigation, and to the storage of the electric current. The difficulties in the way of should prove a greater incentive to the task, which, whatever the result may be, is one that will amply repay experiment.

The most interesting feature in the purely scientific work of the year is the development by Professor Bell and Mr. Tainter of the photophone from the telephone. Two years ago we indicated the direction in which discovery in this matter would take place, and although it is far easier to describe an achievement accomplished than to forecast the future, it may be interesting to note the working of men's minds. Sound is caused by the motion of ponderable bodies. Light is caused by the motion of the so-called imponderable ether; but astronomical and other research indicates that the ether is not altogether imponderable. We may therefore look upon it as being at one extreme end of the scale of density, whilst such a substance as platinum is at the other. Then luminous vibrations are transverse, while those of sound are longitudinal. How far has scientific research yet carried us? Sound waves are reproduced at a distance by means of telephones connected with the point of departure by a ponderable material such as copper wire; further, sound waves are reproduced at a distance by another apparatus, in which the ponderable is replaced by the ethereal light waves. Who will be the man to devise an apparatus by means of which the light waves can be reproduced? The variations in the pitch of light waves are quite as many as the variations in the sound waves. Can these varying light waves be reproduced? We do not for a moment doubt that they can, and it seems to us to be the next step in the ladder of discovery. The light wave now carries the key to act upon a selenium cell, controlling the apparatus for the production of the sound. Let the imagination run riot for an instant with the supposition that the reflection of light from a face to a piece of apparatus in London can so act on that apparatus as to enable it to transmit, say, to Edinburgh the power to affect another apparatus which shall thereupon reverse the order, and give a picture of the face upon which the light waves impinged in London. It will be seen that we ask from light what we have obtained from sound. Our digression has proceeded too far. During the past year over two hundred patents have been taken—in fact, nearly three hundred, for inventions connected with applied electricity. Of these the most important are perhaps those of Fitz-Gerald, Heinricks, and Perry respectively dealing with electric motors. Each of these inventors seems to have taken the Gramme machine as a pattern upon which to improve. Mr. J. E. H. Gordon has also devised a machine, as well as an altogether new type of lamp. Mr. Maxim has again patented what he considers an improvement in incandescent lamps, but it may be said that the correct estimation of the value of the inventions of 1880 is a legacy or 1881. In January, 1882, we shall probably be able to say whether all or any of these patents is worth the money paid for the provisional protection.

THE MAIDSTONE EXPLOSION.

THE explosion of a traction engine at Maidstone raises a question of very great importance to the builders of engines of this class. Messrs. Aveling and Porter designed the engine which exploded for a working pressure of 100 lb. The stays were spaced $5\frac{1}{4}$in. apart. Now Fairbairn's experiments showed that with $\frac{3}{8}$in. plates and $\frac{13}{16}$ stays spaced 5in. apart, a pressure of not less than 815 lb. per square inch was required to burst an experimental box, which gave way ultimately by a bolt pulling through the plate, and the plates did not begin to bulge or swell between the stays until a strain of 450 lb. on the square inch had been reached. We shall not be far wrong then if we take the strength of the fire-box of the exploded boiler while sound and new as 450 lb. on the square inch. Under these conditions Messrs. Aveling and Porter adopt the very ample factor of safety of $4\frac{1}{2}$ to one. They say, "this fire-box will begin to give way at 450 lb., therefore we shall work at 100 lb. only, but for a convenience to the driver we allow an extra 10 lb. to be carried now and then, which may be done, of course, without the ghost of a risk." It is to be assumed that no one knows as well as the makers what the engine will stand. The cost of an 8-horse power engine is so much—let us say £350—though we do not know precisely what the Rochester firm charge. The cost of a 10-horse power engine would be, say, £50 more. What does the purchaser do? He pays £350 for his engine, and at once loads the safety valves to 125 lb., or say to 25 per cent. more than the working pressure the maker intended the engine to carry. It is well known that the full power of a traction engine is seldom required, save for comparatively short intervals, during which the boiler will easily keep steam. The result of the little manœuvre to which we call attention, is that Messrs. Ellis and Co., and other firms, buy an 8-horse power engine and at once convert it into a 10-horse power, and so put £50 into their pockets. Nothing more unfair to the builder can be conceived. Indeed, the practice holds out a direct premium for bad work, because unless the purchaser is sure that the boiler will not carry the extra pressure, he is certain to put it on, and the higher the reputation of the firm from which he buys, the greater is the chance that he will overload his safety-valves. The remedy is obvious. Let all builders of traction-engines enter into a solemn league and covenant that they will not sell a traction engine without a lock-up safety valve, and one half the battle is gained. The other half may perhaps be won by a bye-law to be framed by the town council or local authority of any town, that no traction engine is to be used which has not a locked-up safety valve in the district over which the jurisdiction of the council extends; and furthermore, that whenever called upon by the police or other authorised persons, the driver must prove that the said locked-up valve can be eased on its seat and will blow off steam. No Act of Parliament is wanted for all this. The Maidstone local authorities can prevent manure from being drawn through the town in the day time; they ought to be just as well able to regard a traction engine without a locked safety valve as a dangerous nuisance, and prevent its passage through the streets accordingly. A little firmness on their part would probably readily suffice to overcome all the opposition traction engine proprietors would be likely to offer.

FORTHCOMING RAILWAY DIVIDENDS.

ALTHOUGH we now know approximately the results of the working of our railways for the last half of 1880, so far as the traffic receipts are concerned, yet it is impossible to state with precision what the effect will be on the railway dividends for that period. A general and in some instances a large addition to the income of the corresponding preceding half year has been made, but the other factor—the cost of working—is not as yet exactly known. The increases in the traffic receipts are known to a very great extent. On small lines like the Metropolitan we have an increase of close upon £10,000; and from this sum up to the £340,000 of the North-Eastern Railway the tendency to increase is generally marked but in different grades. It is worth notice too, that the decrease in the first part of the half year that was apparent in several of the lines that depend largely on the agricultural districts, has in the latter part of the half year been changed into an increase, which in the case of the Great Northern Railway is to the amount of £20,000. And on all the great lines the additions to the revenue are substantial. There is ground for the belief that the cost of working has been comparatively small. Coal has been cheap, and over the whole of the year so have been iron, steel, and other materials. It is true that there has been in most cases a growth of the capital, and this now must continue. But with a cheap working of the traffic, and with an increase in the receipts, it may be fairly concluded that the dividend of the preceding corresponding half year may be expected to be maintained; and where there is such an enlargement of the traffic as is seen in the cases of the Midland and the London and North-Western and especially of the Furness and the North-Eastern lines, a substantial increase in the dividend may be expected. It would as yet be wild speculation to name any figure, but it may be concluded with some reason that whilst some of the companies will be only able to maintain the past rate of dividend, on those that have been most favoured an increase varying from $\frac{1}{2}$ to 2 per cent., according to the amount of the increase in the receipts, may be fairly looked for; and there are grounds for the opinion that this improvement is not a temporary one, for our great carrying companies seem now to have entered on a career of higher values and fuller receipts.

THE UTILISATION OF WASTE IVORY.

A CURIOUS and valuable contrivance has been explained to our Sheffield correspondent for the utilisation of waste ivory—a subject of very great importance to other classes besides cutlery manufacturers, in consequence of the rapidly-increasing value of the article. The firm who have made the discovery—Messrs. Kilner Brothers, Albion Works, Holley-street, Sheffield—have patented their plan, and applied it in the first instance to table cutlery. Their object is obtained by using odd ends of ivory, or ivory that is not sufficiently long for the ordinary length of handles, by cementing the pieces together, and by "tapping" the "tang." In this way each piece of ivory is screwed close to its fellow. The handle is then carved or fluted, by which means all joints are concealed. The tang passes through from end to end, and being rivetted, the handle is prevented from leaving the blade, either by being placed in hot water, or by any other means which misdirected domestic ingenuity can contrive. Every housekeeper will appreciate this boon, as in the ordinary method of hafting table cutlery the handles come off with irritating frequency. By their patent, which is also applied to knives with bone, horn, and other handles, the firm can produce a really good article at about one-half the cost of ordinary knives. The ivory waste used in this way costs 2s. 6d. per lb., cut out of the solid piece it would be 20s. Among other specimens exhibited to our correspondent was a carving knife, the ivory handle of which, if the ivory was of one piece, would be worth 3s. 6d. The firm can supply the complete knife and fork for 4s. 3d., with the handle treated according to their patent.

COMMISSIONERS OF PATENTS.—We are given to understand that his Excellency the Governor of the Straits Settlements has appointed Major F. A. M'Nair, R.A., C.M.G., Colonial Engineer, and Mr. Thomas Cargill, M.I.C.E., Municipal Engineer, Singapore, to be Commissioners of Patents for the Straits Settlements.

LITERATURE.

Engine Driving Life: or Stirring Adventures in the Lives of Locomotive Engine Drivers. By MICHAEL REYNOLDS. Crosby Lockwood and Co.: London. 1881.

THIS is by far the best book Mr. Reynolds has written, and a notable improvement is to be seen in his style. The work, too, is not narrow in its subject; and although technical enough, it nevertheless contains a great deal of reading which can hardly fail to prove amusing to a large section of the general public. Indeed, there is no reason why it should not become a railway book, using the words, in the same sense that we employ them when referring to those volumes with which Mr. Smith keeps a vast public carefully supplied.

The general scheme of the book is very simple. Mr. Reynolds begins with the engine-boy, and goes on to speak by degrees of the fireman, and then of the goods and express drivers, illustrating what he has to say of each with an abundance of anecdotes, some amusing, some laughable, some very pathetic, and all readable. Our author has had a large experience of life among locomotives, and he very easily shows that the foot-plate is a remarkable school. Some of our readers may have had the good fortune to peruse Mark Twain's "Mississippi Pilot." If they have read that book in the proper spirit, they will know that it contains one of the strangest psychological studies ever published. They will there see how the performance of a certain duty trained the intellect day by day and hour by hour, until a river, the general features of which the apprentice could hardly take in in the broad light, became in time perfectly well known to him on the darkest night. Mr. Reynolds's book in some respects resembles Mark Twain's, in that it shows how certain qualities are developed on the foot-plate, and it also shows that some men are born to be drivers and others are not. The book gives some very useful information as to the way in which accidents occur—information which has never before been published, although it is familiar enough to many railway men. Thus, for example, he shows how accidents occur because drivers when they go to the shed in the morning will not take pains to read the notice board containing instructions for the day right through. As an example of the want of care in such matters shown by some men, we may quote the following anecdote:—

"A very singular notice was once put upon a board respecting a pair of crossing-gates, which were attended to in the day by a man and in the night mostly by his wife. The old man was accidentally run over and killed, and the railway authorities in consideration of his past duties and unfortunate end were disposed to allow the widow to mind them in the day, and to have them closed at night and opened by the driver. It was a single line, and only three trains passed through them between 8 p.m. and 6 a.m. The notice was there for all to read, but about a dozen gates were demolished before all the drivers whom it concerned really knew of it."

The following passage is worth reproducing:—

"With regard to the dangers attending goods drivers, they, of all railway men, are the safest. Their speed is not very high, and therefore if there is anything on the line that they can see they have ample time to stop before it; but in the dark they fare much better than anybody else on the main line, because they are timed to keep time, and if they don't, which is often the case, they cannot trip anybody else up. But the *high-fliers*—expresses—come into the tails of their trains sometimes with a crash, which may be the length of from forty to sixty wagons distant from the goods driver, who can afford to jump off his engine and ask the "flier" what he thinks of doing. 'If thou thinks to get first,' said one goods driver to an express engineman who was engine deep among the *débris* of a dozen wagons, 'thou'st better back out and then go round Colwick,' which was a route fifty miles away."

If the book possesses interest for the general reader, much more does it do so for the locomotive engine-driver. Every story told by Mr. Reynolds is an apologue. Each is accompanied by its appropriate moral, and yet our author succeeds in avoiding being wearisome. We commend the last chapter to the general public, "How to 'Treat' the Engine-drivers." In the Ashborne-road, Derby, there is a "home" for the fatherless children of railway servants killed on duty. Mr. Reynolds writes, "Instead of there being room for only a few, kindly help to make room for many, that is how I wish you to 'treat' the Locomotive Engine-drivers."

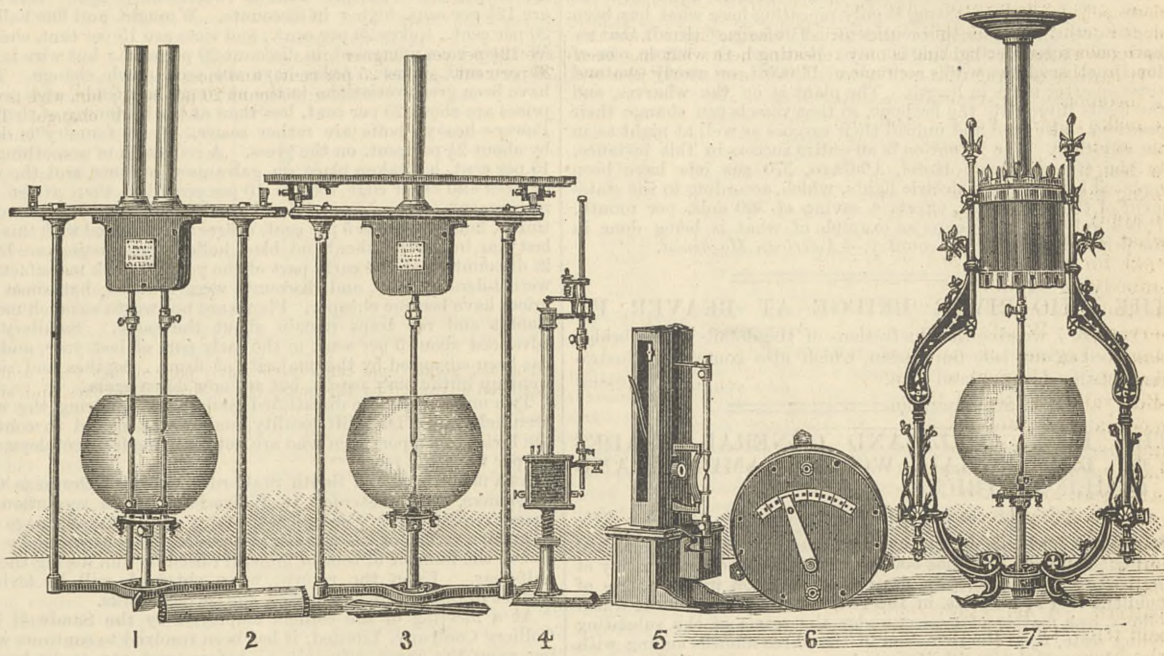
HURD'S WIRE ROPE GEAR.

WE illustrate this week ingenious and interesting applications of wire rope gear to the working of collieries, which depends for its success on the rope pulley invented and patented by Mr. F. Hurd, which is illustrated by Fig. 1. Its construction will be readily understood from the section. At intervals round the periphery of the drum or pulley is arranged a series of clips which consist each of two jaws, the tails of which rest on a fixed support. When a rope enters these jaws, it bears on the bottom near the axis, and forcing the tails against the support, the jaws are compelled to close and pinch the rope with a force proportionate to the pressure put on the tails. In some respects the arrangement resembles the clip drum of Messrs. Fowler and Co., of Leeds. It is used both for chains and ropes, and even for single wires. A 5ft. diameter clip pulley for a ⅝in. wire rope, and with a boss to take a 4in. shaft, weighs 7 cwt., while a 7in. clip pulley, to fit a 1½in. shaft and take a ¼in. rope, weighs 9 lb. The small pulleys are used for transmitting power round corners, down shafts, and into cellars and out-of-the-way places. We understand that an 18in. pulley will work well with an ordinary telegraph wire and transmit as much power as a 4in. belt.

In Fig. 2 is illustrated a 6ft. pulley working a ⅝in. wire rope for hauling and pumping in one of the main roads of the Lochgelly Iron and Coal Company, Lochgelly, Fifeshire. It will be seen that the bight of the rope carries a pump working on the dip. The somewhat similar pump is shown to a larger scale in Fig. 3. The pump is mounted on a bogie, and its own tendency to run down the incline keeps the rope at the proper tension. Fig. 4 shows a 7ft. clip pulley, with a brake wheel cast on for working a self-acting incline, with a ⅝in. steel endless rope, as at work at the Penruifufer Colliery, Glamorganshire; at another pit at Llwrynypie almost a similar arrangement is used, the clip pulley being 4ft. in diameter, and the steel rope ⅝in. thick.

Our drawings explain themselves without further description. Concerning the gear at Lochgelly, we are informed that the rope is two and a-quarter miles long, and is hauling up to the full working strength of the rope. The total cost of working expenses, allowing 11½ per cent. for wear and tear per annum, is one-seventh of that of the horses and ponies which previously performed the same duties.

THE BRUSH ELECTRIC LIGHT.



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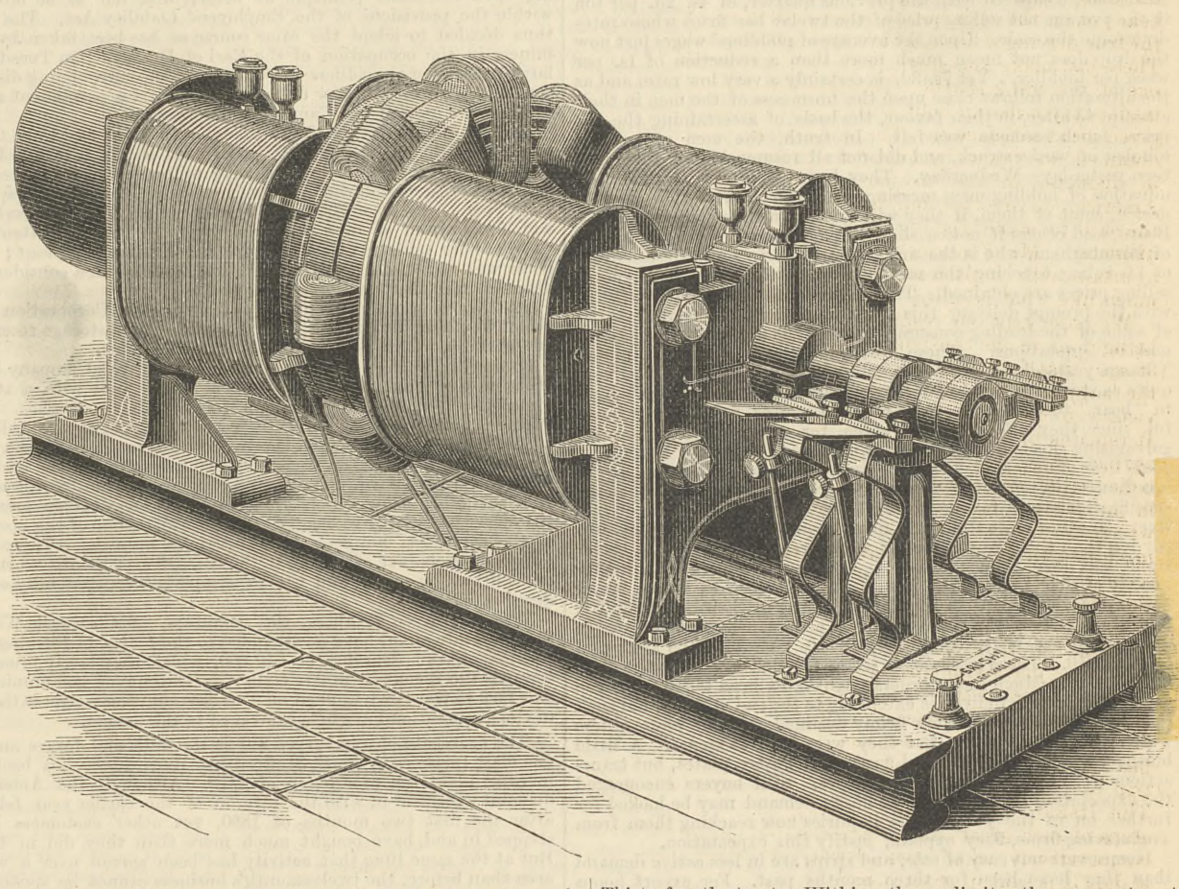


LIGHTING BROADWAY, NEW YORK, WITH THE BRUSH ELECTRIC LIGHT.

A FEW months ago it was announced that the Brush Electric Light Company, of New York, had been organised for the purpose of introducing the electric light into this city for lighting the streets, parks, and large buildings. That company has not been idle during the intervening time, but has located the first station and put down the first plant at 133 and 135, West Twentyfifth-street. First, there is a Corliss engine in operation, built by Watts, Campbell, and Co. The foundation has been arranged for the reception of a pair of 18in. by 42in. engines, to be connected to the same shaft, only one of these engines being now in place. The engine now running is rated at 100-horse power, but can be worked up to 125-horse power. The fly-wheel is 16ft. in diameter, has a 32in. face, runs at a speed of eighty revolutions per minute, and weighs 25,000 lb. The main belt is 71ft. long and 30in. wide. This belt makes a speed of a little upwards of 4000ft. per minute. The boilers for furnishing steam to drive the engines are of the horizontal tubular style, the shells being 16ft. long and 5½ft. in diameter. The upper half of the shells are made of iron, while the lower half is of steel. Each boiler has ninety-two tubes 3in. in diameter, and they are set according to the Jarvis system, with special improvements by Charles A. Berton, the furnaces being arranged for burning coal dust, composed of about one part of bituminous coal to ten parts dust. The whole plant has been devised and constructed under the supervision of Mr. W. H. McGrath, the engineer of the company. His object is to obtain power at the lowest possible cost, and the result will be watched with interest.

There will be two circuits connected with this station, which are to be supplied by five Brush dynamo-electric machines. One of these circuits is to be used exclusively for lighting parks and streets, while the other is for miscellaneous lighting, such as hotels, stores, and other buildings, it being found best not to confound the public with the private lighting.

A No. 7 Brush dynamo-electric machine is represented in one of the accompanying engravings. This machine is 68in. long, 30in. wide, 30in. high, and weighs 2500 lb. The pulley is 14in. in diameter, having a 9in. face, intended for a belt 8in. wide, which will drive the machine from 750 to 800 revolutions per minute. It is calculated to supply ten to eighteen lights, and requires 14-horse power to drive it. A larger machine—a No. 8—is now being built, which is 8ft. long, and of the same style as No. 7. When finished, it is intended to run forty lights, requiring an expenditure of from 30 to 35-horse power. The power here mentioned is calculated to run these machines to their full capacity, causing each lamp to furnish a light equal to that of 2000 candles. The territory controlled by the company extends from Fourteenth-street, Union-square, to Thirty-fourth-street, and from Third Avenue to Eighth Avenue. The first practical electric lighting of streets in this city is upon Broadway, extending from Fourteenth-street to Thirty-fourth-street. Within these limits there are twenty-two lamps, one upon each block. The lamps are mounted upon iron posts of a neat and ornamental design, and 25ft. high, each lamp giving, as stated, a light of 2000 candle power.

The construction of the lamps will be better understood by referring to the engraving, in which Fig. 1 represents a No. 3, or double lamp. This lamp is fitted with two carbon rods, arranged so that when one set of the carbons is consumed, the second set is switched into the circuit, burning until they are consumed. This is done without any interruption whatever to the light. The lamp will burn from fourteen to sixteen hours without attention. A bundle of carbons is represented by Fig. 2 ready for transportation while Fig. 3 shows a No. 2, or single lamp, similar in construction to Fig. 1, but having only one set of carbons. This lamp burns from seven to eight hours without attention. The lamps are all very simple in their construction, the mechanism insuring safety of management and regularity of operation. The double magnet circuit conveys the currents in opposite directions, by means of which any number of lamps may be operated in a single circuit without any irregularity of action. The short circulating safety attachment, by which any lamp offering an abnormally great resistance in consequence of the final consumption of its carbons, or other cause will, without any change of strength in the main current automatically short circuit the said lamp and thus preserve the general circuit. A multiple set of carbons, burning successively without the intervention of any switching or other special mechanism, secures the maintenance of the light for any desirable length of time without requiring attention or adjustment by the attendant other than placing the carbons. These lamps contain no clockwork or similar mechanism of any kind. The movement of the upper carbon actuated by gravity is controlled by a simple annular clamp which surrounds the rod carrying the carbon. When the lamp is in operation one side of this clamp is lifted by magnetic action, which causes it to grasp and raise the rod, and this separates the carbons. As the carbons burn away, the magnetic action diminishes, and the clamp and rod move downward, maintaining only a proper separation of the carbons. But when the tilted annular clamp finally touches the supporting floor from which it started, any further downward movement will at once release the rod, and allow it to slide through the clamp until the latter is again brought into action by the increased magnetism due to the shortened arc between the carbons. In continued operation the normal position of the clamp is in contact with its lower support; the office of the controlling magnet being to regulate the sliding of the rod through it. If, however, the rod slides too far, it will instantly and automatically be raised again, as at first, and the carbon points thus maintained in proper relation to each other.

A focussing lamp, intended for projections in magic lanterns or other similar apparatus, is shown in Fig. 4 of the engraving; and Fig. 5 represents a lamp intended for application to the reflectors of locomotive head lights, or for steamers. An ornamental lamp is shown in Fig. 7, adapted to use in hotels, stores, and other places where a showy lamp is needed. This lamp can be made either single or double, as desired. A regulating switch or dial attachment is shown in Fig. 6. It is intended for use in connection with the largest machines, and is so arranged that any number of lights—from one up to the full number—may be burned without varying the speed of the machine.

This first introduction of the Brush electric light into the metropolis for street lighting is only repeating here what has been done in other cities on this continent. The longest circuit that we have known for electric lighting is in Montreal, O., where one of the Brush machines works a circuit of 14,000ft. or nearly two and three-quarter miles in length. The plant is on the wharves, and the lights illuminate the harbour, so that vessels can change their positions; also load and unload their cargoes as well at night as in the day-time. The invention is an entire success in this instance. In the Grand Pacific Hotel, Chicago, 570 gas jets have been replaced by seventeen electric lights, which, according to the statement of the proprietors, effects a saving of 300 dols. per month. This is only one instance as an example of what is being done in the principal cities of the country.—*American Machinist.*

THE OHIO RIVER BRIDGE AT BEAVER, PA.

ON page 7 we give the illustrations of the details of the bridge described in our last impression, which also contained illustrations of the elevation and plan.

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

(*From our own Correspondent.*)

THE South Staffordshire finished iron trade has been disorganised during the week. This has been owing to an objection by many of the ironworkers to accept a drop of 3d. per ton in the wages of puddlers, and 2½ per cent. in the remuneration of millmen, which follows, as a matter of course, under the terms of the subsisting sliding scale, upon the reduction in the three months ending with November, compared with the previous quarter, of 4s. 2d. per ton in the average net selling price of the twelve bar firms whose rates determine the scale. Upon the average of puddlers' wages just now the drop does not mean much more than a reduction of 1s. per week per puddler. Yet 7s. 3d. is certainly a very low rate, and as the alteration follows close upon the unsuccess of the men in their attempt to alter, in their favour, the basis of ascertaining the net price, much soreness was felt. In truth, the men at a large number of works struck, and did not all resume before the night turn yesterday—Wednesday. They have gone on with the determination of holding mass meetings after the close of this week to decide, some of them, if they will remain members of the Wages Board, and others if notice shall not be served upon the Mayor of Birmingham, who is the arbitrator, requiring a reconsideration of his ruling touching the methods upon which the net average selling prices are obtained. This action by the men has interfered with the prompt delivery this week of iron at the manufactories of some of the leading consumers, but it has not tended to weaken makers' quotations. These quotations upon Wolverhampton 'Change yesterday, and upon 'Change in Birmingham to-day, were quite as strong as those of last week. Nevertheless buyers sought to "bear" the market. Only rarely, however, were they successful, since they offered such a price, for example, as £8 5s. for galvanising sheets of the double gauge, and £9 5s. for lattens. I could hear of no maker, either to-day or yesterday, who would accept less than 5s. per ton advance upon those prices, and then only when the specifications were favourable, and the terms of payment attractive. In other cases the same firms required more money by 10s. per ton than the consumers cited were prepared to give. A better trade was done than a week ago with consumers of a higher quality of sheets than that just spoken of. Makers whose brand has acquired considerable reputation in the market did not find it difficult to sell to the representatives of consumers at a distance galvanising sheets at, for singles, £7 10s.; doubles, £8 15s.; and lattens, £10. These prices were taken for delivery up to the close of February. Much larger orders might have been taken from the same buyers, with deliveries extending to the end of June, but such lengthened deliveries makers firmly declined. Boiler plate orders were much sought after, but they were hard to secure. A little business was done in ship, and tank, and girder plates, but transactions were for only limited quantities. Still buyers encouraged the expectation that a somewhat heavy demand may be looked for further on in the year. The inquiries now reaching them from engineering firms, they explain, justify this expectation.

