LETTERS TO THE EDITOR.

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

TRIAL TRIPS.

SIR,—I have frequently observed so great a divergence of opinion as to the principles upon which the trial runs of steam vessels should be conducted, that it occurs to me to record some of these, and to briefly refer to the various theories which have been started and upheld by the several authorities with whom I have been brought into contact. It seems most essential that some settled basis should be agreed upon, so that all such trials may be conducted as nearly as possible upon even terms. As long as they are not so, the results put before the public in individual cases can prove no relative comparison, and it is impossible to tell from their records whether a steamer built upon certain lines, and furnished with a certain amount of engine-power, developes a better performance than another differently provided. It is, of course, most important to the steamship builder and to the engineer that all these trial trips should furnish him with data from which he can deduce information enabling him to avoid errors in past construction and improve in subsequent designs; but so long as one superintending engineer conducts his trials upon a method varying from those pursued by others, so long will it be impossible to estimate with correctness where possible faults may lie, or by what improvements they may be avoided in the future.

A singular instance of disagreement came under my notice very recently, one the persistence in which must lead to very varying results, even when what are called sister-ships are put upon their performance over the measured mile. It is a fact well known in marine surveying that the measurement of distances by the strokes of a carefully-trained crew vary materially when the boat is being pulled in comparatively shallow water from those obtained when in greater depths. My own experience in harbour surveying has led me to the conclusion that directly an ordinary whale boat—the most convenient for this operation—comes within water of less than 10ft. in depth, the progress per stroke falls off at least 33 per cent., and it has always been my practice, the justness of which has invariably been verified by the results of subsequent angular measurement, to make a corresponding allowance in the distance pulled over. Now, but a short time back I was on board of a steamer which had realised twelve knots over a deep water measured course. On the occasion referred to she was run in a river where there were but 10ft. to 12ft. of water beneath her keel, and her utmost speed was then but from eight and a-half to nine knots. I assigned this to the shallowness of the water, but was surprised to find my argument, although supported by some, altogether disputed by other authorities, who contended that the cause assigned could have nothing to do with the falling off in speed. Facts are, however, stubborn things, and the result being apparent, and the condition of the ship being in every respect similar to that of the former run, my argument was in the end pretty fully accepted. But the reason I then assigned, and have always held, that the attraction exercised by the river bottom, owing to its greater density than that of the water column above it, was the retarding influence, was not so generally accepted; it being argued, with considerable force, that the resistance was rather due to friction, caused by the mass of water dragged, as it were, by the ship along the river bed. Whichever theory may be the correct one of the two, it is manifest that a prime condition of a steamer's trial should be that the run be made in water of a sufficient depth to prevent any chance of such a retarding agency coming into play. As regards the engine power exerted, this can of course be ascertained and allowed for by the result of the indicator diagrams, which are a generally accepted basis upon which allowance for speed due to power can be made, and it eliminates all necessity for consideration as to quality of coal, character of stoking, and temperature of condensing water. But other considerations do not admit of being so readily overcome. Among the most important of these is undoubtedly the state of the tide. There is no measured mile on the British shores where this is not an important factor in the conclusion to be deduced from the results of a run. I find some engineers prefer always to wait for the top of the tide, others have a marked preference for about low water. During a run of—say—six turns over a measured mile, a sufficiency of time must be occupied to ensure that slack water will have ceased, and some of the later runs must be made with, or opposed to, the strength of the tide. With such conditions I am surprised to see how very common it is, when calculating the average speed, to simply divide the sum of the speeds by their number. It is impossible but that when this is held to suffice, serious errors will result from the action of the current, and yet it may be readily got rid of by taking the mean of the means of each run; but if this be done in one case and not in another the average speeds obtained may readily vary to the extent of half a knot or more, and the data established becomes valueless for purposes of comparison.

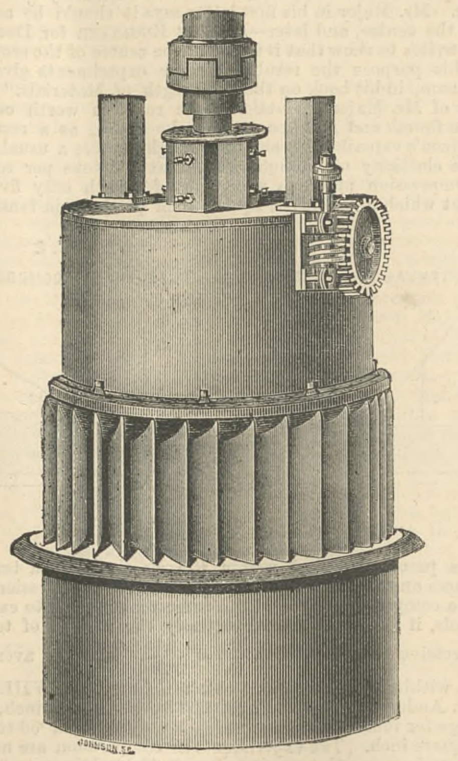
It is further customary to leave out of calculation the retarding force of the wind, it being considered by many that the acceleration due to it on the return run is sufficient to compensate for the retardation on the adverse run. But it is evident that it is not so, for the opposing force is not only continued over a much longer period than is available for that favourable to the progress of the ship; but it exercises influence in an increased ratio when being driven against. Circumstances, of course, prevent the choice of weather best suited to steamer trials in most cases; but where it is possible, it is manifest from the foregoing argument that a day should be selected when the wind is fairly a beam—when, in fact, a "soldiers' wind" can be relied upon. There are many other considerations, however, less in their individual importance, but still worth consideration when taken in their sum, into which it is impossible to enter within the limits of a letter such as this, which has for its sole object to point out present divergencies in practice among engineers and others, and to recommend the adoption of fixed rules, whereupon all such trials as we have referred to should, as far as possible, be made. The man who will supply handy tables by which the retarding effect of wind may be readily ascertained and allowed for will confer a boon upon all who are interested in the subject, and some rule more exact in its operation than the present rule-o'-thumb decisions as to its force are also most desirable, for experts vary greatly in their estimate of it. Altogether, my contention is that if results of steamer trials are to be a useful guide to the profession, they must be made upon a generally accepted basis, and not left, as at present, to the individual opinions of experts, which, as I have shown, vary so seriously as to greatly affect results.

London, Dec. 27th. F. A.

THE EFFICIENCY OF TURBINES.

SIR,—I observe in your impression of the 16th inst. a letter from Messrs. Thos. McKenzie and Sons, in reference to the Leffel turbine. The statements therein are, according to my own personal experience, rather misleading. I believe I was about the first in this country to adopt the Leffel turbine, and the result was that both myself and my clients were disappointed. Last year, having in view the application of turbines to the largest water-power we have in Scotland—the quantity of water available and the fall being equal to about 1000-horse power on an average all the year round—and profiting by my experience of the Leffel turbine, I considered it the wisest plan to visit the United States, where water powers are so extensively utilised, and endeavour to get at the actual truth of the so-called results of various turbine wheels of high repute. The result was that I scarcely found one of them to come up to the high percentage claimed for them, my experience quite bearing out the facts published in the "Treatise relative to the Testing of Water Wheels," by James Emerson, 1878, second edition, in which treatise twenty-seven whole gate tests with a 30½in. Leffel turbine are given, the highest result being 74 per cent., and the lowest 65 per cent., and when the quantity of water was reduced by one-half the result was only 59 per cent.

The turbine I found to be the best, and which has since borne out the opinion I then formed of it, was that known as the "Hercules;" and without going into my own figures, the same treatise shows the highest result to be 89 per cent., and with half the full quantity of water, 72 per cent. The Hercules turbine has other advantages over the Leffel which I might here enumerate, such as the smaller number of working parts, their great strength

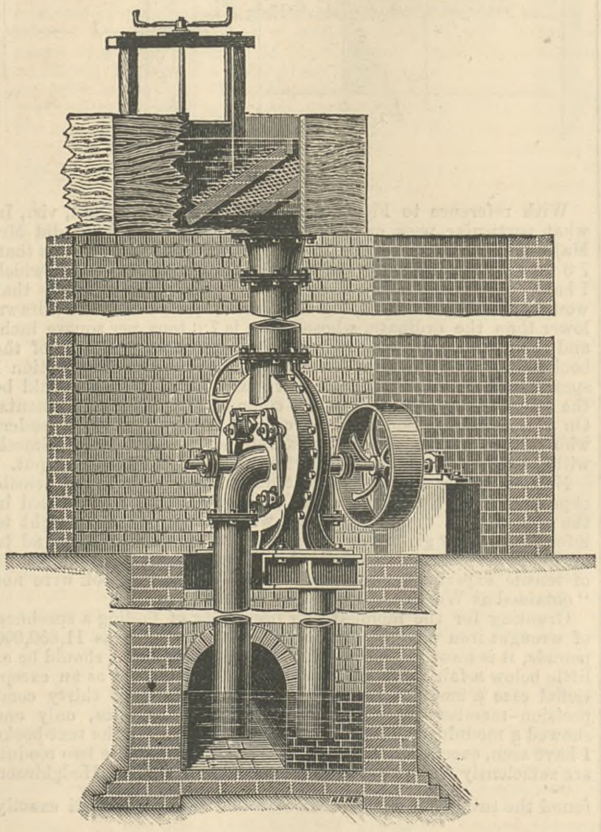


and simplicity, and that for a given fall and quantity of water a turbine only one-half the diameter of a Leffel is required, while it is considerably cheaper, both as to first cost and maintenance.

Messrs. McKenzie say the object of their letter is to bring the Leffel turbine under the notice of those who are engaged in introducing the electric light, and it is also for the information of these gentlemen that I ask you to insert the above remarks. The drawing illustrates the Hercules turbine. JOHN TURNBULL, JUN.

Hercules Turbine Office, 184, Buchanan-street,
Glasgow, December 20th.

SIR,—The vortex turbine—the invention of Professor James Thompson, of Glasgow—is so well known to many of your readers, and has given such general satisfaction, that we do not propose in this letter to enter into a general description of it, but, with your permission, shall at once state the points that make it especially easy of application in using water to drive the dynamo machines for electric lighting. We are encouraged to do so by the unqualified approval expressed by eminent hydraulic engineers who



have it in use for this purpose. (1) The vortex turbine is complete; the outer case and guide blades chamber are in one. The foundation and method of fixing are consequently very simple; this is not the case with many turbines. (2) By means of movable guide blades the power can be adjusted with the greatest ease to suit the requirement. The water space is reduced equally round the periphery of the wheel; all loss by shocks is thus avoided. (3) The speed is singularly uniform under varying loads. (4) The wheel can be placed vertically. In this we claim a decided advantage over almost all other turbines. The drawing we enclose will explain the arrangement, and it will be seen that by means of suction pipes continued below the level of the revolving wheel we are able to place the turbine at any height—up to 25ft.—above the level of the tail water, the full height of the fall being utilised with the same certainty and effect as if the wheel were placed horizontally at the bottom of the fall. All bevel gear is dispensed with; the dynamo machine can be driven direct from a pulley on the turbine spindle. When the fall is a high one the speed of the vortex wheel can be made identical with that required for the spindle of the dynamo machine, and if coupled to it in the same line all loss in the transmission of the power is avoided. We have already done this with the best result, and in conjunction with the fact already stated, viz., that the turbine can be placed at any convenient height, it appears to us to be a very strong recommendation. The growing interest in the subject of electricity, both as a light producer and as a means of conveying power, must be our excuse for trespassing on your valuable space.

GILBERT GILKES AND CO.

Canal Ironworks, Kendal, Dec. 24th.

SIR,—Messrs. McKenzie's letter, published in your issue of the 16th inst., relates to a subject which has of late years received very little attention at the hands of British engineers, and I desire to add some further particulars, which may be of interest to your readers.

The first record with which I am acquainted of the so-called Leffel wheel is to be found in the patent specification, No. 718, granted to Mr. Lake—acting on behalf of Messrs. W. Toos and J. W. Bookwater, of Springfield, Ohio, U.S.A.—in 1869, wherein this machine is clearly illustrated and described. This turbine, in common with almost all of American design, possesses the advantage of a single—downward—discharge pipe, which greatly simplifies the foundation, masonry, &c., necessary to carry the machine. On the other hand, the efficiency is not all that could be desired. For the sake of comparison I will take the experiments made by Mr. Emerson, at his testing flume, at Holyoke, Mass., with the "Leffel," and the "American," made by Messrs. Stout, Mills, and Temple. The main difference between the two turbines is that the Leffel has twelve gates, and Messrs. Stout and Co.'s only six. The Leffel is a double disc, practically composed of half a vortex wheel and half a runner of the Schiele type. Messrs. Stout and Co. have, in fact, adhered more closely to the original model, the vortex wheel of Professor Thompson.

Selected from Emerson's Turbine Reporter, 1877.

Name.	No. tested.	Discharge.	Gate.	Highest percentage.	Average percentage.
Leffel, James	15	Central & down	Fly trap	79·07	68·08
Stout, Mills, and Temple	25	Central	,, ,,	83·14	75·92

The experiments appear to be greatly in favour of the single inward flow wheel. The central discharge possesses the further advantage—that the flowing water exerts no downward pressure on the wheel, so as to increase the friction of the footstep. Although I am a great advocate for the use of turbines, I cannot go so far as to agree with Messrs. McKenzie that an equally good percentage of efficiency can be obtained with one-tenth of the proper quantity of water.

Mr. Webber, in testing the turbines at the Centennial Exhibition, found that the Bollinger gave 69 per cent. at full gate, 68 per cent. at ¾ gate, 63½ per cent. at ⅝ gate, 60 per cent. at ½ gate, and 54 per cent. at ⅜ gate. I have selected this example, as the Bollinger was fitted with gates very similar to the Leffel. Messrs. Poole and Hunt exhibited a 30½in. wheel at the Centennial, but no experiments on it are given in Mr. Webber's report.

I would draw attention to the lists of horse-power, fall, and water used, which are now in the hands of most owners of water-power, and would point out, by way of caution, that they are quite unreliable, the quantity of water required being very much greater than is stated. If they were correct, a duty of 90 per cent. would be obtained; while both Mr. Emerson and Mr. Webber's Centennial experiments prove that the old-fashioned 75 per cent. efficiency assumed by English engineers is about all that can be relied on in practice.

I quite agree with Messrs. McKenzie as to the suitability of the American type of turbine for fixing without any external case, and I recently adopted such an arrangement for a turbine I made for pumping at Blackwell Mill, near Buxton, for the Midland Railway Company. CHARLES L. HETT.

Brigg, December 21st.

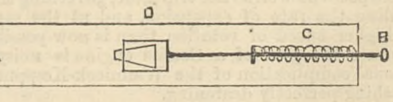
ENGLISH DRAUGHTSMEN IN THE UNITED STATES.

SIR,—With respect to the subject of English draughtsmen in the United States allow me to offer a few remarks. I spent nearly four years as a draughtsman in that country, and during the whole of the time I had constant work at nearly double English wages, the cost of living being about the same; I had no reason whatever to complain, though, of course, I met with some difficulties at first, till I had got somewhat used to the country. Since my return to this country, which was caused by domestic reasons unconnected with business, I gave a young draughtsman a letter of introduction which at once secured him a situation, which he has filled with satisfaction for more than a year. There is a great field for really competent men who are not afraid of work. The hours are longer than in England, and holidays much less frequent, so men who think more of these things than of their advancement in life had better stay in England. I may say that my experience chiefly relates to Philadelphia. Y. R.

Birmingham, December 20th.

INVENTORS AND PATENTS.

SIR,—Will you allow me to add to my letter of the 11th of June a few illustrations showing how much better it would be if a poor inventor could deal directly with the public, instead of having to offer his invention privately? In the former case, people would act with confidence, and with their eyes open; and if the invention was good it would be competed for. In the latter case, everybody is in the dark, and afraid of doing anything for fear of doing wrong; so that the inventor, with as good an invention, has no alternative but to accept such terms as offer themselves. I have been offering to one and another, for twelve months, a regulator for the supply of steam to a steam engine. The invention consists in placing an elastic substance between the power and the weight, which substance will be compressed between the two in proportion to the weight to be moved—the degree of compression to regulate by suitable means the supply of steam to the engine. I don't propose it at all for a locomotive, but a locomotive will furnish an illustration:—A in the figure, then, is a locomotive, the cars being



attached at B; C is a spiral spring, capable of sustaining the whole power of the engine; D is a throttle valve, set so as to admit steam, when turned on, that will drive the engine by itself at the rate of, say, forty miles an hour. If any load be attached the spring will be compressed, and the valve opened to admit steam in proportion to the weight. If the train is running over level ground, up or down an incline, the varying pull on the spring will regulate the supply of steam according to circumstances. Were the heaviest load the engine is fit for to become suddenly disconnected the spring would at once close the valve so as to shut off a corresponding supply of steam. Thus, under all these varying circumstances, the speed of the engine would be forty miles an hour. In case of the spring breaking, the thing to be so arranged as to shut off the steam entirely. From the opinions expressed upon this invention—some of them by eminent engineers—I think something might have been made of it if I could have offered it to the public instead of privately; at any rate, I should have got to the bottom of it with far less trouble and expense.

I have sent you by rail, Sir, a parcel containing a model of a breech action for gun or rifle, and a gimblet. The action consists of a slide, a breech block turning on a centre and enclosing the striker, which turns on the same centre. The breech action has been pronounced in different quarters to be quick, strong, durable, safe, the fewest parts of any we have seen, &c.; and yet it has been hawked about with the same result as the regulator—as I think, from having been offered only in a very limited circle. The man using this rifle would scarcely be conscious of doing anything between firing, except holding the rifle in a certain position and inserting the cartridge. I have a breech action by which a man could fire twelve shots in six seconds, and he would be able to fire sixty rounds a minute from the shoulder, supposing, of course, that he was able to stand the recoil. After placing the rifle to his shoulder he would have nothing to do but keep on pulling the trigger till the magazine was empty. I only mention it to say that the law, as it now stands, prevents me from doing anything with it. The pent-up ingenuity of the country wants an outlet in this direction—the working man wants to be made to feel that in inventing or improving something of general utility he is doing something for himself, and not merely catering for another; it being generally understood that inventors generally are compelled to seek assistance from men of money before they are able to bring their inventions before the public. The British Lion has no "skill in dandling a kid." Patents that produce no more than 20,000 pence are charged as much as patents that produce 20,000 pounds. The consequence is that numberless little improvements are simply held in check, because it would not pay to patent them. The gimblet I send you has been offered to two gimblet manufacturers who could not take it up solely on this account; and yet in the opinion of a great many practical men it is a decided improvement; and, besides, one of the makers said it would cost no more than the ordinary gimblet. In the ordinary shell gimblet the pointed worm has a double thread; one groove only opens into the shell, the other finishes on the back; the consequence is that the wood in one groove passes freely into the shell and is cut away, while the wood in the other groove is jammed tightly round the hole, and if it was not somewhat elastic it would not be cut away at all. Sometime since I made a scraper-sharpener—cabinet making—it was pronounced a decided success by three practical men; but it was not patented solely on the ground that it was doubtful as to whether it would pay expenses. Having shown, as I think, that nothing should be allowed to stand in the way of a poor inventor turning his ingenuity into money, and that charging him more than he can pay, or more than his invention warrants him in paying, does block the way, even so far as in many cases to stifle his invention, besides offering great facilities for dishonesty, I will now venture an opinion as to how inventions may be taxed exactly in proportion to their monetary value. If an inventor does business to the extent of £1, a farthing stamp on the receipt will be required to make it a legal transaction. If the business done amounts to £4, it will afford a penny stamp. If the business done amounts to £400 it will allow of a stamp, stamps, or other equivalent, to the value of 400 farthings; and this amount will be required to make it a legal transaction. The person to whom the receipt is given may be trusted to see that the Government is not defrauded. On this system the receipts from patents would be considerably in excess of what they are at present. But if this were adopted it might extend to commerce; and commercial men, dealing with vast sums of money, would never consent to be taxed in the same ratio as the common tradesman, who is glad to dispose of his goods a few pounds worth at a time; it would be inconvenient and oppressive, not to say intolerable. The thing may therefore be dismissed as a dream, that will not be realised for a hundred years after its justice and expediency have become apparent. The feeling in the country at present is such as our Government cannot disregard without slighting a golden opportunity. If they frame a measure, I believe it can hardly be too liberal for the Opposition; and if they strike while the iron is hot it will be struck off almost at a heat. Just one word in the ear of the inventor, whether he be rich or poor. When my proposal becomes law—which, or something analogous, is sure to be the case before the question will be regarded as settled—allow two clear months of protection to pass without saying a word to anyone; you will thus at once anticipate and rebut all claims to priority, and hold a much better position in case of infringement. EDWARD HOYLE.

3, Pleasant View, Todmorden, Dec. 16th.

100-H.P. ENGINE—WANNIECK KŒPPNER TYPE.

SIR,—I have been looking at the drawings you published last week of an engine of 100-H.P., made by the Berlin Machine Construction Company, and with your permission I would like to make a few remarks upon this class of engine, so many examples of which have lately been brought before the English public.

Many foreign engineers apparently come to this country and to America for original designs, which they improve upon, often in a very astonishing fashion, and then are good enough to send us the results of their labours; but whether this is done for our instruction or criticism it is difficult to tell, for surely it cannot be with any hope of establishing a business connection. The general idea of this particular example seems based upon the Corliss type. Like it there are four valves, but unlike it the close port clearances are conspicuously absent. Like the Corliss, the stroke is long in proportion to diameter of cylinder—22 1/16in. given as the stroke on page 444 is obviously a misprint—for the purpose of securing a high piston speed with the slow rate of rotation permissible with trip disengaging gear. Then the governor is of an exceedingly sensitive type, and it is necessary to provide a dashpot to keep its operations within reasonable bounds, while the efforts to make trip valves rapid in their action have been so successful that other dashpots are required to prevent them from working their own destruction.

These evils afflict all Corliss engines alike, but the Wannieck-Kœppner seems to possess others peculiarly its own. Small port clearances, already mentioned, are absent, while the tolerably direct method by which Corliss valves are worked has given place to something altogether different. Moreover a general clumsiness of the whole design—exaggerated by the distorted photograph from which your engraving has been taken—is only matched by the disproportion of several parts, as between the crank which transmits all the power, and the double levers which actuate the valves, or between the connecting rod and piston area.

The unquestionable advantages of small port clearances can easily be secured in any cylinder; and excentrics can be arranged to work a slight modification of any existing Corliss valves for all practical purposes as well as the trip gear, governing the revolutions by controlling the rate of expansion, and at the same time permitting a higher speed of rotation than is now possible. Even at the usual rate the gear of a Corliss engine is noisy enough, but the additional complication of the Wannieck-Kœppner must bring it to something perfectly deafening.

It is an axiom of mechanical design that silent working is a good test of its perfection; and there is no sound reason why a modern horizontal engine should not work as silently as the older beam type, which it is so rapidly supplementing. The Corliss engine, so far as it goes, has been of great service in exploding the notion that compounding is essential for economy; but notwithstanding its many admirable features, and well-earned popularity, it is not easy to understand why a manufacturer should go to the expense of such an engine, when one of half the size and double the revolutions would drive his machinery with equal economy and steadiness. If the makers or inventors of this German engine would kindly point out the advantages which they consider it to possess, such information might be very interesting to English engineers, and, for my own part, would dissipate any regret I may feel at my own inability to discover them. ARTHUR RIGG.

42, Old Broad-street, London, E.C.
December 22nd.

THE STRAINS ON CRANE POSTS.

SIR,—In my letter which you did me the favour of inserting in your issue of the 16th inst., I made use of an expression which might lead your readers to misinterpret my meaning. I have referred to the practice of neglecting the "effect" of the web in approximate calculations of the stresses in the flanges of a girder. This would be more correctly expressed by using the word *resistance* for *effect*. The "effect of the web" must not be taken to mean the effect which the web exercises in connecting the two flanges. It will be seen that in another part of the letter I used the word *resistance*.

There is one point in connection with this discussion on which some confusion exists. I allude to the position of the neutral axis. This unfortunate line has been knocked about in a most merciless manner, some of your correspondents placing it in the back of the post, others in the breast. Mr. Pendred wishes it to inhabit both back and breast at the same time, and Mr. Hoy attempts a sort of compromise which is absolutely without significance. Mr. Major in his first letter says it should be assumed to be in the centre, and later—see THE ENGINEER for December 9th—he writes to show that it is not in the centre of the section, using for this purpose the results of some experiments given by Dr. Anderson, in his book on the "Strength of Materials." This last letter of Mr. Major's contains some remarks worth considering. In the fourth and fifth paragraphs he states, as a result of Dr. Anderson's experiments, and as though it were a usual condition in the elasticity of wrought iron, that 5·9 tons per square inch in compression produces a change of length only five-sevenths of that which 3·7 tons per square inch produces in tension. This

FIG. 1

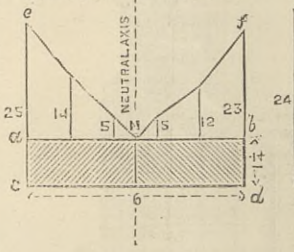
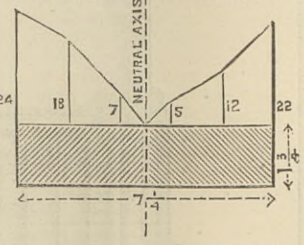


FIG. 2



means practically that within the elastic limit, a tensile force produces an extension equal to 2¼ times the compression resulting from a compressive force of the same amount; or to express it in symbols, if E_t and E_c are respectively the moduli of tensile and compressive elasticity, then $\frac{E_t}{E_c} = \frac{1}{2·25}$. Now the average value of E_t, within the elastic limit obtained from Table VIII., page 59, of Dr. Anderson's book is 27,790,000 lb. per square inch, and is an average for fourteen successive loads varying from ·56 to 7·88 tons per square inch. The experiments in compression are not so complete, and among the results given in Table IX., page 65, there is no load quoted less than 7·8 tons per square inch. The compression due to this load is given as ·0015in. in a length of one inch, and this corresponds to a modulus of compressive elasticity equal to 11,650,000 lb. per square inch. The ratio $\frac{E_t}{E_c}$ is therefore equal to $\frac{2·38}{1}$; consequently Mr. Major, for reasons best known to himself, has inverted this order of things.

I intended making one or two observations on Fig. 7 of Mr. Major's letter, but it has just occurred to me that the figures it contains relating to the compression may prove to be errors on the part of the engraver, which would of course account for their absurdity. May I ask for an editorial note on this point?*

FIG. 3

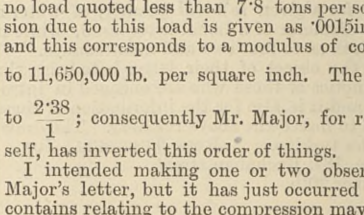
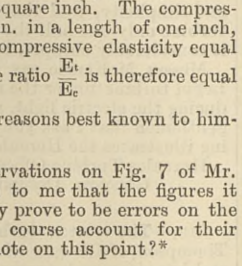


FIG. 4



With reference to Fig. 3, I have one question to ask, viz., In what particular page or pages of Dr. Anderson's book did Mr. Major find the compressions in wrought iron due to less loads than 7·8 tons per square inch? In the fifth edition of that work, which I have before me, I fail to discover any record of experiments that would enable the curve of Fig. 3 in Mr. Major's letter to be drawn lower than the ordinate, whose value is 7·8 tons per square inch, and I am therefore forced to believe either that my edition of the book is less complete than Mr. Major's, or that the information I speak of was derived from another source; and if such should be the case it is one more nail in the coffin of Mr. Major's arguments. On this point I stand open to correction by any of your readers who possess a copy of this book, and perhaps Mr. Major himself will not object to send an answer to the question I have just put.

Now, it appears from Dr. Anderson's work that the tensile experiments were not made with the same metal as was used in the compressive experiments, and we have therefore no right to infer that in any given bar the same proportion will be found to exsist between the two moduli. I will here remark that the results of tensile experiments given in Table VIII. of the book were not "obtained at Woolwich Arsenal by Dr. Anderson."

Granting for the moment the possibility of finding a specimen of wrought iron with so low a compressive modulus as 11,650,000 pounds, it is most improbable that its tensile modulus should be so little below a fair average. General Morin mentions as an exceptional case a modulus of 17,000,000 pounds; and of thirty compression members tested by Mr. Lovett in America, only one showed a modulus below 20,000,000 pounds. In all the text-books I have seen, except Dr. Anderson's, it is stated that the two moduli are sufficiently near in value to be considered equal. Hodgkinson found the ratio $\frac{E_t}{E_c} = \frac{1·18}{1}$. Duleax found the two moduli exactly equal. Prof. Standinger, in twelve different pieces of Bessemer metal, found the ratio $\frac{E_t}{E_c}$ to vary from $\frac{1}{1·19}$ to $\frac{1}{1·02}$. Professor Unwin, in his "Elements of Machine Design" only gives one value for the modulus of longitudinal elasticity. Professor Weyrauch, in speaking of the experiments on wrought iron made by Kupffer and Styffe, says that their results justify the custom of taking the same value for both moduli. He also makes the same observation with respect to the experiments on Bessemer metal made by Bauschinger. On the other hand Mr. Baker, in his book "On the Strength of Beams, &c.," mentions experiments conducted by Mr. Mallet as "showing the high resistance of wrought iron to compression within the elastic limits, and the small change of length resulting therefrom, compared with that exhibited under an equal tensional strain." This is quite the reverse of the conclusion to be drawn from Dr. Anderson's book, and I cannot help thinking that extreme results of this kind are only met with in very exceptional cases, if, indeed, there is no error in the measurements recorded. For instance, according to Table VIII. of Dr. Anderson's work, it will be found that a tensile force of 7·88 tons per square inch produced an elongation of $\frac{1}{1593}$ of the length of the bar; and in Table IX., that the same force in compression produced a depression of $\frac{1}{666}$ of the length of the bar, or more than double the change of length. This discrepancy, as I have already observed, may be partly accounted for by the fact that the metal was not the same in each experiment; but this is not sufficient to dispel the idea that there must have been some other conditions affecting the results, and which have not been made known. About twenty-five years ago Mr. Barlow ascertained by direct measurement the extent of compression and extension in two wrought iron beams. I have shown in Fig. 1 the results of his experiment on a beam of rolled iron 6in. deep and 1¼in. thick, subjected to a bending stress of about 7 tons per square inch on the extreme fibres. The cross-section of the beam is represented by the rectangle a, b, c, d, and the ordinates $a\,e$, $b\,f$, of the triangles $a\,e\,n$, $b\,f\,n$, represent the actual extensions and compressions, measured at six equidistant points in the depth of the beam. The figures marked on the ordinates are the actual micrometer readings. Fig. 2 shows the results obtained in the same way with a hammered beam, 7¼in. deep and 1⅞in. thick, the stress on the extreme fibres in this case being about 10 tons per square inch. These results point to the fact that, within the elastic limit, the neutral axis of a solid wrought iron beam, of rectangular cross-section, subjected to a bending moment only, is in the centre of the depth. The very slight deviations in Figs. 1 and 2 are only what might be reasonably expected from unavoidable errors in measurement, and want of perfect homogeneity of metal. We may also infer from these experiments that the moduli of tensile and compressive elasticity were equal in the metal of which those beams were made, and we are further justified in accepting the theory that the "neutral axis," or plane of "neutral stress" in a beam or girder of any form of cross section, subjected to a bending moment only, is, as defined in my last letter, the plane passing through the centres of gravity of the cross sections.

This definition, however, is in no way inconsistent with the fact that, in addition to the bending force, there may yet be applied to the beam a force, parallel to the neutral axis, which will exert in it a longitudinal stress, and create, as it were, another "neutral axis," which in a certain case, which I will now explain, may be outside the beam. Let A B, Fig. 3, be a solid beam of rectangular cross section, of depth d, and breadth unity, fixed in a wall at A, and carrying a weight W at the end B. The neutral axis A B, as defined above, is situated in the middle of the depth. Let $a_1\,b_1$ and $c\,d$ be two plane sections, perpendicular to A B, and indefinitely near to each other. The effect of the weight W is to bend the beam, so as to cause the section $a_1\,b_1$ to rotate about the point n_1 in A B; producing a tension in the fibre $c\,a_1$ and a compression in $d\,b_1$, thereby increasing the length of $c\,a_1$ to $c\,a_2$ and reducing the length of $d\,b_1$ to $d\,b_2$. The ordinate $a_1\,a_2$ represents the tension at the top edge, and thus the ordinates of the triangles $a_1\,n_1\,a_2$ and $b_1\,n_1\,b_2$ represent the stresses of tension and compression due to bending at any point in the section $a_1\,b_1$, and the particles which were formerly in $a_1\,b_1$ are now in the line $a_2\,b_2$.

Now consider another force equal W, applied at B, acting in the line B A. This force exerts a uniform compression in the section $a_2\,b_2$, thereby moving the particles at a_2 and b_2 to a_3 and b_3, and the particle at n_1 to n_2. The ordinates, parallel to A B, of the rectangle $a_2\,a_3\,b_2\,b_3$ will thus represent the compressive stress, at any point of the section, due to this force. A B is consequently no longer the neutral axis. The final position of the section is in $a_3\,b_3$, and relatively to its original position $a_1\,b_1$ it has rotated about the point n_3. The neutral axis or plane of neutral stress now passes through n_3, and the final stresses in the section are proportional to the ordinates of the shaded triangles $a_1\,n_3\,a_3$, $b_1\,n_3\,b_3$.

The final position of the neutral axis can now be ascertained in the following manner:—In equation (7) of my last letter I indicated that the stress S_1 due to bending, at any point distant x from the neutral axis was equal to $\frac{Mx}{I}$, and that the stress S_2 at any point of the section due to the direct force W was equal to $\frac{W}{A}$.

In Fig 3 $\frac{Mx}{I}$ is proportional to the ordinates of the triangles $a_1\,n_1\,a_2$, $b_1\,n_1\,b_2$, and $\frac{W}{A}$ is proportional to the ordinates $a_2\,a_8$, the resultant stress at any point is therefore proportional to the algebraical sum of these two ordinates at that point. Reckoning tension as positive, the distance $n_1\,n_3$ will be that value of x for which

$$\frac{Mx}{I} - \frac{W}{A} = 0$$

or

$$x = \frac{W\,I}{M\,A}.$$

Substituting for M its value W l—l being the lever arm of W about the centre of gravity of the section—we have

$$x = n_1\,n_3 = \frac{I}{A\,l} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (9)$$

This equation shows that the distance between the first and second neutral axes, as I will now call them, varies inversely as the lever arm of the weight about the centre of gravity of the cross section. Returning to our crane post, we see that this lever arm is constant, and that the second neutral axis is therefore represented by a line parallel to the first neutral axis. But in the beam and system of forces shown in Fig. 3, the lever arm of the weight is a variable quantity, and therefore the second neutral axis is a curve C D, defined by equation (7), and which—in a solid rectangular beam—cuts the upper edge at a point D distant $l = \frac{d}{b}$ from the end B. The vertical section passing through D tends, therefore, to rotate about its top edge. This must not be mistaken for the Galilean fallacy, where the stresses due to bending were alone considered. We see from this that any section between the point D and the free end of the beam has no plane of neutral stress—every part of the section sustains a compression—but it still has a neutral axis, *i.e.*, tends relatively to a vertical line to rotate about an imaginary axis defined by a point outside the beam in the curve C D. This is therefore a case in which the term "neutral axis" is not synonymous with "plane of neutral stress," or "neutral fibre," as it is sometimes called.

It must not be forgotten that M in equation (7) of my last letter is the moment of the weight about the centre of gravity of the cross section; but it must also be remembered that the resultant stresses in the section $a\,b$ Fig. 4 due to the weight W are quite independent of the position of the point c, at which we assume the equal forces W_1 and W_2 to be applied. We might, for instance, consider W_1 and W_2 to be applied at a instead of at c. The moment of W, and consequently the stress at any point of the section due to bending, is then greater, but the stress due to the direct force is no longer uniform. The algebraical sum of these two stresses is nevertheless still the same. By considering W_1 and W_2 to be applied at the centre of gravity of the section, we obtain the most simple value of the direct stress, viz., $\frac{W}{A}$, as in equation (7) referred to above, and this value being constant for all points in the section facilitates the summation of the two stresses S_1 and S_2.

Returning again to equation 7 of my last letter, and adopting the notation of Fig. 4—y being the distance of the centre of gravity of the section from the breast of the post; we have—

$$\text{Tensile stress at } a = \left(\frac{W\,(l+y)\,(h-y)}{I} - \frac{W}{A}\right).$$

Placing this equation equal zero, and equating with respect to l, we obtain—

$$l = \left(\frac{I}{A\,(h-y)} - y\right) \quad . \; . \; . \; . \quad (10).$$

This means that if the weight W in Fig. 4 is applied at a point in

* In the diagrams in question there is an] engraver's error, namely, 2 is given for 27, in Fig. 7 the omission is obvious.

the plane of the section, at a distance l, given by equation (10), from the breast of the post, it will produce no stress in the back edge of the post. Thus for a solid rectangular section of depth h, and width unity, $I = \frac{h^3}{12}$ $A = h$ and $y = \frac{h}{2}$. Substituting these values in equation (10) we have—

$$l = -\left(\frac{h}{3}\right);$$

which is a result known as the principle of the "middle third," used in determining the stability of masonry.

For the box-section of post given by Mr. Fyson in his first letter —THE ENGINEER, October 21st—we obtain from equation 10—

$$l = -3\cdot59\text{in}.$$

I have given the two last results by way of an answer to the suggestion made by one of your correspondents—Mr. Frederico de Vasconcellos, an engineer (?) in the Public Works Department of the Island of Madeira—that a crane of this description might be constructed in such a manner as to obviate the necessity of providing for the tensile stress in the back of the post. Equation 10 proves—if, indeed, any proof were required—that this is not possible, or, to use a hackneyed simile, the crane would be like the play of Hamlet with the part of the Prince of Denmark left out—that is, it would have no jib.