Hoops were not easy of sale, and strips are in less active demand than they have been for three months past. For export hoops were freely offered, both to-day and yesterday, at £6 10s. at the works. The prices did not lead to business, because less money is being taken by a few firms both in this and other districts. Iron of this character is easy to buy in London, on terms which are equal to £6 5s. at the works; but high-class hoops secure better figures. There continues to be but a trifling demand for hoops upon United States account.

Puddled iron was inquired for but rarely. Good scrap iron was saleable. An expanding business is being done at the sheet works in sheet shearings from the tin-plate mills in South Wales. It has been possible, up to a month ago, to get the article at £2 15s. per ton delivered on to sellers' sidings. In the past fortnight or three weeks sellers have required a rise of 2s. 6d. per ton. The rise has been mostly conceded, consumers at the same time asserting that they cannot possibly advance upon that figure, since local scrap of a somewhat similar sort is available at less money. The shearings are attractive because they reach this district bundled, and are therefore handy as well for moving about the works as for serving to the furnaces. This almost new trade is now threatened with destruction. Without any previous notice the railway companies are officially intimating that by an agreement between all the companies in the kingdom, the rates for carrying scrap iron of every sort are from the present date advanced 2s. 6d. per ton, namely, from 10s. to 12s. 6d. Of this, particularly as it affects the shearings from South Wales, ironmasters were in Birmingham and Wolverhampton generally complaining. They argued that even if there were good reason for advancing the rates for loose scrap because of its want of compactness in the trucks, the argument did not apply to shearings, which, because of the way in which they are bound up, are conveyed upon the average in truck-loads of 7 tons. The traffic must therefore be more profitable to the companies than even the carriage of bars, since, in the average of transactions, bars are moved in only 3 ton loads. Representations will shortly be made to the railway companies, but the compact which they have all entered into will, it is feared, prove prejudicial to the amelioration which the ironmasters desire.

Pig iron is generally stronger than it was last week. The higher terms obtained in Middlesbrough for Cleveland brands have contributed to this strength. The rates were without quotable change, but vendors were less desirous to book sales.

Coal is in better demand than last week. Alike manufacturing and domestic samples were in better request both yesterday and to-day.

The colliery proprietors about Cannock Chase are looking for an extension of their markets by reason of a projected railway which will run from the north side of Birmingham to Walsall, the Chase and North Staffordshire, some eight miles north of Rugeley. The cost is estimated at £1,333,000.

The engineering and general metal-working trades have begun the year steadily, but not very briskly in other than exceptional instances.

It is understood that an ironmaking firm in North Staffordshire have just received an order for 2000 tons of puddled bars for despatch to America.

Considerable alterations have been made in the prices of metal wares and metals during the past year. The value of sporting guns is without alteration, though the keen competition in the gun-lock trade has brought prices of those articles down something like 20 per cent. during the year. Anchors, chains, &c., are all 25 per cent. cheaper than a twelvemonth ago. Gas tubes are 12½ per cent. higher in discounts. Wrought and fine nails are 20 per cent., spikes 25 per cent., and vices are 15 per cent. cheaper. Washers have increased in discount 20 per cent.; but wire is fully 30 per cent. lower. Axles have not seen much change. There have been great variations in the nut and bolt trade, and present prices are about 25 per cent. less than at the beginning of the year. Power—heavy—bolts are rather easier. Brass foundry is dearer by about 2½ per cent. on the gross. A reduction of something like 15 per cent. has taken place on galvanised buckets, and the value of hoes and other edge tools is 10 per cent. less than at the commencement of the year. Files have been increased in discount; tinned hollow-ware is 5 per cent. dearer as compared with this time last year, but on the other hand, black hollow-ware castings are higher in discounts. In the early part of the year the lock manufacturers were tolerably busy, and discounts were reduced, but since then prices have become cheaper. Planes are not worth so much money. Rabbit and rat traps remain about the same. Saddlery was advanced about 5 per cent. in the early part of last year, and this has been advanced by the majority of firms. Scythes and sickles went up in the busy season, but are now down again.

Two meetings of the dissatisfied nailers have, during the week, been held in the Old Hill locality, and it was agreed to continue the levies to support men who are not receiving from employers the 3s. per thousand rate.

At a meeting of the South Staffordshire Mines Drainage Commissioners, held yesterday in Wolverhampton, a resolution was passed requiring every occupier of a mine within the drainage area to make a return of the number of acres of mine occupied by him, and of the number of tons of mineral raised by him during the past half-year. Upon the return, when obtained, will be levied a surface drainage rate to carry on the surface works.

At a meeting of the colliers employed by the Sandwell Park Colliery Company, Limited, it has been resolved to continue working upon the same principle as before, and not to be brought within the provisions of the Employers' Liability Act. The men thus decided to adopt the same course as has been taken by the miners in the occupation of the Earl of Dudley. On Tuesday a large meeting of the colliers of Coseley and the surrounding district was held, at which it was determined to start a permanent relief fund on the basis of the Cannock Chase scheme.

At the annual meeting of the Bilston Gas Light and Coke Company, held during the week, it was stated that the trade of the district had improved, and that five million cubic feet more gas had been consumed during the twelvemonth than during the previous year. A profit of £3600 had been made on the year's working, which permitted of an 8 per cent. dividend. Special attention, the directors said, had been given to the distributing plant; that plant was now almost perfect, and had resulted in a considerable diminution in the unaccounted-for gas.

The Water Committee of the Birmingham Corporation are about to obtain tenders for the construction of a storage reservoir at Shustoke, with a capacity of 400 million gallons.

During the week the Wolverhampton Tramways Company have been making trial trips upon one of their lines with a steam locomotive from the Loughborough works of Messrs. Hughes. The engine is neither so long nor so high as the passenger car. All the works, with the exception of the necessary levers, gauges, &c., are covered in. There is no fire to be seen from the outside, and but little steam is emitted. The engine is so constructed that, instead of a turntable being required to reverse it for a return journey, the driver has simply to change ends. An alteration of the position of the car must, however, be effected by shunting. There is a conspicuous absence of jolting in the passage over points, when the car is drawn by steam, and the experiments were generally considered satisfactory.

Messrs. Tangye Brothers, the engineers, of Cornwall Works, Soho, Birmingham, have now handed to the Mayor of Birmingham the magnificent donation of £10,000, which they lately promised towards the Birmingham Art Gallery. The mayor communicated this fact to the Town Council on Tuesday, and the warmest thanks of the Corporation have been conveyed to the donors.

The aggregate of iron turned out at the mills and forges and at the blast furnaces in South Staffordshire during 1880 has been an increase upon the production of 1879. Although the American demand which set in with the autumn of the earlier year fell off after the first two months of 1880, yet other customers have stepped in and have bought much more than they did in 1879. But at the same time that activity has been spread over a wider area than before, the twelvemonth's business cannot be spoken of as satisfactory. Productive machinery has been only irregularly employed, and prices have fallen considerably—though not to a lower point than before the United States commenced buying.

The Earl of Dudley's common bars were priced when the year opened at £9 12s. 6d., and the bars of the other "list" firms at £9. These quotations were an advance upon those of the previous Christmas of 20s. per ton. Sheets of the same makers were quoted at £10 to £11, and boiler plates £10 10s. to £11. No great amount of business was, however, done at these increased prices; and throughout the January quarter the marked bar works were running only about one-half to two-thirds time. Medium quality bars sold at £8 10s. to £8, and the common sorts were, during part of the quarter, obtainable at £7 10s., but the price was not general. No branch was better occupied than galvanising sheets, and this activity has been more or less apparent during the whole year. Indeed, sheets of this description never occupied a more prominent relative position in the South Staffordshire trade than they do now. Sheets (singles) during the three months that opened the year were mostly priced at £11 to £10. Hoops, strips, and bars were being rolled in large quantities on American account during January and February. A considerable decline in trade took place in the fourth and fifth months of the year; and before June set in marked iron saw a drop of £1 per ton, which brought bars down to £8, sheets £9 10s. to £10, and plates £10. Simultaneously a reduction of £2 per ton took place upon tinned sheets. Common bars, before the reduction, were selling at less than £7 per ton, and sheets singles at from £8 to £9. Business became worse during June, and short time marked operations at most of the works. Common bars, when July had set in, fell to between £6 10s. and £6, and sheets to between £7 15s. and £7 10s.

In the July quarter trade rallied a little, but not to a sufficient extent to perceptibly strengthen quotations. There was no relief, however, in the dulness of business in marked iron, and before July expired two of the list firms brought their quotations down to £7 10s. for bars. More than two months elapsed before the other firms followed suit, and dropped prices 10s. The Earl of Dudley's bars now became £8 2s. 6d., and those of the other firms £7 10s. Best sheets became £9 10s., and plates £9 to £9 10s. The list of one of the public iron-making companies issued at this time showed a drop on some sections of bars, upon their prices of May, of 20s. and 30s. per ton.

The closing two months of the year left matters pretty much where they previously stood. The inactivity in best bars, which has been noticeable nearly all the year, has continued, and so, too, has the dulness in boiler-plates. Galvanising sheets are the only branch that exhibits a prosperous demand. Medium and common bars are selling fairly, the latter at £6 to £5 15s. Upon the wages boards accountants' showing, the net average price obtained for bars of all kinds during March, April, and May last was £7 17s. 10d.; during June, July, and August last, £6 19s. 8d.; and during Sept., Oct., and Nov., £6 15s. 6d. Thus, it will be seen, prices have steadily fallen.

Pig iron of Shropshire and Staffordshire best make commenced the year at £4 to £4 10s. per ton for hot blast, and £5 to £5 10s. for cold blast sorts. Cinder pigs were quoted £3 to £2 15s. It was during this, the Lady-day, quarter that Staffordshire pig-makers did the best business of any time during the whole twelve months. The furnaces blowing numbered 63—an increase of 28 upon the previous November. Hematites have figured conspicuously on our Exchanges during 1880, but the prices have been mostly too high to encourage a good business. During Lady-day quarter they were quoted by makers' agents at the prohibitive figure of from £6 10s. to £7, consequent upon the demand at the furnaces which sprang up at the American revival.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—During the week business has been too much influenced by the holidays to afford trustworthy basis for an accurate judgment as to the real condition of trade, but the year has opened under encouraging circumstances. There is a general belief in the substantial improvement in the iron trade, and there was a strong market at Manchester on Tuesday. In some cases higher prices were asked, and sellers as a rule were very cautious about committing themselves to long forward engagements. Consumers in this district being mostly well covered for their present requirements the inquiry is chiefly confined to forward delivery, but as buyers are not willing to pay, and as sellers are disposed to hold for a premium upon present rates for extended periods, any large amount of actual business is for the moment being held in check.

Lancashire makers of pig iron decline to go beyond the end of the next three months, but for this period they are still selling at late rates, their quotations for delivery into the Manchester district being 46s. 6d. for No. 4 forge, and 47s. 6d. for No. 3 foundry, less 2½ per cent. Some of the Lincolnshire makers have this week advanced their prices, and for delivery equal to Manchester forge qualities are being quoted at about 47s., and foundry numbers 48s. to 48s. 6d. per ton, but there are still sellers at 1s. to 1s. 6d. per ton under these figures. Middlesbrough iron is nominally quoted at about 49s. 10d. to 50s. 4d. per ton net cash, but North-country brands do not find many buyers here at these prices. Local producers of hematite are anticipating a very successful year in this particular branch, which, to some extent, is due to the expectation of a considerable American demand for raw and manufactured steel products, and I hear that an enlargement of the production is in contemplation.

In the finished iron trade a better tone is reported; it is exceptional where makers are now quoting under £6 per ton for bars delivered into the Manchester district, but there are still sellers who will take 2s. 6d. per ton under that figure.

In the coal trade business has to a considerable extent been suspended owing to most of the collieries having been closed during the greater portion of the week, and at many of them work has not yet been resumed. For round coals there has been only a moderate inquiry, but there has been a good deal of pressure for engine fuel, and for good slack higher prices are being obtained. The average quotations at the pit mouth are about as under:—Best coal, 8s. 6d. to 9s.; seconds, 7s. to 7s. 6d.; common house coal, 6s. to 6s. 6d.; steam and forge coal, 5s. 3d. to 5s. 6d.; burgy, 4s. 3d. to 4s. 9d.; and good slack, 3s. 3d. to 3s. 9d. per ton.

The Employers' Liability Act, which has come into force this month, has caused a very unsettled feeling throughout the coal trade of the district. At many of the collieries the men have consented to contract themselves out of the Act, on the condition of the masters increasing their subscriptions to the relief funds, but there are large numbers of the miners who decline to enter into any such arrangement, and numbers of the pits are at present stopped until some definite understanding is come to. In the meantime the uncertainty which attaches to their liability under the Act naturally causes colliery proprietors to be very cautious about entering into forward engagements until they can arrive at something like a definite conclusion as to the conditions under which they will have to conduct their business. The trade is also further disturbed by the agitation for an advance of wages which threatens to still further interfere with work at the collieries.

The recurrence of serious floods in the Salford district caused by the overflow of the river Irwell, as a consequence of the recent heavy rains, has brought this matter again under public notice, and the new Springfield-lane Bridge, to the completion of which I referred a week or two back, has come in for some criticism as having contributed towards the serious character of the flood. This criticism has been fully met by Mr. Arthur Jacob, the borough engineer, by whom the bridge was designed, and he urges "that nothing short of abstracting one-third of all the flood water will ever render property owners secure, and obviate such disasters as the floods of 1866 and 1880." The question was also brought before the Salford Town Council on Wednesday, when one of the members proposed a resolution to the effect that the Government should be requested to appoint special commissioners for the purpose of considering the advisableness of widening and deepening the bed of the river between Salford and Runcorn, so as not only to admit vessels of moderate tonnage, but by making the Irwell a tidal stream prevent the recurrence of such disastrous floods. The proposal was, however, postponed until the next meeting of the Council.

Barrow.—The new year opens with much better prospect in the hematite pig iron trade than has been experienced for some time, and already the indication of this increased prosperity in the iron trade is beginning to manifest itself. With the spring there is not the slightest doubt we shall see a very good business done, and the opinion gains ground in well-informed circles, and by people not given to taking too sanguine a view of things, that not only is trade about to revive, but that we shall have a very brisk and steady time, and at the same time will prove to be a firm and sound revival. Producers are well employed, and their output is larger; home deliveries on a good scale are being made. The inquiries from America and the Continent are well maintained, and buyers from these places are showing a disposition to place contracts in the hands of makers, and there are visible signs that the demand from abroad will shortly be very large. The home demand is also good, and a healthy outlook characterises the market. Prices are unchanged, makers being very firm. The steel mills are well employed. There is a large production of steel, and at Barrow the production of Siemens steel is likely to keep them busy. Good inquiries for steel are being made. Shipbuilders are very busy, and are likely to continue so for some time. Engineers and others engaged in the different industries are also well supplied with work. Shipping fairly employed. Iron ore is in good request at from 12s. 6d. to 16s. 6d. per ton.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

WORK has now been generally renewed after the holidays, except in the case of those establishments which have taken advantage of this period to make extensive additions to their machinery and plant. Conspicuous among the companies who are showing great enterprise in extending and improving their appliances, are Messrs. Steel, Tozer, and Hampton, Phœnix Bessemer Works, the Ickles, Rotherham. The output of this firm during the year that has expired has been from 15,000 to 20,000 tons greater than it was in 1879. At present the works are capable of turning out 2000 tons per week. The proprietors are about to lay down new machinery—including a cogging mill, which is being carried out by Messrs. Davy Brothers, Park Ironworks—by which their output will be doubled. The additions comprise what was expected to be, when completed, the largest Bessemer blowing engines in the world. The engines consist of a pair of high-pressure condensers, with cylinders 6ft. in diameter and 6ft. stroke. In the new cogging mill the engines will be of similar dimensions. Ingots weighing about a ton each will be rolled into three lengths of rails.

Rail orders of any magnitude have been rather scarce of late, and rates continue low. Of the 29,950 tons of steel rails ordered by the New South Wales Government, only 7000 tons were given to Sheffield, the successful company being Messrs. Charles Cammell and Co. The rest have gone to Messrs. Bolckow, Vaughan, and Co., Middlesbrough; Ebbw Vale; and another firm. Messrs. Wilson, Cammell, and Co., Dronfield Steel Works, have, I hear, just secured another order for steel rails for India—for the Oude and Rohilkund Railway. The order is only for some 4000 tons, and the price is stated at £6 6s., delivered in London.

At the Parkgate Ironworks, the mills, forges, and blast furnaces are fairly well employed. There is a good demand for blast and merchant iron, though prices are weaker than they were this time last year. At the Northfield Ironworks the tire department is slack; the rolling mills are languid, builders' castings are still fairly inquired for, though in girders Belgium still holds her supremacy.

Stove-grates have of late years rapidly increased in importance as one of the district trades. It is one of the oldest of our industries, and has been conducted with great energy. In Rotherham the business is equally vigorously pursued. At the Masborough Stove-grate Works, Messrs. W. Corbitt and Co., Limited, have recently had some excellent orders for Australia. The colonists prefer the Queen Anne style of grate. A number of engraved burnished steel stoves of the seventeenth century pattern have recently been finished for a nobleman in the South of England. Among the company's most recent customers have been his Royal Highness Prince Leopold and Count Gleichen. The various firms engaged in this trade find that, in consequence of the spread of art education, customers are more exacting than in former years, and anything like activity in the trade can only be maintained by enterprise and taste in the production of new patterns.

The railway wagon trade continues brisk, chiefly for Scotch companies, notably the North British. A noticeable feature in the railway material trade is the frequency of foreign inquiries which would appear to indicate that railway speculation is once more making some progress abroad.

The reduction of 3d. per ton on puddlers' wages in Staffordshire also affects the Yorkshire district. The net average price of bar iron sold by the twelve selected firms in September, October, and November was £6 15s. 6·65d. per ton; during the previous quarter the price was £6 19s. 8d. The wages now paid to puddlers will be 7s. 3d. per ton, a reduction of 3d. per ton on the previous quarter. Millmen's wages will be reduced $2\frac{1}{2}$ per cent.

Alarming telegrams are flying over the country about a projected strike of over 20,000 miners in South Yorkshire. I have been over most of the South Yorkshire district during the last fortnight, and have talked freely both with coalowners and colliers. The former declare they will not concede the 10 per cent. advance asked for by the men, while many of the latter state that they signed the demand because the union have resolved upon it—adding, "We know it's only a farce." If the union make up their mind, however, that the men must come out, the men and masters may alike find that it is more than a farce.

Cutlery and general hardware trades remain as in my last report. A good business generally doing, and excellent prospects for the new year.

Students of the Sheffield School of Art have been very successful in the recent competitions in London. The Goldsmiths' Company have awarded a prize of £20 to Mr. Robert Needham for a design for a kettle and stand; the proprietors of the *Art Journal* have given a prize of £5 to Mr. Alfred Pearce for a design for a salt-cellar; and the Royal Academy have awarded an extra medal for painting a head from the life to Mr. Cecil Sykes, who was a student at Sheffield before he removed to London.

Messrs. Brown, Bayley, and Dixon, Limited, the Sheffield Steel and Ironworks, convened a meeting of their creditors on Wednesday. A statement of accounts submitted by Mr. Peat, accountant, London, showed the liabilities to amount to £263,949, and the assets to £120,246, equal to 9s. in the pound if the works were broken up. The directors recommended voluntary liquidation, and this course was approved of by the creditors, who appointed Mr. J. H. Barber, the secretary of the company, and Mr. Peat, accountant, London, joint liquidators. A committee was also appointed to confer with the liquidators and directors as to the continuance of the business of the company, and to consider any scheme of compromise between the company and the creditors. A meeting of shareholders is called for the 7th.

Dr. Webster, the American consul, completed his return of Sheffield exports to the States for 1880 on Wednesday evening. The total for the year is £1,075,242, as compared with £671,739 for 1879, which shows the reality of the revival of Sheffield trade with America.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

COMPARATIVELY little work has been done this week in connection with the iron trade, owing to the new year holidays, which are observed in Scotland instead of Christmas as in England. The markets have been closed a part of the week, and the works for several days, so that there is less to note in this correspondence than usual. Since Christmas-day 2908 tons of pigs have been added to the stock in Messrs. Connal and Co.'s stores, which now amounts to 498,758 tons. There are 124 furnaces in blast, as compared with 100 at the same date last year, and the weekly output is estimated at about 25,000 tons. Advices from America have not been quite favourable of late; but owing to the excitement and strength in the warrant market resulting from the satisfactory nature of the annual statistics, the prices of makers' iron are generally better, and in some cases substantial advances have been made.

The warrant market was closed on Friday afternoon and on Monday. It opened very strongly amid no little excitement on Tuesday, when a large business was done from 54s. one month, and 53s. $10\frac{1}{2}$d. cash to 53s. $3\frac{1}{2}$d. cash, and 53s. 5d. one month. On Wednesday business was done from 53s. 3d. to 53s. 1d. one month and 53s. $1\frac{1}{2}$d. to 52s. $10\frac{1}{2}$d. cash, and at 53s. cash and 53s. 2d. one month. The market was firm to-day —Thursday—from 53s. to 53s. 3d. fourteen days and 53s. 1d. cash.

It may be of some consequence to note that during the past year the United States took from us 234,343 tons of pigs as against 139,497 in 1879, and 15,961 in 1878; Germany, 65,459 against 73,811 in 1879, and 63,135 in 1878; British America, 49,246 against 21,956 in the preceding year; Holland, 38,756 against 48,365; Italy and Austria, 32,305 against 24,515; France, 25,468 against 23,936; Russia, 23,029 against 22,642; Belgium, 10,474 against 10,888; Denmark, Sweden, and Norway, 8078 against 8869; Spain, Portugal, Gibraltar, and Malta, 8496 against 8784; Greece, Turkey, and Egypt, 911 against 1011; South America, 3620 against 3030; West Indies, 200 against 121; East India, China, Japan, Australia, &c., 19,802 against 15,782; and Africa, 178 against 85 tons.

It is so far satisfactory to note that in the closing months of the year, when the demand for America was not so good as it had been earlier in the season, there sprung up an improved general inquiry from other parts of the world. The highest price reached in the course of the past year by mixed numbers of warrants was on the 12th January, when the figure was 73s. 3d., and the lowest on 2nd June, when it was 44s. 5d., that is, taking the weekly averages.

The production of malleable iron during the year was the largest on record, being 292,000 tons, as compared with 222,000 in the preceding year. Our best customers were the East Indies, and next best the United States. A very large proportion of the malleable iron made was used up at home, chiefly in connection with the shipbuilding trade.

Last week's shipments of iron manufactures from the Clyde embraced £9600 worth of machinery, of which £7225 were locomotives for Bombay, and £1845 for Calcutta; £4620 sewing machines, of which £2475 were dispatched to Santandar, £1070 to Marseilles, £565 to Calcutta, and £510 to Antwerp; £5500 manufactured irons, of which £1300 were castings for Santandar, £1310 castings for Port Natal, £1109 steel goods for New York, £815 for Calcutta, and £650 for Bombay.

The coal trade, which was backward during the greater portion of the year, has of late begun to show some improvement, and better things are anticipated. In a letter to the Scotch miners' delegates, read at a private meeting in Glasgow on Monday, Mr. Macdonald, M.P., says he is free to confess that the same strength has not yet been shown among the Scotch coal districts as among the English and the Welsh. He attributes this to over-competition; but he considers that if they keep wise men at their head, they may better their position in the course of the present year.

The past year's shipbuilding on the Clyde amounted to 218 vessels, with an aggregate tonnage of 241,668, as compared with 177 vessels of 180,576 tons in 1879.

The year's work is the largest since 1874, and is exceeded only by that year and by 1873 in the history of the trade. There has never been so much tonnage on hand at the beginning of any previous year, there being 180 vessels of 318,789 tons in course of construction.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

A CONSIDERABLE change has come over the Middlesbrough pig iron market during the last week. The announcement that the result of the yearly stocktaking at Glasgow was a decrease of 6000 tons, seems to have produced no small amount of speculation for a rise. By impulsive competition an upward movement was actually brought about, and Glasgow iron went up to 53s. 9d. In sympathy with this the Middlesbrough market also gradually rose during the week until on Tuesday morning, 42s. 6d. was paid for delivery over the first quarter, and 42s. for prompt. Some sellers even demanded 42s. 9d. This was a total rise of 3s. to 3s. 6d. per ton during the week. News having arrived from Glasgow that there were signs of a reaction there, prices became easier towards the close of the market. Connal's warrants are still in good demand, and fresh paper is being issued every day for the additions which are being made to the quantity in the store. These additions have amounted during the week to 3737 tons, an unusually large quantity. The total stands at present at 127,890 tons in the Middlesbrough, and 498,353 tons in the Glasgow store. The Cleveland Ironmasters' statistics for December have just been issued — Wednesday noon—with the following result, viz.:—Increase for December: In makers' stocks, 2976; in makers' stores, 5981; in public stores, 10,042; total increase of stocks, 18,999. Two more furnaces have been blown in during the month, but three have been put on hematite instead of Cleveland iron. This will reduce the make of Cleveland pig by about 2000 tons, and increase the make of hematite by about 7000 tons monthly. The general result is looked upon as disappointing to sellers, who expected an increase of not more than 10,000 tons for the month. It at once had a depressing effect upon the market, and the price has fallen to 41s. 6d. sellers, and no offers from buyers. Manufactured iron continues firm, on account of the rise in pig and the additional difficulty of buying forward. Plates may be considered to be really £7 per ton at works, though nominally 5s. less. Bars and angles are quoted at £6 per ton. The price of coal is rather flatter, partly owing to the continuance of mild weather, and therefore lessened demand for household purposes, and partly because of the lessened consumption at the manufactured ironworks on account of Christmas holidays.

A strike has taken place at Messrs. Richardson and Spence's shipyard at South Stockton. The platers' helpers demand $7\frac{1}{2}$ per cent., and the carpenters 4s. per week advance. The men consider they are underpaid compared with other yards. The firm have offered to grant the advance from February 1st, but this offer has not yet been accepted, and the strike continues.

Messrs. Bolckow, Vaughan, and Co. have just obtained a new contract for steel rails. A total of 29,350 tons were required for New South Wales. The order has been divided between the above-named firm, C. Cammell and Co., Sheffield, and two other firms. The prices is said to be £6 5s. per ton f.o.b.

The following is an epitome of the iron shipbuilding statistics for 1880, compared with the same for 1879:—

	No. of ships.	Tonnage.
1880.		
Tyne	109	149,082
Wear	77	116,227
Hartlepool	30	47,511
Tees	38	48,506
1879.		
Tyne	130	139,843
Wear	65	92,176
Hartlepool	20	27,644
Tees	25	31,756

It would appear from the above that on the Tyne the average tonnage per ship has largely increased since 1879.

The Port Commissioners at Sunderland have agreed to advertise for tenders for the execution of work connected with the improvement of the River Wear at the North Ferry landing. They have also decided to invite loans for £100,000, at a rate of interest not exceeding $4\frac{1}{2}$ per cent. to enable them to proceed with the work. The expenditure of sums such as this in useful enterprises is likely to help forward the much-coveted revival of trade in a genuine and wholesome manner.

The General Purposes Committee of the Middlesbrough Town Council have been considering a notice recently given by the North-Eastern Railway Company to take off, from the 1st inst., a certain rebate of $7\frac{1}{2}$ per cent. allowed on dues for mineral traffic. This rebate is the residue of a larger one which was allowed during the recent depressed times, in consideration of the unremunerative condition of the iron trade, and of the lower cost at which railways could be worked. The company contend that trade has now revived, and the full rates ought to be paid. The ironmasters, on the contrary, point to the extremely low prices they are still compelled to take; to the fact that they have given away all advantage so far to workmen, and in other ways; and say that they really cannot afford to be come upon so soon. They also point to the high dividends recently paid, and likely to be paid, by the railway company, and that they, as public trustees, should not stifle the trade of the district in order to augment, for the benefit of already prosperous shareholders, their already unusually high dividends. A similar course has been taken by the Middlesbrough Chamber of Commerce. It remains to be seen what success will attend these efforts.

The keenness with which the shares of the new Hull and Barnsley Railway were competed for appears not to have escaped the notice of the numbers of professional "getters up" of limited companies, who for several years must have had but a sorry time of it. Since 1876 prospectuses have, I suspect, almost invariably been consigned to the waste-paper basket, no matter whose names were upon the directorate, and no matter what percentage of profits was promised. Indeed, the British public having suffered terribly was uncommonly shy. The list of new companies in our leading newspapers, previously so long and often so amusing, dwindled gradually down until only an odd one now and then was mentioned. But the authors of many a bubble scheme must not be supposed to be dead. They have only been sleeping. What happened as regards the Hull and Barnsley Railway will not escape the observation of such adventurers, and the British investor must now begin to look out lest history should be about to repeat itself in this respect. Most likely the new companies which are beginning rapidly to be evolved will be sound in the main for a time. But we shall also see before very long a plentiful supply of the old familiar air-castle sort. Investors beware. The greatest possible danger lies in the common habit of following others blindly into adventures without the trouble of a full, complete, and personal sufficient investigation. Those who will take no trouble, deserve no profit. They are very likely to get a heavy loss to boot. At all events the unfortunates who found the money which was so freely wasted in multitudinous directions between 1871 and 1874, deserve no quarter, if they should be caught in the same way between 1881 and 1884.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

THE great feature of the week has been the action of the colliers in reference to the Miners' Fund, and I am glad at length to chronicle their awakening to the need of doing something. I have thought for a long time that the colliers would not do anything until the public sympathy became less practical. Gethin was so bountifully subscribed to that its funds will outlast the longest lived. Abercarn was similarly richly aided; but Risca could not get sufficient; Dinas will be run out in the course of twelve months, and the total of Penygraig so far—and it seems to have come to an end—amounts only to £16 per recipient. It is evident from this that the public wish to rouse the colliers to act for themselves, and action has begun at last. The colliers have been busily discussing it this week, and object to the 3d. per week. They had understood that 1d. a week would suffice, and as they already subscribe to local funds and benefit meetings, this 1s. a month will be too great a tax. This is their argument, and it seems a reasonable one. I have all along contended for the 1d. a week. The charge of 3d. is based on only a proportion subscribing. My theory is, legislative enactment; 1d. a week to be stopped from wages from all employed at a colliery; owners to contribute 5 per cent. and landlords $2\frac{1}{2}$ per cent. on totals of colliers' contributions, and I am glad to find that many leading gentlemen connected with this large industry support this view. There must be one great institution. Why not try the voluntary 1d.? the public would aid such a fund in event of any great calamity. This 3d. a week will never become general, and we shall have the same inefficient local funds and benefit societies along with it, and neither powerful enough to meet a great disaster.

Mr. W. T. Lewis and Mr. Galloway descended Penygraig coal-pit this week, and minutely examined the workings. At the sale of Penygraig pit, known by the same name, but not connected with the scene of explosion, Mr. Lewis was the purchaser for £16,500. There was a spirited bidding, the colliery being a valuable one, with coke ovens and a quantity of plant.

With regard to the Liability Act, which came into operation this week, the men are divided in opinion as to "contracting themselves out of it" as some of the employers suggest. By the clause added to the Act in committee the colliers or ironworkers, or any class of workmen can do this. Employers in some parts of Wales have offered 50 per cent. towards forming an accidental fund; and the Llynvi Company as much as 25 per cent. if their workmen will contribute $2\frac{1}{2}$d. per week, and "contract."

In another week or two some progress will be made towards a settlement. At Llynvi the men have taken time to decide. Meetings have been held at Dowlais, Cyfarthfa, and Plymouth. I hear good news from Cwmavon. It is reported that the works, employing two thousand hands, are to be formed into a strong company with very likely the tin works again added. Mr. Shaw's health has given way seriously, and necessitates his retirement for a time.

The iron and steel trades are still buoyant; prices about the same, with an upward tendency. Good orders for the United States are on hand, and on the whole, what with home and foreign demand, the signs are healthy for a good continuance.

An engineman at Cwmavon, has been committed for manslaughter, charged with having caused the death of an overman by reckless winding.

The total coal exports from Wales last week amounted to 125,000 tons, of which Cardiff sent 89,000. Newport showed a falling off, Swansea was fairly sustained, but business at all the ports is scarcely up to December work. In iron shipments there has been but little done, some few cargoes to America, principally South, and a large consignment of iron pipes to Caligari from Newport, Mon. One cargo for New York was composed of 300 tons pig, a large quantity of blooms and 100 tons tin-plates.

The tin-plate trade continues dull. Notice of a reduction of wages has been posted at the Vernon Iron and Tin-plate Works of D. Morris and Co., to come into operation February 1st.

Operations in the ocal trade continue of an active character, and in the house-coal district new sinkings are the order of the day. This is the case at Holly Bush, Argoed, and Blackwood. An early re-start is likely at the Parkend collieries, Forest of Dean. This will employ 700 men.

The French trade has fallen off of late with Cardiff, but there are hopes of a revival. The Newport Abercarne Colliery Company, Limited, has announced an interim dividend of 5 per cent. A dispute at the Great Western Colliery has been brought to a satisfactory conclusion, but there are still points of disagreement pending which have to be discussed and settled.

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 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 of the agent is printed in italics.

28th December, 1880.

5445. VALVES, T. Meacock and A. W. C. Ward, Chester.
5446. ORDNANCE, Sir W. G. Armstrong, Newcastle.
5447. PURIFYING STEAM, J. F. Belleville, Paris.
5448. BICYCLES, &c., I. T. Townsend, Coventry.
5449. SIGNALLING, W. B. Barker, Hoboken.
5450. MECHANICAL CARRIAGE, *W. E. Gedge*, London.
5451. MASH COOLING APPARATUS, *W. Brierley*, Halifax.
5452. STAYS OR CORSETS, *W. R. Lake*, London.
5453. ARTIFICIAL EAR DRUMS, H. P. K. Peck, Cincinnati.
5454. SKYLIGHTS, A. Forbes, Govan.
5455. SHIPS, &c., F. H. Danchell and R. Blum, Paris.
5456. ROTARY PUMPS, G. Waller, Surrey.
5457. REVOLVING FURNACE, *B. J. B. Mills*, London.
5458. HEAVY ORDNANCE, *B. J. B. Mills*, London.
5459. MACHINE GUNS, *B. J. B. Mills*, London.
5460. PIRNS OR SKEWERS, *A. W. L. Reddie*, London.
5461. PRINTING MACHINERY, W. C. Kritch, Leeds.
5462. ROPEMAKING MACHINERY, *A. M. Clark*, London.
5463. STAINING WOOD, *E. A. Brydges*, Berlin.

29th December, 1880.

5464. FURNACES, J. Jackson, Liverpool.
5465. RAISING SUNKEN VESSELS, W. Atkinson, London.
5466. TRANSFERS, A. E. M'Donald, New York.
5467. DESTROYING MICE, *H. A. Bonneville*, London.
5468. OPENING, &c., DAMPERS, R. Waller, Leeds.
5469. MOULDING, *F. Wirth*, Germany.
5470. CARRIAGES, W. Andrews, Birmingham.
5471. GAS MOTOR ENGINES, R. Hutchinson, London.
5472. GLAZING, C. F. Elliott, Liverpool.
5473. WINDOW SASHES, J. Terry, R. Judson, and G Smith, Keighley.
5474. OIL, &c., CAKES, C. Eskrett & W. H. Searle, Hull.
5475. ORNAMENTING PLASTIC MATERIALS, *W. P. Thompson*, London.
5476. TREATING EXCRETA, R. Hoodless, Ormskirk.
5477. SADDLE BARS, Sir T. Dancer & E. Chappell, Wilts.
5478. AMMONIA, *H. A. Dufrené*, London.
5479. MOTIVE POWER, J. Graddon, Kent.
5480. PUMPS, *A. M. Clark*, London.
5481. SOFA BED, R. E. Parr, Greenwich.

30th December, 1880.

5482. TELEPHONIC APPARATUS, C. J. Wollaston, London.
5483. WHEELS, J. Trippett and T. Walton, Sheffield.
5484. PUMPING APPARATUS, E. H. Greeven, London.
5485. WATERPROOF CLOTHING, J. Neville, London.
5486. CUBES OF SUGAR, &c., G. Jager, jun., Liverpool.
5487. WINDING YARNS, J. Grayson, Leeds.
5488. LIFE-SAVING APPARATUS, *J. Wetter*, London.
5489. STEAM ENGINES, H. Davey, Leeds.
5490. ILLUMINATED CLOCKS, C. H. Leycester, S. Wales.
5491. WEB PRINTING MACHINES, J. Foster, Preston.
5492. RECIPROCATING MOTION, H. M. Brunel, London.
5493. FLANGING BOILER PLATES, R. H. Tweddell, London, J. Platt and J. Fielding, Gloucester, and W. Boyd, Newcastle-upon-Tyne.

5494. SUSPENDING FABRICS, &c., G. Allix, London.
5495. REGULATING AIR, R. Burchell, Kettering.
5496. CENTRIFUGAL MACHINES, R. Lafferty, Gloucester.
5497. FIRING APPARATUS, A. M. Maude, London.
5498. TREATING CAST IRON, J. J. Shedlock, Uxbridge.
5499. COMPOUNDS, I. R. Blumenberg, London.

31st December, 1880.

5500. PREVENTING SHIFTING of CARGOES, J. Goudie, East Hartlepool.
5501. FASTENERS, H. Fletcher, London.
5502. VALVES, N. Foley, Jarrow-on-Tyne.
5503. UMBRELLA STRETCHERS, J. Smith, Birmingham.
5504. SULPHATE of AMMONIA, *W. L. Wise*, London.
5505. STEAM TRAPS, H. Lancaster, Pendleton.
5506. PLOUGHS, &c., *H. J. Allison*, London.
5507. MOULD CANDLES, W. E. Nutt, Hounslow.
5508. FEEDING APPARATUS, W. Fox and J. Hall, Leeds.
5509. CHIMNEY PIECES, J. H. Corke, Southsea.
5510. SAFETY VALVE, T. Sturgeon, Newlay, and J. W. de V. Galwey, Warrington.
5511. VELOCIPEDES, J. Starley, Coventry.
5512. DRAIN PIPES, *W. R. Lake*, London.
5513. GAS, P. J. Wates, Balham.
5514. TORPEDOES, C. A. McEvoy, London.
5515. CRUCIBLES, &c., A. Landsberg, Stoberg.
5516. PRODUCING DESIGNS on WOOD, A. Guattari, Paris.
5517. TREATING PORK, *A. M. Clark*, London.

1st January, 1881.

1. VENTILATING APPLIANCE, G. D. Robertson, London.
2. MECHANISM, E. Underwood, Birmingham.
3. FLOOR SPRINGS, E. Bull, Halifax.
4. SHAPING, &c., HAT BRIMS, T. Rowbotham, Chester.
5. CARTRIDGES, *F. Wirth*, Frankfort-on-the-Maine.
6. COMMUNICATING APPARATUS, H. Morris, Manchester.
7. FLOORS or SURFACES, R. L. Rylance, Blackburn.
8. ROASTING COFFEE, &c., W. Parnall, Bristol.
9. RAILWAY VEHICLES, *H. H. Lake*, London.
10. PHOTOGRAPHIC PRINTING, *A. M. Clark*, London.
11. COMPRESSING AIR, *F Wirth*, Germany.
12. MOTIVE-POWER ENGINE, G. O. Topham, London.

3rd January, 1881.

13. LITHOGRAPHIC MACHINES, G. Newsum, Leeds.
14. PORTABLE FURNACES, J. Tenwick, Spittlegate.
15. ELEVATORS, W. Dover, Liverpool.
16. SCREW STEAMSHIPS, T. F. Irwin, Liverpool.
17. YEAST, S. Fulda, London.
18. TIP-WAGONS, &c., G. Allix, London.
19. BOOTS, Col. E. Harnett, Aldershot.
20. DENTAL ENGINE, P. Shaw, Manchester.
21. FIRE EXTINGUISHER, *O. Wolff*, Dresden.
22. CAST IRON ARTICLES, *C. F. Claus*, London.
23. COUPLING APPARATUS, *H. H. Lake*, London.
24. SECURING PICTURES to WALLS, *H. H. Lake*, London.
25. SHEARING MACHINES, *J. H. Johnson*, London.
26. WEIGHING APPARATUS, *J. H. Johnson*, London.

Inventions Protected for Six Months on deposit of Complete Specifications.

5447. PURIFYING STEAM, J. F. Belleville, Paris.—*28th December* 1880.
5475. ORNAMENTING PLASTIC MATERIALS, W. P. Thompson, Lord-street, Liverpool.—*29th December*, 1880.

Grants and Dates of Provisional Protection for Six Months.

3904. JEWEL, &c., CASES, T. Heath, Hylton-street, Birmingham.—*27th September*, 1880.
4686. SIGNALLING on RAILWAYS, W. W. Biddulph, East Sheen.—*13th November*, 1880.
4720. GENERATING HEAT, J. M. Forbes, jun., Cornhill, London.—A communication from B. N. Huestis, Shanghai.—*16th November*, 1880.
4832. WOODEN PAVEMENTS, E. Young, High-street, Steyning.—*22nd November*, 1880.
4888. WASHING MACHINES, A. G. Collings and F. Bryant, Wimbledon.—*24th November*, 1880.
5068. TELEPHONIC APPARATUS, J. N. Culbertson, Holborn Viaduct Hotel, London, and J. W. Brown, Upper Kennington-lane, London.—*6th December*, 1880.
5074. MINERS' SAFETY LAMPS, E. Robathan, Risca.—*6th December*, 1880.
5100. REGULATING GAS, H. Barlow, Fleet-street, London.—*7th December*, 1880.
5118. WORKING HOBBY-HORSES, &c., A. Waddington, Bradford.—*8th December*, 1880.
5120. HOLDING, &c., WINDOW BLIND CORDS, C. E. Gibson, Birmingham.—*8th December*, 1880.
5122. GAS GOVERNORS, W. Cowan, Edinburgh.—*8th December*, 1880.
5126. VALVES, J. A. Mays, Great Winchester-street, London.—*8th December*, 1880.
5128. COUPLING APPARATUS, W. Pollard, Burnley.—*8th December*, 1880.
5130. GAS MOTOR ENGINES, J. Livesey, Victoria-chambers, Westminster.—A communication from F. H. W. Livesey, Calais.—*8th December*, 1880.
5132. TREATING HOP PLANT, T. J. Wall, Laura-place, Southampton.—*8th December*, 1880.
5134. PRODUCING LIGHT, &c., F. Wilkins, Southampton-buildings, London.—*8th December*, 1880.
5136. SHAFT COUPLINGS, A. M. Clark, Chancery-lane, London.—A communication from T. R. Almond, New York.—*8th December*, 1880.
5140. BOXES or CASES, F. S. Colas, Boulevard St. Denis, Paris.—*9th December*, 1880.
5142. BOBBINS, W. and J. Dixon, Steeton.—*9th December*, 1880.
5146. SULPHURIC ACID, W. Weldon, Rede Hall, Burstow.—*9th December*, 1880.
5148. FURNACES, &c., A. M. Clark, Chancery-lane, London.—A communication from S. W. Underhill, Croton Landing, U.S.—*9th December*, 1880.
5150. PREPARING MOULDS for CASTING, H. Gibbons, Kennet Ironworks, Hungerford.—*9th December*, 1880.
5154. WINDING GEAR, R. Hitchcock, Albemarle-terrace, Taunton.—*9th December*, 1880.
5156. GAS, A. P. Chamberlain, Finsbury, London.—*10th December*, 1880.
5162. TRANSMITTING, &c., APPARATUS, H. V. Hoevenbergh, Ludgate-circus, London.—*10th December*, 1880.
5166. STANDS for BOTTLES, J. E. Bingham, Sheffield.—*10th December*, 1880.
5168. IRON and STEEL, G. Ellinor, Sheffield.—*10th December*, 1880.
5170. WEIGHING MACHINES, &c., W. B. Avery, Birmingham.—*10th December*, 1880.
5174. DIGGING MACHINES, H. de Mornay, Queen's-gardens, Bayswater.—*10th December*, 1880.
5178. HORSESHOE NAILS, H. P. Fenby, Leeds.—*10th December*, 1880.
5180. ALKALI SALTS, J. A. Dixon, West George-street, Glasgow.—A communication from C. Koenig, Germany.—*11th December*, 1880.
5186. TRAM RAILS, J. Sharp and J. T. Tong, Bolton.—*11th December*, 1880.
5192. SPINNING MACHINERY, J. C. Fell, Ashton-under-Lyne.—*11th December*, 1880.
5194. FURNACES, D. and J. Warren, Glasgow.—*11th December*, 1880.
5196. SCREW CLAMPS, H. Metham, Church-street, Deptford.—*11th December*, 1880.
5198. GAS, W. L. Wise, Whitehall-place, Westminster.—A communication from V. C. Devolz, Paris.—*11th December*, 1880.
5200. TURNING OVER the LEAVES of MUSIC, M. Volk, Brighton.—*11th December*, 1880.
5202. STUFFING-BOXES, C. E. Hœger, High Holborn, London.—*13th December*, 1880.
5204. PAPER BAGS, &c., R. Woods, Manchester.—*13th December*, 1880.
5206. STEAM GENERATORS, H. J. Allison, Southampton-buildings, London.—A communication from J. Mac Nicol, Seraing, Belgium.—*13th December*, 1880.
5208. SHAKING STRAW, R. G. Morton, Errol Works, Perth.—*13th December*, 1880.
5212. ASHPANS, B. Banks, Leeds.—*13th December*, 1880.
5224. PRINTING MACHINERY, J. Davies, Bermondsey, London.—*13th December* 1880.
5226. TRANSMITTING TELEPHONIC MESSAGES, A. M. Frankenberg, Baltimore, U.S.—*14th December*, 1880.
5228. STRIKING, SCOURING, and FLESHING LEATHER, &c., E. Wilson, Exeter.—*14th December*, 1880.
5232. TUBE FASTENINGS, E. H. Bennett, Bayonne, U.S.—*14th December*, 1880.

Patents on which the Stamp Duty of £50 has been paid.

4914. TOOLS, &c., J. Hall, Chancery-lane, London.—*28th December*, 1877.
11. PREPARING WOOL, &c., D. Smith, Keighley.—*1st January*, 1878.
99. MANHOLE and SLUDGE DOORS, C. McNeil, jun., Glasgow.—*8th January*, 1878.
4945. FEED-WATER APPARATUS, W. R. Lake, Southampton-buildings, London.—*31st December*, 1877.
4948. RAILS, S. Aldred, Maryon-road, Charlton.—*31st December*, 1877.
397. BREECH-LOADING FIRE-ARMS, J. Purdey, Oxford-street, London.—*30th January*, 1878.
4939. SHEETING RAILWAY TRUCKS, &c., G. A. Walker, Danes-hill, near Retford.—*31st December*, 1877.
2. OPENING, &c., COTTON, &c., W. R. Lake, Southampton-buildings, London.—*1st January*, 1878.
36. KERITE COMPOUNDS, W. R. Lake, Southampton-buildings, London.—*2nd January*, 1878.

Patents on which the Stamp Duty of £100 has been paid.

58. ROTARY ENGINES and PUMPS, G. T. Bousfield, Sutton.—*5th January*, 1874.
74. ACTUATING BRAKES, J. Steel and J. McInnes, Glasgow.—*6th January*, 1874.
30. SCOURING, &c., FLUTED ROLLERS, R. A. Threlfall, W. Hamer, and J. Bond, Bolton.—*2nd January*, 1874.

Notices of Intention to Proceed with Applications.

Last day for filing opposition 21st January, 1881.

3477. GAS BURNERS, J. Haworth, Blackburn. — *27th August*, 1880.
3487. BOTTLE STOPPERS, J. Rettie, Hatton-garden, London.—*28th August*, 1880.
3498. IRON GRILLS, H. W. Perrers, Devonshire-hill, Hampstead.—*28th August*, 1880.
3501. COCKS and VALVES, J. C. Etchells, Newton Heath, Manchester.—*28th August*, 1880.
3502. SAFETY CASES, F. Cooper, Handsworth.—*28th August*, 1880.
3515. LUBRICATING APPARATUS, W. R. Lake, Southampton-buildings, London.—A communication from G. H. Flower.—*30th August*, 1880.
3532. CIGARETTES, G. F. Redfern, South-street, Finsbury, London.—A communication from E. Side.—*31st August*, 1880.
3577. CAGES, LIFTS, &c., M. Bauer, Paris.—A communication from L. Ricq.—*3rd September*, 1880.
3584. HYDROGEN, C. Hessel, Palmerston-road, Kilburn.—*3rd September*, 1880.
3659. STEEL WIRE CARDS, G. and E. Ashworth, Manchester.—*9th September*, 1880.
3730. GAS, A. Pope, Slough.—*13th September*, 1880.
3767. PACKING BRAN, &c., A. M. Clark, Chancery-lane, London.—A communication from W. L. Williams.—*16th September*, 1880.
4239. EXTINGUISHING, &c., FIRE, M. Windsperger and A. Schaedler, Finsbury-square, London.—*18th October*, 1880.
4864. SHARPENING, &c., MILLSTONES, P. Jensen, Chancery-lane, London.—A communication from P. Graham.—*23rd November*, 1880.
4980. HUSKING RICE, &c., J. H. C. Martin, Church-hill, Walthamstow.—*30th November*, 1880.
5041. SPINNING, &c., MACHINERY, B. A. Dobson and R. C. Tonge, Bolton.—*3rd December*, 1880.

Last day for filing opposition, 25th January, 1881.

3506. INCUBATORS, C. H. Dunn and H. T. Cartwright, Mile End, London.—*30th August*, 1880.
3508. FOLDING SEATS, &c., H. Kinsey, Swansea.—*30th August*, 1880.
3510. HEAT GENERATORS, J. H. Johnson, Lincoln's-inn-fields, London.—A communication from P. Gaillard, I. Haillot, R. Radot, and A. Lencauchez.—*30th August*, 1880.
3520. REVIVING SPENT STEAM, &c., H. A. Bonneville, Piccadilly, London.—A communication from J. Belou.—*30th August*, 1880.
3524. POLISHING SILVER, J. Beresford, Altrincham.—*31st August*, 1880.
3530. HEATING APPARATUS, F. Hart, Queen Victoria-street, London.—*31st August*, 1880.
3531. WINDOWS, &c., H. Brittain, Birmingham.—*31st August*, 1880.
3533. PROPELLING CARRIAGES, E. Edwards, Southampton-buildings, London.—*31st August*, 1880.
3537. DOVETAILING MACHINERY, W. T. Mackey, Kingsland-road, London.—*1st September*, 1880.
3575. TAPS, T. Singleton, Over Darwen.—*3rd September*, 1880.
3595. BOXES, &c., L. Wahltuch, City-road, London.—*4th September*, 1880.
3597. TRAM RAILS, J. Smith, jun., E. Lones and J. Hill, Barrow-in-Furness.—*4th September*, 1880.
3598. BICYCLES, C. D. Abel, Southampton-buildings, London.—A communication from La Société Clement et Cie.—*4th September*, 1880.
3602. CASES, W. Hardy, Thistleton.—*4th September*, 1880.
3606. VALVE GEAR, A. J. Stevens, Newport.—*4th September*, 1880.
3629. ARMOUR-PLATES, J. D. Ellis, Sheffield.—*7th September*, 1880.
3667. RAISING, &c., APPARATUS, C. D. Abel, Southampton-buildings, London.—A communication from E. Borde, J. Petit-Laroch, and E. Labellette.—*9th September*, 1880.
3697. FUEL ECONOMISERS, J. Parker, Manchester.—*11th September*, 1880.
3704. SCREW PROPELLERS, C. Jones, Liverpool.—*11th September*, 1880.
3805. SAILOR'S HAT, J. Christie, Haugesund.—*20th September*, 1880.
3861. PAPER, N. G. Richardson, Tyaquin-Monivea, and W. Smith, Dublin.—*23rd September*, 1880.
4027. CHECKING WASTE of WATER, B. J. B. Mills, Southampton-buildings, London.—A communication from E. E. Furney.—*4th October*, 1880.
4110. COCKS, T. J. Easey, High-street, Stepney.—*9th October*, 1880.
4180. BRACE-ENDS, A. S. Taylor, Manchester.—*14th October*, 1880.
4853. DRAIN PIPES, J. Lovegrove, Urswick-road, Lower Clapton, London.—*23rd November*, 1880.
4901. DYEING, J. Rogers, Stroud.—*25th November*, 1880.
5061. ADMIXTURE of LIQUIDS, W. Bradford, King William-street, London.—*4th December*, 1880.
5132. TREATMENT of HOP PLANTS, T. J. Wall, Laura-place, Southampton.—*8th December*, 1880.
5137. DYNAMO-ELECTRIC APPARATUS, &c., W. T. Henley, Plaistow.—*9th December*, 1880.
5169. WASHING CHINA CLAY, J. Lovering, jun., St. Austell, Cornwall.—*10th December*, 1880.
5475. COLOURING PLASTIC MATERIALS, W. P. Thompson, High Holborn, London.—A communication from the Dickinson Hard Rubber Company.—*29th December*, 1880.

Patents Sealed.

(*List of Letters Patent which passed the Great Seal on the 31st December*, 1880.)

2455. TESTING CEMENTS, P. Adie, Pall Mall, London.—*17th June*, 1880.
2700. METAL GATES, S. Wilkes, Sedgley, Stafford.—*1st July*, 1880.
2710. TELEGRAPH APPARATUS, C. Kesseler, Mohrenstrasse, Berlin.—*2nd July*, 1880.
2714. FORCING WATER, &c., A. Anderson, Brixton.—*2nd July*, 1880.
2717. BOTTLING MACHINES, G. Jones, Camberwell, Surrey.—*2nd July*, 1880.
2747. MOISTENING, &c., OIL SEEDS, H. Holt, Hull.—*5th July*, 1880.
2750. BACKS of ACCOUNT BOOKS, &c., W. Hawtin, jun., Paternoster-row, London, and A D. Collier, Camberwell, Surrey.—*6th July*, 1880.
2786. CRANKS, J. Turner, Coventry.—*7th July*, 1880.
2793. ANNEALING POTS, I. Jones, Swansea.—*7th July*, 1880.
2823. PEN-HOLDERS, R. Spear, North-buildings, London.—*9th July*, 1880.
2839. TANNING HIDES, S. F. Cox, Yatton, Somerset.—*9th July*, 1880.
2900. SEWING MACHINES, T. Fletcher, Hyde, Chester.—*14th July*, 1880.
2915. SORTING ORES, &c., J. H. Johnson and W. Haydock, Wigan.—*15th July*, 1880.
2927. STEAMING WOVEN FABRICS, F. W. Ashton, Hyde, Chester.—*15th July*, 1880.
2976. HOLLOW ARTICLES, F. Walton, Heatham House, Twickenham.—*19th July*, 1880.
3011. COILING, &c., WIRE, J. Patchett, Haybridge, Salop.—*22nd July*, 1180.
3226. CLIPPING SEAL SKINS, L. A. Groth, Fisbury Pavement, London.—*6th August*, 1880.
3281. SEWING MACHINES, F. Cutlan, Cardiff. — *11th August*, 1880.
3560. MOISTENING the INTERIOR of RIFLE BARRELS, R. H. Finlay, Govanhill, N.B.—*2nd September*, 1880.
3780. DOOR KNOBS, F. R Meeson, Southampton-street, Bloomsbury, and J. T. Hopkinson, Hunter-street, Brunswick-square, London.—*17th September*, 1880.
4025. SEWING MACHINES, G. Browning, Glasgow.—*4th October*, 1880.
4258. LOCKING STOPPERS in BOTTLES, G. Travis, Broom Cliffe, Sheffield.—*19th October*, 1880.
4404. SEWING MACHINES, G. Browning and S. Mort, Glasgow.—*28th October*, 1880.

(*List of Letters Patent which passed the Great Seal on the 4th January*, 1881.)