This letter has already reached a greater length than I intended, and I must therefore renounce the intention I had of attempting to offer your correspondent "A Student" a solution of his difficulties. I say "attempting," because, although I see no difficulty in calculating the stresses in his "crane," yet I am not so sure of being able to satisfy him as to the accuracy of the results. The very fact of "A Student" using the term "transverse radial compressive strains in the web or webs," and then drawing a figure without any "web or webs," and providing as a substitute a "series of studs;" and further stating that "a load applied at the crown of an arch roof would not produce compression on the web so long as the outer flange of the roof was strong enough to resist compression," raises a doubt in my mind as to what amount, if any, of correct previous knowledge of the subject I should be justified in assuming him to possess. A "Student" thinks he has raised "a very important question concerning the stability of arched roof members." I can only assure him that so far as the present knowledge of the theory of elasticity goes, the question is thoroughly well understood, and the impropriety of merely reproducing here what is contained in treatises on the subject must be obvious.

Permit me, in reply to the letter of your correspondent "R." in your issue of the 23rd inst., to express my regret at having misunderstood Mr. F. de Vasconcello's allusion to Cooper's Hill College.

In "Q. E. D.'s" letter, which appears in the same paper, there are one or two points which I wish to notice. That gentleman accuses me of being "enough to imperil the reputation of mathematics as a means of solving such questions;" but in the next sentence he writes, "I may say, however, since an appeal has been made to mathematics, that Mr. Coventry is accurately right;" and further on: "At least, Mr. Coventry's views are those held by the best trained men of the day." This is very flattering; but if I am "accurately right," in what way are my calculations likely to "imperil the reputation of mathematics?"

"Q. E. D." says it is necessary that he should "treat the subject mathematically." I quite agree with him there. Fancy such an equation as "strains = toe!" I am also told by this writer that I am, "in a sense," right. Now, would it not have been better if "Q. E. D." had pointed out where I was wrong, instead of making absurd attempts to secure his own position?

It may interest "Q. E. D." to know that I am not a Cooper's Hill man. I mention this because he has expressed a doubt on the subject, and he might like to have another guess at the source of my education.

I have now a few remarks to make upon Mr. Major's letter which also appears in your issue of December 23rd. In the second paragraph of that letter I find it stated that "the post has twofold functions to perform, first to resist the bending strain . . . and, secondly, as a column to carry the load itself." This, of course, is indisputable, but let me call attention to the fact that the truth of this statement was demonstrated by Mr. Tozer, Mr. Fyson, and "J. H. H." in THE ENGINEER of October 21st, and subsequently ridiculed by Mr. Major in THE ENGINEER of November 11th. *Quantum mutatus ab illo!* But let us see whether Mr. Major adheres to his corrected statement. In the next sentence he says: "The latter duty" (*i.e.*, the duty of resisting the direct compressive strain) "must not be considered separately, but simply as a modification of the former" (*i.e.*, as a modification of the duty of resisting the bending strain); "and the load considered once only is the sole source of the whole of the strains under both headings." Of course the load is the "sole source of the strains," &c.; this is a mere truism, but Mr. Major has no right to say that the twofold "functions" or "duties" mentioned above "must not be considered separately." I maintain that they may be considered separately, and that in doing so I act in accordance with the principle known as the "superposition of equilibrium."

In the fifth paragraph Mr. Major states that Mr. Pendred's "error arises solely from, and consists in, calculating his forces as acting about one or both of the faces of the post instead of about the neutral axis." My answer to this is, that if any number of forces act in one plane at different points in the plane of section of a crane post, it will be admitted by all engineers who do not wish to gain for themselves an unenviable notoriety, that these forces will be in equilibrium if the algebraic sums of their components, in the plane of the forces, resolved parallel and perpendicular to the plane of the section, are each equal to zero; and the sum of the moments of all the forces about any point in the plane of the forces, or about any axis at right angles to the plane of the forces, is also equal to zero. If this is correct there is no reason why Mr. Pendred should not take the moments of his forces about any point in the plane of his forces, or about any axis perpendicular to that plane, and consequently his "error" does not "arise solely," &c.

There is, perhaps, even an advantage in taking moments about the back and breast of the post, inasmuch as we then have only one kind of equilibrium to consider, viz., with respect to rotation; but if the moments are taken, say about the neutral axis, we have besides to consider a condition of translation before we can obtain the unknown strains in the flanges. In either case we have two unknown quantities, and consequently require two equations. Thus, in Fig. 2 of Mr. Major's letter—December 23rd—if C = compression in breast flange and T = tension in back flange, then, by taking moments about the neutral axis we have:—

$$(60\,W - 3\cdot5\,T - 5\cdot5\,C) = O \quad . \; . \; . \; . \; . \; . \quad (a)$$

$$\text{also} \quad (C - W - T) = O \quad . \; . \; . \; . \; . \; . \quad (b)$$

Or, by taking moments about the back and breast we have:—

$$(63\cdot5\,W - 9\,C) = O \quad . \; . \; . \; . \; . \quad (\alpha)$$

$$\text{and} \quad (54\cdot5\,W - 9\,T) = O \quad . \; . \; . \; . \; . \quad (\beta)$$

Mr. Major's argument practically is, that (*a*) and (*b*) are the only correct equations to use, and that Mr. Pendred's "error" "arises solely, &c.," in using the two equations (α) and (β). It is, however, evident that only two of the above equations are sufficient to obtain C and T when W is known, and this, of course, means that Mr. Pendred or anyone else may, if he thinks fit, consider one strain by taking moments about one point, and the other strain by taking moments about any other point.

There is one more point in this letter which I should like to bring under the special notice of your readers. In THE ENGINEER of October 21st Mr. Fyson gives an example of a crane, such that a load of 20 tons—neglecting the weight of the crane, &c.—produces a tensile stress of 4·66 tons per square inch in the extreme fibres of the back flange, and a compressive stress of 5·24 tons per square inch in the breast flange, and I have in a previous letter given my reasons for saying that these stresses are correct. Mr. Major, however, has denied the accuracy of these results in THE ENGINEER of November 11th, and now again he says, "nothing like this proportion of stress could be obtained with a central neutral axis." Now if Mr. Major knows that these stresses are erroneous, why does he not say what values they ought to have? I conclude that he does not know. According to equation (9) of my last letter, the neutral axis in Mr. Fyson's crane post is about 10·53in. from the centre of gravity of the cross section, or 4·47in. from the back edge of the post; and the flanges are not as Mr. Major says "each the same distance from the neutral axis." It will be observed that Mr. Major also says that the values of stress given by Mr. Fyson are "most improbable if not impossible." I again ask why Mr. Major does not give what he calls the correct values? or why does he not tell us, to use his own language, what is something like, or most probable, or even possible in this respect?

In some of his remarks—see sixth paragraph, December 23rd—Mr. Major is inclined to be very exact, and seems to have an aversion to approximate calculations. May I, therefore, ask him why he does not take into account—(1) The increased stress due to the horizontal deflection of the end of the jib. (2) The increase of stress which would result from an increase of temperature. (3) The stresses due to the tension in the chain. For instance, if the chain were carried along the back of the post, the tension in this part of the chain would exert a tension in the breast, and a compression in the back as well as a direct compression through the post. I do not mean to say that the two last sources of stress are ever likely to be worth considering from a practical point of view. The first, however, would become important if the length of jib were great in comparison with the thickness of the post; but for obvious reasons no one would think of constructing a crane so flexible as to be liable to a material increase of stress from this source. A glance at the record of Wöhler's experiments is sufficient to know that such a crane would have a comparatively very short life.

I will now sum up the principal arguments contained in my three letters as follows:—(1) Nearly all the best authorities agree that the moduli of tensile and compressive elasticity within the elastic limit of wrought iron are equal. (2) It follows that the neutral axis—when bending alone is considered—in the post of the crane instanced by Mr. Fyson in THE ENGINEER of October 21st is in the plane passing through the centres of gravity of the cross sections. (3) That the effect of the direct compression due to the load is to alter the neutral axis and to create, as it were, another one, or "second" neutral axis at a distance—see equation 9 of my second letter—equal to 10·53in. from the "first" neutral axis, or 4·47in. from the back of Mr. Fyson's crane post.

If any of your correspondents differ with me as to these results, I shall be glad if they will not merely state them to be false, but at the same time give what they consider to be the correct substitutes for them, as well as their reasons for so doing. I cannot insist too strongly on the advantage of pursuing this course. Were Mr. Major to do so it might enable him to carry out the laudable motive which he suggested in the first paragraph of his third letter, of imparting to your readers that "grasp of the subject" which he appears to profess, and in which he finds some of your other correspondents so deficient. I think it would also tend to further the object he has of "endeavouring to extract truth" from a discussion which I fear will otherwise become tedious and of very little "service to your readers." If, on the other hand, any persons of the "Q. E. D." stamp should come to the conclusion that I am "accurately right," I hope they will not think it worth their while to state in a contiguous sentence that I am "enough to imperil the reputation" of a science which it must be admitted is often useful in "solving such questions," even if we draw only upon the elementary portions of that science. W. B. COVENTRY.

Fordingbridge, Dec. 27th.

SIR,—Had Mr. Coventry, whose letter appeared on the 16th inst., previously had an opportunity of reading my letters, printed on the 9th and 23rd insts., he would probably have honoured me by a criticism of my method of fixing the position of the neutral axis as therein set forth, instead of simply re-stating the well-known centre of gravity theory. If Mr. Coventry's four hypotheses are admitted, I have not a word to say in opposition to his results. I am fully aware that these hypotheses are "generally admitted," that, as "Q. E. D." says, "Mr. Coventry's views are those held by the best men of the day; and that as "R." tells us, Mr. Coventry's equations have been taught at Cooper's Hill. Yet in spite of all this, with all proper fear and trembling, I venture to dispute the soundness of the hypotheses. I do not know if Mr. Coventry's last paragraph had any reference to myself, but should like to remind that gentleman that it is quite possible for a man to fully "understand what are, and what are not, the generally accepted theories," and yet not accept them for himself.

By your permission I will shortly draw Mr. Coventry's attention to the grounds upon which I differ from him. Hypothesis 1 commences with a reference to a rectangular beam. All four of them lead up to the conclusion that the moment of resisting stress is the same on both sides of the neutral axis. It follows that the strain to be resisted will also be equal. In a rectangular beam subjected to a cross breaking strain only, these conditions obtain. To speak of a rectangular beam then, in common with these hypotheses, is to assume that the strains of compression and tension exerted on opposite sides of the neutral axis are equal, and it would be clearer to state this as a preliminary hypothesis. That these strains must be equal in a beam subjected to cross breaking strain only, I have shown in my letter appearing on the 9th inst. Passing on, I admit hypotheses 1 and 2; but I assert that 3 and 4 are groundless assumptions, unsupported by any experiments upon metals used in the arts. In my letter above referred to, experiments are quoted which conclusively prove that extension and compression for both cast and wrought iron do not even approach proportionally to the strain exerted, and that the modulus of elasticity for compression in either metal is again very different to that for tension in the same metal.

I believe the extensive experiments carried out by Mr. Kirkaldy show the same results; but I have not a copy of his work at hand, and have to speak from memory. If I am correct upon this point, there goes the centre of gravity theory, save as a rough-and-ready approximation. Leaving this for a moment, and accepting the centre of gravity theory as depending upon the five hypotheses, the first of these says the compression and tension strains must be equal. In the crane post they are not equal. One of the props gone, the structure falls. The centre of gravity formula will not apply; the neutral axis is removed to a line more distant from the centre of application of the greater strain.

Mr. Coventry contends that the neutral axis is still at the centre of gravity. He admits that the compression stress will be greater than the tension. He would possibly provide for this by a wider flange on the breast, the increased area being the equivalent of the load. The centre of gravity is now nearer the breast than the back. With the assumed proportions, the stress per unit of area for both compression and tension will be equal. Hypothesis 3 says, "that the extension or compression of the material is proportional to the forces exerted." As in our case we have equal forces per unit of area, we shall, under the law, get equal extensions and compressions. But the breast is nearer the neutral axis—centre of gravity—than the back, and the particles are moving on a shorter radius. If these moving on the shorter radius are to describe the same length of arc as those on the longer radius, the angles traversed by each will be different; and this is obviously absurd. The centre of gravity would not be the neutral axis of the crane post, even if we accept the four hypotheses. My letter appearing on the 23rd inst. shows where it is to be found.

"Q. E. D.," in his letter published on the same date, is altogether too lowly. He confines his attention to the foundations of his crane. If he were to take a higher view of the question—say a foot higher—he would be more upon a level with his fellow-correspondents. We may safely assume that "Q. E. D.'s" crane will be fastened somehow, and the point at issue is the amount and nature of the strains in the post at, say, a foot above the ground line. It may be "obvious" to "Q. E. D." that at such a point "there is no tendency to turn about a neutral axis;" but it is not so obvious to some other of your readers. A few reasons why might assist us.

Mr. Coventry will, I doubt not, be gratified at the adhesion of "Q. E. D.," and I beg to congratulate him thereupon. I do not know why "Q. E. D" should call upon me to show that the extra strain upon the breast is diffused throughout the post. I have stated and argued that it is not so diffused, and objected even to a temporary assumption in that direction made by Mr. Fyson for the purposes of calculation; nor why I should be asked to show that under stated conditions the neutral axis will be found at the centre of gravity, when such force of argument as I could bring to bear had been exerted in the opposite contention. "Q. E. D." is energetically thrashing wind. C. G. MAJOR.

34, Freke-road, Lavender-hill, S.W.,
December 24th.

COLD-AIR MACHINES.

SIR,—It will be esteemed a favour by me if you will spare a little space for a few remarks upon the letter of "Purchaser" in your issue of the 16th inst. It is somewhat strange that this correspondent should come forward principally to laud the machines of three or four makers while condemning "Sturgeon's," and yet call his letter a "reply" to that of Mr. J. W. de V. Galwey. I am sure many of your readers would be pleased to see further particulars of what Mr. Hawley has done through the medium of your valuable paper.

"Purchaser" says, "The American machines will not compare favourably with those of Messrs. Hicks and Hargreaves, Bell and Coleman, or Mr. Lightfoot's." Would this gentleman kindly state who are the makers of American cold-air machines, as the best known among American freezing machines employ chemicals, and therefore are not comparable; and also whether he considers the makers above referred to are representatives of this branch of engineering in this country, and that J. and C. Hall's, Gwynne's, Haslam's, Kirk's, Giffard's, &c., are only the "small fry," to be left out in the cold (air).

Hall and Haslam's machines are well before the public, and have stood the test of practical working, and have surely an equal claim to be mentioned with those singled out, for some mysterious reason, by "Purchaser."

The Bell-Coleman machine is well known, but I should like to know where one of Hicks and Hargreave's machines can be seen working, as also one of Mr. Lightfoot's, whose interesting and ingenious method of stage expansion has been so excellently described and illustrated in your journal—a method so redundant with theory that its practical application should be particularly interesting. There is something almost facetious about "Purchaser's" statement, that "one maker produces a machine with a 10in. expansion cylinder, 14in. stroke, that will discharge 40,000 cubic feet per hour of cold dry air!" Even Mr. Sturgeon would not venture to make a machine to run 524 revolutions per minute!

A word about Mr. Coleman's experiment. I cannot help thinking it is a pity that your several correspondents, who have given their views upon this subject, do not understand the very simple fact that the lowering of temperature of expanding air is proportionate to the resistance it has to overcome. In Mr. Coleman's experiment, the resistance was the external atmospheric air, which the expanding air had to displace, and this being little, the fall of temperature was also so little that its friction produced sufficient heat, probably, to compensate for that fall. Had the expanding air been discharged into a vacuum, then theoretically there would have been no fall of temperature—*vide* Clausius. Hence the double utility of the expansion cylinder. OCTOPUS.

Newcastle-on-Tyne, December 22nd.

SIR,—No one has been more surprised than myself to see a letter signed "Purchaser" and replies thereto made by Mr. Sturgeon and Mr. Galwey in your valuable journal. Both of the last-named gentlemen are entirely unknown to me, and "Purchaser" might almost come under the same category, as although I suppose I must have seen him once, I know nothing of him except that he, with many others, must have been present at a time when I have been experimenting with machines.

"Purchaser" is slightly in error in stating that I informed him that a 10in. by 14in. cylinder would only deliver about 2000 cubic feet per hour. I trust I am not imputing any want of technical knowledge to Mr. Sturgeon when I mention that this depends entirely on the speed at which piston is driven. I certainly am surprised that an engineer with Mr. Sturgeon's presumed experience should state that a machine is no better for working at a low temperature. If air is discharged into a chamber of 40,000 cubic feet capacity at 18 deg. Fah. it will surely take longer to cool this chamber than if it was discharged into it at 50 deg. below zero. I may mention that my machine works on the dry principle with a surface cooler, that the simplicity of the valve arrangement is in accordance with the rest of the machine, and that the machine has been experimented with for nine months without having had one hour's labour expended upon it for repairs since it was first completed, either in removing valves or otherwise.

In conclusion allow me to state that I cannot be held responsible for other's criticisms either favourable or adverse upon my machines, and to most emphatically deny that "Purchaser" or any other of your correspondents has any interest in my machine that I am aware of except in the light of possible purchasers.

JAMES HAWLEY.

Derby Works, Vauxhall, Liverpool, December 27th.

BALANCING PORTABLE ENGINES.

SIR,—The suggestion of Mr. Chandler that portable engine fly-wheels should be balanced to overcome the excessive vibration, or rocking, is one that will commend itself to users of that almost perfect machine. Will not the end be better attained by makers giving some attention to the subject of weight of moving parts, as arranged by Mr. Porter, of Philadelphia, in his high-speed engines, to the very great reduction of their vibration and increase of their running speed? The weight added to present designs would be compensated for in reduction of weight and size of fly-wheel. A balanced wheel is well, but can only deal with the crank and connecting-rod, and not perfectly with those. May I make a further suggestion of detail? In making a finished machine, which is largely used in the open air under the worst conditions as to cleaning after dampness, and the majority of which machines, after a few months' use, are almost eaten up with rust, why cannot makers adopt a permanent cover for the machinery, that would enable oiling and wiping to be done while protecting the working parts?

If makers think the matter worth the attention that I do, I will gladly give them my sketches on the subject, to which I have devoted some attention. R. BOLTON.

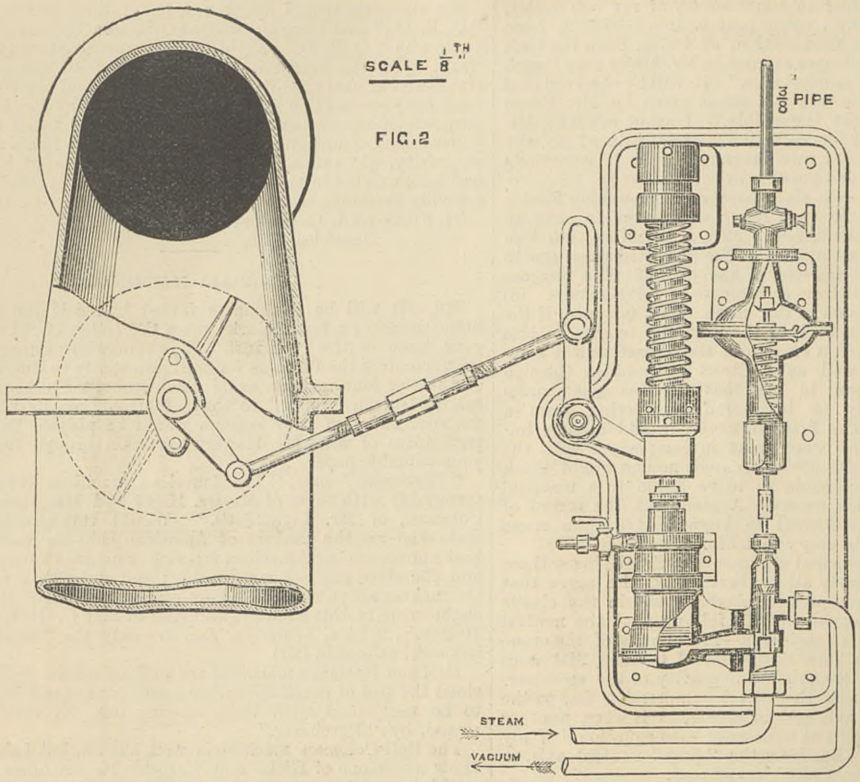
Terrace Royal, Nottingham.
December 26th.