2742. CASKS and BARRELS, G. D. Terry, Marylebone, London.—*5th July*, 1880.
2743. CUTTING GLASSES, &c., E. Edmonds, Fleet-street, London.—*5th July*, 1880.
2758. STEAM, &c., WINDING MACHINERY, H. S. Mackenzie, Penwenach, Falmouth.—*6th July*, 1880.
2764. ELECTRIC LAMPS, G. G. André, Dorking, Surrey.—*6th July*, 1880.
2767. REDUCING, &c., CORNS on the FEET, M. Wilson, Leadenhall-street, London.—*6th July*, 1880.
2781. DRIVING, &c., GEAR for WASHING MACHINES, E. Taylor, Salford.—*7th July*, 1880.
2784. ARTIFICIAL ALIZARIN, A. Domeier, Botolph-lane, and J. Marzell, London.—*7th July*, 1880.
2785. REGULATOR for SPINNING ENGINES, M. Bauer, Boulevard Magenta, Paris.—*7th July*, 1880.
2790. DISINFECTING MOHAIR, &c., J. Scharr, Bradford.—*7th July*, 1880.
2799. JUMPING TIRES of LOCOMOTIVES, &c., W. Brierley, Halifax.—*7th July*, 1880.
2800. STORING BRAKES, W. Brierley, Halifax.—*7th July*, 1880.
2811. CAP for SHIPS' MASTS, A. A. Rickaby, Bloomfield Engine Works, Sunderland.—*8th July*, 1880.
2818. ARTIFICIAL HATCHING, &c., of CHICKENS, H. Tomlinson, Gravelly-hill, Warwick.—*9th July*, 1880.
2821. DISPLAYING CLOTHING in SHOP WINDOWS, F. McIlvenna, Liverpool.—*9th July*, 1880.
2825. PREPARING WASTE WOOL, &c., R. Ashton and R. A. Kinder, Manchester.—*9th July*, 1880.
2830. SECURING GLASS in SKYLIGHTS, &c., A Smith, Goudhurst, Kent.—*9th July*, 1880.
2831. TREATMENT of VEGETABLE OILS, T. H. Gray, Deptford.—*9th July*, 1880.
2846. SAND MOULDS, T. H. Chatton, Little Lever, Bolton.—*10th July*, 1880.
2847. LOCOMOTIVE, &c., STEAM BOILERS, S. Perkins, Fairfield.—*10th July*, 1880.
2852. ATTACHMENTS OF FASTENINGS, P. D. Reynolds Aldersgate-street, London.—*10th July*, 1880.
2855. FEEDING PAPER to PRINTING, &c., MACHINES, J. H. R. Dinsmore, Liverpool, and F. Hoyer, Waterloo, Lancaster.—*10th July*, 1880.
2856. CUTTING TOOLS, C. Whitehouse, Cannock, Stafford.—*10th July*, 1880.
2863. STEAM ROAD ROLLERS, W. Holloway, Rydal House, Portinscale-road, Putney.—*12th July*, 1880.
2864. LACE, &c., F. E. A. Büsche, Schwelm, Westphalia, Germany.—*12th July*, 1880.
2878. BITTER ALMOND OIL, &c., F. A. Zimmermann, Mincing-lane, London.—*12th July*, 1880.
2885. EXTRACTING AMMONIA, W. Brierley, Halifax.—*13th July*, 1880.
2897. SEPARATING LIME, &c., T. Hicken, Dunchurch, and J. Hopewell, Rugby.—*13th July*, 1880.
2916. GOVERNING APPARATUS, J. Coutts and H. Adamson, Liverpool.—*15th July*, 1880.
2975. OXIDISED OIL, F. Walton, Heatham House, Twickenham.—*19th July*, 1880.
2983. CHIMNEY POTS, L. A. Groth, Finsbury-pavement, London.—*20th July*, 1880.
3008. KNITTING MACHINES, W. R. Lake, Southampton-buildings, London.—*21st July*, 1880.
3024. TYPES, &c., J. Greene, Reform Club, Pall Mall, London.—*22nd July*, 1880.
3027. SPINNING MIXED FIBRES, A. M. Clark, Chancery-lane, London.—*22nd July*, 1880.
3035. PACKING FRUITS, &c., F. Wright, Kensington High-street, London.—*23rd July*, 1880.
3079. PLOUGHING, &c., ENGINES, R. Burton, Steam Plough Works, Leeds.—*26th July*, 1880.
3199. PREPARING GRAIN, &c., E. R. Southby, Holborn Viaduct, London.—*5th August*, 1880.
3201. AQUA AMMONIA, F. J. Cheesbrough, Water-street, Liverpool.—*5th August*, 1880.
3212. STEAM GENERATORS, A. M. Clark, Chancery-lane, London.—*5th August*, 1880.
3231. TELEPHONIC APPARATUS, H. H. Lake, Southampton-buildings, London.—*7th August*, 1880.
3391. CONTROLLING CASH RECEIPTS, L. von Hoven, Castle-street, Holborn, London.—*20th August*, 1880.
3451. TRAPS for BIRDS, &c., R. J. Sankey, Margate.—*26th August*, 1880.
3686. COOLING ATMOSPHERIC AIR, J. Sturgeon, Newlay, near Leeds.—*10th September*, 1880.
3725. SEWING MACHINES, W. Webster, New Wortley, Leeds.—*13th September*, 1880.
3765. ELECTRIC LAMPS, E. G. Brewer, Chancery-lane, London.—*16th September*, 1880.
3880. CONDUCTORS, P. Jensen, Chancery-lane, London.—*24th September*, 1880.
3917. CROTCHET-LIKE EDGINGS, &c., J. Booth, New Basford, Nottingham.—*27th September*, 1880.
4009. MOTIVE POWER, J. G. Lorrain, Edinburgh.—*2nd October*, 1880.
4012. VELOCIPEDES, W. R. Lake, Southampton-buildings, London.—*2nd October*, 1880.
4039. TELEPHONES, J. G. Lorrain, Edinburgh.—*5th October*, 1880.
4204. EMBROIDERY APPARATUS, W. R. Lake, Southampton-buildings, London.—*15th October*, 1880.
4289. ROLLERS, R. Carlyle, Manchester.—*21st October*, 1880.
4324. FLUFFING, &c., LEATHER SKINS, S. Haley, Bramley.—*23rd October*, 1880.
4384. SELF-LEVELLING TABLES, &c., B. J. B. Mills, Southampton-buildings, London.—*27th October*, 1880.
4435. STOVE, C. M. Westmacott, Bridge-street, Westminster.—*30th October*, 1880.
4476. ROLLER SKATES, W. P. Gregg, Boston, U.S.—*2nd November*, 1880.
4566. FORGING MACHINERY, W. R Lake, Southampton-buildings, London.—*6th November*, 1880.
4619. BOOKBINDING, L. Finger, Boston, U.S. — *10th November*, 1880.

List of Specifications published during the week ending January 1st. 1881.

1661, 6d.; 1907, 6d.; 1921, 2d.; 1996, 6d.; 2120, 6d.; 2143, 6d.; 2151, 6d.; 2171, 6d.; 2175, 6d.; 2177, 4d.; 2180, 6d.; 2187, 2d.; 2188, 6d.; 2191, 2d.; 2194, 6d.; 2196, 2d.; 2197, 2d.; 2199, 6d.; 2200, 4d.; 2201, 8d.; 2203, 6d.; 2206, 6d.; 2208, 6d.; 2209, 2d.; 2210, 6d.; 2212, 4d.; 2213, 6d.; 2214, 4d.; 2215, 4d.; 2216, 4d.; 2218, 2d.; 2219, 6d.; 2221, 6d.; 2222, 6d.; 2224, 6d.; 2225, 6d.; 2227, 4d.; 2228, 2d.; 2229, 6d.; 2230, 6d.; 2231, 4d.; 2232, 6d.; 2233, 6d.; 2234, 10d.; 2235, 4d.; 2236, 2d.; 2237, 2d.; 2240, 6d.; 2241, 4d.; 2242, 2d.; 2243, 2d.; 2244, 2d.; 2245, 6d.; 2246, 2d.; 2247, 8d.; 2249, 4d.; 2250, 8d.; 2251, 4d.; 2252, 6d.; 2253, 4d.; 2254, 2d.; 2255, 6d.; 2256, 2d.; 2257, 2d.; 2258, 6d.; 2259, 6d.; 2260, 6d.; 2262, 2d.; 2263, 2d.; 2264, 6d.; 2265, 6d.; 2266, 6d.; 2268, 6d.; 2269, 6d.: 2270, 2d.; 2271, 8d.; 2272, 6d.; 2275, 4d.; 2276, 2d.; 2277, 4d.; 2278, 6d.; 2279, 6d.; 2282, 6d.; 2283, 2d.; 2286, 6d.; 2288, 6d.; 2289, 2d.; 2304, 4d.; 2308, 6d.; 2332, 6d.; 2376, 6d.; 2385, 6d.; 2536, 6d.; 2731, 6d.; 2807, 6d.; 3012, 8d.; 3140, 6d.; 3653, 2d.; 3984, 6d.; 4115, 4d.

*** Specifications will be forwarded by post from the Patent-office on receipt of the amount of price and postage. Sums exceeding 1s. must be remitted by Post-office order, made payable at the Post-office, 5, High Holborn, to Mr. H. Reader Lack, her Majesty's Patent-office, Southampton-buildings, Chancery-lane, London.

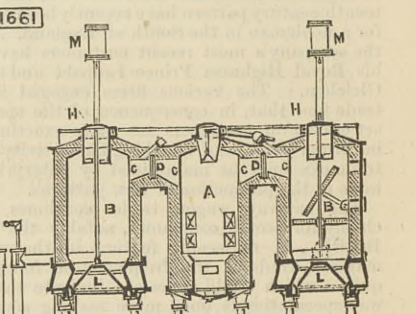
ABSTRACTS OF SPECIFICATIONS.

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

1661. DISTILLATION OF COAL, &c., *J. G. Beckton.—Dated 22nd April*, 1880. 6*d*.

The drawing shows a vertical section of a line of retorts with a generator placed between each pair. A is a gas generator communicating with the retorts B B by the passages C C, provided with regulating slides D D and serving to conduct the gas or gases from the generators to the spaces above the substances

1661

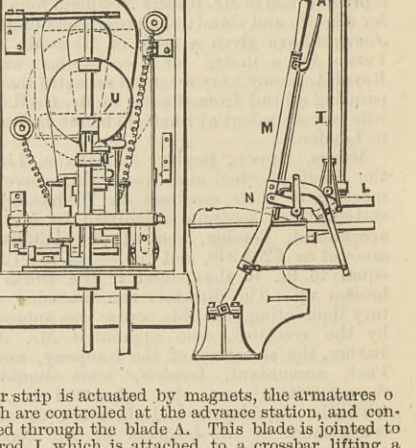


to be distilled. The matters for distillation are supplied to the retorts through openings at the top, closed by removable covers H. The openings in the retorts, whereby the matters remaining after distillation are discharged, are closed by conical valves or bells L L opening downwards, and each connected by a rod passing upwards through the retort to a cylinder M fitted with a piston or to a travelling crane running along the line of rails above.

1907. RAILWAY SIGNAL APPARATUS, *G. W. R. Sykes.—Dated 10th May*, 1880. 6*d*.

This relates to improvements upon a previous invention. Taking three successive stations, the signal apparatus is so arranged that B releases A and enables an alteration in the signal to be made, but B cannot release A's apparatus till he has signalled the train to C, that is, till the train is past his station. Over the lever is a case, shown in front elevation in Fig. 1, containing the upper lock. Fig. 2 shows case and lever. Words to show condition of line are painted on two metal strips, and can be shown. The

1907

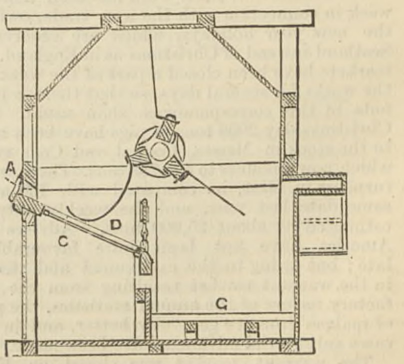


upper strip is actuated by magnets, the armatures o which are controlled at the advance station, and connected through the blade A. This blade is jointed to the rod I which is attached to a crossbar lifting a sliding piece which forms the lock, out of and into a notch cut in a tappet L attached to signal lever as shown. L is attached to the lever M by a stud N, and the action of the combined mechanism can be seen from the figure. The lower slip is carried by another blade held by a click resting on a pin on a blade. The click is pushed off the pin by a plunger and angle piece. The blade U is actuated by the motion of the lever.

2120. APPARATUS FOR CLEANING CARPETS, &c., *W. Millward and B. Richards.—Dated 25th May*, 1880. 6*d*.

The carpet or other fabric is conducted through th opening A on to an elastic frame C, and as it passe

2120



over the bands D it is subjected to the action of the beater employed, and thence it passes down on to the grating G.

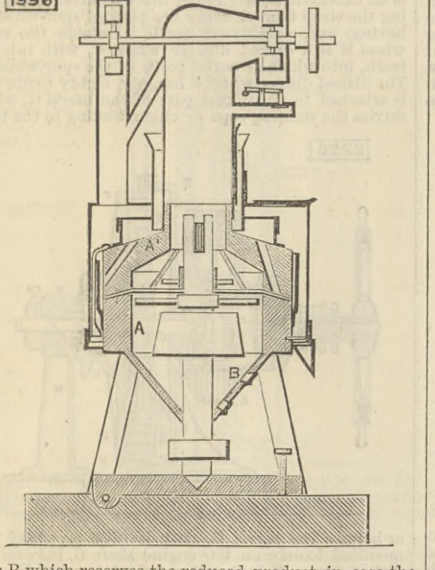
1921. Decomposition of Certain Salts of Soda and Potash, *C. Humfrey.—Dated 11th May*, 1880. 2*d*.

This consists in the use of sulphurous acid gas for the precipitation of aluminia from solutions of aluminate of soda or potash, and for the reduction of tri-sodic (or tri-potassic) phosphate into hydro-disodic (or hydro-dipotassic) phosphate and sodic sulphite.

1996. Grinding and Purifying Grain, &c., *W. Clark.—Dated 14th May*, 1880.—(*A communication.*)—(*Complete.*) 6*d*.

In the drawing A A^1 represent the pair of millstones, the former being the bed and fixed in place, the latter being the runner. Forming part of or attached to the bed stone A is a receptacle, preferably a conical chamber B which reserves the reduced product in case the feed is from the periphery to the centre, the discharge taking place through a valve, which is closed when the feed is in the opposite direction. Air currents also pass through the said chamber B during the reducing operation and act to purify the product.

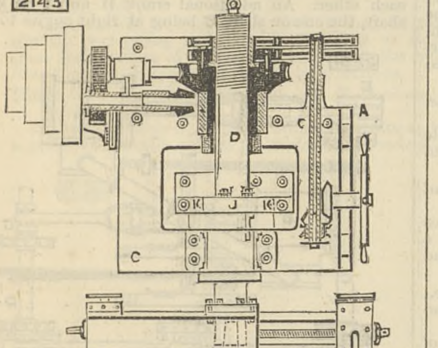
1996



2143. Flange Facing and Oval Hole Cutting Machines, *D. Embleton and P. A. Porter.—Dated 26th May*, 1880. 6*d*.

On the framework A the saddle C is fitted so as to slide freely; on this is mounted the spindle D in bearings. For the production of oval holes it is necessary to impart not only a rotary motion to the spindle, but also a lateral reciprocating motion, which is effected by means of the adjustable cam J rotating with the spindle D between the jaws K.

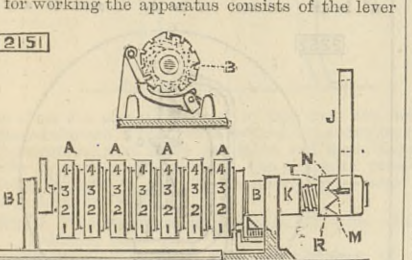
2143



2151. Counters, Indexes, and Registering Apparatus for Recording the Revolutions of Shafts, &c., *W. Chadburn.—Dated 26th May*, 1880. 6*d*.

A series of discs A are marked with numerals representing units, tens, &c. These discs are mounted loosely on the shaft B, and are caused to work by pawls and ratchet wheels. The spring lever arrangement for working the apparatus consists of the lever J, which is loosely mounted on the shaft K, and is provided with teeth or projections M which gear into corresponding teeth or projections on the sliding washer or sleeve N which has to travel on shaft K to the extent of the slot T, and is fixed to and moves the shaft K by the pin R.

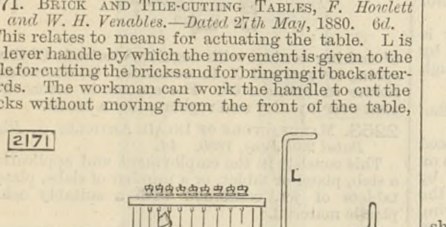
2151



2171. Brick and Tile-cutting Tables, *F. Howlett and W. H. Venables.—Dated 27th May*, 1880. 6*d*.

This relates to means for actuating the table. L is the lever handle by which the movement is given to the table for cutting the bricks and for bringing it back afterwards. The workman can work the handle to cut the bricks without moving from the front of the table, where he has to be to separate the clay, with the single wire at H, also to slide the block on to the table, and then after the bricks are cut and the table has been brought back to slide the bricks off the receiving surface on to the barrow.

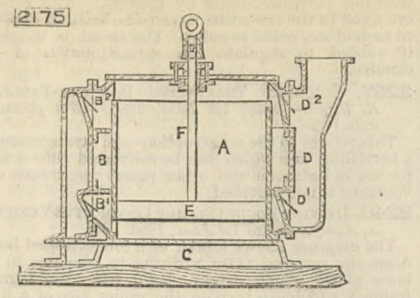
2171



2175. Air Pumps, *J. Miller.—Dated 28th May*, 1880. 6*d*.

The drawing shows a sectional elevation of the pumping cylinder. A is the cylinder, B the wind chest, C the air chamber, D the outlet passage, E the piston, F the piston rod; B^1 and B^2 are the inlet valves, and D^1 and D^2 the outlet or exhaust valves. When the piston E travels upwards the air in the cylinder above the piston is driven out through the valve D^2 into the outlet passage D, and the air in the chamber C, which is connected by pipes or otherwise to that part of the building or ship which requires ventilation, is drawn into the cylinder through valve B^1 on the down stroke; this air is expelled through the valve D^1, and the upper part of the cylinder is again filled through the valve B^2, which also communicates with the air chamber.

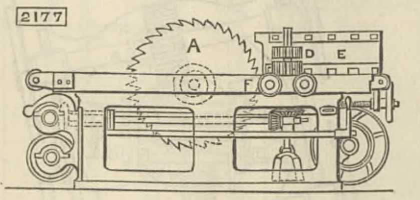
2175



2177. Machinery for Sawing Wood, *J. and G. Pickles.—Dated 28th May*, 1880. 4*d*.

This consists in having the table or top F loose and capable of sliding in suitable bearings, so that when the size or diameter of the saw or saws A is changed the feed rollers D and fence E, which are connected to the sliding table F, always maintain the same relative position to the saw or saws. The table or top is caused to move backward and forward by means of a screw, rack, and pinion, or other mechanical equivalent.

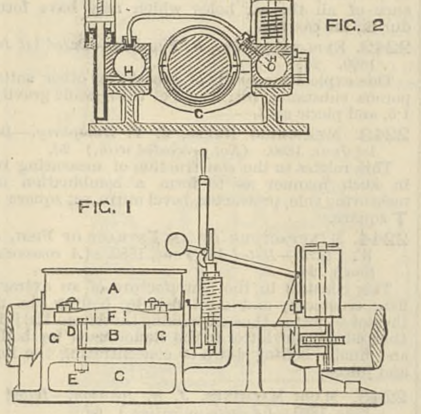
2177



2180. Ascertaining the Effective Pressure of Screw Propellers, *G. W. Cabjolsky.—Dated 28th May*, 1880. 6*d*.

Fig. 1 represents a side view of the indicating apparatus, and Fig. 2 a section through the hydraulic cylinder. A is a plummer block containing an annular bearing and fitted with longitudinal flanges B and rests on the bed-plate C, on which it will be free to move a short distance in a fore and aft direction as soon as the wedges D, that can be tightened by the screws E, are removed. Wrought iron bars F keep the plummer block from rising on its bed-plate. The fore-and-aft motion of the screw shaft and thrust block is limited by the projections G on the bed-plate, against which the flanges B press when the apparatus is not in use, and thus transmit the pressure immediately to the ship in the ordinary way. The ends of the flanges B press against the pistons of the hydraulic cylinders H which are secured by four screw bolts to abutments formed on the bed-plate. One of the two cylinders is fitted with an indicator.

2180



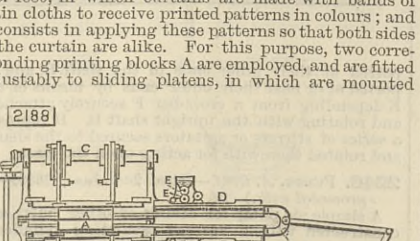
2187. Looms, *T. Quarmby.—Dated 29th May*, 1880.—(*Not proceeded with.*) 2*d*.

This relates, First, to apparatus used in conjunction with the pattern links of change shuttle box looms; Secondly, to improved apparatus for holding down and steadying the box lever when depressed by the tappet.

2188. Printing Lace Fabrics, *R. F. Carey.—Dated 29th May*, 1880. 6*d*.

This relates to improvements on patent No. 502 A.D. 1880, in which curtains are made with bands of plain cloths to receive printed patterns in colours; and it consists in applying these patterns so that both sides of the curtain are alike. For this purpose, two corresponding printing blocks A are employed, and are fitted adjustably to sliding platens, in which are mounted shafts C, each carrying two pairs of cams, one serving to withdraw the platens from the fabric, and the other to move them into action. The blocks are inked or coloured from the pads D, supplied by rollers E, and moving in guides, being actuated by a cam on shaft F. A sliding clutch is provided to throw the driving pulley to the shaft G.

2188



2191. Fastening for Metal Boxes, Cases, &c., *A. Montoriol and P. P. Tarride.—Dated 29th May*, 1880.—(*Not proceeded with.*) 2*d*.

The boxes are made so as to be opened by pulling outwards by means of a finger passed through a loop or ring of iron wire, a plate which at the time of manufacturing the box has been cut out, then replaced and soldered either by immersion in a bath of tin or by means of the soldering iron.

2196. Looms, *J. H. Johnson.—Dated 29th May*, 1880.—(*A communication.*)—(*Not proceeded with.*) 2*d*.

This consists in arranging a series of tappets or cams fixed upon a shaft for the purpose of actuating in an irregular manner three, four, or five treadles only, with a view to simplifying the mechanism.

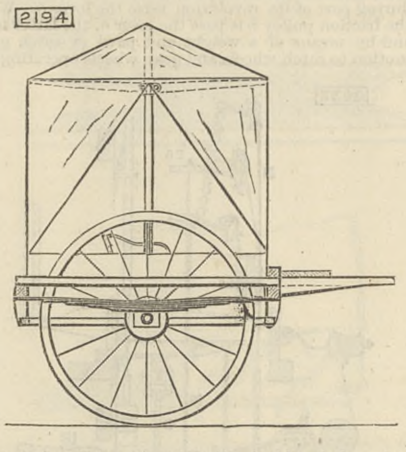
2197. Mowing and Reaping Machines, *A. C. Bamlett.—Dated 29th May*, 1880.—(*Not proceeded with.*) 2*d*.

In order to enable the driver of a mowing machine more readily to elevate the points of the cutters, the bracket that carries the regulating lever is pivotted and which lever has formed on it a projection, pressure on which, by the driver's foot, elevates the points of the cutters.

2194. Two-wheel Carriages, &c., *H. Duddy.—Dated 29th May*, 1880. 6*d*.

This consists partly in mounting each wheel on a short separate axle carried in bearings by two springs, one spring being placed on the inside of the wheel, and the other outside. On the back and front ends of the springs are mounted and secured the cross-trees, which carry the shafts and body of the carriage or other conveyance.

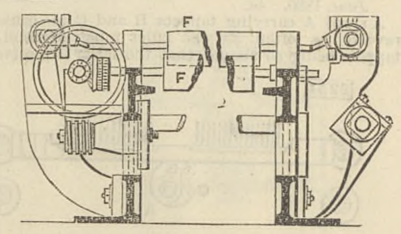
2194



2199. "Hardening" Felted or other Fabrics, *B. and T. B. Rhodes, and H. W. and J. H. Whitehead.—Dated 29th May*, 1880. 6*d*.

The hardening rollers are made of a composition having a rough or gritty surface, such as stone, or mixtures of various kinds of stone or cement, asphalte, concrete, or emery; or if made of metal, their peripheries are formed with V screw threads or grooves, intersected by longitudinal grooves, so as to give the required roughness of surface. The drawing shows the manner of mounting and driving these rollers F.

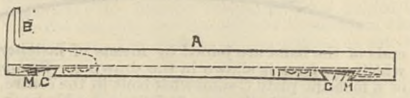
2199



2200. Horseshoes, *O. Lampe.—Dated 29th May*, 1880. 4*d*.

The main shoe consists of a flat iron shoe-piece A of common construction, which may be fastened to the hoof by nails or otherwise, and which may be furnished with clips or tongues B in front and at the sides of the shoe. In the bottom plane of this shoe are constructed three parallel dovetail-shaped grooves C, of which one is placed at the front end, and of the other two, one at each hinder end of the shoe. These grooves are prepared for the reception of toe-pieces and caulks, which are furnished with corresponding dovetail projections, and are slipped into the grooves sideways, and are kept in position by flat springs M.

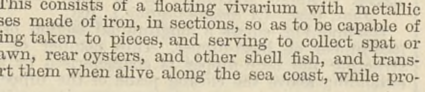
2200



2201. Boats and Apparatus for the Cultivation, Preservation, and Conveyance of Oysters, &c., *W. R. Lake.—Dated 29th May*, 1880.—(*A communication.*) 8*d*.

This consists of a floating vivarium with metallic cases made of iron, in sections, so as to be capable of being taken to pieces, and serving to collect spat or spawn, rear oysters, and other shell fish, and transport them when alive along the sea coast, while protecting them from crabs and the like. The interior of the vivarium is formed with partitions A and breakwater partitions B, angle iron uprights connected with the partitions by cross pieces. Openings are formed at the bow and others at the stern, communicating with the inner compartments, and fitted with sluices V. Around the vivarium are compartments. Metallic cases are placed in the different compartments of the vivarium, such cases being detachable, and they are covered with wire gauze.

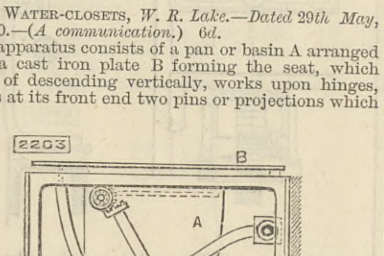
2201



2203. Water-closets, *W. R. Lake.—Dated 29th May*, 1880.—(*A communication.*) 6*d*.

This apparatus consists of a pan or basin A arranged under a cast iron plate B forming the seat, which instead of descending vertically, works upon hinges, and has at its front end two pins or projections which rest upon rods jointed to pivotted levers, which levers being in one piece, with upwardly extending arms, operate the traps by means of toothed blocks or sectors, gearing with pinions fixed upon the axes of the valves or traps.

2203



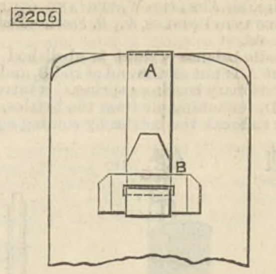
2209. Spinning, Twisting, Doubling, and Winding Wool, &c., *T. Whitley.—Dated 31st May*, 1880.—(*Not proceeded with.*) 2*d*.

This consists partly in having a screw or worm on each spindle, rotary motion being given thereto by means of wheels, by which means the driving bands at present employed are dispensed with.

2206. Closing the Mouths of Bags, *L. Planche.—Dated 31st May*, 1880. 6*d*.

A strip of paper is secured to the top of the bag, and on one side is the piece B slotted in the middle and attached by its ends only. The strip A is passed under B, and its end folded upwards and passed through the slot in B.

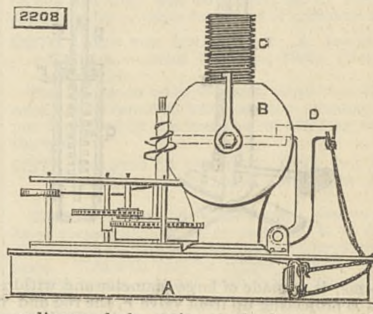
2206



2208. Alarm Apparatus, *J. McNeice.—Dated 31st May*, 1880. 6*d*.

A is a spherical chamber; B is a stop cock with a screw nozzle C, on which a condensing pump of ordinary construction may be screwed to allow of filling the chamber A with compressed air; D is a snap catch for keeping the stop cock B closed; an ordinary clock spring and alarum gearing or mechanism operates the hammer of the bell. To a ring on a coil spring a cord is attached, which has been rendered inflammable. The cord is extended through the building, and with cords or guys, as may be required. The snap catch is also connected to the ring by means of a slack cord. A regulator and snail wheel are provided to allow the cock to open gradually as the air in the chamber decreases.

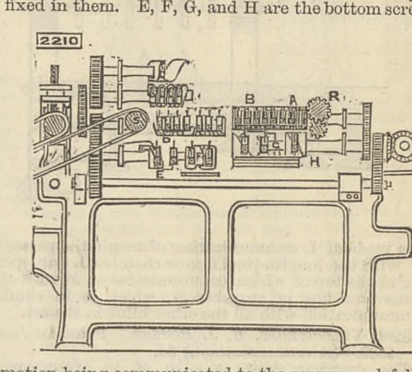
2208



2210. Screw Gill Boxes, *T. Whitley.—Dated 31st May*, 1880. 6*d*.

This consists in employing three or four sets of fallers and six or eight top screws, formed in two or more barrels, the threads of each being of different pitch to the other, by which means a draught is obtained between each set of fallers. The first two top screws A and B are formed in one barrel, and the succeeding two screws C and D are formed in another barrel. Each screw has a set of fallers, each set having a different number of pins fixed in them. E, F, G, and H are the bottom screws, motion being communicated to the screws and fallers by gear wheels. The speed of each pair of screws can be regulated independently of the other pair, and by change wheels the speeds of both pairs of screws can be regulated when required, according to the wool or other fibre under operation. Between the feed rollers R and delivery rollers S the wool is subjected to five different drafts.

2210



2212. Rolling Stock for Railways and Tramways, *F. C. Glaser.—Dated 31st May*, 1880.—(*A communication.*)—(*Not proceeded with.*) 4*d*.

The brasses of the end axle boxes are on one side of the vehicle, capable of turning on a vertical axis, while those on the other side are capable both of turning on a vertical axis, and of shifting to a certain extent in the direction of the length of the carriage. To enable this to be done, the brasses of such axle boxes do not rest directly on the cast iron boxes, but on wrought iron transverse slides, passing through the two sides thereof, which slides are connected together by guide rods and double-ended levers, in such manner that the brasses of the two end axles can only shift simultaneously, and in a symmetrical manner relative to the central transverse axis of the vehicle.

2213. Combinable Garments, *G. W. Von Nawrocki.—Dated 31st May*, 1880.—(*A communication.*) 6*d*.

This refers to a combined fur collar or collaret and bag muff, and consists mainly in a mode of separating the collar from the muff, so that either may be used separately as desired.

2214. Distillation of Anthracene, *C. M. Warren.—Dated 31st May*, 1880. 4*d*.

This consists in the process of obtaining anthracene by the distillation of a mixture of coal tar or coal tar pitch and petroleum residuum or other equivalent material.

2215. Folding Joints for Seats and Tables, *N. Descourtils.—Dated 31st May*, 1880.—(*Not proceeded with.*) 2*d*.

A piece of wood having its ends of the shape of an inverted triangle serves at the same time to stop the half of the lower feet or supports and of the upper ones. Right angle plates are fixed upon its ends and serve to secure the supports.

2216. Black Printers' Ink, *C. Kesseler.—Dated 31st May*, 1880.—(*A communication.*) 4*d*.

This consists in preparing from pitch or asphalte, fatty-acid, violet aniline, resinous, oily fat and heavy oil of tar (so-called oil of anthracene), which will be coloured black by boiling and adding at least 10 per cent. of chloride of copper, a printing ink also applicable as etching varnish.

2218. Locomotive Engines, *J. H. Johnson.—Dated 31st May*, 1880.—(*A communication.*)—(*Not proceeded with.*) 2*d*.

This relates to that class of locomotive engines in which one pair only of driving wheels is used, and consists in a means of enabling the engineer to readily increase the weight upon the said driving wheels, so that they may have the proper adhesion for starting the engine and train, and after they are in motion, to transfer part of the weight to the trailing wheels, which take the place of the usual second pair of driving wheels.

2219. Pillow and Bed Divider, *J. F. C. Farquhar.—Dated 31st May*, 1880. 6*d*.

This consists in the combination with the head of a bedstead of a readily detachable or movable arm which projects out from it, so as to extend over the pillow or bolster and form a vertical partition to divide it into two compartments.

2221. FILLING AERATED WATER AND OTHER SIMILAR LIQUIDS INTO BOTTLES, &c., *R. Foote.—Dated 1st June, 1880.* 6d.

The treadle balance weight is abolished and in its place a nut A is put on the end of rod B, and between it and the stationary bearing a spring C is introduced. As the tube D, for taking air from the bottles, is liable to bend and to break the bottles by coming against their

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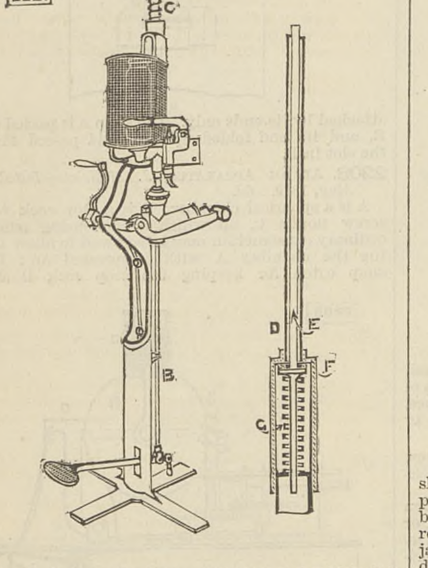
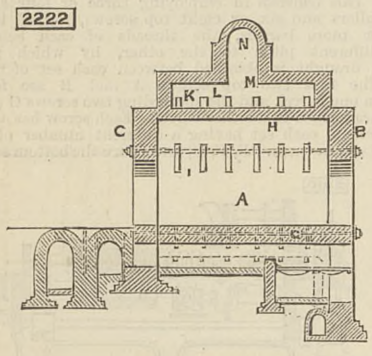


bottoms, it is made of large diameter and within it is a rod E projecting up from valve F, the rod and valve being kept up by an adjustable spring G, but as the rod strikes the bottom of the bottle it is pressed down, thus opening the valve. A vertical pump is used its plunger being attached to the rack by a pin.

2222. KILNS FOR BURNING BRICKS, &c., *J. P. Cramp.—Dated 1st June, 1880.* 6d.

A is the body of the kiln, B and C being its front and back, provided with openings or doorways. Beneath the floor are arranged two fireplaces, transverse openings G being made through the door in the body of the kiln. In the arched roof H openings are

2222

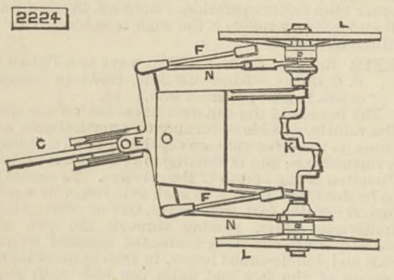


also made at I, communicating through the passages K with the longitudinal flue or chamber L; an opening at the top of which communicates at M with the transverse flue or chamber N, which is in similar communication with all the other kilns in the shed.

2224. VELOCIPEDES, *H. J. Haddan.—Dated 1st June, 1880.—(A communication.)* 6d.

The drawing shows a plan of an arrangement whereby, when the guide wheel C is turned by means of the handles F on frame E, the one of the wheels L, on the inner side of the curve, in which it is desired to turn, is automatically disengaged from the crank

2224



shaft K, so as to facilitate turning round. For this purpose, the rods N, attached to frame E, are fitted with forks which move clutches into or out of gear with similar clutches on the hubs of the wheels L.

2225. PACKING FOR STEAM JOINTS, &c., *J. Kirkman.—Dated 1st June, 1880.* 6d.

This consists in building asbestos millboard or other forms of asbestos into a tube and cutting it into slices or annular discs of the right thickness.

2227. PURIFYING SEWAGE, *P. Spence.—Dated 1st June, 1880.* 4d.

The sewage or effluent water, as it comes from the tanks where lime has been used for its clarification, is run into other tanks along with a solution of sulphate, or other salt of alumina, or alumina and iron.

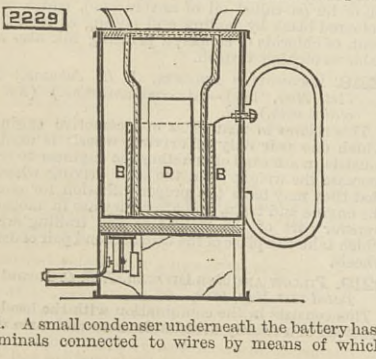
2228. MANUFACTURE OF WICKS FOR LAMPS OR STOVES, *C. Quitmann.—Dated 1st June, 1880.—(A communication.)—(Not proceeded with.)* 2d.

This consists in combining with the wick a series of fine metallic wires or threads.

2229. IMPROVEMENTS IN THE CONSTRUCTION OF APPARATUS FOR LIGHTING GAS, *Charles Leigh Clarke and John Leigh.—Dated 1st June, 1880.* 6d.

This consists of a small portable battery as shown, the zinc being outside and the carbon inside the porous

2229

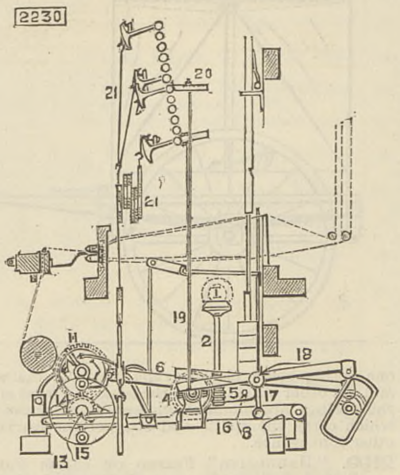


cell. A small condenser underneath the battery has its terminals connected to wires by means of which a spark can be obtained when required. B B is the zinc, D the carbon.

2230. LOOMS, *J. H. Brierley.—Dated 1st June, 1880.* 6d.

At 1 is a bevel wheel on crank shaft of loom; 2 is an upright shaft having worm 3 gearing with wheel 4. The latter operates lever 5 as the wheel 4 revolves its axis, on which lever 5 causes the latter to revolve, and during part of its revolution raise the lever 6. When the friction pulley 8 is past the lever 6, the latter falls, and by means of a weight and pawl or catch gives motion to catch wheels and gear wheels operating the

2230



shaft 13, on which are the discs 14. The friction pulleys 15 act upon the cranked lever 16; the latter, by means of links 17 which are connected with pin 18, removes the fulcrum 18, drawing heald rods 19 and jacks 20 operating the heald staves 21, thus alternately dividing and bringing together the warp's threads.

2231. GILL BOXES, *G. and W. H. Ingham.—Dated 1st June, 1880.* 4d.

A shaft A carrying tappets B and C is caused to revolve as often as the faller must descend, the tappets being so shaped that the faller is received as

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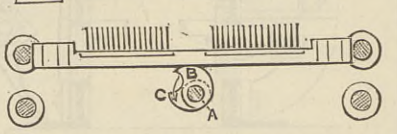

soon as it leaves the upper worm or screw upon the beak of the tappet, and is, by the half revolution of the latter, quietly lowered to its position without shock.

2232. METALLIC BELTS FOR DRIVING MACHINERY, *J. H. A. Bleckmann.—Dated 1st June, 1880.—(A communication.)* 6d.

A band or strip of hardened steel is used as the belt, and the surface of the pulley is turned cylindrical, the surface of one or both being coated with a varnish consisting of shellac dissolved in turpentine. The

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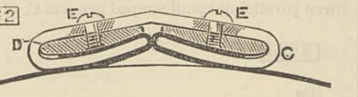

ends of the band are joined by means of fasteners, of which one form is shown in the drawing. It consists of a metallic plate C somewhat bent in the centre, and its ends curved back so as to form a double hook and leave an intermediate space, into which the ends of the band are introduced and bent over. D are wedges which are forced into the space so as to secure the ends of the band, and they may be kept in position by set screws E.

2233. LINEAL MEASURES, *L. Appleton.—Dated 1st June, 1880.* 6d.

This relates to the system or mode of dividing or marking rules, tapes, &c., whether straight or curved.

2234. COMBING MACHINES, *E. de Pass.—Dated 1st June, 1880.—(A communication.)* 10d.

The first Fig. is a longitudinal section of the feed-nipper or head-nipper. This manner of constructing the head-nipper is characterised by a rib extending above the closing plane of the nipper by the lugs A or other analogous arrangement permitting the direct attachment to the heads of the nipper H—traversed by the opening rod—of the cross-bar B furnished with lugs receiving saddle pieces, which at

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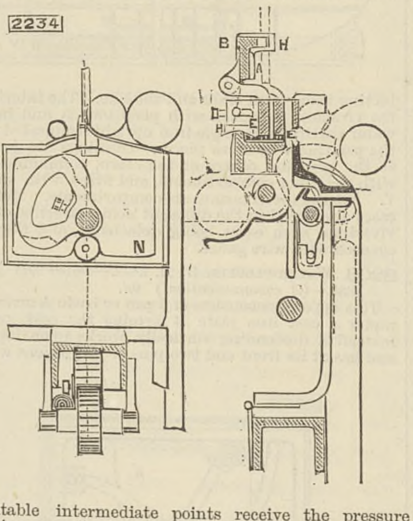


suitable intermediate points receive the pressure acting upon the bars E. The second Fig. is a side view showing the movement of the comb-holder. The movement of the excentric frame carrying the comb-holder is characterised by the application of an under pressure, which may be applied in any suitable manner, acting to instantly raise the frame N.

2235. APPARATUS FOR COMMUNICATING BETWEEN PASSENGERS AND SERVANTS IN RAILWAY TRAINS, *E. and A. E. Gilbert.—Dated 1st June, 1880.—(Not proceeded with.)* 4d.

This consists essentially in using the power of the pneumatic pressure or vacuum which actuates the continuous brakes of a railway train to apply those brakes, and simultaneously cause the display of a semaphore or other visible signal to the guard or driver, by the simple action of any passenger pulling a cord, or pushing or pulling a handle or lever, in the carriage or compartment to admit the air to or allow it to escape from the pneumatic tubes of the brake.

2236. ELECTRIC LAMPS, &c., *S. Cohné.—Dated 1st June, 1880.—(Not proceeded with.)* 2d.

A cylinder is filled with water or other fluid, in which is submerged a movable vessel, preferably of a globular form, and made of metal. The vessel supports two double racks, affixed to a top and bottom cross-bar, forming a parallelogram-shaped frame, working perpendicularly by pinions. The candles are fixed in the cross-bars so as to be brought opposite to each other, point to point. The vessel is weighted if needed to regulate the approximation of the candles.

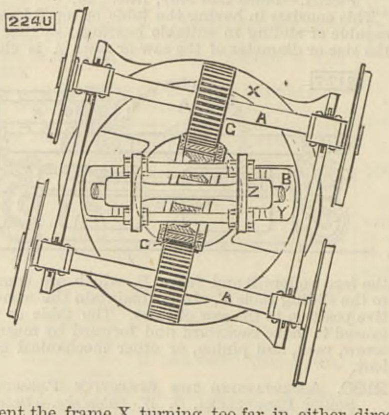
2237. COMBINED TRAVELLING BOX AND TABLE, *G. R. Gwyn.—Dated 1st June, 1880.—(Not proceeded with.)* 2d.

This relates to the construction and arrangement of a travelling box which can be converted into a table for use in bedrooms and other places where such convenience is not provided.

2240. DRIVING BOGIE AXLES OF LOCOMOTIVE VEHICLES, *J. Apsey.—Dated 1st June, 1880.* 6d.

The drawing shows a plan of a four-wheeled bogie. A are the running axles working in bearings in the horn plates which extend down from the turning frame X which can turn on the under face of a fixed plate, from which brackets Y extend through slots in the turning frame X to carry the driving shaft B driven from the engine. The brackets Y form stops to

2240



prevent the frame X turning too far in either direction. On shaft B are cranks Z connected by round pins. The driving wheel C, which gears with wheels on the running axles A, is fitted to revolve between cheeks bracketted down from the middle of the turning frame X, so that as the bogie is angled one way or the other, the wheel C is angled with it. In a rectangular slot in wheel C are slide blocks, which can move radially towards or away from the centre of C. These blocks form bearings for balls, through the centres of which pass the crank pins.

2241. MANUFACTURE OF STEEL CASTINGS, *J. Imray.—Dated 1st June, 1880.—(A communication.)* 4d.

This consists in the manufacture of articles in steel without air holes, the process of which is characterised by the combined employment of two operations, viz., the casting of the articles in a rough form, and the stamping of the same in matrices, an operation which, by the compression of the metal, causes the disappearance of all the air holes which may have formed during the casting.

2242. EXPLOSIVES, &c., *R. Punshon.—Dated 1st June, 1880.* 2d.

This explosive consists of asbestos or other suitable porous substance, nitric acid of the specific gravity of 1·5, and picric acid.

2243. MEASURING RULES, *J. T. Humphrey.—Dated 1st June, 1880.—(Not proceeded with.)* 2d.

This relates to the construction of measuring rules in such manner as to form a combination of a measuring rule, protractor, bevel mitre, set square and T square.

2244. MANUFACTURE OF AN EXTRACT OF FISH, &c., *W. Clark.—Dated 1st June, 1880.—(A communication.)* 4d.

This consists in the manufacture of an extract of fish, crustacea, and shell fish by boiling the flesh thereof in water, thus expressing therefrom the juices, then adding the latter to the liquor used for boiling, and finally boiling down or concentrating the liquor and juices.

2245. MASH MACHINES, *J. H. Johnson.—Dated 2nd June, 1880.—(A communication.)* 6d.

B is a central vertical shaft which supports the mechanism for stirring or agitating the mash, and the lower end of which rests in a step bearing at the bottom of the tub. Rotary motion may be imparted to the said shaft by means of bevel gearing C or in any other desirable manner. D are horizontal shafts sup-

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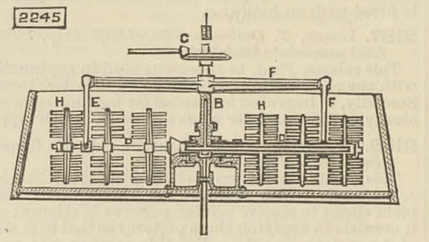

ported at their inner ends in the shaft B, and supported at or near their outer ends by means of arms E depending from a cross-bar F securely attached to and rotating with the upright shaft B. H represents a series of stirrers or agitators secured to the shafts D and rotated therewith for acting upon the mash.

2246. PUMPS, *A. Graf.—Dated 2nd June, 1880.—(Not proceeded with.)* 2d.

A simple air pump for diving or other purposes is constructed with a vertical oscillating cylinder, by means of which one man is able to pump air enough for two divers.

2247. MANUFACTURE OF FELT, *W. Bywater.—Dated 2nd June, 1880.* 8d.

The batts and sheets to be operated upon are placed on a steam heated box B, and the top plate C rests on them and on the box, and is made to oscillate by levers and excentrics for a certain time until the material between them is felted. D is the driving shaft of the self-acting motion; a clutch and wheels raise the table; a clutch and wheels lower

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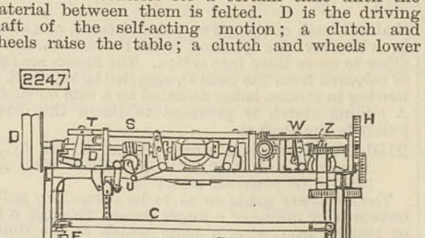

the table; Z the clutch and worm to traverse the batts; S T and W clutch levers and bars; and V a catch to hold the bar S and lever out of gear. A catch holds the bar T and levers out of gear. A catch holds the bar W and levers out of gear. E are shaft screws, nuts and balls to raise the top plate C; H are change wheels to give the required time for the hardening effect.

2249. PAINTING PHOTOGRAPHS, ENGRAVINGS, AND PRINTS ON CLOTH, *B. de Dutkiewicz and A. E. Decouflé.—Dated 2nd June, 1880.* 4d.

The process is divided into four principal parts: First, the preparation of the cloth; Secondly, photographic painting; Thirdly, glueing or fixing the painted cloth on a sustaining or supporting cloth; Fourthly, finishing or touching up of the painting.

2250. STEAM STEERING ENGINES, *C. W. King and A. Cliff.—Dated 2nd June, 1880.* 8d.

According to one arrangement the three-cylinder engine A is attached to a frame B, which is constructed in the form of a dished disc. The main shaft C of the engine passes through a stuffing box in the centre of the frame B. Fixed on to the shaft C there is an excentric D, and round this excentric, and forming the strap thereof, there is a toothed spur-wheel E, having, say, seventy-six teeth. Outside the spur-wheel E is a dished disc or wheel F, with internal teeth, into which gear the teeth of the spur-wheel E. The dished disc or wheel F has, say, eighty teeth, and is attached to and forms part of the barrel G, which carries the steering rope or chain leading to the tiller

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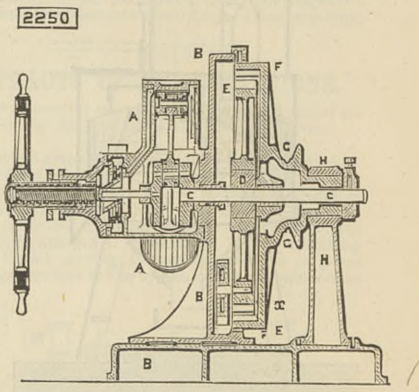

or helm. The barrel G, with its disc or wheel F, is mounted loosely on the engine shaft C, between the dished frame B and the standard bearing H. The dished frame B is provided with a guide into which takes a pin on the toothed wheel E. The movement of the internal spur-wheel E, caused by the rotation of the excentric D by the engine shaft, causes the toothed disc or wheel F, in connection with the chain barrel G, to rotate at a speed of one to twenty of the engine A.

2251. PROPELLING VESSELS, *A. Fildes.—Dated 2nd June, 1880.* 4d.

The two single cylinders A and B are arranged side by side, each coupled to and driving its own propeller shaft C and D by cranks F and G set at right angles to each other. An additional crank H and I on each shaft, the one on shaft C being at right angles to the

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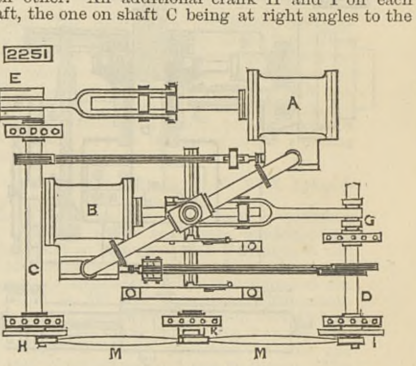
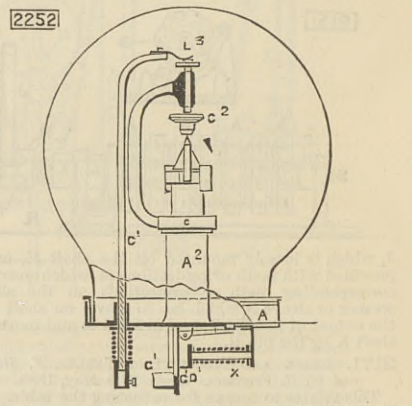


corresponding steam crank, and the one on shaft D being nearly in a line with its corresponding steam crank. Between the two shafts is mounted a beam K turning on a central fulcrum, and each end connected by a link M with one of the auxiliary cranks H and I. Thus when one cylinder is at the full stroke the other is always at half stroke.

2252. IMPROVEMENTS IN ELECTRIC LAMPS, *G. G. André and E. Easton.—Dated 2nd June, 1880.* 6d.

This is an improvement of M. André's incandescent lamp. A is a plate upon which is the lamp cover, A^2 is also secured on to A. C and C^1 are arms,

2252



C^1 making contact with negative electrode C^2 through spring L^3 and coil X, to terminal. D^1 shows carbon holder in cylinder G^1. The carbon is actuated by a cord over a pulley and regulated by a brake.

2253. MANUFACTURE OF INLAID ARTICLES, *G. Hirst.—Dated 2nd June, 1880.* 4d.

This consists in the employment and application of a slab, plate, or tablet, or a number of slabs, plates, or tablets of jet, combined with a suitably coloured plastic material.

2254. MECHANISM FOR STOPPING AND RESTARTING VEHICLES, &c., *J. C. Mewburn.—Dated 2nd June, 1880.—(A communication.)—(Not proceeded with)* 2d.

This consists in mechanism by which the winding up and unwinding of a spring are effected, so that the power stored up during the stopping of the vehicle or machine is restored to the axle or shaft upon restarting. The result is chiefly attained by means of toothed sleeves or collars, which constitute internal mechanism for putting the parts into and out of gear.

2255. APPARATUS FOR MANUFACTURING ILLUMINATING GAS, *W. T. Sugg.—Dated 2nd June, 1880.* 6d.

The poor coal gas after purification or before any deposit of the naphthaline takes place, is caused to pass over the surface of a liquid hydrocarbon, and when the vapour and gas are combined, and subject them to a high temperature which will convert the mixture into a permanent highly illuminating gas. This apparatus consists mainly of two closed vessels A B, set one above the other, and connected together by a central pipe C. This pipe is carried to near the bottom of the lower vessel B, and rises to about the middle of the vessel A, and is covered with a rose head. The vessel A is partly surrounded by a wrought iron skin forming a water jacket to the vessel A. The vessel B, and also the lower portion of the vessel A, are surrounded by a fire brick flue D, which is divided by dampers above the top of the vessel B for the purpose of ensuring the heating of the two vessels A and B by the flue D at greatly differing temperatures. The flue D is connected at the bottom with a heat generator, which

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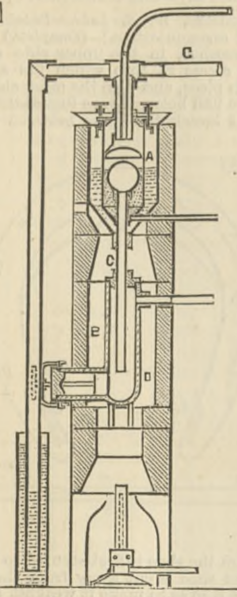

may be a Bunsen burner, and the top of the flue is connected with a chimney by a passage for conducting off the gases of combustion. G is the gas supply pipe.

2256. COMBINATION OF MATERIALS FOR PRODUCING NON-FADING SIGNS, &c., *J. Budd.—Dated 2nd June, 1880.—(Not proceeded with.)* 2*d.*

A shell or "dish" of glass is first produced which is scored during the moulding. The devices are then transferred on to the skin or paper which is placed upon the inner surface of the shell or dish. Boiling engraver's wax, hardened by spirits of wine, is next poured on to the skin. Fine powdered flint or sand is then put on to the wax at a red heat, and forms a rough surface to receive a layer of plaster of Paris or Portland cement.

2257. PREVENTING ALTERATIONS IN CHEQUES, &c., *S. Simmons. — Dated 2nd June,* 1880.—*(Not proceeded with.)* 2*d.*

This consists in embossing, and it may be also slightly perforating with numerous points or short lines that portion of a cheque upon which the sum for which the cheque is drawn has been written.

2258. IRONING WOVEN FABRICS, *A. B. Furlong.—Dated 2nd June,* 1880. 6*d.*

The ironing table D is heated either by steam or by a gas stove beneath, and its top surface is curved, so as

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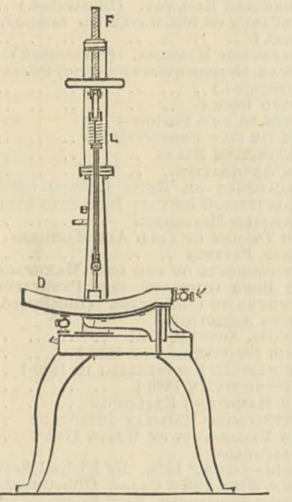

to allow the smoothing iron to pass over the fabric placed thereon. The iron is secured to a swinging arm B suspended from above the table, and made adjustable by means of a screw F, the requisite pressure being brought to bear on the fabric by means of an adjustable spring L.

2259. MANUFACTURE OF ALKALIES, *C. Wigg.—Dated 3rd June,* 1880. 6*d.*

The drawing shows a sectional elevation of the furnace, in which A is the fire grate and fuel chamber placed much lower, as regards the revolving furnace B, than has been heretofore the practice; C are fuel feed openings; D air chamber or jacket surrounding

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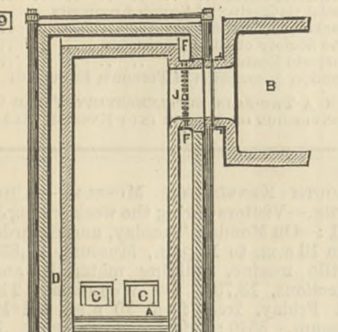

the firegrate and fuel chamber; E openings for the supply of air to the chamber D; F openings from the chamber D to the combustion space J; G doors for regulating the inflow of air to the fireplace. Part of the air passing through the chamber D and openings F mixes with the burning and unburnt gases from the fuel chamber A to the interior of the revolving furnace B.

2260. MANUFACTURE OF GAS, *W. W. Monk.—Dated 3rd June,* 1880. 6*d.*

The hydraulic main is formed so as to throw all the heavy tar to the point to be drawn off, and the main from the retort bench is so supported by crutches that its front overhangs the bench sufficiently to admit of the ascension pipe passing through and extending a considerable distance above it. Fixed to the top of the hydraulic main is a pipe that surrounds the ascension pipe, and of such diameter as to form a space for the passage of gas. The top of the ascension pipe is open, but the surrounding pipe is closed at top by a bonnet, while its lower end descends into the hydraulic main low enough to permit of it being sealed by the liquid therein. A separate hydraulic main is provided for each bench of retorts, and from each retort there rises an ascension pipe passing through the main and enveloped by a surrounding pipe. Attached to the wall in front of the retort benches is a syphon-box capable of containing liquid, and of being adjusted to any height by screw and bevel gear. Extending rom the hydraulic main to the syphon-box is a pipe with two descending legs, one entering the hydraulic main, and the other entering the syphon-box, thus forming a syphon. Each hydraulic main has a pipe to convey away the gas, tar, and liquor to a conducting main. In the drawings, Fig. 1 shows a front elevation of a bench of retorts

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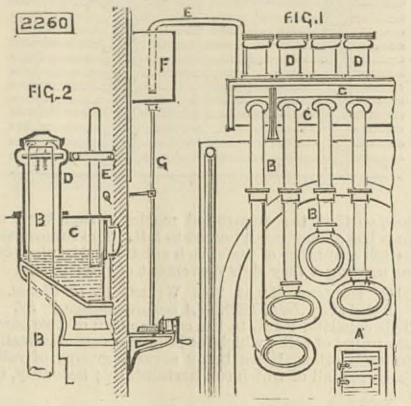

with ascensions, hydraulic main, and the dip seal regulator; and Fig. 2 shows the details of the ascension, hydraulic, and dip pipe arrangement. A is the retort bench, B the ascension pipes, C the hydraulic main, D the surrounding pipes, and E the syphon pipe leading from the hydraulic main to the seal regulating tank F, supported and adjusted by a screwed shaft, fitted with bevel gearing. Q is the pipe to convey away the gas, tar and liquor.