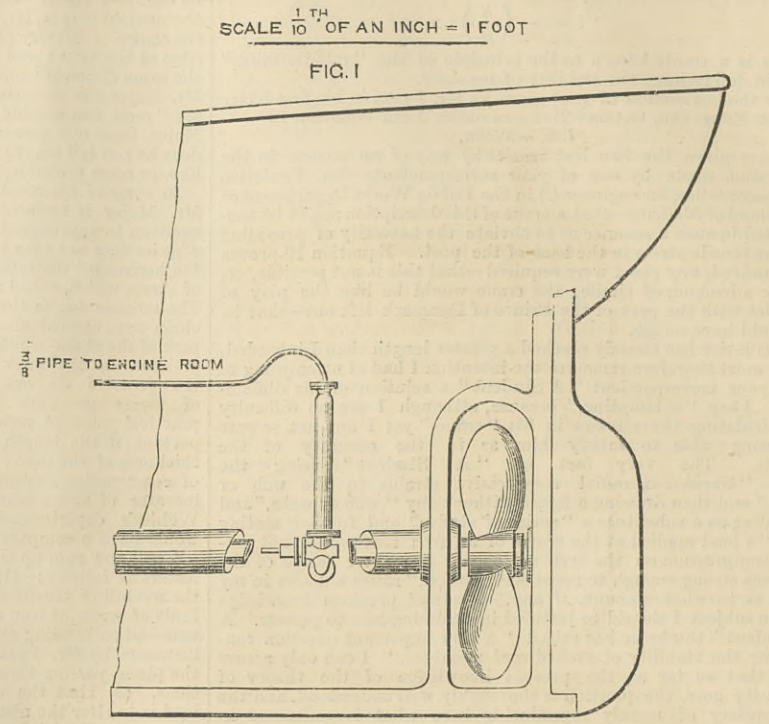
THE DITTON ENGINES.—INITIAL CONDENSATION.

SIR,—The amount of water passed through the cylinders averaged over two days' trial ·6510 lb. per stroke, which includes the weight of steam shut in the high-pressure clearance by the compression. The weight of steam per stroke accounted for by the indicator, as averaged from a great number of diagrams, is ·4544 lb. per stroke, leaving ·1966 lb. of water at cut-off; which is just about 30 per cent., as stated in my previous letter; and if the priming water were deducted, this percentage would be slightly lower.

Engine Works, Grosvenor-road, JOHN J. MAIR, M.I.C.E.
Pimlico, London, Dec. 28th.

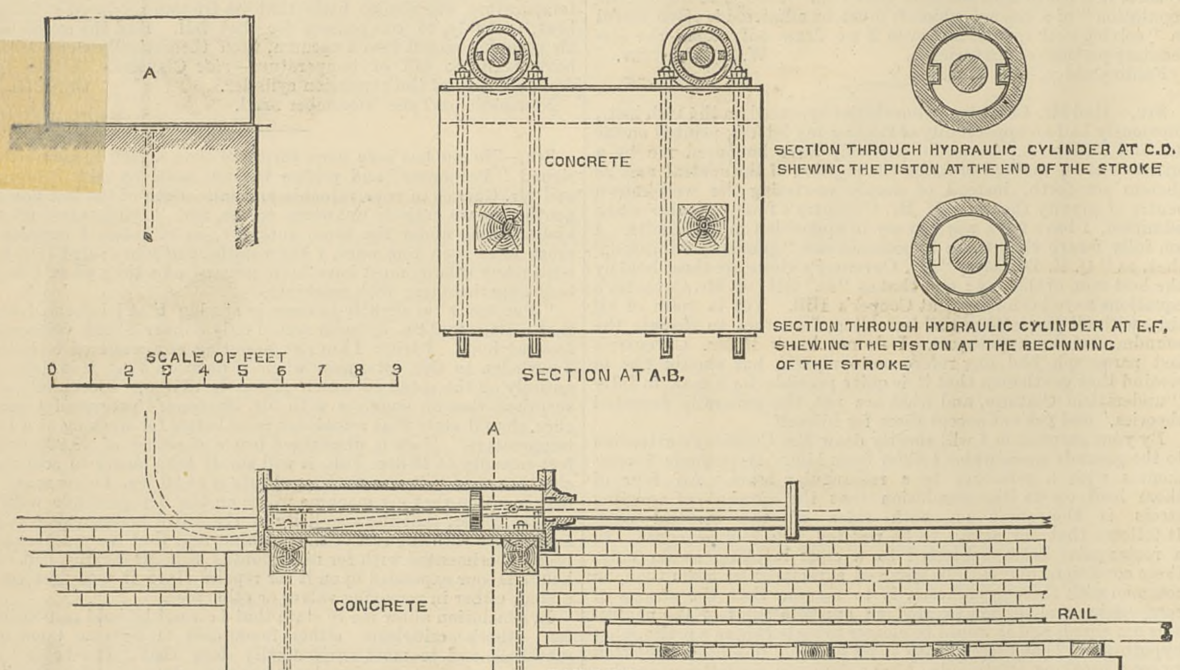
COUTTS AND ADAMSON'S MARINE GOVERNOR.





The general arrangement of the illustrated governor above and mode of working can be seen very readily. It is claimed that it is easily kept in order, as there are no large number of working parts, and it is small and compact, so that it can be placed close to the throttle valve. Fig. 1 shows an air stand pipe and cock fixed to the inside of the ship, as close to the propeller as possible. To the top of the stand pipe is attached a small copper pipe, carried forward to the engine room, and connected to the apparatus, shown in Fig. 2. This represents a flexible diaphragm connected to a small equilibrium steam valve, which admits steam into a cylinder connected to the throttle valve lever by means of a rod and lever. As the head of water varies at the stern there is movement given to this valve, and the throttle valve is opened or shut accordingly. To adjust it as the engineer may think proper, there is a small right and left-hand screw nut connecting the diaphragm and steam-valve spindle together, which on being turned raises or lowers the valve. As the stern of the vessel rises the steam valve rises, and reaching the point set to, steam enters the cylinder and shuts the throttle valve. As the stern of the ship lowers the valve lowers, and at that same point the throttle valve is opened again. The governors are made by Messrs. A. and P. Brown, Waterloo-road, Liverpool. It is obvious that they can exert no control over the engines should the propeller shaft break.

LANGLEY'S SAFETY BUFFER STOPS.

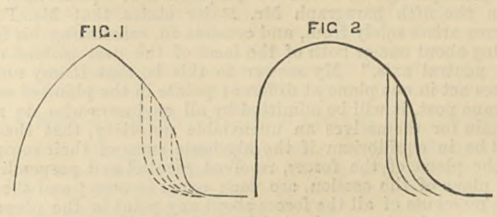


We illustrate herewith a simple and ingenious form of hydraulic buffer stop, designed by Mr. A. A. Langley, engineer of the Great Eastern Railway. In our engravings the small tank A is placed at the top of some convenient building, at a height sufficient to give a head of water equal to a pressure of, say 20 lb. to 30 lb. on the square inch. The head thus obtained gives a constant minimum pressure on both sides of the piston. After the buffers have been used and have come to rest, this pressures acts upon the area of the piston rod, and is sufficient to cause the piston to travel outwards, and thus restore the buffers to a state of readiness for further use. When it is impracticable to fix the tank at a sufficient elevation, another arrangement is used for restoring the buffers to their normal position. The action of the buffers is described as follows by the inventor.

The cylinder and piston are bored and turned to an easy fit. The cylinder has two taper bars fixed along its length; the piston has two square slots cut in it to correspond with the bars, and the effect is, when a train strikes the buffers, that the first part of the stroke is performed without much resistance, as the difference in size of the slots in the piston and the taper ends of the bars gives sufficient area for the water to pass—see section at E F. As the piston travels along the cylinder, this aperture becomes less and less, and consequently the piston is retained at a nearly uniform pressure of 500 lb. per square inch throughout the stroke, although the velocity is continually diminishing until the train is brought to rest. With these buffers there is no recoil or rebound as with the ordinary spring buffers. It is the recoil after striking the ordinary buffer stops which generally causes more injury to passengers than the actual blow. The apparatus has been suggested by the frequent accidents caused by trains running into dead ends at stations at a higher speed than was intended. The risk of such accidents is of course daily increasing with the extension of powerful systems of brakes. On most railways it is a rule that drivers are not to rely on the patent brakes for coming into stations, but it is in the nature of things that they will do so, and it frequently happens that a driver does run into a station at a higher speed than he intended or expected. In such cases the use of these buffers would, at any rate, vastly diminish the liability to serious accident, as they afford a constant resistance, sufficient to receive with safety a train at six or seven miles an hour. A set of these buffers has been fixed at Liverpool-street Station, London, and has been frequently tested at the above speed. They were made by Messrs. Ransomes and Rapier, of Ipswich and London.

LOCOMOTIVE FLANGES.

A correspondent, writing from Sacramento to the *Railroad Gazette*, remarks that "The article in the *Gazette* of July 1 from the London *Engineer* 'On the Form and Dimensions for Flanges of Locomotive Wheels' suggests a reference to the writer's experience on the Hudson River Railroad during the severe winter of 1854-5. The locomotives on that road at that time had single flanges—no flanges on the forward drivers—and the flanges were round and thick like Fig. 2, or approximating the flanges of the London Brighton, and South Coast Railway of England. During the winter referred to the snow was so troublesome that very little



work could be done on the track, and as a consequence the joints got into very bad condition. A number of locomotives got off the track that winter going at full speed with passenger trains. The round blunt flange of the back drivers would climb the rail at a bad joint and go off, carrying the front drivers with them. The engine would bound over cross ties until the train could be stopped with hand brakes—the best we had at that time. It occurred to the writer that the shape of the flange was entirely wrong. My engine was in the shop for repairs at that time, and I persuaded the master mechanic to have the flanges of my engine turned like Fig. 1, after which my engine never left the track, although it was run over very bad track during the rest of the winter.

The form of a flange should be determined by three considerations, namely, strength, durability, and safety. A glance at flange, Fig. 1, will show that it has all the strength of the round, blunt flange, Fig. 2, while the wear—as indicated by the worn tires—does not make it dangerous, as in flange, Fig. 2; that is, liable to go off the track at a bad joint. I think it will be acknowledged that a flange like Fig. 1 will go through frogs split-switches, and guard rails, clean and smooth. One other consideration—the sharp flange would be likely to cut the bones and flesh of animals run over, while the round, blunt flange would be likely to be thrown from the rail. It might be contended that a little more material should be left at the base of the flange to experiment with, to see if the engine just out of the shop would track square."

Sewage of Leyton, Essex.—The Local Board of Leyton, Essex, have entered into a contract with the Rivers Purification Association, of 232, Gresham House, E.C., for the purification and disposal of the sewage of their district. In these works the method of pressing the sludge into a portable condition, recently so successfully introduced at the Coventry Sewage Works, will be employed.

BOULTON'S POTTERY MACHINERY.

MESSRS. MINTON AND CO.'S WORKS, STOKE-UPON-TRENT.

(*For description see page* 472.)

FIG. 1.

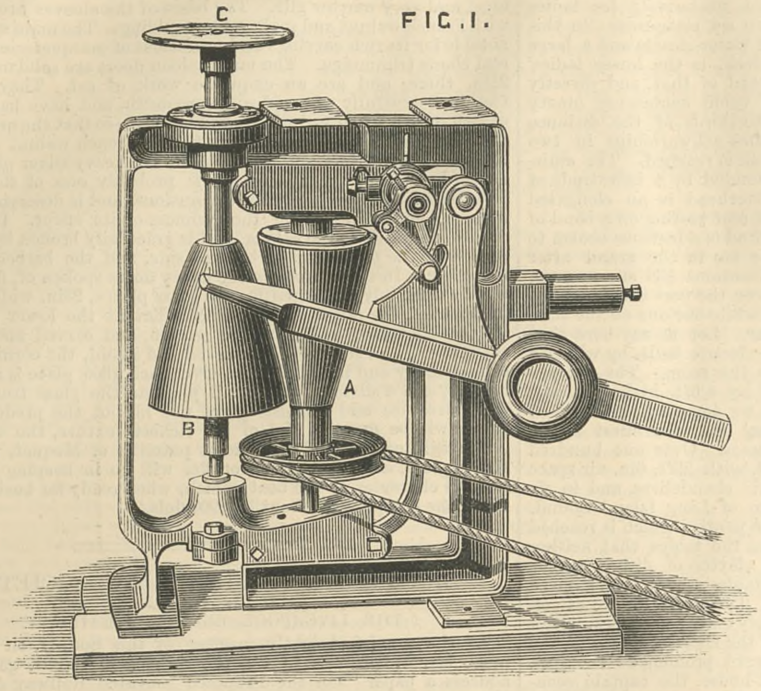


FIG. 2. FIG. 4.

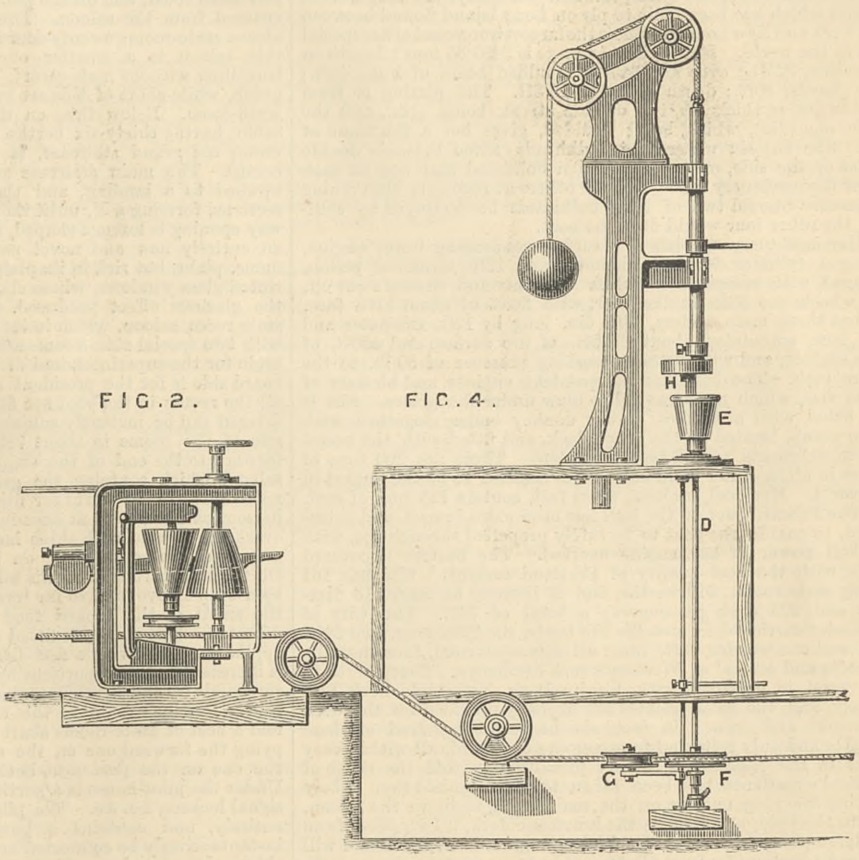


FIG. 3 FIG. 5.

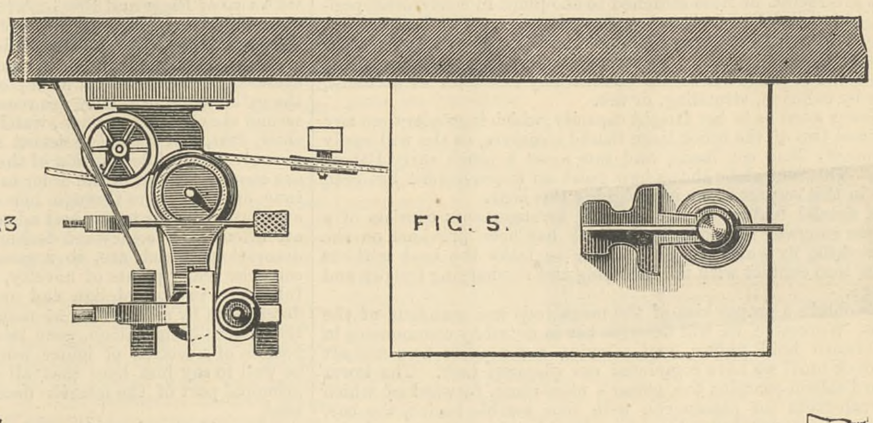


FIG. 6.

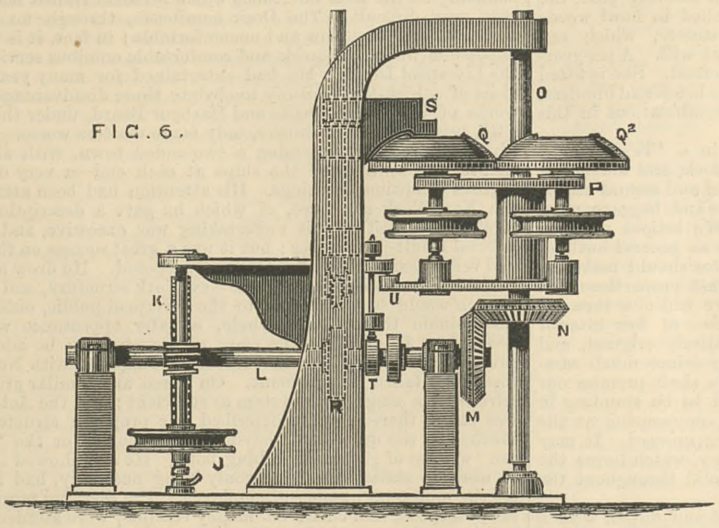


FIG. 7.

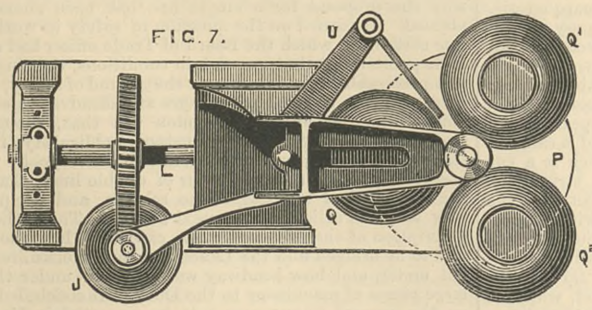


FIG. 8. FIG. 9

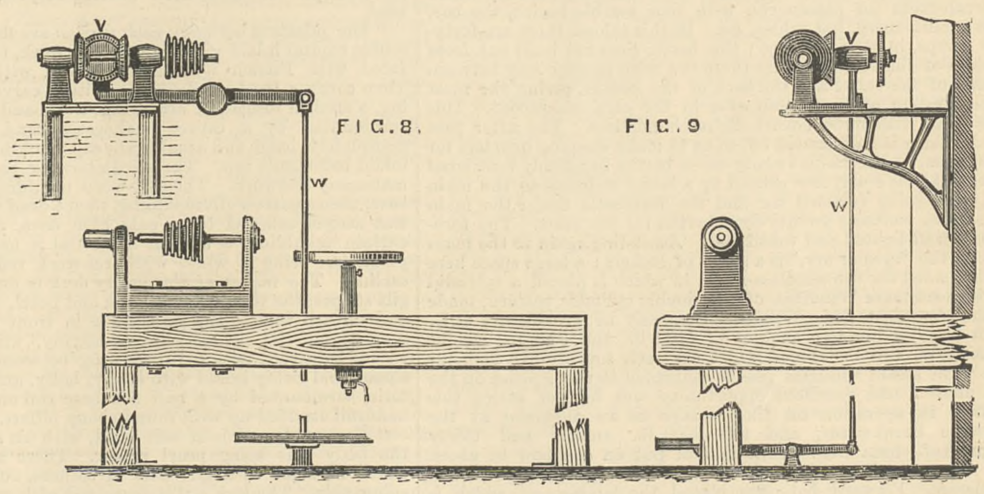


FIG. 10.

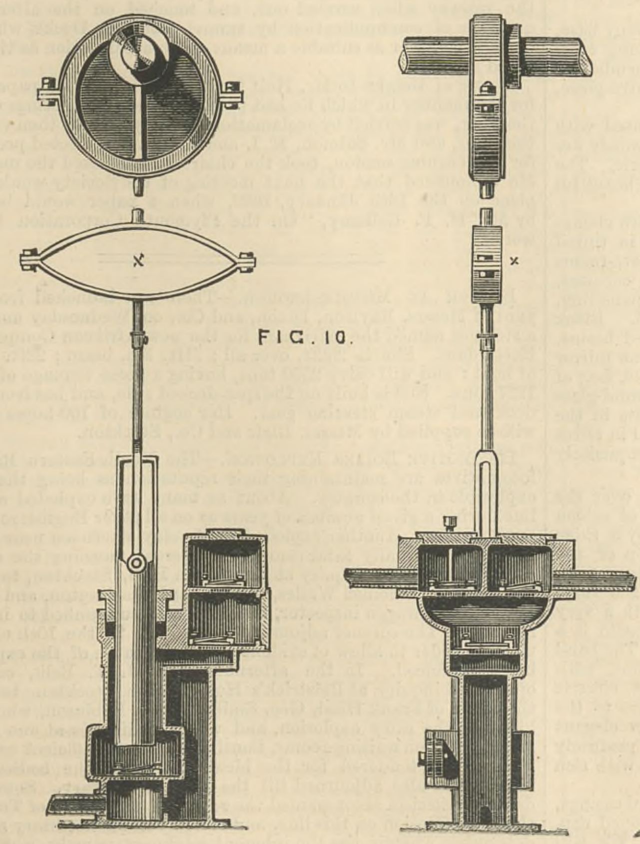
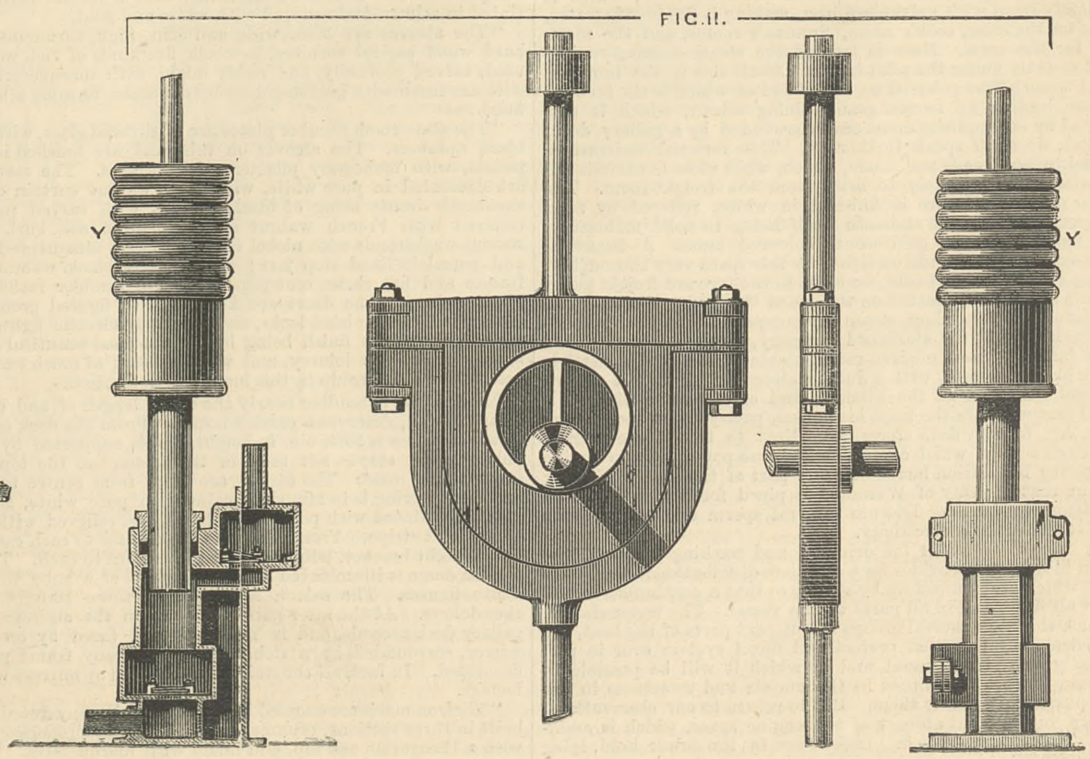


FIG. 11.



THE CITY OF WORCESTER.

THE following description of an American first-class steamer has appeared in the United States *Nautical Gazette*. It cannot fail to prove interesting to many of our readers:—"The Harlan and Hollingsworth Company turned over, on September 4th, to Capt. S. A. Gardner, jun., superintendent of and representing the Norwich and New York Transportation Company, the magnificent steamer which has been built to ply on Long Island Sound between New York and New London. She is the largest iron vessel of her special class in the world. Her register tonnage is 2485·85 tons; length on water line, 325ft.; over all, 340ft.; moulded beam of hull, 46ft.; over guards, 80ft.; depth of hold, 16·3ft. The plating is from $\frac{7}{16}$in. to $\frac{3}{4}$in. in thickness, the outside streak being $\frac{11}{16}$in., and the inside one $\frac{10}{16}$in., which, being doubled, gives her a thickness of $1\frac{1}{2}$in. She has six water-tight bulkheads fitted between double frames on the side, one as a collision bulkhead and one at each end of the machinery space, and the others at regularly intervening distances. Should two of these bulkheads be destroyed by collision, the other four would float the boat.

"Her machinery consists of a surface-condensing beam engine, having a cylinder 90in. in diameter and 12ft. stroke of piston, arranged with composition valves and seats and Steven's cut-off. The wheels are 38ft. in diameter, with floats of about 11ft. face. She has three main boilers, 37ft. 6in. long by 12ft. diameter and 13ft. face, containing about 9300ft. of fire surface and 550ft. of grate surface, and will sustain a working pressure of 50 lb. to the square inch. The boat has independent engines and blowers of ample size, which are arranged to blow under the grates. She is also fitted with a 40-horse power donkey boiler, together with steam pump, located on the guard deck, and fitted with the necessary attachments and fixtures complete. There are 200 tons of boilers in all, and her main boilers are claimed to be the largest in the world. Her coal bunkers, when full, contain 125 tons of coal.

"The forward part of the hull has been extra-braced and extra-plated, to enable the boat to be safely propelled through ice, with the full power of her engine exerted. The bottom is covered inside with the best quality of Portland cement. She has 161 selling state-rooms, 519 berths, and is licensed to carry 519 first-class and 223 deck passengers; a total of 742. The City of Worcester carries eight metallic life boats, six 22ft. long, two 24ft. long, and one wooden 16ft. long, all square-sterned, four metallic life rafts and several of Woolsey's cork life-buoys. Every berth in the vessel is provided with Kanhweiler's Neversink Cork Life Jackets, and the same jackets are liberally provided for the deck passengers and crew. In fact, she has eight hundred of these valuable and only reliable life preservers on board, all within easy access to the passengers. Every precaution within the range of practical experience has been taken to guard against fire. There are nine fire plug outlets on the main deck, eight in the saloon, four in the hold, and four on the hurricane deck, all supplied from two large pumps driven by the donkey engine, in which steam will always be kept up for immediate action in case of an emergency. There are 1450ft. of hose attached to the plugs in convenient positions, to be used for no other purpose whatever. The boiler space is closed in with iron fire-proof bulkheads to prevent any danger of fire from that quarter. So far as we can see nothing has been left undone to make her secure against any character of accident, either by collision, stranding, or fire.

"Now a word as to her freight capacity, which is greater than any combined two of the other large Sound steamers, as she will easily stow ninety long car loads, and can upon a pinch carry 110 car loads. This fact alone shows how great an improvement has been made in this respect alone in designing this boat.

"A special feature of her internal arrangements consists of a separate gangway for passengers which has been provided on the freight deck, by which they can enter or leave the boat without coming into contact with the incoming and discharging freight and baggage.

"To obtain a proper idea of the magnitude and grandeur of the City of Worcester, we will describe her in detail by commencing in the forward hold proper, and carrying our readers fore and aft each deck until we have completed our pleasant task. The lower forward saloon contains the officer's mess-room, forward of which is a wash-room for passengers, with four marble basins, the bar, and a small pantry, hot tables, &c. In this saloon there are forty-eight berths, in tiers of three; the berth tiers are built out from the sides of the vessel, so that there is a wide passage way between the skin of the vessel and the back of the berths, giving the most perfect system of ventilation ever in use on a steamboat. This saloon is lit with three electric-light chandeliers. The after part of this saloon is bulkheaded off, so as to make sleeping quarters for the waiters, and contains twenty-seven berths in a finely ventilated apartment. We will now ascend by a broad staircase to the main deck, and going forward we find the forecastle under the main deck, which contains twenty-four berths for the crew. The forecastle is well lighted and ventilated. Ascending again to the main deck, in the 'eyes of her,' is a series of lockers; a large space here is lightened for the windlass-room, in which is placed a splendid Providence Steam Windlass, of the double cylinder pattern, made by the American Ship Windlass Company of Providence, R.I., which handles her two anchors of 4100 lb. and 3000 lb. weight respectively, and her cables, which are each seventy-five fathoms long. The steam windlass gear is connected to the capstan on the deck above. An excellent opportunity was had of seeing this windlass in operation on the passage as we anchored at the Delaware Breakwater, and the 3000 lb. anchor and thirty fathoms of chain were taken in and put on the bow in about five minutes, a vast saving of time over the old-fashioned windlasses. Forward here are placed the lamp-room, which is completely lined with galvanised iron, making it fire-proof, water, closets for the crew, cook's room, fireman's rooms, and the mess-room for the crew. Here is located the steam-steering engine-placed directly under the pilot house. Abaft this is the immense freight space before referred to, at the end of which is the forward staircase leading up to the grand dining saloon, which is surmounted by an exquisite dome and surrounded by a gallery deck, of which we shall speak further on. This forward staircase is enclosed by bulkheads and doors, which, when closed, exclude all the noise and dust likely to arise from the freight-room. The interior of the inclosure is finished in white, relieved by solid mahogany pilasters, the staircase itself being in solid mahogany, with foot treads in gold-bronze coloured brass. A beautiful guinea-gold tinted chandelier lights up this space very thoroughly. Passing aft, on the port side, we come to the forward freight gangway, aft of which is located on the guard the donkey boiler-room, a miniature machine shop, steam fire pumps, &c. In a corresponding location, abaft the starboard gangway, is the kitchen, fitted with a large and most modern range, steam boiler, steam kettles, double broiler, pumps, with a dumb waiter leading to the pantry overhead. Abreast of the kitchen, and on the after side of a special gangway, are the large ice houses, pastry-cook's room, store rooms, &c., for steward's stores, &c. Next to this is the electric lamp engine-room, which contains a 20-horse power electric engine for lighting 160 Edison lamps on every part of the boat. We may say here that the City of Worcester is piped for gas, is provided with lamps for burning Downer mineral sperm oil, and also for complete lighting by electricity.

"In respect to water for drinking and washing purposes, the system in use here provides for a complete distribution from central tanks, which are pumped up by steam, so that a continuous flow is had at all times and in all parts of the vessel. The water-closets, of which there are several groups in different parts of the boat, are all 'flushed' by the most perfect and novel system ever in use, especially on a steam vessel, and by which it will be possible to maintain perfect cleanliness in the closets and sweetness in the atmosphere surrounding them. But to return to our observations. We are now brought abreast of the engine space, which is amidship. The boilers, three in number, are in the lower hold, lying fore and aft, and connected with two steam chimneys and two smoke stacks. The boilers and coal bunkers take away no freight space, and in laying out the joiner work the steam chimneys are completely hidden from view. We now come to the after main deck freight space, and the magnificent front to the lower grand saloon. About 20ft. of the deck in front of the saloon and abreast of the after gangways, are alternate strips of ash and black walnut. On the starboard side is the barber shop and wash room, and on the port side is the purser's room, which is entered from the saloon. This saloon contains a double tier of alcove state-rooms twenty-four in number in the group. Abaft of this saloon is a smaller one, designed exclusively for ladies travelling without male escort. There are six state-rooms in this group, while abaft of this are two sets of water-closets and a large wash-room. Below this, on the next deck, is the lower ladies' cabin, having thirty-six berths, and forward of that, and directly under the grand staircase, is a ladies' cabin containing ninety berths. The main staircase ascends two-thirds of the distance upward to a landing, and then branches athwartships in two sections, forming a Y, until the upper deck is reached. The stairway opening is lozenge-shaped, and surrounded by a balustrade of an entirely new and novel pattern. Overhead is an elongated dome, plain, but rich in its plainness, the roof resting on a band of tinted glass windows, whose choice colour adds a lustrous charm to the glorious effect produced. Here we are in the grand after state-room saloon, which in its entirety contains 136 state-rooms, with two special state-rooms aft, the one on the port side being set aside for the superintendent of the line, while the one on the starboard side is for the president of the line. Let us say here that all the rooms in the boat are fitted with electric bells, by which a servant can be instantly summoned into the room. The average size of the rooms is about 7ft. by 7ft. by 8·6ft. high. Passing forward to the end of the engine space we come to the forward saloon, which contains the grand dining hall, the finest apartment afloat in the world for dining purposes. Over one hundred persons can be seated at once in this hall, with 23ft. 6in. air space overhead, lighted with three large electric chandeliers, and in air as pure as can be breathed on the bosom of Long Island Sound. On the starboard side of this saloon is the pantry, which is reached by a deep alcove, and so far removed from the tables that neither the smell of the cooked food nor the clatter of dishes can be detected. The pantry is fitted with hot tables and all the modern appliances for serving a first-class *menu*. The grand dining saloon is increased in its proportions by the gallery state-room deck, which surrounds it, and which contains some of the choicest rooms on the boat. Passing out on to the upper forward promenade deck, we find a nest of state-rooms abaft the pilot-house, the captain occupying the forward one on the starboard side, and the chief pilot the one on the port side, both connecting with the pilot-house. Under the pilot-house is a portion of the steam steering gear, the signal lockers, &c. &c. The pilot-house is finished in hard woods entirely, and contains a powerful steam steerer, which can instantaneously be connected or disconnected at will. A six-year-old boy can steer her, so far as strength is concerned. She is fitted with two of Riggs and Brother's patent binnacle heads and blinders, with liquid compasses, which are the finest combinations in this line we have yet seen on a steamboat.

"The officers of the boat are quartered in a 'Texas,' built against the paddle-boxes, on top of the upper deck, and abreast of the gallows-frame. Here are rooms for the chief and second mates, second steward, wheelsmen, watchmen, express and baggage men, chief, first, and second assistant engineers. We believe we have now given a full description of the boat, so far as general outlines are concerned, and in the order in which a visitor should make his tour of inspection through her to see her vast proportions and exquisite beauties to the best advantage, and we will now turn our attention to a somewhat technical description of her interior decorations, which are, to a great extent, entirely original, and comprise many points of novelty, and certainly evince much careful study, in both design and execution. We shall premise our description by saying that we may be supposed to be standing in the grand dining saloon, near the iron mast, commencing at the bottom of a section of joiner work, and noting upward. It may be well to say just here that all the mahogany, which forms the principal part of the interior decorations, is solid throughout the boat.

"The pilasters between each section are flat and fluted, with a centre capital inlaid with marqueterie work, top capital carved and faced with French walnut, and inlaid with more marqueterie. Then comes a hard wood cornice, with a carved mahogany moulding, a sunken rosette of amaranth, a V band of polished cypress, surmounted by a carved mahogany band and cove; then a marqueterie band, and a mahogany cap moulding, topped by an ebony inlaid balustrade top. The ventilators for the state-rooms are in mahogany fretwork. The soft-wood moulding has a pearl-tinted base, then a narrow gilt moulding, then a dead white band, a salmon-tint stripe, relieved by a pale blue cove, above which is a cut curtain moulding, a salmon band and a narrow gilt stripe, the planissiere being in white with fret-work ventilators between the carlins. The facing of the galley deck is decorated with narrow gilt stripes, the tints being salmon and pearl, with a moulded plate and an ash base. The balustrade in front of the gallery state-rooms is of the richest solid mahogany, with eight carved and turned balusters, with a carved wing between each post, which is square and richly inlaid with ebony, holly, amaranth, and marqueterie, surmounted by a half flat base rail and topped by a round handrail studded up with round ebony pillars.

"The panel work is of soft wood, with an imitation ebony base, the body tint being pearl colour. There are two oblong cross panels moulded with gilt dots in corners, and two perpendicular sub panels. The lock rail is decorated with a rosette centre-piece, tinted in salmon and relieved with white and gold.

"The alcoves are 30in. wide and 92in. high, surmounted with hard wood capital cornices, in which five kinds of rich woods are used, carved profusely, and richly inlaid with marqueterie. The sills are faced with guinea-gold-coloured brass, forming a beautiful finish.

"The state-room number plates are of silvered glass, with ebony-black numbers. The alcoves on this deck are finished in tinted panels, with mahogany pilasters and cornices. The state-rooms are decorated in pure white, with black walnut curtain cornices, the berth fronts being of black walnut, with carved panelling, relieved with French walnut and Hungarian ash burl. Black walnut washstands with nickel trimmings and ornamented basins, and porcelain-lined slop jars; richly-fluted black walnut mirror frames and hat racks, coat pegs, comb and tumbler racks, &c., of black walnut. The doors are finished with figured ground-glass plates, brass and nickel locks, and are lit by electric lights in the alcoves, the whole finish being by far the most beautiful in effect of any steamboat joinery, and we can boast of much exquisitely beautiful workmanship in this branch of decoration.