2262. SHEEP FENCING, &c., *J. Sainty.—Dated 3rd June, 1880.—(Not proceeded with.)* 2*d.*

This consists in the main of a combination of wood, iron, and steel, or solely of iron and steel.

2263. MANUFACTURE OF WOODEN GUTTERS, TROUGHS, &c., *G. Baumber and A. Logan.—Dated 3rd June, 1880.—(Not proceeded with.)* 2*d.*

This relates to the construction of a machine or apparatus for cutting or forming hollow or concave gutters, troughs, or spouts, from rectangular lengths of timber by cutting or sawing out a solid core of a semi-cylindrical form, so that no part of the timber excepting the sawdust and the very small chips or shavings will be wasted.

2264. WEIGHING, MEASURING, RECORDING, AND DELIVERING QUANTITIES OF LIQUID, *M. Graham.—Dated 3rd June,* 1880. 6*d.*

The apparatus is made with a hollow cast iron base 9, above which there is a rocking-box 10 made with two compartments 11, 12, separated by a transverse partition 13 at the middle of the box. In the middle of the partition there is formed a track or passage 16,

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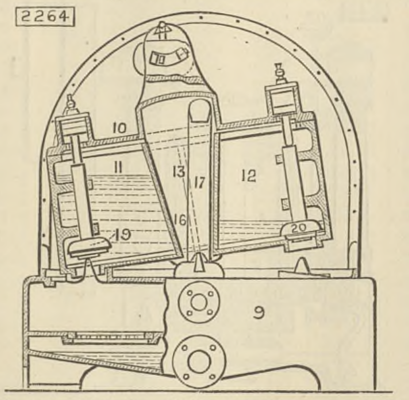

up through which the supply pipe 17 passes. At the extreme ends of the bottoms of the compartments 11, 12 there are valves 19, 20 opening inwards, and when one compartment—11 for example—is filled sufficiently to overbalance, that end of the box 10 in descending brings its valve 19 into contact with a stationary projection on the receiving cistern or hollow base 9 below, and causes the valve to open so as to discharge the contents of that compartment into the cistern below.

2265. INCREASING THE ILLUMINATING POWER OF GAS FLAMES, *M. Williams.—Dated 3rd June,* 1880. 6*d.*

A piece of metal wire B, preferably platinum, is fitted to the burner A over the openings through which the gas escapes, and parallel with the flame at

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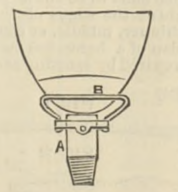

such a height that it is at the centre of the lower part of the gas flame, and out of and below the luminous zone of it. The flame is thereby separated into two parts, which curve round the wire and re-unite above it.

2266. KNIVES AND FORKS, *W. E. Darwin.—Dated 3rd June,* 1880. 6*d.*

This consists chiefly in forming the metallic handle, or a portion of the metallic handle, in combination with the bolster, in two parts or halves, which are afterwards joined together in the usual way, and secured to the blade by soldering or similar means.

2268. FIGURED WOVEN GOODS, *J. Kippax.—Dated 3rd June,* 1880. 6*d.*

In the weaving of counterpanes, quilts, &c., and particularly to such as are woven with two or more colours in addition to the white or coloured ground, the coloured warps in some parts of the design float together over the same spaces, and by mixing do not

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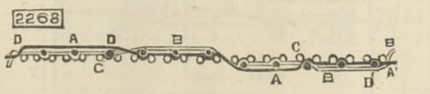


produce the effect desired. To obviate this, at intervals in the weaving, picks are put in, which tie down the warps not desired to appear on the surface. In the drawing A is a blue yarn and B a red yarn, while C represent the ordinary ground picks, and D the tying down picks.

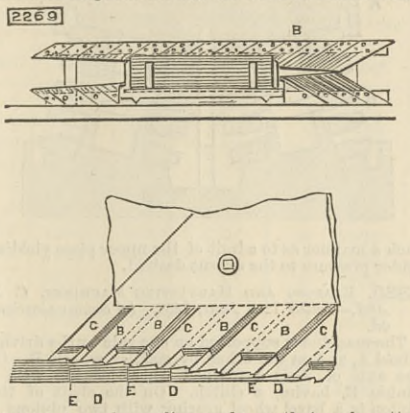
2270. SELF-CLOSING STOPPERS OR SYPHONS FOR BOTTLES CONTAINING AERATED LIQUIDS, *F. Wirth. Dated 3rd June,* 1880.—*(A communication.)—(Not proceeded with.)* 2*d.*

This consists partly in making and arranging the parts in such a manner that the liquid comes in contact only with hard india-rubber, or glass, or other material which is not affected by the frequent contact of liquid, nor influences the latter by its contact.

2269. MACHINERY FOR CUTTING TIMBER, *W. R. Lake.—Dated 3rd June,* 1880.—*(A communication.)* 6*d.*

This comprises a series of cutters B arranged and adapted to cut through a log lengthwise thereof and parallel with the grain, each cutter operating on the principle of a carpenter's plough, and cutting a shaving the entire length of the log, the series of cutters being

2269

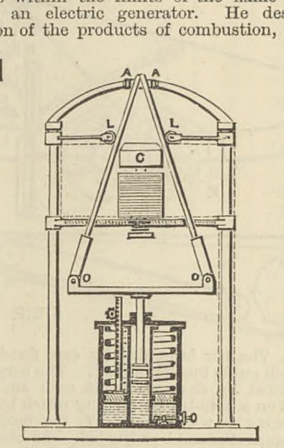


arranged in a descending scale, so that each cutter after the first will enter the log more deeply than the cutter preceding it. Each cutter is made of a plate of steel and provided on its sides with diagonal grooves or channels C, and on its lower edge with inclined surfaces D D and projections or heels E E.

2271. ARTIFICIAL ILLUMINATION, *J. J. W. Watson.—Dated 3rd June,* 1880. 8*d.*

The aim of the inventor is to increase the light-giving powers of compound combustibles, by rendering the dark part of the flame incandescent. To effect this he makes special arrangements of his burners, and introduces within the limits of the flame the electrodes of an electric generator. He desires the dissociation of the products of combustion, and uses

2271



a high temperature obtained by high electrical resistance. Metals such as platinum around graphite, asbestos, lime, &c., in various forms are used. Where the electric arc proper is to be used with a gas flame, a lamp as shown in the Fig. is used. A A shows the gas jets; the carbons hinged at O are guided by L L on the one side, and the steatite or porcelain disc C on the other. The motion of the carbons is obtained as shown.

2272. IMPROVEMENTS IN OBTAINING, INCREASING, AND EMPLOYING ELECTRICAL CURRENTS, *Thomas Slater.—Dated 3rd June,* 1880. 6*d.*

The machine devised has a modified Gramme ring, more completely encircled than in some other machines. A A are the fixed electro-magnets, having their like poles opposed and separated by a strip B of non-magnetic material. Each magnet surrounds one-half the circumference of the revolving armature C, and the poles are each brought to a line where opposed to the revolving armature. The form of the core of these magnets is clearly shown in the drawings, the

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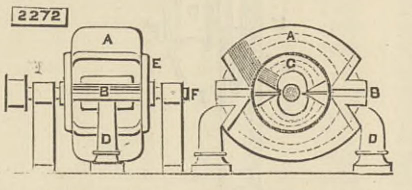
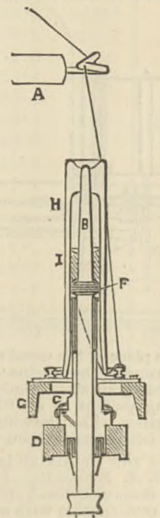


wire being wound thereon in the direction of the axis of the revolving armature. These fixed magnets are supported by pillars D, or by any other suitable means. The revolving armature C is in like manner composed of two similar electro magnets, with their like poles opposed and separated by a strip of non-magnetic material. The wire is wound on in the direction of the axis, as in the fixed magnets. On the ends of the ring are fixed two plates E, and these carry the shaft F for imparting rotary motion to the armature. The shaft F is supported in bearings and carries a driving pulley. The author claims the form and construction of armature, and the form and construction of the fixed magnets.

2277. RING SPINNING, DOUBLING, AND TWISTING FRAMES, *T. Guest and T. Brookes.—Dated 4th June,* 1880. 4*d.*

A washer of india-rubber is fixed on the spindle

2277

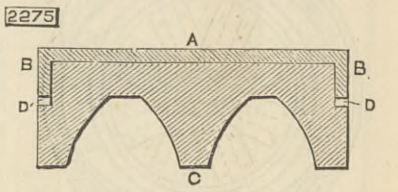


above the tube by a grooved collar, the washer being rather larger in diameter than the inside of the bobbin. When the bobbin is taken off the spindle, a portion of the yarn is allowed to unwind itself and coil round the spindle. The empty bobbin is then dropped on to the spindle, and catches the yarn between the washer and the bobbin, and holds it secure. In the drawing, A is the thread-board, C the bolster, D the spindle rail, E the footstep, and G the ring rail, all of ordinary construction, while B is the spindle, F the washer, H the bobbin, and I a bush which rests on the washer.

2275. SECURING STEREOTYPE PLATES, *E. D. Rogers.—Dated 4th June,* 1880. 4*d.*

The plate A is formed with vertical flanges B along its edges and the sides of the bed C having corresponding recesses D into which the flanges fit. Thus by

2275



placing the plate by a vertical downward movement on the bed they will be locked up by the ordinary column rules or other furniture of sufficient height.

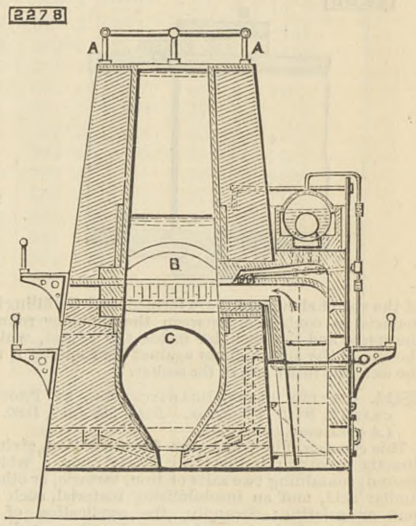
2276. BEDS FOR INVALIDS, *J. A. Daniel and R. Whiteley. — Dated 4th June, 1880.—(Not proceeded with.)* 2*d.*

This relates to beds so constructed that the patient need not be removed from bed for sanitary purposes, nor disturbed by the insertion of sanitary vessels into the bed.

2278. BURNING OR CALCINING LIME, &c., *J. W. and G. T. Raynes and P. Evans.—Dated 4th June,* 1880. 6*d.*

The kiln A may be of the section shown, or it may be of rectangular or other section. It is divided by the wall or partition B having a tapered or rounded apex. This wall may be supported and strengthened by iron beams covered with brick, cement, or other

2278

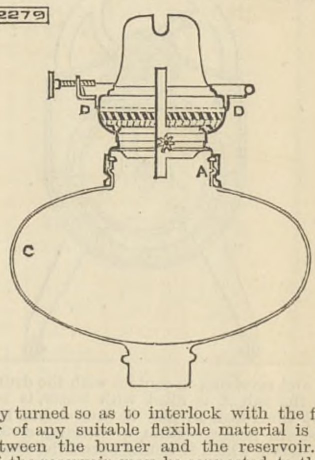


suitable non-conducting substance to protect the same from the action of the gas, and to relieve the strains from the central passage on the top. The wall or partition B is carried by an arch C, and divides the central portion of the kiln A into two passages, and diverts the material that is fed into the kiln through the top thereof into two streams.

2279. LAMPS, *T. Kennedy.—Dated 4th June,* 1880. 6*d.*

At the top of the reservoir C is a projection or flange A, at two opposite points of which are notches or depressions. The burner D is of ordinary construction, but in place of the screw at the bottom there is a socket with one or two projections which pass into the notches D in flange A and below such flange, when

2279

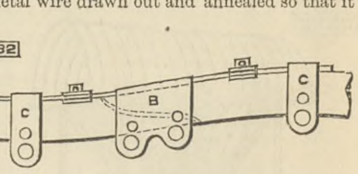


it is partly turned so as to interlock with the flange. A washer of any suitable flexible material is introduced between the burner and the reservoir. The bottom of the reservoir may be connected to the foot or stand in a similar manner.

2282. REPAIRING BROKEN OR CRACKED SHAFTS, BEAMS, &c., *W. P. Thompson.—Dated 5th June, 1880.—(A communication.)* 6*d.*

This consists in the employment of an armature of soft metal wire drawn out and annealed so that it can

2282



follow on being applied the modifications of form that can result from the accident. B and C are collars for imprisoning the fractured part.

2283. LOOMS, &c., *R. Greenwood and W. H. Hayhust.—Dated 5th June, 1880.—(Not proceeded with.)* 2*d.*

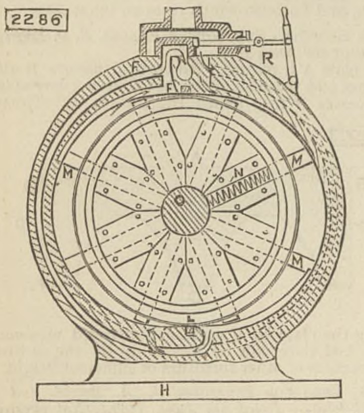
This relates partly to a means of stopping the loom immediately upon the completion of any determined length of cloth or piece.

2289. MACHINERY FOR DRYING, DISINTEGRATING ANIMAL AND VEGETABLE REFUSE, *M. Higgins.—Dated 5th June, 1880.—(Not proceeded with.)* 2*d.*

This consists of an iron cylinder mounted horizontally on suitable supports and having a solid continuous revolving shaft working in suitable bearings passing longitudinally through its entire length, and projecting at either end for gearing purposes. Fitted to such shaft are one, two, or more agitators, each of which consists of a suitable number of fans provided with a series of arms of beaters fitted longitudinally in a frame, and having suitable interstices and spaces left between them.

2286. ROTARY ENGINES, *H. Thibault and T. Hawkins.*—*Dated 5th June,* 1880. 6*d.*

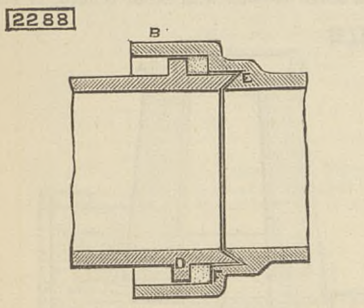
A case R is mounted or secured on a bed H, this case is provided with channels or ports F for the passage of steam, and with recesses. Within the case revolves a drum L connected with and secured to a shaft O. This drum is provided with end flanges bevelled outwardly, and eight sliding pistons M which



slide in receptacles provided in the drum L, and which pistons rest on springs N, which are for the purpose of holding the piston M in position to take steam, and at the same time to diminish the shock when the pistons M by the revolution of the drum L are forced down by contact with the case R into the receptacles of said drum L.

2288. JOINT FOR WATER-PIPES, &c., *J. Robbins.*—*Dated 5th June,* 1880. 6*d.*

One end of the pipe has a socket B, at the extreme inner end of which is a shoulder E, while one or more shoulders F are made inside the socket. Near the end



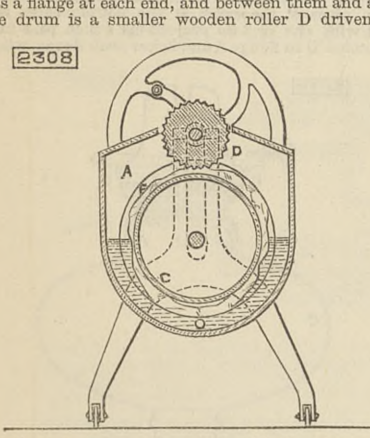
of the spigot shoulders D are formed, and the filling in material is contained between the shoulder round the spigot and the shoulder inside the socket, while the end of the spigot abuts against the shoulder E at the extreme inner end of the socket.

2304. COPYING PLANS, DRAWINGS, &c., BY PHOTOGRAPHY, *W. P. Thompson.*—*Dated 8th June,* 1880.—(*A communication.*) 4*d.*

This consists, First, in a gum ferric solution, giving directly proofs in indigo black shade upon a white ground, containing two salts of iron, tartaric, or other similar acid, and an insolubilising material, such as gum or gelatine; Secondly, the application of a developing solution, consisting of red or yellow prussiate of potash, or metallic solution, such as salts of silver, zinc, and the like, to a surface impregnated with salts of iron and other chemicals for the purpose of making a dark or blue black lined or marked positive direct from an original with photographically dark opaque lined or marked negative.

2308. WASHING MACHINE, *A. J. Forbes.*—*Dated 8th June,* 1880. 6*d.*

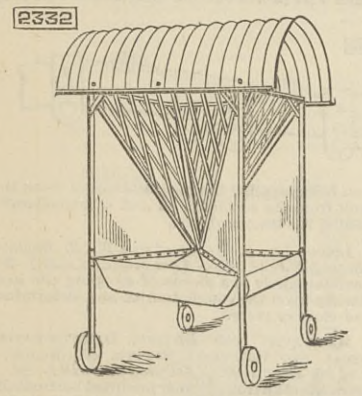
A vessel A of U-shaped section contains a water-tight revolving drum C on a spindle which is free to move in a groove in each end of the tub. The drum has a flange at each end, and between them and above the drum is a smaller wooden roller D driven by a



crank and revolving in contact with the drum, which, when the tub A is filled with water, is buoyed up against the roller D, and is thus driven by it. The clothes are placed within a washing cloth of open woven fabric which is wound round the drum.

2332. FEEDING HORSES, &c., *W. Griffiths.*—*Dated 9th June,* 1880. 6*d.*

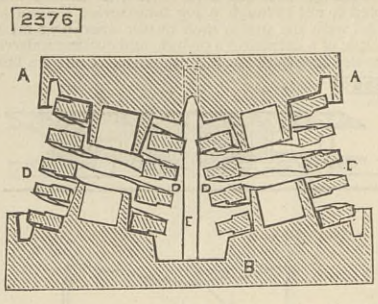
This consists of a three, four, or more-sided structure, each side or section comprising a feeding trough and rack complete, and being so divided or screened off from the other sides or sections as to prevent the



animal that may be feeding thereat from seeing or being interfered with by another animal which may be feeding at another section of the structure.

2376. SPRINGS FOR RAILWAY CARRIAGES, &c., *J. H. Johnson.*—*Dated 11th June,* 1880.—(*A communication.*) 6*d.*

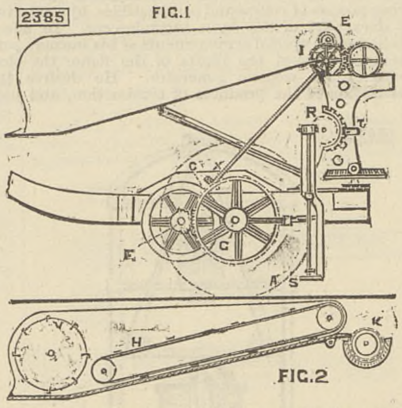
A is the top plate and B the bottom plate of the spring, and between the two plates are interposed the two spirals D D, which are arranged at reverse but otherwise similar angles in respect to a vertical line. The two plates are connected together by rods E in



such a manner as to admit of the upper plate yielding under pressure to the extent desired.

2385. REAPING AND HARVESTING MACHINES, *C. D. Abel.*—*Dated 12th June,* 1880.—(*A communication.*) 6*d.*

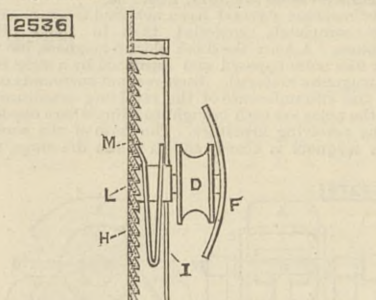
The machine is supported on one side by the driving wheel A, and on the other by smaller wheels B. On the axle of A is a toothed wheel gearing with a pinion E, having a clutch. On the shaft of this pinion is a bevel wheel gearing with two pinions G and G^1, the former on an inclined shaft, which, by bevel gear, pulleys, and strap works the beating drum. By pinions E is worked from the same shaft the upper shaft of the travelling band H, and by gearing I is worked the hulling cylinder K. The pinion G^1 is on a horizontal shaft, having a crank to work the reaping blades S, which are fixed on a bar terminating in a piece having uprights between which the crank is



engaged. The bar is guided by ears fixed on a bar from which guide fingers project. The reaping frame is suspended by chains, one at each end, led over pulleys R on a spindle, by turning which by a handle, and engaging it with notches T, the height of the reaping apparatus can be adjusted. The beating drum V has beater blades which strike off the heads of corn, which are then carried by the travelling bands H along the inclined bottom of the casing, and delivered to the casing of the hulling cylinder K.

2536. RACK PULLEYS FOR THE CORDS OF WINDOW BLINDS, &c., *E. and C. Showell and J. Empson.*—*Dated 22nd June,* 1880. 6*d.*

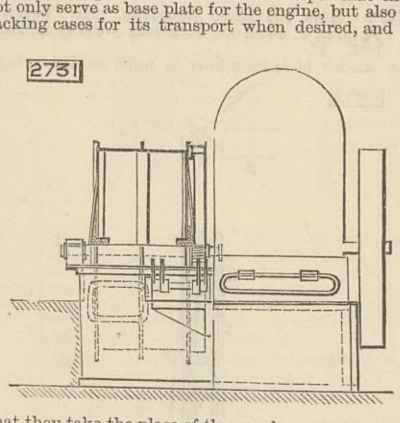
This relates to the combination with the bodies of rack pulleys having rack teeth on their backs, of a slide or pulley carrier consisting of a catch plate H having at its back a spring I, the top of the said plate H being furnished with a tooth or catch M for engaging



with the rack teeth, and at its sides or vertical edges with bearing parts L L, for causing the slide or pulley carrier to accurately fit and work smoothly in the body of the rack pulley, the axis carrying the pulley D, and thumb plate F being connected to the catch plate H, and the catch of the said plate being engaged with and disengaged from the rack teeth.

2731. MINING ENGINES, *J. Richardson.*—*Dated 3rd July,* 1880. 6*d.*

The invention consists in making the foundation of wrought iron plates of such form and depth that they not only serve as base plate for the engine, but also as packing cases for its transport when desired, and so



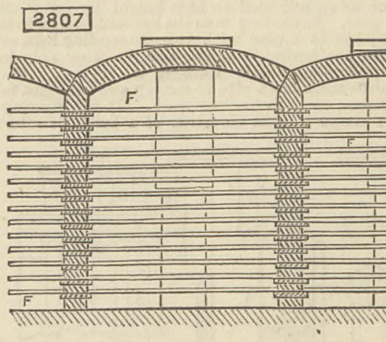
that they take the place of the usual masonry or other foundation, and render the engine entirely self-contained and workable even when combined with winding gear or driving pulleys in addition to the usual parts of such engines. The drawing shows an end view of an engine with section through drum.

3653. APPARATUS FOR OBTAINING IMPRESSIONS FROM SUBSTANCES, *H. A. Bonneville.*—*Dated 8th September,* 1880.—(*A communication.*)—(*Complete.*) 8*d.*

This consists in combination with a teapot, properly so-called, of a cup, bowl, or receptacle whatever, into which the tea or substance to be infused is put. The sides and bottom of this receptacle are perforated.

2807. RECOVERY OF LEAD AND OTHER METALLIC SUBSTANCES FROM FURNACE FUMES, *E. A. Cowper and F. Sopwith.*—*Dated 8th July,* 1880. 6*d.*

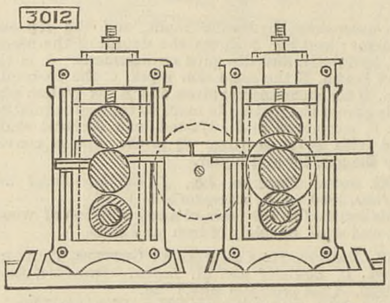
The fumes are caused to pass very slowly through flues, so as to prevent any scouring action taking place, and so as to greatly reduce the time required for the solid matter to fall. A number of shelves F are placed inside the flue at small distances one above the



other, so that the suspended matter in each layer of fumes has a very small height to fall. The fumes pass through a number of flues, each subdivided by shelves, thus causing a very slow movement of the current.

3012. ROLLING MILLS FOR WIRES, *F. C. Glaser.*—*Dated 22nd July,* 1880.—(*A communication.*) 8*d.*

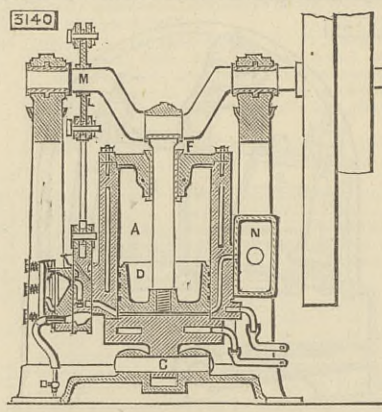
This consists, First, in the combination of two complete trains of rolls, which feed the wires automatically into each other, there being several groups of rolls to each set, all of which run horizontally; Secondly, in



the peculiar mode of driving both trains of rolls by means of one driving shaft lying between them, and by means of toothed gearing so proportioned as to impart the necessary increasing speed to each successive pair of rolls. The drawing is a cross section.

3140. GAS ENGINES, *H. H. Lake.*—*Dated 30th July* 1880.—(*A communication.*) 6*d.*

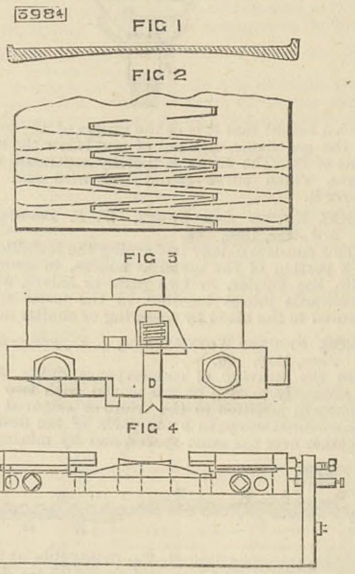
A vacuum is produced in the rear of the piston after the explosion of the gaseous mixture, whereby atmospheric pressure can be utilised. The bottom of cylinder A has an extension to receive a shaft C serving as a trunnion, on which the cylinder oscillates. The rod of piston D is connected to and operates the crank shaft M, and at the top of the cylinder this rod is



guided by the guide F which prevents straining of the rod. On the front of the cylinder is a slide valve to admit the explosive mixture, and it is worked by a cam L on the crank shaft. On top of the engine is placed a governor serving to regulate the introduction of the explosive mixture by opening or closing the gas supply valves. At the back of the cylinder is an exhaust chamber N which will be brought into action at the proper time by the oscillation of the cylinder.

3984. MANUFACTURE OF HORSESHOE NAILS, &c., *W. R. Lake.*—*Dated 1st October,* 1880.—(*A communication.*)—(*Complete.*) 6*d.*

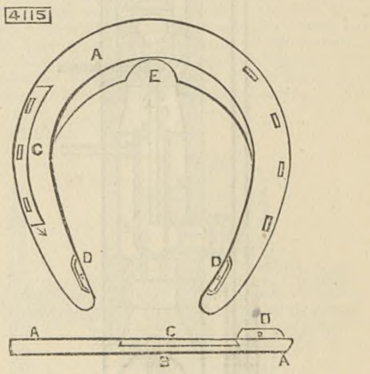
Fig. 1 represents a cross section of a plate which has been prepared by the ordinary hot rolling process, and which has at its several parts the proper thickness to permit horseshoe nails to be cut or punched therefrom with their heads at the edges of the plate and their points in the thinner, middle, or central part. Fig. 2 represents a plan of a horseshoe nail plate of homogeneous iron prepared by spotting as described in speci-



fication of patent dated 28th June, 1877, No. 2497, but having the spots which are placed in two rows alternately far enough apart to enable this invention to be carried into practice. In Fig. 3 D represents the finger which is forced up when the punch is depressed upon the plate and the punches are in use. This finger or bolt D is placed opposite the end of the second nail punch, and its points reach the bed die somewhat in advance of it, so that the said points may pass one upon each side of the strip of metal left by the first punch, from which strip the overlapping nails are cut by the second punch, and by means of their sloped or curved inner faces act upon the metal to move it sidewise, if sprung, and bring its centre opposite the point of the punch, so that the point of the nail will be cut from the centre of the strip and spot prepared for the purpose. Fig. 4 is a front view of the bed with the dies, guides, and adjusting connections upon it.

4115. HORSESHOES, *W. R. Lake.*—*Dated 9th October,* 1880.—(*A communication.*)—(*Complete.*) 4*d.*

A is a horseshoe, in the upper side of which is a dovetailed recess B, into which fits a removable piece C. This piece, and also the other side or arm of the shoe, have nail holes. D are lugs at the heel of the shoe which fit loosely the space between the walls of



the hoof when the shoe is first secured to the foot. A portion of the shoe is cut away from the toe on the inner edge at E so as to make it weakest at this part, and when force is applied between the lugs D to spread this portion, the shoe will bend at E and not at any intermediate point, thus preventing the binding of the removable piece C. The piece C is first nailed to the hoof, and the shoe then passed over it and secured by the other arm.