"The dome, extending nearly the entire length of and over the dining saloon, deserves a passing notice. From the deck of saloon to top of dome is 23ft. 6in. in height, and is supported by a ridge pole and by stays—not seen in the saloon—to the top of the forward iron mast. The carlins are 20in. from centre to centre, and the covering is in 2in. stuff, painted in pure white, the ridge pole being tinted with pearl and salmon, and relieved with a very narrow gilt stripe. From the base of the dome to each carlin is a chaste light bracket, with a pendant ornament to each. The band of this dome is illuminated by figured glass of a ruby tint, with white figures. The saloon is lighted by three 16-light electric chandeliers. At the after part of the saloon the staircase to the gallery deck ascends, and is Y-shaped, and faced by an elegant mirror, surrounded by a rich carved mahogany frame profusely decorated. In fact, all the staircases are faced by mirrors with rich facings.

"The iron masts are encased in beautiful mahogany fluted casings, built in three sections, ornamented with a finely-proportioned cap, with a Hungarian ash top, and inlaid with marqueterie. We will now turn our attention to the main deck saloon parlour, which is furnished with its state-room alcoves entirely in hard wood. The bases are of black walnut, pilasters of mahogany, caps inlaid with rich marqueterie, with a cornice same as we have described in the dining saloon. The panels are of blister maple, mouldings mahogany, ground panels of satin wood, raised with very handsome French walnut, and finished with gilt edges. The centre munton of the panel is 3in. wide, with inlaid cap and base block, the lock rail same pattern as the upstair work, but very richly carved; the ventilator, mahogany fretwork. The cornice is quite heavy and broken in 3ft. sections, and tinted with salmon, white, pale blue, and very narrow gilt. The bases of the alcoves are cypress, with French walnut and mahogany mouldings. The main staircase is notable for its rich carvings and profusions of marqueterie work and real ebony trimmings. The main saloon doors are solid mahogany, $2\frac{1}{2}$in. thick, and are an exquisite work of art. They are half Gothic, beautifully adorned with amaranth, and have base panels of rich dark French walnut, carved through, so that the ornamentation of mahogany shows out through the French walnut in a rich contrast. The trimmings on the doors are heavy silver plate. The main deck front of this saloon is probably one of the richest features of this boat's interior decorations, and is deserving of the highest commendations for the richness of its effect. It extends across the width of the saloon, and is gracefully broken by the projection of the purser's office on one side, and the barber shop on the other. In the centre are the heavy doors spoken of, flanked by eight exquisitely decorated French glass plates, 28in. wide by 72in. in height. The pilasters are partially flat at the lower part, and beautifully turned at the middle section, and carved above. The caps, bases, and sub-bases are carved and inlaid, the cornices being of mahogany and inlaid ebony. Over each glass plate is a rich cap cornice, and a silvered guard rail protects the glass from injury. The furniture and upholstery are not in, but the predominating colour will be maroon, and of the richest texture, the carpetings are in light colours and of choicest patterns of Moquet, while the silver, glass, china, and table outfits will be in keeping with the general character of the boat, which, when ready for business, will stand the company in about 500,000 dols."

LIVERPOOL ENGINEERING SOCIETY.

THE LIVERPOOL ELEVATED RAILWAY.

AT the usual fortnightly meeting of this Socieiy, on the 14th inst., Mr. A. Holt, M.I.C.E., the retiring president, gave in his address a paper "On the Proposed Elevated Railway Along the Liverpool Docks." Mr. Holt remarked that Liverpool was a long, one-sided town, the river and docks forming a continuous straight boundary on the west side, along which personal transit had always been very difficult. The Dock omnibuses, through no fault of their own, are very slow and uncomfortable; in fact, it is virtually impossible to have a quick and comfortable omnibus service along the Liverpool Docks. He had entertained for many years crude ideas of a high-level railway to obviate these disadvantages. The works of the Mersey Docks and Harbour Board, under the Act of 1873, being at the extremities, only made matters worse. In fact, Liverpool was fast becoming a two-ended town, with all offices, &c., in the centre, and the ships at each end—a very disadvantageous condition of things. His attention had been attracted to the New York structure, of which he gave a description. The capital embarked in this undertaking was excessive, and had the natural result—high fares; but it was a great success on the whole, and very considerable increase was proposed. He drew attention to the insecure appearance of the New York structure, and doubted if such would be acceptable to the Liverpool public, entertaining the opinion that, on the whole, a safer appearance would be desirable. In deciding the class of structure to be adopted in Liverpool, the much smaller traffic, as compared with New York, should be taken into account. On these and similar grounds he advocated a single line system as sufficient; and the Act of 1878 was based thereon. He described the proposed structure, and touched on the question of having the "trough" or the "American" system of girder, describing both. He also showed the mode of working stations, and, economy being necessary, had arranged for the minimum number of employés. The carrying power of the line, its speed, and check on money receipts, were alluded to, and estimates of cost and of working expenses were given. The reason why the proposal for a single line has been abandoned was explained. It turned on the question of safety in working the single line station, to which the Board of Trade officer had objected. Mr. Holt pointed out that, on certain conditions, the single line system was preferable to double line on the ground of safety, and explained by comparison the real advantages and disadvantages of single and double line systems. His opinion was that, though the double system may be under the circumstances obligatory, it is evidently an excessive provision for the wants of Liverpool. So strong has been the set of opinion in favour of double lines, that it led to the abandonment of the single line scheme, and the promotion of a new Act of Parliament for next session. The author then gave a description of the proposed work, explained how the Stanley Dock was to be bridged and the Lancashire and Yorkshire Coal Railway got under, and how headway was provided under the line to take large pieces of machinery to the Dock. He concluded with remarks on the general improvement to be expected in Liverpool, and in the method of carrying on the shipping business, as the result of the railway when carried out, and touched on the alternative question of communication by tunnel along the Docks, which he did not consider as suitable a means of communication as the proposed railway.

A vote of thanks to Mr. Holt for his very interesting paper, and for the manner in which he had presided over the meetings during the year, was carried by acclamation. The president then vacated the chair, and Mr. Salmon, M. I. and S. Inst., the elected president for the ensuing session, took the chair and addressed the meeting. He announced that the next meeting of the Society would take place on the 18th January, 1882, when a paper would be read by Mr. H. F. Bellamy, "On the Plymouth Corporation Waterworks."

LAUNCH AT MIDDLESBROUGH.—There was launched from the yard of Messrs. Raylton, Dixon, and Co., on Wednesday morning, a steamer named the Afrikaan, for the new Afrikcan Company, of Rotterdam. She is 232ft. over all; 31ft. 3in. beam; 22ft. depth of hold; and will carry 2550 tons, having a gross tonnage of about 1227 tons. She is built on the spar-decked rule, and has iron main deck and steam steering gear. Her engines of 100-horse power will be supplied by Messrs. Blair and Co., Stockton.

LOCOMOTIVE BOILER EXPLOSION.—The North-Eastern Railway locomotives are maintaining their reputation as being the most explosible in the country. About as many have exploded on this line during a given number of years as on all other English railways put together. Another exploded on Monday afternoon near Stockton, with unusually fatal results. Yesterday morning the county coroner opened an inquiry at the Town Hall, Stockton, touching the deaths of Thomas Wailes, goods guard, Darlington, and Ralph Hutchinson, wagon inspector, Shildon, who succumbed to injuries received. The coroner adjourned the inquiry to the 10th of January, in order to allow of evidence as to the cause of the explosion being produced. In the afternoon, Mr. J. T. Belk, coroner, opened an inquiry at Raistrick's Hotel, South Stockton, touching the death of Frank Hind, Geo. Smith, and J. Robinson, who were killed by the same explosion, and whose bodies lie at one of the railway station waiting-rooms, South Stockton. Sufficient evidence having been tendered for the identification of the bodies, this inquiry was also adjourned till the 10th of January. Some very definite criticism accompanied the report of the Board of Trade on the last explosion on this line, and it will become necessary now to determine wherein lies the inherent weakness, namely, whether in the engines or the boilers.

RAILWAY MATTERS.

A BILL has been lodged for the construction of an electric railway under the Thames to connect Waterloo and Charing-cross stations. The gradients on either side will be such that very little power will be required to work the line.

DURING the past year twenty-eight "secondary" railways, whose aggregate length will be 888 miles, have been begun in Prussia; some of them are well under way and some completed. Most of them are short, but one or two are as much as 75 miles long.

THE Midland Railway Company is replacing the Broadholme wood viaduct, near Belper, with one of wrought and cast iron; screw piles, 2ft. 6in. diameter, with saw tooth bottoms, will form the supports, upon which will rest five sill girders, bracing the screw piles together. The superstructure will consist of five main girders, 4ft. deep, extending over seven spans to a length of 340ft.; each girder will joint over a centre stone pier, and be continuous over the screw pile piers. This viaduct is expected to occupy twelve months in re-construction. The approximate weight of ironwork is about 400 tons.

IN an article on the influence of frost on the resistance of materials, by M. L. Baclé, in the *Annales Industrielles*, the author admits the necessity for further experimental data on the subject, but with respect to railway tires, indicates that low temperature has little to do with their fracture, except by increasing the rigidity of their roads, and thereby the severity of the shocks, and states that the breakages are in proportion to this severity, as shown by the record of fractures of tires of different vehicles. Thus, of all the tires broken—presumably in France—two-thirds are engine tires, two-ninths tender tires, and one-ninth wagon and carriage tires, which are much less, in his opinion, severely tried.

AN eastward bound train on the Western Division of the Wabash railway was crossing the bridge over the Missouri river at St. Charles on the 8th inst. when the eastern span of the bridge gave way, and the entire train, composed of thirty-two cars, thirteen of which were laden with live stock, was precipitated into the river, about 80ft. below. The driver is missing, but everybody else on the train was saved, although one or two of the crew are said to be badly wounded. The conductor and several stock men were in the guard's van, but they leaped out on to the bridge when the train began to fall, and, so far as is known, are uninjured. The cause of the accident is unknown, but one theory is that the train was thrown from the track.

WHEN early this year the Board of Trade sent a letter to the railway companies relative to the inconvenience which is caused to passengers by their being allowed to proceed by train when it is within the knowledge of the railway officials that the line has from one cause or another become blocked, and asking that in all cases when it is in the knowledge of the officials of the company that a line of railway has become blocked, by accident, stress of weather, or other cause, the passengers, or intending passengers, should be made acquainted with the fact, and be informed that if they decide to proceed with their journey they must do so at their own risk, most of the companies wrote saying it was their custom to do so. What a whop—that is to say, we are glad to hear it.

THE French Government in 1879 bought a railroad from Lérouville to Sedan, and since that time it has built seven other local lines in the north-eastern part of the country. The Minister of Public Works was authorised to have these lines worked in whatever way he might judge best for the interests of the country. Recently he has concluded a contract with one of the great companies, the Eastern, to work all these roads, which are within the territory occupied by its system. The contract specified the way in which traffic shall be sent, and the method of charging expenses, and then the State is credited with all the earnings and charged with all the expenses of its lines, the latter being limited to a certain amount per train mile. It may easily happen that the Government will have to pay a balance for having its roads worked, but it is not uncommon for the expenses of French local lines to exceed their receipts.

THE number of trains each way daily on the New York elevated railroads at the present time is as follows:—Second Avenue-road, 236; Third Avenue-road, 427; Sixth Avenue-road, 335; Ninth Avenue-road, 173; total, 1171. "At one time," the *Railroad Gazette* says, "there were 440 trains each way daily on the Sixth Avenue line, and after the introduction of four-car trains 401 trains were run for a long time on this line. The reduction is made in the number of trains in the middle of the day and late, there being as many as ever in the busy hours. In the busiest hour no less than forty-four trains run south over one track, and forty-two trains are despatched from a single station in one hour, which, we venture to say, is unexampled in the history of railroads."

A RETURN just published relating to street and road tramways down to June 30th this year, shows remarkable growth of tramways in public favour since 1876, when they were first introduced into this country. The capital authorised to be raised by shares in 1876 was £3,141,000; it is now £7,602,509, and of this amount £5,096,030 has been paid up, and to this adding the sums raised by loans and debentures makes the total amount expended £6,939,838. There are 488 miles open for public traffic. The stock of the companies comprises 15,220 horses, 40 locomotive engines, and 2045 cars. There have been 205,623,510 passengers carried down to 30th June this year; the gross receipts were £1,570,301; and the net receipts, after paying working expenses, £336,405.

CHRISTMAS holiday traffic was not quite so great this year as last. The London, Brighton and South Coast Railway had a Boxing-day excursion traffic of 7240 passengers, of whom 6250 in 18 trains travelled from London-bridge, 1892 in six trains from Victoria, and 233 from Kensington. Of the London-bridge passengers 134 went to Brighton, 1500 to Croydon and Epsom (in three trains), and 4620 to the Crystal Palace (14 trains). From Victoria 120 went to Brighton, 1772 to the Crystal Palace, and the Palace was also the destination of nearly all the Kensington passengers. The traffic on the East London line was light. The South-Eastern Railway booked 58,597 passengers from its London stations on the 24th, 25th, and 26th, Saturday's traffic being the largest. On that day 774 went to Greenwich, 579 to Gravesend, 1403 to the seaside, 21,373 to other stations, making the total of 24,129. On Sunday the Greenwich passengers numbered 748, those to Gravesend 457, to the seaside 325, to other stations 11,872—total, 13,402. On Boxing-day, 1077 travelled to Greenwich, 412 to Gravesend, 266 to the seaside, 19,311 to other stations—a total of 21,066 for the day.

A WRITER in the *Cincinnati Gazette* thus describes a railway ride through an Arkansas canon:—"On our way to Gunnison from Pueblo the Denver and Rio Grande Railroad enters the canon at Canon City, which soon closes in. This is the 'Royal George' of the Arkansas. It is a canon through which never white man—nor Indian either, for that matter—had passed previous to the inception of the railroad. I passed up this canon at night—a bright moonlight night—and from the rear platform of the sleeper drank in the grandeur of the scenery. As I remarked, the hills approach each other as we leave Canon City, become higher and higher and more and more precipitous until they approach within 50ft. to 100ft., leaving a bare passage for the Arkansas—usually a very sleepy, sluggish stream, but here a raging torrent—not deep, but so swift as to defy man or beast to breast its current, and the inhospitable cliffs, at places 2500ft. to 3000ft. high, offering no foothold from base to pinnacle for even the mountain sheep, much less for man. Up this magnificent gorge our little train found its way, while we, the spectators, or rather passengers, were lost in wonder or admiration at the awfulness of the scenery, hardly having thought as to the engineering difficulties overcome that enabled us to enjoy it. Think of about eight miles of essentially vertical and parallel cliffs—sometimes not 50ft. apart—over 2000ft. high."

NOTES AND MEMORANDA.

SOME of the best American cast iron, as used for guns and railway wheels, will stand a tensile strain of as much as 39,500 lb. per square inch or 13·17 tons per square inch.

ACCORDING to a German physicist, Dr. Hartig, a strong man working a hand fire-engine to his utmost for two minutes can do work amounting to 0·403 in the highest and 0·227 of 1-horse power as the lowest maximum effort attainable.

THE recent exploration party of Colonel Mercer up the Spanish River, in the province of Ontario, is said to have discovered vast pine forests, containing upwards of 24,000,000,000ft. of a superior quality of pine lumber, with good facilities for getting it to market.

HOLLOW steel shafting is said to be made in France by casting the metal around a core of lime, the ingot being finally rolled into shafting, the lime core going with it and diminishing in diameter in the same proportion as the metal, even when the total diameter is reduced as low as one-fourth of an inch. We have not seen it done.

A SERIES of observations on the oscillations or variations in the rate of advance and melting of the lower extremity of the Rhone Glacier since 1856 have been made by M. Forel, of Geneva, which seem to indicate that the chief cause of this variation is variation of thickness or increase and decrease of head under which the ice, considered plastic, flows, whether that flow be a true flow or consist of ruptures and regelation.

THE secretary of the German Imperial Post-office, Dr. Stephan, in reply to questions by the Magdeburg Fire Insurance Company, states that overhead wires for telephones and other purposes have not to his knowledge increased the dangers from lightning, but he thinks if the wires were so arranged that any atmospheric discharges which might affect them have a sufficient path to earth, that houses connected by such wires might even receive some protection.

AT the chemical factory of Finzelberg, in Aldernach, a mixture is made with the aid of which a temperature of —15 deg. to 30 deg. C. (+5 deg. to —22 Fahr.) may be obtained. It is composed, according to the *Chemist and Druggist*, of—calcium chloride, 20 parts; magnesium chloride, 20 parts; sodium chloride, 6 parts; potassium chloride, 13 parts; water, 41. On mixing this salt with an equal volume of snow, the temperature of the mixture is depressed to —15 deg. or —20 deg. C. With an equal bulk of snow and crushed ice at —5 deg. C. a cold of —30 deg. C. may be obtained.

A TRIAL recently took place in America during which evidence was given of the relation between the size of a bullet or shot and the hole it made in a pane of glass. Dr. Lewis Balch, of Albany, N.Y., reviewing the evidence considers it established "that a ball fired through glass may make a hole enough smaller than the full size of the ball before firing to prevent an unfired ball of like calibre passing. In an experiment with a baseball it was found that the hole made was too small by one-third to let the ball be passed through." After this the camel and the needle is nothing remarkable.

GOOD STEARIC acid candles are used in the deep mines of Nevada, where the temperature sometimes reaches 125 deg. Common candles would be useless as they would melt at 30 deg. less than this. At the factory of Messrs. Proctor and Gamble, in Cincinnati, it is said that over 100,000 stearic candles are made per day. This industry may be said to have sprung from the discoveries of the French chemist, M. E. Chevreul, published in 1823 in his book entitled "Recherches sur les corps gras, d'origine animale' though it needed the lapse of many years and the labours of many chemists and practical men to apply the discoveries in the second half of this century.

SOME experiments on the strength of hard pine and oak columns, largely used in mill construction in America, have lately been made at the Watertown Arsenal by Prof. Lanza, of the Department of Mechanical Instruction of the Institute of Technology. All the columns tested were large and all but two of them were round, hollow columns, of from 8in. to 11in. diameter, the two being about 9in. square. The greatest amount of pressure exerted in any case was about 265,000 pounds. The tests have disclosed frequent instances of defective boring in the columns. The object of boring is to open an air passage through the heart of the column for the prevention of dry rot after it is in position in the building. The columns were bored from either end, the borings having sometimes failed to meet in the middle of the column. The tests also show that to taper the column is a mistake, inasmuch as it weakens the column more than has heretofore been estimated.

AT the late meeting of the Meteorological Society a paper was read on "The Rainfall of Cherrapunji," by Professor J. Eliot. Cherrapunji is notorious for its excessive rainfall. It is a small Indian station situated in the south-west of Assam on a small plateau forming the summit of one of the spurs of the Khasia Hills, which rise on the south with exceeding abruptness, and have the Bengal plains and lowlands at their base. Cherrapunji stands at an elevation of about 4100ft. The hill rises precipitously from the lowlands of Cachar and Sylket, which are barely 100ft. above the sea level. During the S.W. monsoon the lower atmospheric current advancing across the coast of Bengal has a direction varying between S.S.W. and S.E. in lower and central Bengal. In thus advancing almost directly towards the hills of Western Assam, the mountain ranges cause a very considerable deflection o. the current; one portion is forced upwards as an ascending current with a velocity directly dependent upon the strength of the current in the rear, and certain modifying conditions. The rapid diminution of temperature which accompanies expansion due to ascensional movement of air is usually followed by rapid condensation in the case of a moist current such as the S.W. monsoon current. The normal annual rainfall in Cachar and in the plains of Northern Bengal is about 100in. The average annual rainfall of Cherrrapunji is 493in., that is 393in. in excess of that at the foot of hills on which it is situated. The rainfall of Cherrapunji is not due to any abnormal local conditions of atmospheric pressure, air movement, &c., but simply and solely owing to the presence of a vast mechanical obstruction which converts horizontal air motion into vertical air motion.

THERE is considerable disparity in engineers' opinions respecting crowd weights, or the actual weight which should be allowed for as the crowd load of a bridge. The following is from *Calvert's Mechanics' Almanack*:—Mr. E. A. Cowper states that he had placed a number of men together, and they weighed 140 lb. to the square foot. Mr. Parsey is of opinion that, upon an average, men, when put together closely, would weigh at least 112 lb. per square foot, but in ordinary crowds of people 80 lb. might be taken as sufficient. While Englishmen would weigh about 150 lb., a Belgian would weigh 140 lb., and a Frenchman 136 lb. Mr. F. Young, at a meeting of the Society of Engineers, said 80 lb. per square foot was quite safe in practice. Mr. George Gordon Page, in a paper on the construction of Chelsea Suspension Bridge, says for troops on march, 21in. in rank and 30in. in pace are allowed, giving 4·37 superficial feet per man, which, at 11 stone, would be 35½ lb. per square foot. The load taken in the calculation for the Menai Bridge was 43 lb. per superficial foot. An experiment was made by the engineer of the Chelsea Bridge, by packing picked men on a weighbridge, with a result of 84 lb. per superficial foot, but it is not likely that such a crowd could accumulate on any bridge. It may here, perhaps, be useful to add that a cavalry horse weighs about 11 cwt.; a strong carthorse, about 14 cwt.; and a riding horse, about 8 cwt. The weight of horses in the United States ranges from 800 lb. to 1200 lb. The average weight of 2000 men and women, weighed at Boston, 1864, was—men, 141¼ lb.; women, 124½ lb. The average weight of an elephant is 60 cwt.; a camel, 10½ cwt.; large ox, 10 cwt.; small ox, 6 cwt.; cow, 6½ cwt.; heifer, 3½ cwt.; pig, 1¼ cwt.; and sheep, 60 lb. to 90 lb.

MISCELLANEA.

"A RIDE to Khiva," by Lieut.-Col. F. Burnaby, has been published in a cheap form, similar to the cheap edition of Brassey's "Voyage of the Sunbeam," by Messrs. Cassell, Petter, and Galpin.

THE Secretary of State for War has signified his intention to allow an exhibition of the military electrical appliances now adopted in the service to form part of the forthcoming Electrical Exhibition at the Crystal Palace.

AN exhibition of photographic apparatus is to be held by the Society of Arts next month, and Mr. H. Trueman Wood, the secretary, will be glad to receive examples of the application of photography to scientific purposes for exhibition.

THE Perseverance Ironworks of Mr. T. Corbett, of Shrewsbury, occupy the place of honour in the *Shrewsbury Journal* Almanack for 1882. Though the works were started but about fifteen years ago, Mr. Corbett is amongst the most successful agricultural implement makers.

DURING the recent visit of the Royal Princes to Manchester, the front of the business establishment of Messrs. Lewis was illuminated with between thirty and forty electric lamps. The glare is said to frighten horses, though, like a fisherman's lamp, it attracts other beings.

THE number of Private Bills which have been deposited for next session exceeds the number last year by 91, no less than 323 Bills having been brought forward as against 232 last year. The number of provisional orders, which increases yearly, is far beyond any previous year.

IT is said that the commanding royal engineer at Pietermaritzburg has been directed to draw up plans for the erection of a suspension bridge over the Incandu River, between Newcastle and Fort Amiel, the difficulties of transport having come specially under the notice of Sir Evelyn Wood.

THE crank pins of the new steel shaft which has been fitted to the Mercury being hollow, has afforded the engineer department at Portsmouth an opportunity for testing the practicability of keeping the bearings cool by means of centrifugal lubrication, and thus dispensing with the usual telescopic lubricators. The new system, as the *Times* calls it, consists in carrying a supply of oil into the centre of the pin by means of a tube running along the arms of the crank.

A FINE screw steamer, the Merton Hall, was launched on Saturday afternoon from the Camperdown Shipbuilding Yard of Messrs. Gourlay Brothers and Co., Dundee. It is a steel steamer of 4178 tons gross register, and is the largest vessel yet built in Dundee or the east of Scotland. Her extreme length is 411ft., or 400ft. between perpendiculars; extreme breadth, 42ft. 3in.; depth of hold, 29ft. 6in. The Merton Hall has been built to the order of Messrs. Alexander and Radcliffe, of Liverpool, for their Hall Line of steamers, which run between Liverpool and Bombay. The engines are to be high and low pressure and surface condensing of 460 nominal, or 2500 effective horse-power. The cylinders are respectively 45in. and 84in. diameter; and the length of stroke 5ft. The pressure of steam is to be 80 lb. per square inch, and will be supplied by three double-ended boilers having fourteen corrugated steel furnaces.

IN Kelway's electric log as now made, the rotation of the log screw is made to complete an electric circuit a given number of times (regulated by the number of teeth in a ratchet wheel placed on the "mile" spindle of the log) in a mile, which, as now arranged, amounts to eight. At each completion of the circuit a current of electricity passes through the coils of a step-by-step counter which forms the dial similar to a clock face. This dial being placed in the chart-room, captain's or engineer's cabin (or a dial may be placed in each, and worked from the same log), the distance run can be read off at any moment, and the actual speed of the ship noted at will. To render unnecessary frequent reference to the dial to see if the log is working correctly, a single-stroke bell is supplied which announces each indication by sound in addition to the automatic record. In its improved form, the log is lowered down a small tube, preferably passing through the engine-room in the case of steamers, in such a manner that it is easy of access, should an inspection become necessary.

SPEAKING of the past year our Manchester correspondent says: The commencement of the year will in the coal trade be memorable for the most serious struggle between the employers and the men which has ever been known in the district, and which for nearly two months caused the stoppage of the bulk of the collieries throughout Lancashire. During this strike there was naturally an inflation of prices, which went up at least 5s. or 6s. per ton, but with the resumption of work a period of extreme depression, extending all through the summer, followed. Heavy stocks accumulated, the pits had to go on short time, and prices fell to such an extent that common round coal was being sold at very little over 4s. per ton at the pit mouth. Apprehensions of a renewal of the strike, with the close of the year, brought about an exceptional demand during September and October, stocks were reduced, pits got into full work, and prices went up about 2s. per ton. A falling off in the demand for house fire coals has since taken place, and prices have slightly receded, but for manufacturing purposes the quantity of fuel going into consumption is large, and this, no doubt, will have a steadying effect upon tho market during the ensuing year.

AT the annual opening meeting of the Civil and Mechanical Engineers' Society, held on the 15th inst., at the Society's Chambers, Mr. Arthur T. Walmisley delivered his inaugural address. The society was established in 1859, for the discussion of engineering and scientific subjects, and had done good work among many of the younger members of the profession, who, by their continued interest in its welfare, testified to its usefulness. After describing somewhat at length the qualifications necessary for an engineer, Mr. Walmisley expressed himself in favour of examinations as an educational test, by means of which the profession might be rescued from its present condition of undefined proficiency. The Institute of British Architects and the Institute of Surveyors were about to establish such tests, and he thought the time had now come when a similar course of action would be expedient in the engineering profession. The number of engineers was small in comparison with that of lawyers and doctors, and much of the want of employment complained of by young engineers was due more to their inability to undertake the responsibility of any special work than to the profession being overstocked.

MR. J. H. A. MACDONALD, Ex-Solicitor-General for Scotland, has just invented, under the designation of holophate course indicator, an electric apparatus, the object of which is to diminish the risk of collision by night at sea. The indicator consists of an electric light with a reflector, which is fixed on a movable arm. When the helm is amidships the reflector throws the light straight ahead, the arm being held fast by two pegs, or detents, which are under the control of the helm by means of an electric connection. When the helm is ported, an electric circuit is formed, by which one of the detents holding the arm is depressed, leaving the reflector free to move, and then the light sweeps round to starboard with an action like the wave of a hand. When the light has gone round a certain number of points to starboard, a screen rises up and shuts it out from view, when the arm comes back to 'midships. If, on the other hand, the helm be put to starboard, the other detent is removed, when a movement exactly the converse of that above described can be performed. Thus the strong beam of the electric light is waved to one side or the other, indicating every alteration in the course of the vessel to all who may be within sight; and that at the instant that the course is changed. Under the ordinary method of showing red and green lights on port and starboard, a ship may swing round several points, while the distance is rapidly diminishing between her and another vessel, before those on board the latter can have any warning of the change.

THE VIENNA CIRCULAR RAILWAY—CENTRAL STATION.

MR. J. FOGERTY, M.I.C.E., WESTMINSTER, ENGINEER.

(For description see page 469.)

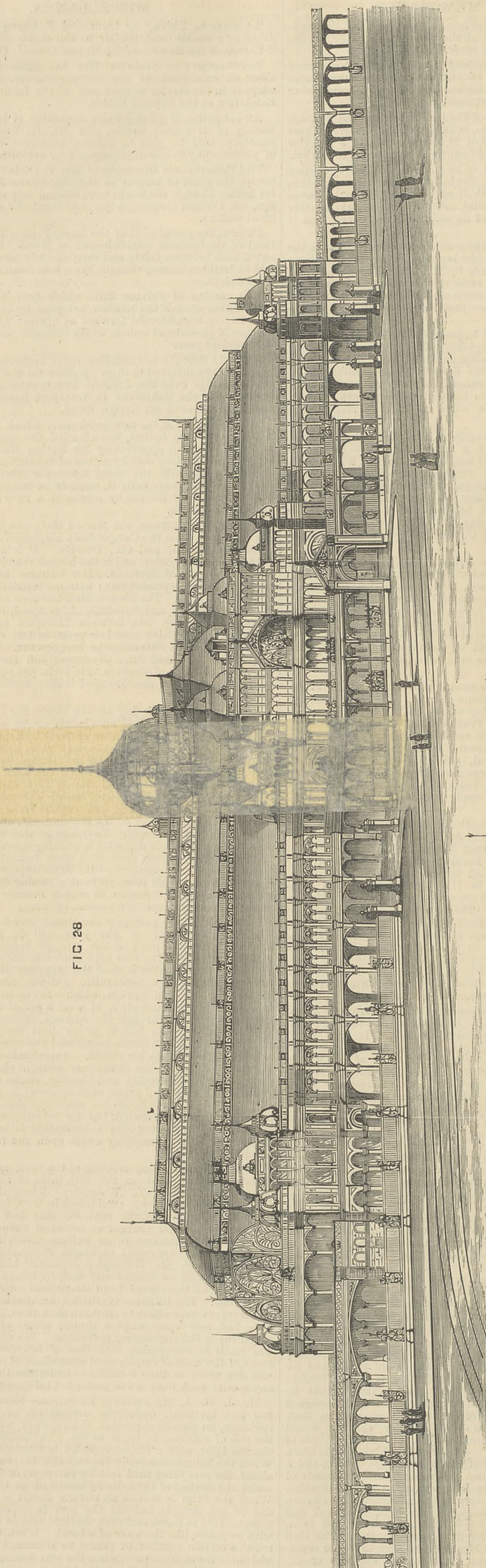


FIG. 28

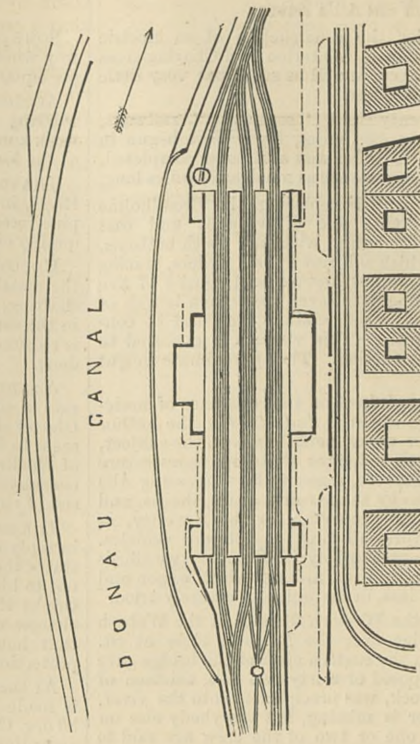


FIG. 26

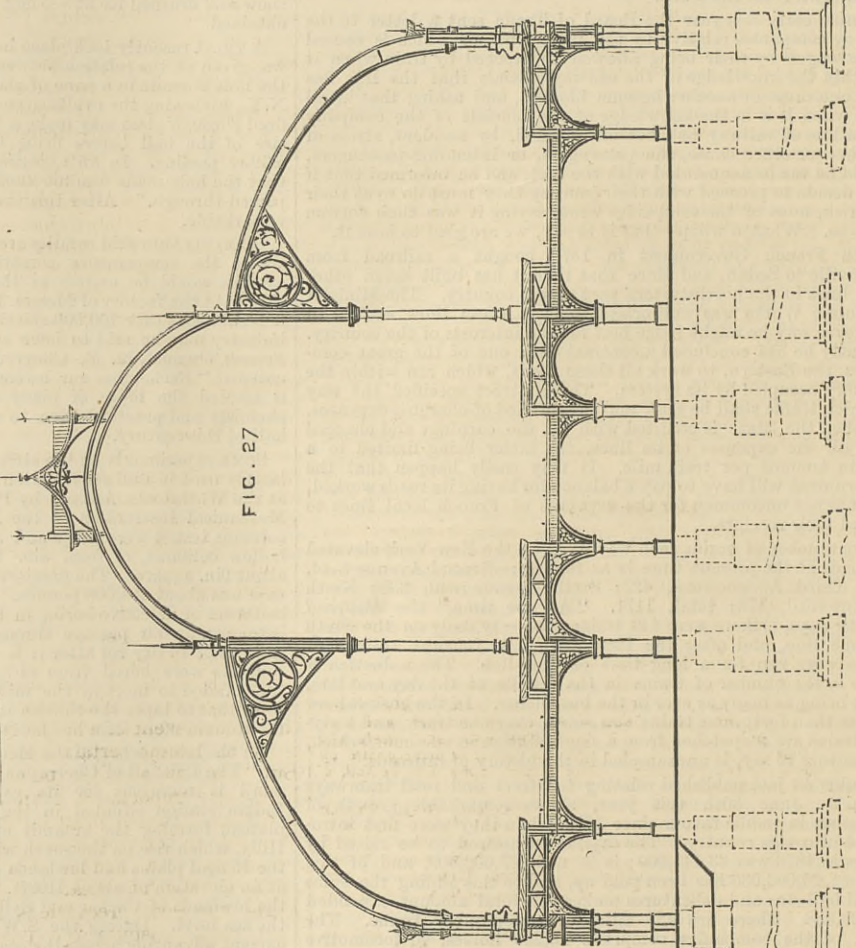


FIG. 27

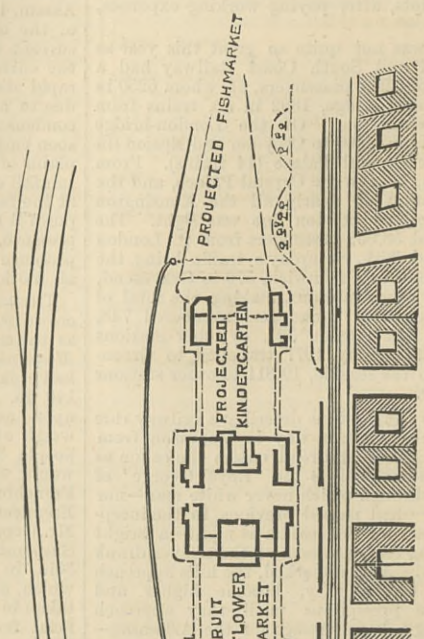


FIG. 25

TO CORRESPONDENTS.

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

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

*** *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. P.—*If you like to send an adequate sketch or photograph of your engine, we will illustrate it. For small powers it might possibly be made useful. We do not think it worth a patent.*

E. L. D. (Santander).—*We have heard nothing more of the invention, and for the reasons given in an article to which you have referred, it is evident that the inventor is mistaken, and that nothing is to be expected from the invention. Madrid millers appear to be easily led.*

H. Q. (Strains on Crane Posts).—*We find it quite impossible to find room for the very large number of letters which continue to reach us on this subject. Mr. Coventry and Mr. Major appear to adequately represent the two sides of the discussion, and we cannot insert letters from other correspondents than those who have already written on the subject unless they can import some novel matter, which appears to be difficult.*

W. R.—*The idea of using a friction clutch in a propeller shaft is not new, but no one has yet succeeded in making a clutch which can transmit the requisite power, and will slip in case of necessity. A far simpler plan is to introduce a breaking spindle—that is to say, a short length of shaft easily replaced and weaker than any other part of the shaft. The breaking spindle is used in rolling mills with the best results.*

EIDER DOWN.

(*To the Editor of The Engineer.*)

SIR,—We shall be glad if any of your readers can send us illustrated particulars and prices of machinery for teasing feathers for making imitation eider down. EIDER DOWN.

December 28th.

WASTE IN FORGES.

(*To the Editor of The Engineer.*)

SIR,—Can any reader inform me what ought to be a proper amount of waste on good hammered forgings. I mean supposing a forging weighs in the rough 112 lb., what ought it to weigh when finished? I am aware that this waste would differ with different jobs, but I presume according to the best modern shop practice there is some rule to go by.

December 28th. TIPTON.

WATER VORTICES.

(*To the Editor of The Engineer.*)

SIR,—When water is discharged through a circular orifice in the bottom of a vessel, it acquires a whirling motion, and the water no longer fills the orifice, but takes the form of a hollow cone. Will any of your readers kindly tell me (1) Why does the water acquire a vortex motion? (2) What is the curve of the water surface within the hollow cone? (3) Is the velocity of discharge reduced or augmented by the vortex action? To the first question answers are given in text books which do not satisfy me. To the last two I can find no direct replies. AQUARIUS.

SUBSCRIPTIONS.