CONTENTS.

THE ENGINEER, January 7th, 1881.

WITH A TWO-PAGE SUPPLEMENTARY TABLE FOR THE CONVERSION OF METRIC INTO ENGLISH MEASURES.

SOUTH KENSINGTON MUSEUM. — CHRISTMAS WEEK.—Visitors during the week ending Jan. 1st, 1881 :—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 27,835; mercantile marine, building materials, and other collections, 13,797. On Wednesday, Thursday, and Friday, free, from 10 a.m. till 10 p.m., Museum, 5549; mercantile marine, building materials, and other collections, 5076. Total, 52,257. Average of corresponding week in former years, 39,597. Total from the opening of the Museum, 19,610,141.

CONVERSION TABLES FOR FRENCH AND ENGLISH MEASURES OF LENGTH.

(For Explanation see page 3.)

No.	Metres = Feet.	Feet = Metres.	Cm. = Inches.	Inches = Cm.	Kilos. = Miles.	Miles = Kilos.
100	328·1	30·5	39·4	254·0	62·1	160·9
1	331·4	30·8	39·8	256·5	62·8	162·5
2	334·6	31·1	40·1	259·1	63·4	164·1
3	337·9	31·4	40·5	261·6	64·0	165·8
4	341·2	31·7	40·9	264·1	64·6	167·4
5	344·5	32·0	41·3	266·7	65·2	169·0
6	347·8	32·3	41·7	269·2	65·9	170·6
7	351·1	32·6	42·1	271·8	66·5	172·2
8	354·3	32·9	42·5	274·3	67·1	173·8
9	357·6	33·2	42·9	276·8	67·7	175·4
110	360·9	33·5	43·3	279·4	68·4	177·0
1	364·2	33·8	43·7	281·9	69·0	178·6
2	367·5	34·1	44·1	284·5	69·6	180·2
3	370·7	34·4	44·5	287·0	70·2	181·9
4	374·0	34·7	44·9	289·5	70·9	183·5
5	377·3	35·0	45·3	292·1	71·5	185·1
6	380·6	35·3	45·7	294·6	72·1	186·7
7	383·9	35·6	46·1	297·2	72·7	188·3
8	387·1	35·9	46·4	299·7	73·3	189·9
9	390·4	36·3	46·8	302·2	73·9	191·5
120	393·7	36·6	47·2	304·8	74·6	193·1
1	397·0	36·9	47·6	307·3	75·2	194·7
2	400·3	37·2	48·0	309·9	75·8	196·3
3	403·5	37·5	48·4	312·4	76·4	197·9
4	406·8	37·8	48·8	314·9	77·1	199·6
5	410·1	38·1	49·2	317·5	77·7	201·2
6	413·4	38·4	49·6	320·0	78·3	202·8
7	416·7	38·7	50·0	322·6	78·9	204·4
8	419·9	39·0	50·4	325·1	79·5	206·0
9	423·2	39·3	50·8	327·6	80·2	207·6
130	426·5	39·6	51·2	330·2	80·8	209·2
1	429·8	39·9	51·6	332·7	81·4	210·8
2	433·1	40·2	52·0	335·3	82·0	212·4
3	436·4	40·5	52·4	337·8	82·6	214·0
4	439·6	40·8	52·8	340·3	83·3	215·7
5	442·9	41·1	53·2	342·9	83·9	217·3
6	446·2	41·4	53·5	345·4	84·5	218·9
7	449·5	41·7	53·9	348·0	85·1	220·5
8	452·8	42·1	54·3	350·5	85·8	222·1
9	456·0	42·4	54·7	353·0	86·4	223·7
140	459·3	42·7	55·1	355·6	87·0	225·3
1	462·6	43·0	55·5	358·1	87·6	226·9
2	465·9	43·3	55·9	360·7	88·2	228·5
3	469·2	43·6	56·3	363·2	88·8	230·1
4	472·4	43·9	56·7	365·7	89·5	231·7
5	475·7	44·2	57·1	368·3	90·1	233·3
6	479·0	44·5	57·5	370·8	90·7	235·0
7	482·3	44·8	57·9	373·4	91·3	236·6
8	485·6	45·1	58·3	375·9	92·0	238·2
9	488·8	45·4	58·7	378·4	92·6	239·8
150	492·1	45·7	59·1	381·0	93·2	241·4
1	495·4	46·0	59·4	383·5	93·8	243·0
2	498·7	46·3	59·8	386·1	94·4	244·6
3	502·0	46·6	60·2	388·6	95·1	246·2
4	505·3	46·9	60·6	391·1	95·7	247·8
5	508·5	47·2	61·0	393·7	96·3	249·4
6	511·8	47·5	61·4	396·2	96·9	251·1
7	515·1	47·8	61·8	398·8	97·6	252·7
8	518·4	48·1	62·2	401·3	98·2	254·3
9	521·7	48·4	62·6	403·8	98·8	255·9
160	524·9	48·8	63·0	406·4	99·4	257·5
1	528·2	49·1	63·4	408·9	100·0	259·1
2	531·5	49·4	63·8	411·5	100·7	260·7
3	534·8	49·7	64·2	414·0	101·3	262·3
4	538·1	50·0	64·6	416·5	101·9	263·9
5	541·3	50·3	65·0	419·1	102·5	265·5
6	544·6	50·6	65·3	421·6	103·1	267·1
7	547·9	50·9	65·7	424·2	103·8	268·8
8	551·2	51·2	66·1	426·7	104·4	270·4
9	554·5	51·5	66·5	429·2	105·0	272·0
170	557·8	51·8	66·9	431·8	105·6	273·6
1	561·0	52·1	67·3	434·3	106·3	275·2
2	564·3	52·4	67·7	436·9	106·9	276·8
3	567·6	52·7	68·1	439·4	107·5	278·4
4	570·9	53·0	68·5	441·9	108·1	280·0
5	574·2	53·3	68·9	444·5	108·7	281·6
6	577·4	53·6	69·3	447·0	109·4	283·2
7	580·7	53·9	69·7	449·6	110·0	284·8
8	584·0	54·2	70·1	452·1	110·6	286·5
9	587·3	54·6	70·5	454·6	111·2	288·1
180	590·6	54·9	70·9	457·2	111·8	289·7
1	593·8	55·2	71·3	459·7	112·5	291·3
2	597·1	55·5	71·6	462·3	113·1	292·9
3	600·4	55·8	72·0	464·8	113·7	294·5
4	603·7	56·1	72·4	467·3	114·3	296·1
5	607·0	56·4	72·8	469·9	115·0	297·7
6	610·2	56·7	73·2	472·4	115·6	299·3
7	613·5	57·0	73·6	475·0	116·2	300·9
8	616·8	57·3	74·0	477·5	116·8	302·5
9	620·1	57·6	74·4	480·0	117·4	304·2
190	623·4	57·9	74·8	482·6	118·1	305·8
1	626·6	58·2	75·2	485·1	118·7	307·4
2	629·9	58·5	75·6	487·7	119·3	309·0
3	633·2	58·8	76·0	490·2	119·9	310·6
4	636·5	59·1	76·4	492·7	120·5	312·2
5	639·8	59·4	76·8	495·3	121·2	313·8
6	643·1	59·7	77·2	497·8	121·8	315·4
7	646·3	60·0	77·6	500·4	122·4	317·0
8	649·6	60·3	77·9	502·9	123·0	318·6
9	652·9	60·6	78·3	505·4	123·7	320·3
200	656·2	61·0	78·7	508·0	124·3	321·9
1	659·5	61·3	79·1	510·5	124·9	323·5
2	662·7	61·6	79·5	513·1	125·5	325·1
3	666·0	61·9	79·9	515·6	126·1	326·7
4	669·3	62·2	80·3	518·1	126·8	328·3
5	672·6	62·5	80·7	520·7	127·4	329·9
6	675·9	62·8	81·1	523·2	128·0	331·5
7	679·1	63·1	81·5	525·8	128·6	333·1
8	682·4	63·4	81·9	528·3	129·2	334·7
9	685·7	63·7	82·3	530·8	129·9	336·3
210	689·0	64·0	82·7	533·4	130·5	338·0
1	692·3	64·3	83·1	535·9	131·1	339·6
2	695·5	64·6	83·5	538·5	131·7	341·2
3	698·8	64·9	83·8	541·0	132·4	342·8
4	702·1	65·2	84·2	543·5	133·0	344·4
5	705·4	65·5	84·6	546·1	133·6	346·0
6	708·8	65·8	85·0	548·6	134·2	347·6
7	711·9	66·1	85·4	551·2	134·8	349·2
8	715·2	66·4	85·8	553·7	135·5	350·8
9	718·5	66·7	86·2	556·2	136·1	352·4
220	721·8	67·1	86·6	558·8	136·7	354·0
1	725·1	67·4	87·0	561·3	137·3	355·7
2	728·4	67·7	87·4	563·9	137·9	357·3
3	731·6	68·0	87·8	566·4	138·6	358·9
4	734·9	68·3	88·2	568·9	139·2	360·5
5	738·2	68·6	88·6	571·5	139·8	362·1
6	741·5	68·9	89·0	574·0	140·4	363·7
7	744·8	69·2	89·4	576·6	141·0	365·3
8	748·0	69·5	89·8	579·1	141·7	366·9
9	751·3	69·8	90·2	581·7	142·3	368·5
230	754·6	70·1	90·6	584·2	142·9	370·1
1	757·9	70·4	90·9	586·7	143·5	371·8
2	761·2	70·7	91·3	589·3	144·2	373·4
3	764·4	71·0	91·7	591·8	144·8	375·0
4	767·7	71·3	92·1	594·3	145·4	376·6
5	771·0	71·6	92·5	596·9	146·0	378·2
6	774·3	71·9	92·9	599·4	146·6	379·8
7	777·6	72·2	93·3	602·0	147·3	381·4
8	780·8	72·5	93·7	604·5	147·9	383·0
9	784·1	72·8	94·1	607·0	148·5	384·6
240	787·4	73·1	94·5	609·6	149·1	386·2
1	790·7	73·4	94·9	612·1	149·7	387·8
2	794·0	73·7	95·3	614·7	150·4	389·4
3	797·3	74·1	95·7	617·2	151·0	391·1
4	800·5	74·4	96·1	619·7	151·6	392·7
5	803·8	74·7	96·5	622·3	152·2	394·3
6	807·1	75·0	96·8	624·8	152·9	395·9
7	810·4	75·3	97·2	627·4	153·5	397·5
8	813·7	75·6	97·6	629·9	154·1	399·1
9	816·9	75·9	98·0	632·4	154·7	400·7
250	820·2	76·2	98·4	635·0	155·3	402·3
1	823·5	76·5	98·8	637·5	156·0	403·9
2	826·8	76·8	99·2	640·1	156·6	405·5
3	830·1	77·1	99·6	642·6	157·2	407·2
4	833·3	77·4	100·0	645·1	157·8	408·8
5	836·6	77·7	100·4	647·7	158·5	410·4
6	839·9	78·0	100·8	650·2	159·1	412·0
7	843·2	78·3	101·2	652·8	159·7	413·6
8	846·5	78·6	101·6	655·3	160·3	415·2
9	849·7	78·9	102·0	657·8	160·9	416·8
260	853·0	79·2	102·4	660·4	161·6	418·4
1	856·3	79·5	102·8	662·9	162·2	420·0
2	859·6	79·8	103·1	665·5	162·8	421·6
3	862·9	80·2	103·5	668·0	163·4	423·2
4	866·2	80·5	103·9	670·5	164·1	424·9
5	869·4	80·8	104·3	673·1	164·7	426·5
6	872·7	81·1	104·7	675·6	165·3	428·1
7	876·0	81·4	105·1	678·2	165·9	429·7
8	879·3	81·7	105·5	680·7	166·5	431·3
9	882·6	82·0	105·9	683·2	167·2	432·9
270	885·8	82·3	106·3	685·8	167·8	434·5
1	889·1	82·6	106·7	688·3	168·4	436·1
2	892·4	82·9	107·1	690·9	169·0	437·7
3	895·7	83·2	107·5	693·4	169·6	439·3
4	899·0	83·5	107·9	695·9	170·3	441·0
5	902·2	83·8	108·3	698·5	170·9	442·6
6	905·4	84·1	108·7	701·0	171·5	444·2
7	908·7	84·4	109·1	703·6	172·1	445·8
8	912·0	84·7	109·4	706·1	172·7	447·4
9	915·4	85·0	109·8	708·6	173·4	449·0
280	918·7	85·3	110·2	711·2	174·0	450·6
1	921·9	85·6	110·6	713·7	174·6	452·2
2	925·2	85·9	111·0	716·3	175·2	453·8
3	928·5	86·2	111·4	718·8	175·8	455·4
4	931·8	86·6	111·8	721·3	176·5	457·0
5	935·1	86·9	112·2	723·9	177·1	458·7
6	938·3	87·2	112·6	726·4	177·7	460·3
7	941·6	87·5	113·0	729·0	178·3	461·9
8	944·9	87·8	113·4	731·5	179·0	463·5
9	948·2	88·1	113·8	734·0	179·6	465·1
290	951·5	88·4	114·2	736·6	180·2	466·7
1	954·7	88·7	114·6	739·1	180·8	468·3
2	958·0	89·0	115·0	741·7	181·4	469·9
3	961·3	89·3	115·3	744·2	182·1	471·5
4	964·6	89·6	115·7	746·7	182·7	473·1
5	967·9	89·9	116·1	749·3	183·3	474·7
6	971·1	90·2	116·5	751·8	183·9	476·4
7	974·4	90·5	116·9	754·4	184·6	478·0
8	977·7	90·8	117·3	756·9	185·2	479·6
9	981·0	91·1	117·7	759·4	185·8	481·2
300	984·3	91·4	118·1	762·0	186·4	482·8
1	987·6	91·7	118·5	764·5	187·0	484·4
2	990·8	92·0	118·9	767·1	187·6	486·0
3	994·1	92·3	119·3	769·6	188·3	487·6
4	997·4	92·7	119·7	772·1	188·9	489·2
5	1000·	93·0	120·1	774·7	189·5	490·8
6	1004·	93·3	120·5	777·2	190·1	492·4
7	1007·	93·6	120·9	779·8	190·8	494·1
8	1010·	93·9	121·3	782·3	191·4	495·7
9	1013·	94·2	121·7	784·8	192·0	497·3
310	1017·	94·5	122·1	787·4	192·6	498·9
1	1020·	94·8	122·4	789·9	193·2	500·5
2	1023·	95·1	122·8	792·5	193·9	502·1
3	1026·	95·4	123·2	795·0	194·5	503·7
4	1030·	95·7	123·6	797·5	195·1	505·3
5	1033·	96·0	124·0	800·1	195·7	506·9
6	1036·	96·3	124·4	802·6	196·4	508·5
7	1040·	96·6	124·8	805·2	197·0	510·2
8	1043·	96·9	125·2	807·7	197·6	511·8
9	1046·	97·2	125·6	810·2	198·2	513·4
320	1049·	97·5	126·0	812·8	198·8	515·0
1	1053·	97·8	126·4	815·3	199·5	516·6
2	1056·	98·1	126·8	817·9	200·1	518·2
3	1059·	98·4	127·2	820·4	200·7	519·8
4	1063·	98·7	127·6	822·9	201·3	521·4
5	1066·	99·0	128·0	825·5	201·9	523·0
6	1069·	99·3	128·3	828·0	202·6	524·6
7	1072·	99·7	128·7	830·6	203·2	526·2
8	1076·	100·0	129·1	833·1	203·8	527·9
9	1079·	100·3	129·5	835·6	204·4	529·5
330	1082·	100·6	129·9	838·2	205·1	531·1
1	1086·	100·9	130·3	840·7	205·7	532·7
2	1089·	101·2	130·7	843·3	206·3	534·3
3	1092·	101·5	131·1	845·8	206·9	535·9
4	1095·	101·8	131·5	848·3	207·5	537·5
5	1099·	102·1	131·9	850·9	208·2	539·1
6	1102·	102·4	132·3	853·4	208·8	540·7
7	1105·	102·7	132·7	856·0	209·4	542·3
8	1108·	103·0	133·1	858·5	210·0	544·0
9	1112·	103·3	133·5	861·0	210·6	545·6
340	1115·	103·6	133·9	863·6	211·3	547·2
1	1118·	103·9	134·2	866·1	211·9	548·8
2	1122·	104·2	134·6	868·7	212·5	550·4
3	1125·	104·5	135·0	871·2	213·1	552·0
4	1128·	104·8	135·4	873·7	213·8	553·6
5	1131·	105·1	135·8	876·3	214·4	555·2
6	1135·	105·4	136·2	878·8	215·0	556·8
7	1138·	105·7	136·6	881·4	215·6	558·4
8	1141·	106·1	137·0	883·9	216·3	560·0
9	1145·	106·4	137·4	886·4	216·9	561·7
350	1148·	106·7	137·8	889·0	217·5	563·3
1	1151·	107·0	138·2	891·5	218·1	564·9
2	1154·	107·3	138·6	894·1	218·7	566·5
3	1158·	107·6	139·0	896·6	219·3	568·1
4	1161·	107·9	139·4	899·1	220·0	569·7
5	1164·	108·2	139·8	901·7	220·6	571·3
6	1168·	108·5	140·2	904·2	221·2	572·9
7	1171·	108·8	140·5	906·8	221·8	574·5
8	1174·	109·1	140·9	909·3	222·5	576·1
9	1177·	109·4	141·3	911·8	223·1	577·7
360	1181·	109·7	141·7	914·4	223·7	579·3
1	1184·	110·0	142·1	916·9	224·3	581·0
2	1187·	110·3	142·5	919·5	224·9	582·6
3	1191·	110·6	142·9	922·0	225·6	584·2
4	1194·	110·9	143·3	924·5	226·2	585·8
5	1197·	111·2	143·7	927·1	226·8	587·4
6	1200·	111·5	144·1	929·6	227·4	589·0
7	1204·	111·8	144·5	932·2	228·0	590·6
8	1207·	112·2	144·9	934·7	228·7	592·2
9	1210·	112·5	145·3	937·2	229·3	593·8
370	1213·	112·8	145·7	939·8	229·9	595·4
1	1217·	113·1	146·1	942·3	230·5	597·1
2	1220·	113·4	146·5	944·9	231·2	598·7
3	1223·	113·7	146·9	947·4	231·8	600·3
4	1227·	114·0	147·3	949·9	232·4	601·9
5	1230·	114·3	147·6	952·5	233·0	603·5
6	1233·	114·6	148·0	955·0	233·6	605·1
7	1236·	114·9	148·4	957·6	234·3	606·7
8	1240·	115·2	148·8	960·1	234·9	608·3
9	1243·	115·5	149·2	962·6	235·5	609·9
380	1246·	115·8	149·6	965·2	236·1	611·5
1	1250·	116·1	150·0	967·7	236·7	613·1
2	1253·	116·4	150·4	970·3	237·4	614·8
3	1256·	116·7	150·8	972·8	238·0	616·4
4	1259·	117·0	151·2	975·3	238·6	618·0
5	1263·	117·3	151·6	977·9	239·2	619·6
6	1266·	117·6	152·0	980·4	239·9	621·2
7	1269·	117·9	152·4	983·0	240·5	622·8
8	1273·	118·2	152·8	985·5	241·1	624·4
9	1276·	118·6	153·2	988·0	241·7	626·0
390	1279·	118·9	153·5	990·6	242·3	627·6
1	1282·	119·2	153·9	993·1	243·0	629·2
2	1286·	119·5	154·3	995·7	243·6	630·9
3	1289·	119·8	154·7	998·2	244·2	632·5
4	1292·	120·1	155·1	1000·	244·8	634·1
5	1296·	120·4	155·5	1003·	245·5	635·7
6	1299·	120·7	155·9	1005·	246·1	637·3
7	1302·	121·0	156·3	1008·	246·7	638·9
8	1305·	121·3	156·7	1010·	247·3	640·5
9	1309·	121·6	157·1	1013·	247·9	642·1
400	1312·	121·9	157·5	1016·	248·5	643·7
1	1315·	122·2	157·9	1018·	249·2	645·3
2	1318·	122·5	158·3	1021·	249·8	646·9
3	1322·	122·8	158·7	1023·	250·4	648·6
4	1325·	123·1	159·1	1026·	251·0	650·2
5	1328·	123·4	159·5	1028·	251·7	651·8
6	1332·	123·7	159·8	1031·	252·3	653·4
7	1335·	124·0	160·2	1033·	252·9	655·0
8	1338·	124·3	160·6	1036·	253·5	656·6
9	1341·	124·7	161·0	1038·	254·1	658·2
410	1345·	125·0	161·4	1041·	254·8	659·8
1	1348·	125·3	161·8	1043·	255·4	661·4
2	1351·	125·6	162·2	1046·	256·0	663·0
3	1355·	125·9	162·6	1049·	256·6	664·7
4	1358·	126·2	163·0	1051·	257·2	666·3
5	1361·	126·5	163·4	1054·	257·9	667·9
6	1364·	126·8	163·8	1056·	258·5	669·5
7	1368·	127·1	164·2	1059·	259·1	671·1
8	1371·	127·4	164·6	1061·	259·7	672·7
9	1374·	127·7	165·0	1064·	260·4	674·3
420	1378·	128·0	165·4	1066·	261·0	675·9
1	1381·	128·3	165·7	1069·	261·6	677·5
2	1384·	128·6	166·1	1071·	262·2	679·1
3	1387·	128·9	166·5	1074·	262·8	680·7
4	1391·	129·2	166·9	1076·	263·5	682·3
5	1394·	129·5	167·3	1079·	264·1	684·0
6	1397·	129·8	167·7	1082·	264·7	685·6
7	1400·	130·1	168·1	1084·	265·3	687·2
8	1404·	130·4	168·5	1087·	265·9	688·8
9	1407·	130·7	168·9	1089·	266·6	690·4
430	1410·	131·1	169·3	1092·	267·2	692·0
1	1414·	131·4	169·7	1094·	267·8	693·6
2	1417·	131·7	170·1	1097·	268·4	695·2
3	1420·	132·0	170·5	1099·	269·1	696·8
4	1423·	132·3	170·9	1102·	269·7	698·4
5	1427·	132·6	171·3	1104·	270·3	700·1
6	1430·	132·9	171·7	1107·	270·9	701·7
7	1433·	133·2	172·1	1110·	271·5	703·3
8	1437·	133·5	172·5	1112·	272·2	704·9
9	1440·	133·8	172·9	1115·	272·8	706·5
440	1443·	134·1	173·2	1117·	273·4	708·1
1	1446·	134·4	173·6	1120·	274·0	709·7
2	1450·	134·7	174·0	1122·	274·6	711·3
3	1453·	135·0	174·4	1125·	275·3	712·9
4	1456·	135·3	174·8	1127·	275·9	714·5
5	1460·	135·6	175·2	1130·	276·5	716·1
6	1463·	135·9	175·6	1132·	277·1	717·8
7	1466·	136·2	176·0	1135·	277·8	719·4
8	1469·	136·5	176·4	1137·	278·4	721·0
9	1473·	136·8	176·8	1140·	279·0	722·6
450	1476·	137·1	177·2	1143·	279·6	724·2
1	1479·	137·4	177·6	1145·	280·2	725·8
2	1483·	137·7	178·0	1148·	280·9	727·4
3	1486·	138·1	178·4	1150·	281·5	729·0
4	1489·	138·4	178·8	1153·	282·1	730·6
5	1492·	138·7	179·1	1155·	282·7	732·2
6	1496·	139·0	179·5	1158·	283·4	733·9
7	1499·	139·3	179·9	1160·	284·0	735·5
8	1502·	139·6	180·3	1163·	284·6	737·1
9	1505·	139·9	180·7	1165·	285·2	738·7
460	1509·	140·2	181·1	1168·	285·8	740·3
1	1512·	140·5	181·5	1170·	286·5	741·9
2	1515·	140·8	181·9	1173·	287·1	743·5
3	1519·	141·1	182·3	1176·	287·7	745·1
4	1522·	141·4	182·7	1178·	288·3	746·7
5	1525·	141·7	183·1	1181·	288·9	748·3
6	1528·	142·0	183·5	1183·	289·6	749·9
7	1532·	142·3	183·9	1186·	290·2	751·5
8	1535·	142·6	184·3	1188·	290·8	753·2
9	1538·	142·9	184·7	1191·	291·4	754·8
470	1542·	143·2	185·0	1193·	292·1	756·4
1	1545·	143·5	185·4	1196·	292·7	758·0
2	1548·	143·8	185·8	1198·	293·3	759·6
3	1551·	144·2	186·2	1201·	293·9	761·2
4	1555·	144·5	186·6	1203·	294·5	762·8
5	1558·	144·8	187·0	1206·	295·2	764·4
6	1561·	145·1	187·4	1209·	295·8	766·0
7	1565·	145·4	187·8	1211·	296·4	767·6
8	1568·	145·7	188·2	1214·	297·0	769·3
9	1571·	146·0	188·6	1216·	297·6	770·9
480	1574·	146·3	189·0	1219·	298·3	772·5
1	1578·	146·6	189·4	1221·	298·9	774·1
2	1581·	146·9	189·8	1224·	299·5	775·7
3	1584·	147·2	190·2	1226·	300·1	777·3
4	1588·	147·5	190·6	1229·	300·7	778·9
5	1591·	147·8	190·9	1231·	301·4	780·5
6	1594·	148·1	191·3	1234·	302·0	782·1
7	1597·	148·4	191·7	1237·	302·6	783·7
8	1601·	148·7	192·1	1239·	303·2	785·3
9	1604·	149·0	192·5	1242·	303·8	787·0
490	1607·	149·3	192·9	1244·	304·5	788·6
1	1610·	149·6	193·3	1247·	305·1	790·2
2	1614·	149·9	193·7	1249·	305·7	791·8
3	1617·	150·2	194·1	1252·	306·3	793·4
4	1620·	150·6	194·5	1254·	307·0	795·0
5	1624·	150·9	194·9	1257·	307·6	796·6
6	1627·	151·2	195·3	1259·	308·2	798·2
7	1630·	151·5	195·7	1262·	308·8	799·8
8	1633·	151·8	196·1	1264·	309·4	801·4
9	1637·	152·1	196·5	1267·	310·1	803·1
500	1640·	152·4	196·9	1270·	310·7	804·7
1	1643·	152·7	197·2	1272·	311·3	806·3
2	1647·	153·0	197·6	1275·	311·9	807·9
3	1650·	153·3	198·0	1277·	312·5	809·5
4	1653·	153·6	198·4	1280·	313·2	811·1
5	1656·	153·9	198·8	1282·	313·8	812·7
6	1660·	154·2	199·2	1285·	314·4	814·3
7	1663·	154·5	199·6	1287·	315·0	815·9
8	1666·	154·8	200·0	1290·	315·7	817·5
9	1670·	155·1	200·4	1292·	316·3	819·1
510	1673·	155·4	200·8	1295·	316·9	820·8
1	1676·	155·7	201·2	1297·	317·5	822·4
2	1679·	156·0	201·6	1300·	318·1	824·0
3	1683·	156·3	202·0	1303·	318·8	825·6
4	1686·	156·7	202·4	1305·	319·4	827·2
5	1689·	157·0	202·8	1308·	320·0	828·8
6	1692·	157·3	203·2	1310·	320·6	830·4
7	1696·	157·6	203·5	1313·	321·3	832·0
8	1699·	157·9	203·9	1315·	321·9	833·6
9	1702·	158·2	204·3	1318·	322·5	835·2
520	1706·	158·5	204·7	1320·	323·1	836·8
1	1709·	158·8	205·1	1323·	323·7	838·4
2	1712·	159·1	205·5	1325·	324·4	840·1
3	1715·	159·4	205·9	1328·	325·0	841·7
4	1719·	159·7	206·3	1330·	325·6	843·3
5	1722·	160·0	206·7	1333·	326·2	844·9
6	1725·	160·3	207·1	1336·	326·8	846·5
7	1729·	160·6	207·5	1338·	327·5	848·1
8	1732·	160·9	207·9	1341·	328·1	849·7
9	1735·	161·2	208·3	1343·	328·7	851·3
530	1738·	161·5	208·7	1346·	329·3	852·9
1	1742·	161·8	209·1	1348·	330·0	854·5
2	1745·	162·1	209·4	1351·	330·6	856·2
3	1748·	162·4	209·8	1353·	331·2	857·8
4	1752·	162·8	210·2	1356·	331·8	859·4
5	1755·	163·1	210·6	1358·	332·4	861·0
6	1758·	163·4	211·0	1361·	333·1	862·6
7	1761·	163·7	211·4	1363·	333·7	864·2
8	1765·	164·0	211·8	1366·	334·3	865·8
9	1768·	164·3	212·2	1369·	334·9	867·4
540	1771·	164·6	212·6	1371·	335·5	869·0
1	1775·	164·9	213·0	1374·	336·2	870·6
2	1778·	165·2	213·4	1376·	336·8	872·2
3	1781·	165·5	213·8	1379·	337·4	873·9
4	1784·	165·8	214·2	1381·	338·0	875·5
5	1788·	166·1	214·6	1384·	338·7	877·1
6	1791·	166·4	215·0	1386·	339·3	878·7
7	1794·	166·7	215·4	1389·	339·9	880·3
8	1797·	167·0	215·8	1391·	340·5	881·9
9	1801·	167·3	216·2	1394·	341·1	883·5
550	1804·	167·6	216·5	1397·	341·8	885·1
1	1807·	167·9	216·9	1399·	342·4	886·7
2	1811·	168·2	217·3	1402·	343·0	888·3
3	1814·	168·5	217·7	1404·	343·6	890·0
4	1817·	168·8	218·1	1407·	344·2	891·6
5	1820·	169·1	218·5	1409·	344·9	893·2
6	1824·	169·4	218·9	1412·	345·5	894·8
7	1827·	169·8	219·3	1414·	346·1	896·4
8	1830·	170·1	219·7	1417·	346·7	898·0
9	1834·	170·4	220·1	1419·	347·4	899·6
560	1837·	170·7	220·5	1422·	348·0	901·2
1	1840·	171·0	220·9	1424·	348·6	902·8
2	1843·	171·3	221·3	1427·	349·2	904·4
3	1847·	171·6	221·7	1430·	349·8	906·0
4	1850·	171·9	222·1	1432·	350·4	907·6
5	1853·	172·2	222·4	1435·	351·1	909·3
6	1857·	172·5	222·8	1437·	351·7	910·9
7	1860·	172·8	223·2	1440·	352·3	912·5
8	1863·	173·1	223·6	1442·	352·9	914·1
9	1866·	173·4	224·0	1445·	353·6	915·7
570	1870·	173·7	224·4	1447·	354·2	917·3
1	1873·	174·0	224·8	1450·	354·8	918·9
2	1876·	174·3	225·2	1452·	355·4	920·5
3	1880·	174·6	225·6	1455·	356·0	922·1
4	1883·	175·0	226·0	1457·	356·7	923·7
5	1886·	175·3	226·4	1460·	357·3	925·4
6	1889·	175·6	226·8	1463·	357·9	927·0
7	1893·	175·9	227·2	1465·	358·5	928·6
8	1896·	176·2	227·6	1468·	359·2	930·2
9	1899·	176·5	228·0	1470·	359·8	931·8
580	1902·	176·8	228·4	1473·	360·4	933·4
1	1906·	177·1	228·7	1475·	361·0	935·0
2	1909·	177·4	229·1	1478·	361·6	936·6
3	1912·	177·7	229·5	1480·	362·3	938·2
4	1916·	178·0	229·9	1483·	362·9	939·8
5	1919·	178·3	230·3	1485·	363·5	941·4
6	1922·	178·6	230·7	1488·	364·1	943·1
7	1925·	178·9	231·1	1490·	364·7	944·7
8	1929·	179·2	231·5	1493·	365·4	946·3
9	1932·	179·5	231·9	1496·	366·0	947·9
590	1935·	179·8	232·3	1498·	366·6	949·5
1	1939·	180·1	232·7	1501·	367·2	951·1
2	1942·	180·4	233·1	1503·	367·9	952·7
3	1945·	180·7	233·5	1506·	368·5	954·3
4	1948·	181·0	233·9	1508·	369·1	955·9
5	1952·	181·4	234·3	1511·	369·7	957·5
6	1955·	181·7	234·7	1513·	370·3	959·2
7	1958·	182·0	235·0	1516·	371·0	960·8
8	1962·	182·3	235·4	1518·	371·6	962·4
9	1965·	182·6	235·8	1521·	372·2	964·0
600	1968·	182·9	236·2	1524·	372·8	965·6
1	1971·	183·2	236·6	1526·	373·4	967·2
2	1975·	183·5	237·0	1529·	374·1	968·8
3	1978·	183·8	237·4	1531·	374·7	970·4
4	1981·	184·1	237·8	1534·	375·3	972·0
5	1984·	184·4	238·2	1536·	375·9	973·6
6	1988·	184·7	238·6	1539·	376·6	975·2
7	1991·	185·0	239·0	1541·	377·2	976·9
8	1994·	185·3	239·4	1544·	377·8	978·5
9	1998·	185·6	239·8	1546·	378·4	980·1
610	2001·	185·9	240·2	1549·	379·0	981·7
1	2004·	186·2	240·6	1551·	379·7	983·3
2	2007·	186·5	240·9	1554·	380·3	984·9
3	2011·	186·8	241·3	1557·	380·9	986·5
4	2014·	187·1	241·7	1559·	381·5	988·1
5	2017·	187·4	242·1	1562·	382·2	989·7
6	2021·	187·7	242·5	1564·	382·8	991·3
7	2024·	188·0	242·9	1567·	383·4	993·0
8	2027·	188·4	243·3	1569·	384·0	994·6
9	2030·	188·7	243·7	1572·	384·6	996·2
620	2034·	189·0	244·1	1574·	385·3	997·8
1	2037·	189·3	244·5	1577·	385·9	999·4
2	2040·	189·6	244·9	1579·	386·5	1001·
3	2044·	189·9	245·3	1582·	387·1	1002·
4	2047·	190·2	245·7	1584·	387·7	1004·
5	2050·	190·5	246·1	1587·	388·4	1005·
6	2053·	190·8	246·5	1590·	389·0	1007·
7	2057·	191·1	246·9	1592·	389·6	1009·
8	2060·	191·4	247·3	1595·	390·2	1010·
9	2063·	191·7	247·7	1597·	390·8	1012·
630	2067·	192·0	248·0	1600·	391·5	1013·
1	2070·	192·3	248·4	1602·	392·1	1015·
2	2073·	192·6	248·8	1605·	392·7	1017·
3	2076·	192·9	249·2	1607·	393·3	1018·
4	2080·	193·2	249·6	1610·	394·0	1020·
5	2083·	193·5	250·0	1612·	394·6	1021·
6	2086·	193·8	250·4	1615·	395·2	1023·
7	2089·	194·1	250·8	1617·	395·8	1025·
8	2093·	194·4	251·2	1620·	396·4	1026·
9	2096·	194·7	251·6	1623·	397·1	1028·
640	2099·	195·1	252·0	1625·	397·7	1030·
1	2103·	195·4	252·4	1628·	398·3	1031·
2	2106·	195·7	252·8	1630·	398·9	1033·
3	2109·	196·0	253·2	1633·	399·6	1034·
4	2112·	196·3	253·6	1635·	400·2	1036·
5	2116·	196·6	253·9	1638·	400·8	1038·
6	2119·	196·9	254·3	1640·	401·4	1039·
7	2122·	197·2	254·7	1643·	402·0	1041·
8	2126·	197·5	255·1	1645·	402·6	1042·
9	2129·	197·8	255·5	1648·	403·3	1044·
650	2132·	198·1	255·9	1651·	403·9	1046·
1	2135·	198·4	256·3	1653·	404·5	1047·
2	2139·	198·7	256·7	1656·	405·1	1049·
3	2142·	199·0	257·1	1658·	405·8	1050·
4	2145·	199·3	257·5	1661·	406·4	1052·
5	2149·	199·6	257·9	1663·	407·0	1054·
6	2152·	199·9	258·3	1666·	407·6	1055·
7	2155·	200·2	258·7	1668·	408·2	1057·
8	2158·	200·5	259·1	1671·	408·9	1058·
9	2162·	200·9	259·5	1673·	409·5	1060·
660	2165·	201·2	259·8	1676·	410·1	1062·
1	2168·	201·5	260·2	1678·	410·7	1063·
2	2172·	201·8	260·6	1681·	411·3	1065·
3	2175·	202·1	261·0	1684·	412·0	1067·
4	2178·	202·4	261·4	1686·	412·6	1068·
5	2181·	202·7	261·8	1689·	413·2	1070·
6	2185·	203·0	262·2	1691·	413·8	1071·
7	2188·	203·3	262·6	1694·	414·5	1073·
8	2191·	203·6	263·0	1696·	415·1	1075·
9	2194·	203·9	263·4	1699·	415·7	1076·
670	2198·	204·2	263·8	1701·	416·3	1078·
1	2201·	204·5	264·2	1704·	416·9	1079·
2	2204·	204·8	264·6	1706·	417·6	1081·
3	2208·	205·1	265·0	1709·	418·2	1083·
4	2211·	205·4	265·4	1711.	418·8	1084·
5	2214·	205·7	265·8	1714·	419·4	1086·
6	2217·	206·0	266·1	1717·	420·1	1087·
7	2221·	206·3	266·5	1719·	420·7	1089·
8	2224·	206·6	266·9	1722·	421·3	1091·
9	2227·	207·0	267·3	1724·	421·9	1092·
680	2231·	207·3	267·7	1727·	422·5	1094·
1	2234·	207·6	268·1	1729.	423·2	1095.
2	2237·	207·9	268·5	1732.	423·8	1097.
3	2240·	208·2	268·9	1734·	424·4	1099·
4	2244·	208·5	269·3	1737·	425·0	1100·
5	2247·	208·8	269·7	1739·	425·6	1102·
6	2250·	209·1	270·1	1742·	426·3	1104.
7	2254·	209·4	270·5	1744·	426·9	1105·
8	2257·	209·7	270·9	1747·	427·5	1107·
9	2260·	210·0	271·3	1750·	428·1	1108·
690	2263·	210·3	271·7	1752·	428·8	1110·
1	2267·	210·6	272·1	1755·	429·4	1112·
2	2270·	210·9	272·4	1757·	430·0	1113·
3	2273·	211·2	272·8	1760·	430·6	1115·
4	2276·	211·5	273·2	1762·	431·2	1116·
5	2280·	211·8	273·6	1765·	431·9	1118·
6	2283·	212·1	274·0	1767·	432·5	1120·
7	2286·	212·4	274·4	1770·	433·1	1121·
8	2290·	212·7	274·8	1772·	433·7	1123·
9	2293·	213·1	275·2	1775·	434·4	1124·
700	2296·	213·4	275·6	1778·	435·0	1126·
1	2299·	213·7	276·0	1780·	435·6	1128·
2	2303·	214·0	276·4	1783·	436·2	1129·
3	2306·	214·3	276·8	1785·	436·8	1131·
4	2309·	214·6	277·2	1788·	437·4	1133·
5	2313·	214·9	277·6	1790·	438·1	1134·
6	2316·	215·2	278·0	1793·	438·7	1136·
7	2319·	215·5	278·3	1795·	439·3	1137·
8	2322·	215·8	278·7	1798·	439·9	1139·
9	2326·	216·1	279·1	1800·	440·6	1141·
710	2329·	216·4	279·5	1803·	441·2	1142·
1	2332·	216·7	279·9	1805·	441·8	1144·
2	2336·	217·0	280·3	1808·	442·4	1145·
3	2339·	217·3	280·7	1811·	443·0	1147·
4	2342·	217·6	281·1	1813·	443·7	1149·
5	2345·	217·9	281·5	1816·	444·3	1150·
6	2349·	218·2	281·9	1818·	444·9	1152·
7	2352·	218·5	282·3	1821·	445·5	1153·
8	2355·	218·8	282·7	1823·	446·2	1155·
9	2359·	219·1	283·1	1826·	446·8	1157·
720	2362·	219·4	283·5	1828·	447·4	1158·
1	2365·	219·7	283·9	1831·	448·0	1160·
2	2368·	220·0	284·3	1833·	448·6	1161·
3	2372·	220·4	284·7	1836·	449·2	1163·
4	2375·	220·7	285·1	1838·	449·9	1165·
5	2378·	221·0	285·4	1841·	450·5	1166·
6	2381·	221·3	285·8	1844·	451·1	1168·
7	2385·	221·6	286·2	1846·	451·7	1170·
8	2388·	221·9	286·6	1849·	452·4	1171·
9	2391·	222·2	287·0	1851·	453·0	1173·
730	2395·	222·5	287·4	1854·	453·6	1174·
1	2398·	222·8	287·8	1856·	454·2	1176·
2	2401·	223·1	288·2	1859·	454·8	1178·
3	2404·	223·4	288·6	1861·	455·5	1179·
4	2408·	223·7	289·0	1864·	456·1	1181·
5	2411·	224·0	289·4	1866·	456·7	1182·
6	2414·	224·3	289·8	1869·	457·3	1184·
7	2418·	224·6	290·2	1871·	458·0	1186·
8	2421·	224·9	290·6	1874·	458·6	1187·
9	2424·	225·2	290·9	1877·	459·2	1189·
740	2427·	225·5	291·3	1879·	459·8	1190·
1	2431·	225·8	291·7	1882·	460·4	1192·
2	2434·	226·1	292·1	1884·	461·1	1194·
3	2437·	226·5	292·5	1887·	461·7	1195·
4	2441·	226·8	292·9	1889·	462·3	1197·
5	2444·	227·1	293·3	1892·	462·9	1198·
6	2447·	227·4	293·7	1894·	463·5	1200·
7	2450·	227·7	294·1	1897·	464·2	1202·
8	2454·	228·0	294·5	1899·	464·8	1203·
9	2457·	228·3	294·9	1902·	465·4	1205·
750	2460·	228·6	295·3	1905·	466·0	1207·
1	2464·	228·9	295·7	1907·	466·7	1208·
2	2467·	229·2	296·1	1910·	467·3	1210·
3	2470·	229·5	296·5	1912·	467·9	1211·
4	2473·	229·8	296·9	1915·	468·5	1213·
5	2477·	230·1	297·3	1917·	469·1	1215·
6	2480·	230·4	297·6	1920·	469·8	1216·
7	2483·	230·7	298·0	1922·	470·4	1218·
8	2486·	231·0	298·4	1925·	471·0	1219·
9	2490·	231·3	298·8	1927·	471·6	1221·
760	2493·	231·6	299·2	1930·	472·2	1223·
1	2496·	231·9	299·6	1932·	472·9	1224·
2	2500·	232·2	300·0	1935·	473·5	1226·
3	2503·	232·5	300·4	1938·	474·1	1227·
4	2506·	232·9	300·8	1940·	474·7	1229·
5	2509·	233·2	301·2	1943·	475·4	1231·
6	2513·	233·5	301·6	1945·	476·0	1232·
7	2516·	233·8	302·0	1948·	476·6	1234·
8	2519·	234·1	302·4	1950·	477·2	1236·
9	2523·	234·4	302·8	1953·	477·8	1237·
770	2526·	234·7	303·2	1955·	478·5	1239·
1	2529·	235·0	303·6	1958·	479·1	1240·
2	2532·	235·3	303·9	1960·	479·7	1242·
3	2536·	235·6	304·3	1963·	480·3	1244·
4	2539·	235·9	304·7	1965·	480·9	1245·
5	2542·	236·2	305·1	1968·	481·6	1247·
6	2546·	236·5	305·5	1971·	482·2	1248·
7	2549·	236·8	305·9	1973·	482·8	1250·
8	2552·	237·1	306·3	1976·	483·4	1252·
9	2555·	237·4	306·7	1978·	484·1	1253·
780	2559·	237·7	307·1	1981·	484·7	1255·
1	2562·	238·0	307·5	1983·	485·3	1256·
2	2565·	238·3	307·9	1986·	485·9	1258·
3	2569·	238·6	308·3	1988·	486·6	1260·
4	2572·	239·0	308·7	1991·	487·2	1261·
5	2575·	239·3	309·1	1993·	487·8	1263·
6	2578·	239·6	309·5	1996·	488·4	1264·
7	2582·	239·9	309·8	1998·	489·0	1266·
8	2585·	240·2	310·2	2001·	489·6	1268·
9	2588·	240·5	310·6	2004·	490·3	1269·
790	2591·	240·8	311·0	2006·	490·9	1271·
1	2595·	241·1	311·4	2009·	491·5	1273·
2	2598·	241·4	311·8	2011·	492·1	1274·
3	2601·	241·7	312·2	2014·	492·8	1276·
4	2605·	242·0	312·6	2016·	493·4	1277·
5	2608·	242·3	313·0	2019·	494·0	1279·
6	2611·	242·6	313·4	2021·	494·6	1281·
7	2614·	242·9	313·8	2024·	495·2	1282·
8	2618·	243·2	314·2	2026·	495·9	1284·
9	2621·	243·5	314·6	2029·	496·5	1285·
800	2624·	243·8	315·0	2032·	497·1	1287·
1	2628·	244·1	315·4	2034·	497·7	1289·
2	2631·	244·4	315·8	2037·	498·3	1290·
3	2634·	244·7	316·2	2039·	499·0	1292·
4	2637·	245·0	316·6	2042·	499·6	1293·
5	2641·	245·3	316·9	2044·	500·2	1295·
6	2644·	245·6	317·3	2047·	500·8	1297·
7	2647·	246·0	317·7	2049·	501·4	1298·
8	2651·	246·3	318·1	2052·	502·1	1300·
9	2654·	246·6	318·5	2054·	502·7	1301·
810	2657·	246·9	318·9	2057·	503·3	1303·
1	2660·	247·2	319·3	2059·	503·9	1305·
2	2664·	247·5	319·7	2062·	504·6	1306·
3	2667·	247·8	320·1	2065·	505·2	1308·
4	2670·	248·1	320·5	2067·	505·8	1310·
5	2673·	248·4	320·9	2070·	506·4	1311·
6	2677·	248·7	321·3	2072·	507·0	1313·
7	2680·	249·0	321·7	2075·	507·7	1314·
8	2683·	249·3	322·1	2077·	508·3	1316·
9	2687·	249·6	322·4	2080·	508·9	1318·
820	2690·	249·9	322·8	2082·	509·5	1319·
1	2693·	250·2	323·2	2085·	510·1	1321·
2	2696·	250·5	323·6	2087·	510·8	1322·
3	2700·	250·8	324·0	2090·	511·4	1324·
4	2703·	251·1	324·4	2092·	512·0	1326·
5	2706·	251·4	324·8	2095·	512·6	1327·
6	2710·	251·7	325·2	2098·	513·3	1329·
7	2713·	252·0	325·6	2100·	513·9	1330·
8	2716·	252·4	326·0	2103·	514·5	1332·
9	2719·	252·7	326·4	2105·	515·1	1334·
830	2723·	253·0	326·8	2108·	515·7	1335·
1	2726·	253·3	327·2	2110·	516·4	1337·
2	2729·	253·6	327·6	2113·	517·0	1339·
3	2733·	253·9	328·0	2115·	517·6	1340·
4	2736·	254·2	328·4	2118·	518·2	1342·
5	2739·	254·5	328·8	2120·	518·9	1343·
6	2742·	254·8	329·1	2123·	519·5	1345·
7	2746·	255·1	329·5	2125·	520·1	1347·
8	2749·	255·4	329·9	2128·	520·7	1348·
9	2752·	255·7	330·3	2131·	521·3	1350·
840	2756·	256·0	330·7	2133·	522·0	1351·
1	2759·	256·3	331·1	2136·	522·6	1353·
2	2762·	256·6	331·5	2138·	523·2	1355·
3	2765·	256·9	331·9	2141·	523·8	1356·
4	2769·	257·2	332·3	2143·	524·4	1358·
5	2772·	257·5	332·7	2146·	525·1	1359·
6	2775·	257·8	333·1	2148·	525·7	1361·
7	2778·	258·1	333·5	2151·	526·3	1363·
8	2782·	258·5	333·9	2153·	526·9	1364·
9	2785·	258·8	334·3	2156·	527·5	1366·
850	2788·	259·1	334·7	2159·	528·2	1367·
1	2792·	259·4	335·0	2161·	528·8	1369·
2	2795·	259·7	335·4	2164·	529·4	1371·
3	2798·	260·0	335·8	2166·	530·0	1372·
4	2801·	260·3	336·2	2169·	530·7	1374·
5	2805·	260·6	336·6	2171·	531·3	1376·
6	2808·	260·9	337·0	2174·	531·9	1377·
7	2811·	261·2	337·4	2176·	532·5	1379·
8	2815·	261·5	337·8	2179·	533·1	1380·
9	2818·	261·8	338·2	2181·	533·8	1382·
860	2821·	262·1	338·6	2184·	534·4	1384·
1	2824·	262·4	339·0	2186·	535·0	1385·
2	2828·	262·7	339·4	2189·	535·6	1387·
3	2831·	263·0	339·8	2192·	536·2	1388·
4	2834·	263·3	340·2	2194·	536·9	1390·
5	2838·	263·6	340·6	2197·	537·5	1392·
6	2841·	263·9	341·0	2199·	538·1	1393·
7	2844·	264·2	341·3	2202·	538·7	1395·
8	2847·	264·5	341·7	2204·	539·4	1396·
9	2851·	264·9	342·1	2207·	540·0	1398·
870	2854·	265·2	342·5	2209·	540·6	1400·
1	2857·	265·5	342·9	2212·	541·2	1401·
2	2860·	265·8	343·3	2214·	541·8	1403·
3	2864·	266·1	343·7	2217·	542·5	1404·
4	2867·	266·4	344·1	2219·	543·1	1406·
5	2870·	266·7	344·5	2222·	543·7	1408·
6	2874·	267·0	344·9	2225·	544·3	1409·
7	2877·	267·3	345·3	2227·	545·0	1411·
8	2880·	267·6	345·7	2230·	545·6	1413·
9	2883·	267·9	346·1	2232·	546·2	1414·
880	2887·	268·2	346·5	2235·	546·8	1416·
1	2890·	268·5	346·9	2237·	547·4	1417·
2	2893·	268·8	347·2	2240·	548·1	1419·
3	2897·	269·1	347·6	2242·	548·7	1421·
4	2900·	269·4	348·0	2245·	549·3	1422·
5	2903·	269·7	348·4	2247·	549·9	1424·
6	2906·	270·0	348·8	2250·	550·5	1425·
7	2910·	270·3	349·2	2252·	551·2	1427·
8	2913·	270·6	349·6	2255·	551·8	1429·
9	2916·	271·0	350·0	2258·	552·4	1430·
890	2920·	271·3	350·4	2260·	553·0	1432·
1	2923·	271·6	350·8	2263·	553·7	1433·
2	2926·	271·9	351·2	2265·	554·3	1435·
3	2929·	272·2	351·6	2268·	554·9	1437·
4	2933·	272·5	352·0	2270·	555·5	1438·
5	2936·	272·8	352·4	2273·	556·1	1440·
6	2939·	273·1	352·8	2275·	556·8	1442·
7	2943·	273·4	353·2	2278·	557·4	1443·
8	2946·	273·7	353·6	2280·	558·0	1445·
9	2949·	274·0	354·0	2283·	558·6	1446·
900	2952·	274·3	354·3	2285·	559·2	1448·
1	2956·	274·6	354·7	2288·	559·9	1450·
2	2959·	274·9	355·1	2291·	560·5	1451·
3	2962·	275·2	355·5	2293·	561·1	1453·
4	2965·	275·5	355·9	2296·	561·7	1454·
5	2969·	275·8	356·3	2298·	562·3	1456·
6	2972·	276·1	356·7	2301·	563·0	1458·
7	2975·	276·4	357·1	2303·	563·6	1459·
8	2979·	276·7	357·5	2306·	564·2	1461·
9	2982·	277·0	357·9	2308·	564·8	1462·
910	2985·	277·3	358·3	2311·	565·5	1464·
1	2988·	277·6	358·7	2313·	566·1	1466·
2	2992·	277·9	359·1	2316·	566·7	1467·
3	2995·	278·3	359·5	2319·	567·3	1469·
4	2998·	278·6	359·9	2321·	567·9	1470·
5	3002·	278·9	360·3	2324·	568·6	1472·
6	3005·	279·2	360·6	2326·	569·2	1474·
7	3008·	279·5	361·0	2329·	569·8	1475·
8	3011·	279·8	361·4	2331·	570·4	1477·
9	3015·	280·1	361·8	2334·	571·0	1479·
920	3018·	280·4	362·2	2336·	571·7	1480·
1	3021·	280·7	362·6	2339·	572·3	1482·
2	3025·	281·0	363·0	2341·	572·9	1483·
3	3028·	281·3	363·4	2344·	573·5	1485·
4	3031·	281·6	363·8	2346·	574·1	1487·
5	3034·	281·9	364·2	2349·	574·8	1488·
6	3038·	282·2	364·6	2352·	575·4	1490·
7	3041·	282·5	365·0	2354·	576·0	1491·
8	3044·	282·8	365·4	2357·	576·6	1493·
9	3048·	283·1	365·8	2359·	577·3	1495·
930	3051·	283·4	366·2	2362·	577·9	1496·
1	3054·	283·7	366·5	2364·	578·5	1498·
2	3057·	284·0	366·9	2367·	579·1	1499·
3	3061·	284·4	367·3	2369·	579·7	1501·
4	3064·	284·7	367·7	2372·	580·4	1503·
5	3067·	285·0	368·1	2374·	581·0	1504·
6	3070·	285·3	368·5	2377·	581·6	1506·
7	3074·	285·6	368·9	2379·	582·2	1507·
8	3077·	285·9	369·3	2382·	582·9	1509·
9	3080·	286·2	369·7	2385·	583·5	1511·
940	3084·	286·5	370·1	2387·	584·1	1512·
1	3087·	286·8	370·5	2390·	584·7	1514·
2	3090·	287·1	370·9	2392·	585·3	1516·
3	3093·	287·4	371·3	2395·	586·0	1517·
4	3097·	287·7	371·7	2397·	586·6	1519·
5	3100·	288·0	372·1	2400·	587·2	1520·
6	3103·	288·3	372·5	2402·	587·8	1522·
7	3107·	288·6	372·8	2405·	588·4	1524·
8	3110·	288·9	373·2	2407·	589·1	1525·
9	3113·	289·2	373·6	2410·	589·7	1527·
950	3116·	289·5	374·0	2412·	590·3	1528·
1	3120·	289·8	374·4	2415·	590·9	1530·
2	3123·	290·1	374·8	2418·	591·6	1532·
3	3126·	290·5	375·2	2420·	592·2	1533·
4	3130·	290·8	375·6	2423·	592·8	1535·
5	3133·	291·1	376·0	2425·	593·4	1536·
6	3136·	291·4	376·4	2428·	594·0	1538·
7	3139·	291·7	376·8	2430·	594·7	1540·
8	3143·	292·0	377·2	2433·	595·3	1541·
9	3146·	292·3	377·6	2435·	595·9	1543·
960	3149·	292·6	378·0	2438·	596·5	1544·
1	3153·	292·9	378·4	2440·	597·1	1546·
2	3156·	293·2	378·8	2443·	597·8	1548·
3	3159·	293·5	379·2	2446·	598·4	1549·
4	3162·	293·8	379·6	2448·	599·0	1551·
5	3166·	294·1	379·9	2451·	599·6	1553·
6	3169·	294·4	380·3	2453·	600·3	1554·
7	3172·	294·7	380·7	2456·	600·9	1556·
8	3175·	295·0	381·1	2458·	601·5	1557·
9	3179·	295·3	381·5	2461·	602·1	1559·
970	3182·	295·6	381·9	2463·	602·7	1561·
1	3185·	295·9	382·3	2466·	603·4	1562·
2	3189·	296·2	382·7	2468·	604·0	1564·
3	3192·	296·5	383·1	2471·	604·6	1565·
4	3195·	296·9	383·5	2473·	605·2	1567·
5	3198·	297·2	383·9	2476·	605·8	1569·
6	3202·	297·5	384·3	2479·	606·5	1570·
7	3205·	297·8	384·7	2481·	607·1	1572·
8	3208·	298·1	385·0	2484·	607·7	1573·
9	3212·	298·4	385·4	2486·	608·3	1575·
980	3215·	298·7	385·8	2489·	608·9	1577·
1	3218·	299·0	386·2	2491·	609·6	1578·
2	3221·	299·3	386·6	2494·	610·2	1580·
3	3225·	299·6	387·0	2496·	610·8	1582·
4	3228·	299·9	387·4	2499·	611·4	1583·
5	3231·	300·2	387·8	2501·	612·1	1585·
6	3235·	300·5	388·2	2504·	612·7	1586·
7	3238·	300·8	388·6	2506·	613·3	1588·
8	3241·	301·1	389·0	2509·	613·9	1590·
9	3244·	301·4	389·4	2512·	614·5	1591·
990	3248·	301·7	389·8	2514·	615·2	1593·
1	3251·	302·0	390·2	2517·	615·8	1594·
2	3254·	302·3	390·6	2519·	616·4	1596·
3	3257·	302·6	391·0	2522·	617·0	1598·
4	3261·	303·0	391·4	2524·	617·6	1599·
5	3264·	303·3	391·7	2527·	618·3	1601·
6	3267·	303·6	392·1	2529·	618·9	1602·
7	3271·	303·9	392·5	2532·	619·5	1604·
8	3274·	304·2	392·9	2534·	620·1	1606·
9	3277·	304·5	393·3	2537·	620·8	1607·
1000	3281·	304·8	393·7	2539·	621·4	1609·