THE ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred be supplied direct from the office, on the following terms (paid in advance):—*

Half-yearly (including double numbers) .. .. .. £0 14s. 6d.
Yearly (including two double numbers) .. .. .. £1 9s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made. THE ENGINEER *is registered for transmission abroad.*

Cloth Cases for binding THE ENGINEER *Volume, Price* 2s. 6d *each.*

Many Volumes of THE ENGINEER *can be had price* 18s. *each*

Foreign Subscriptions for Thin Paper Copies will, until further notice be received at the rates given below:—Foreign Subscribers paying in advance at the published rates will receive THE ENGINEER *weekly and post-free. Subscriptions sent by Post-office order must be accompanied by letter of advice to the Publisher. Thick Paper Copies may be had, if preferred, at increased rates.*

Remittance by Post-office Order.—Australia, Belgium, Brazil, British Columbia, British Guiana, Canada, Cape of Good Hope, Denmark, Egypt, France, Germany, Gibraltar, Italy, Japan, Malta, Natal, Netherlands, New Brunswick, Newfoundland, New South Wales, New Zealand, Portugal, Roumania, Switzerland, Tasmania, Turkey, United States, West Coast of Africa, West Indies, China *via* Southampton, Cyprus, £1 16s. India, £2 0s.6d.

Remittance by Bill in London.—Austria, Buenos Ayres, and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili, £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Mauritius, £2 5s.

ADVERTISEMENTS.

*** *The charge for Advertisements of four lines and under is three shillings; for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more the charge is ten shillings per inch. All single advertisements from the country must be accompanied by stamps in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.*

Advertisements cannot be Inserted unless Delivered before Six o'clock on Thursday Evening in each Week.

*** *Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of* THE ENGINEER, 163, *Strand.*

THE ENGINEER.

DECEMBER 30, 1881.

THE CHANNEL TUNNEL.

EVERY now and then a paragraph appears in the columns of the daily press to the effect that the works of the Channel Tunnel are progressing satisfactorily. These paragraphs bear no internal evidence that they have been written by men possessing any technical knowledge whatever; they convey no real information, being for the most part vague and indefinite. They give, it is true, sometimes, the number of yards of advance effected; but how, or under what conditions, or at what cost they do not say. We have endeavoured to obtain some official information which should be accurate, but without avail. That some sort of tunnelling operations are being carried on, both near Dover and on the coast of France opposite, may be taken as a fact; but concerning the true nature of these operations no one seems to know anything. They have been going on now for many months in a desultory kind of way, and it is time that something should be said about them by an independent authority, because we understand that a company is being, or has been formed, to make the tunnel, and that the shares of the South-Eastern Railway Company have gone up. We do not pretend to assert that the whole affair is not being managed in the most straightforward and honourable way; but it has been suggested very freely that if railway shares can be made to rise by rooting a little in the chalk cliffs at Dover, the temptation to root must be very strong. So long as a railway company with plenty of money thinks fit to spend some of that money on boring in the chalk and running headways in it, no one need object, save perhaps the shareholders concerned; but as soon as an attempt is made to induce the outside public to put money into a scheme for tunnelling under the Channel, it becomes the duty of a technical journal to put some facts before them, so that they may see both sides of the question. The sanguine advocates of a Channel tunnel may be trusted to paint their proposals in brilliant hues. It is for us to make statements which are based on experience, and the truth of which cannot be disputed.

Whether it is or is not wise to have a Channel tunnel at all, is a matter deserving very grave consideration. We are able to get on without a large standing army solely because we are insulated from the Continent of Europe. No one in his senses supposes that if our borders were conterminous with those of France, we could dispense with conscription, with all its evils. To be weaker than our European neighbours would be to hold out an irresistible temptation to plunderers. All past experience proves that when states, kingdoms, empires, and even republics are readily accessible by land, they must keep large armies to secure their possessions. Now, the English Channel is worth to us as it stands, at a very moderate computation, about £50,000,000 per annum. It would be impossible to maintain the standing army of at least 500,000 men, including reserves, which would be required for safety, for a smaller sum. We include in the £100 per man the injury done by the forced service of the men and the consequent loss of their labour. But were a Channel tunnel completed we should at once do away with the security now conferred by the sea. It would be by no means impossible, if war were suddenly declared, for France to land a considerable body of men on the English shore, and obtain possession of the English mouth of the tunnel. It is true that the force landed might be unable unaided to maintain its position for more than a day. The transports might be all sunk in a few hours after the landing was effected, and the whole British fleet might be assembled to prevent the landing of more troops; but meanwhile the tunnel would continue to deliver men in England at a rate which is readily calculated. If the tunnel can be worked as its advocates anticipate, trains, consisting of twenty vehicles, under proper organisation, might be loaded and despatched every quarter of an hour. Each train could convey 1500 men. While a train was being loaded at one end another train would be unloading at the other end, and allowing half-an-hour for the run across, four trains would be always in the tunnel, proceeding full toward England, and returning empty from it. Thus 6000 men per hour might be landed in England with proper discipline and arrangements. Making large allowances, we may assume that a skilful staff would land in twenty-four hours on English shores an army of 50,000 men fully equipped. We could get nothing together which could drive away such a force from the head of the tunnel, which would constitute a *tête du pont* of the most important character, and strategists know what that means. It has been argued that in the event of war the tunnel could be flooded; but it is by no means certain that it could be flooded in time. But there is another point to be considered, of perhaps more importance than any we have yet considered. A Channel tunnel must be international in its character. We look on the tunnel as a means by which France might invade us; but France will return the compliment, and realising the fact that we might also use it to march on Paris, will take precautions accordingly. We are not so vain as to dispute the possibility of a serious reverse some day at the hands of a French army. Given that reverse, is it unreasonable to hold that a prominent condition of peace would be the maintenance by France of a fort at this end of the tunnel? It may be said that peace reigns triumphant between England and France. Granted, but the way to be at peace is to be prepared for war; and our readers may rest assured that no Channel tunnel will be made until the French Government and the French people have said their say on the subject. It would be awkward for the shareholders in the Channel Tunnel Company to find the works stopped by insuperable political difficulties after they had made some progress. The attitude adopted by the Government of the United States towards the Panama Canal scheme is very suggestive to those who can draw deductions.

Putting political considerations on one side, however, we have arguments which will, perhaps, be regarded as yet more conclusive, to urge against the tunnel. We shall assume that the tunnel can be made. We may do this, because we suppose there are plenty of persons willing to stake very large sums on the chance that it can be made; so that to assert that it cannot would be waste of time. But it is to be supposed that if constructed by a company the shareholders will expect to get some interest for their money. Now whether they will or not depends on the cost of the tunnel and its net earnings. The expense of tunnelling varies so much that it is simply impossible to give any figures likely to be found minutely accurate. The smallest cost of a long railway tunnel is £30 per yard, for which sum the Lydgate Tunnel, 1332 yards long, on the London and North-Western Railway, was made. The Guildford Tunnel, 965 yards long, through the chalk, on the London and South-Western Railway, cost a similar sum per yard; but there is nothing in common between such tunnels and one beneath the Channel. The cost of leading the spoil would alone be enormous. Certainly it would not be safe to suppose the work could be done for less than £200 per yard. The whole length being twenty-two miles, or 38,720 yards, we have a capital sum of £7,744,000. The interest on this at 4 per cent. would be in round numbers £310,000 per annum. Taking the working expenses at a similar sum, the twenty-two miles of line must earn £620,000 a year, or £28,181 per mile. But £4000 per mile per annum is considered excellent work; and the Channel tunnel would have to earn seven times as much. What reason is there to suppose that it would do anything of the kind?

So far we have assumed that there would be no difficulty in working it; but it is not too much to say that to work it in the ordinary way would be quite impossible. In a paper read by Mr. Morrison, in 1876, before the Institution of Civil Engineers, on the "Ventilation and Working of Railway Tunnels," will be found much infomation applicable to the Channel tunnel; and in Simms' "Practical Tunnelling," edited by Clark, will be found a table of the power required to ventilate artificially a tunnel 20 miles long, only four trains passing through it per hour. This power is not less than 15,000 horses indicated. As it would be preposterous to assume that mechanical agency would be employed under such conditions, we must take it for granted that ordinary locomotives would not be used to draw the trains. What is to take their place? On this point the closest silence is observed by the advocates of the scheme—because they do not know. We might go on to add argument to argument to prove that the tunnel if constructed cannot be made to pay; but it is needless. Before, however, the promoters of the scheme are entitled to receive one shilling from the public, they ought to be able to give conclusive answers to at least a few of the objections we have raised. We need not trouble them to prove that the tunnel can be made. That would be to expect too much, we suppose. But those who are asked for their money ought to have adequate securities from the French and English Governments that they will not interfere to stop the work; and from the promoters that a sufficient number of trains can be worked to pay at least £28,000 per mile per annum. Until reasonable proof to this effect has been given, those who buy shares in the Channel Tunnel Company deserve to lose their money, and they will get what they deserve.

LOCOMOTIVE ENGINE ECONOMY.

WE have more than once had occasion to call attention to the remarkable economy in the consumption of fuel of English locomotives—an economy which we have reason to believe has never been equalled by locomotives built or designed out of Great Britain. It is no longer a mere matter of speculation how much fuel a railway engine consumes; what that consumption may be in every case is not perhaps known, but it is a recognised fact that the best locomotives do a great deal of very hard work on a very small consumption of fuel; and whenever experiments have been made to obtain accurate numerical statements of results, these statements have always shown that the weight of fuel consumed per indicated horse-power per hour is very small. The latest investigation of the kind was made by Mr. Patrick Stirling, at the instance of Mr. Wright, of the Admiralty, who wished to obtain some particulars concerning the evaporative efficiency of locomotive boilers for his guidance in considering designs for torpedo boats. Mr. Stirling's experiments extended over a considerable period. They were made with the bogie engines which he specially designed some years ago for working express traffic on the Great Northern Railway. It is to be regretted that Mr. Stirling has not published any of the particulars of his experiments, but he has informed us that the consumption of fuel amounted to but 2·06 lb. of good coal per indicated horse-power per hour. This result is so excellent that it is difficult to believe that some error has not crept into Mr. Stirling's calculations; but even if we allow something for this, much remains in the performance of his engines on which he can be congratulated. It may be taken as certain that locomotives as a rule are much more economical than any other type of non-condensing engine. We have been recently asked more than once by correspondents why the locomotive is so economical, and the right answer to this question is so full of instruction that it deserves to be made better known than it is.

The locomotive must be regarded as a composite machine. We have, first, the furnace; secondly, the boiler; and, lastly, the engine. All these have, by the lapse of time, the exercise of ingenuity, and the survival of the fittest, come to be exactly adapted to each other, so that the complete machine constitutes one concrete whole, admirably suitable for the discharge of certain duties—namely, the burning of fuel; the conversion of water into steam; and the obtaining of power from that steam. The management of the locomotive engine exerts a very marked effect on its economy; and the best results can only be got when the engine makes long runs at rather high speeds under the control of a driver and stoker who properly understand what they are about. Furthermore, there is a load and speed for every engine which is better than any other load and speed, so far as economy of fuel is concerned. We shall suppose, then, that the engine of which we are speaking makes long runs—say, from London to Grantham, or London to Leicester—at average speeds of over fifty miles an hour; the loads being such that the engine can be run linked-up to a considerable extent. Beginning with the furnace, we find that good coal is burned to the best possible advantage. The fire is so thick and so well looked after that it has no holes in it through which cold air may enter. Moreover, it will be found that the fire-box of a locomotive is really a gas furnace. Comparatively little air is admitted through the grate-bars. The rest is supplied through the fire-door under a scoop, and being caught by the brick arch, is beaten down on and mixed with the gas rising from the fuel. On the London and Brighton line the ash-pit dampers are usually kept almost closed, nearly the whole of the air being admitted through the fire-doors. The practice varies on different lines, but the principle does not. In all cases air is admitted through the fire-hole. The proportion coming in through the bars and the door varies according to the characteristics of the load and the coal. The fire being always lighted hours before the engine is going to make her trip, the fire-brick arch is raised to a high temperature, and the products of combustion when first rising from the grate strike it, and are well mixed with air before they touch the comparatively cold plates. The temperature in a locomotive engine furnace, when running, is always very high. An engine with 17 square feet of heating surface will burn from 25 lb. to 33 lb. of coal per mile, according to load and weather. Taking 30 lb. as an average consumption, and fifty miles an hour as the speed, we have $\frac{50 \times 30}{17} = 88$ lb. per square foot of grate per hour. Even at 25 lb. the weight burned per square foot per hour would be 60 lb. A consumption at the rate of one-third of this is large for stationary boilers, and is quite up to the average performance of marine boilers. It is obvious that when the rate of burning is so rapid the temperature must be very high, and the result is that the heat is taken up very quickly by the water. Again, in locomotives there are only copper and brass fire surfaces. The tubes are less than 2in. in diameter, and over 10ft. long. The surfaces are kept very clean, and only the best clear water is used. Thus, then, we have a furnace admirably qualified to burn fuel to the best advantage, and a boiler equally well adapted to take up heat, in spite of its comparatively small dimensions. It is not remarkable, therefore, that the evaporation of English locomotive engines should usually reach, and in most cases exceed, 10 lb. of water per pound of coal burned. This performance is not exceptional, but nothing save the precautions employed to obtain it could get it under the conditions. A locomotive burning 1500 lb. of coal per hour is evaporating 15,000 lb. of water. The heating surface will not exceed 1200 square feet; so that evaporation takes place at the rate of 12·5 lb. of water per square foot of heating surface per hour. In stationary boilers an evaporation at the rate of 180 lb. to 200 lb. of water per hour per square foot of *grate surface* is not uncommon. In a locomotive engine it rises to 880 lb., or four or five times as much. The Sphynx, on the Manchester, Sheffield, and Lincolnshire Railway, is reported by Mr. Clark to have evaporated at the rate of 22 cubic feet, or over 1300 lb. of water per foot of grate per hour. The Sphynx had a very small grate—only 10·56 square feet, but it had 1056 square feet of heating surface, and the evaporation was about 13 lb. per foot. In stationary boilers 4 lb. or 5 lb. is considered high.

Turning now to the engines we find that the conditions under which they work are about the best possible for promoting economy. The cylinders in inside engines are kept very warm, and even in outside cylinder engines they are so carefully clothed and protected in the present day that little loss from condensation takes place. The steam pipe is short, and it is kept very hot. As the pressure within it is less than that in the boiler, no deposit of condensed steam can take place within that portion of the pipe in the boiler; that part in the smoke-box is yet hotter. The cylinders of a locomotive engine are supplied with steam dry, hot, and clean, conditions very favourable to economy. But the condition most conducive to economy is the mode of operation of the valve gear. As the link is raised the lead is altered, and compression augments, the exhaust closing earlier and earlier in the stroke. Some engineers hold the mistaken view that this is a defect; but nothing can be more untrue. It is to this great compression that the locomotive engine owes not only its great economy in the use of steam, but its freedom from "knocking" and hot bearings. It is well known that an engine with a little too much play in axle boxes and big ends, will thump in full gear, and run quite quietly if linked up a little. The compression insures the quick getting away of the piston from the end of the stroke. If it were not thus, the piston would have to be dragged away by the crank pin. It is impossible to lay too much stress on the truth that nearly all the hot, thumping, bearings that are to be met with on land and at sea are due to want of sufficient lead; and those who have the chance and will try the remedy that we now suggest will be charmed with the result. It must of course not be forgotten that we are speaking of quick running engines; that is, engines with a high piston speed. Locomotive pistons make at sixty miles an hour, with a 7ft. wheel and a 24in. stroke, 960ft. per minute, and were it not for large measures of compression it would be difficult to keep such engines in order. But the great advantage of compression is that it saves all the steam which would otherwise be wasted in clearance and filling ports and passages. The compressed steam also rises in temperature, and re-evaporates any water condensed on the surfaces. The result is that the fresh steam coming in at the beginning of the stroke finds hot and dry instead of cold and damp metal to come in contact with. It is not remarkable that under such conditions careful experiment has shown that nearly the whole of the steam may be accounted for by the indicator diagrams, and that the consumption of fuel seldom exceeds 3 lb. per horse-power per hour, and is often much less.

INVENTORS AND INVENTIONS.

M. L. Poillon, well-known in Paris as the engineer and agent for the Grendl pump, and other inventions of merit, has lately published a lively *brochure* on "Mechanical Inventions and their Commercial Development." He describes his object to "consist in giving some practical advice to anybody who undertakes the difficult task of winning a fortune and an independent position, by conferring on his contemporaries the benefit of an invention of which those who are to profit by it will not at first be willing even to hear the name." This sentence felicitously describes at once the path of a successful inventor, and some of the obstacles which render success so rare. But M. Poillon understands his subject far too well to lay all the mishaps of inventions at the door of the selfish and indifferent public. His sketch of the inventor himself, hasty though it be, will be recognised by all who have had to do with that "*genus irritabile*" as a lifelike portrait; and whilst doing his utmost to help him over external obstacles, he does not conceal from him that the most serious of his difficulties are likely to come from within. In these days of scientific wonders and patent law reform, the subject has so much interest, that we may well devote a short space to describing "how it strikes a contemporary," the contemporary in question being a lively, shrewd, and experienced Frenchman, who is not, be it noted, an inventor himself.

M. Poillon divides his subject into three heads—(1) The inventor and his invention *per se;* (2) the construction and cost of the necessary apparatus; (3) the "vulgarisation," or in plain English, the pushing and advertising of the invented article, so as to bring it into common use. These three heads he discusses separately. With regard to the first, our author holds that an inventor, like a poet, is born, not made; and that it is equally useless to dissuade him from following his natural vocation. We will not dispute the point with him, but will simply observe that the conditions of our birth are matters on which, perhaps, from want of memory, we are apt to be at fault; and that, as there are notoriously many rhymers who fancy themselves born poets, so there are at least as many schemers who fancy themselves born inventors. Taking, however, our inventor, born or made, as we find him, what advice shall we give him for his own advantage? In the first place, says M. Poillon, "he should be at once modest and courageous." Here we are inclined to demur. The second piece of advice seems to us wholly unnecessary, and the first more than doubtful. We have known modest inventors, and dearly have we prized them for their modesty as contrasted with the great mass of their brethren; but we cannot remember that any of them had made any money by their inventions. An indestructible belief in the value of his own discovery, and the excellence of his own brains, seems absolutely necessary to a man who is to overcome all the external obstacles in the way of success. M. Poillon, however, is careful to explain that a modest man need not be one who always agrees with the last speaker, who asks counsel of his coachman or his housekeeper, or even who attends greatly to criticisms, "*dont le plus grand nombre est généralement inepte*," which, in plain Carlylese, may be rendered, "critics are mostly fools." We have the less scruple in giving currency, in the course of a criticism, to this apparently damaging remark, because further on M. Poillon makes a pointed exception in favour of the scientific press, which, he says, constitutes perhaps the best and fairest tribunal to which an inventor can appeal. We acknowledge ourselves complimented, and are quite willing to leave our other critical friends to make their own defence as best they may.

All, in fact, that M. Poillon means, is that an inventor, when he once sees clearly that he has mastered a new and valuable truth, should go forward in spite of all difficulties and discouragements; but that he should look well, and look long, before he assures himself that he does see clearly, and above all should avoid falling into the common delusion that the thing must be new and valuable because *he* has discovered it. In the hope of increasing the stock of modesty among inventors, we may add that the simple fact of inventing something, even something that will work, is not after all a very notable achievement. To recur to our former comparison, the successful carrying out of a great discovery is a work comparable perhaps in grandeur, as it is in rarity, with the writing of a great poem; but simply to produce a workable invention is no more rare or difficult than to produce readable verses, which latter is probably within the compass of three out of every four educated and intelligent persons. There is a well-known story of a watchmaker, who offered to invent a new escapement every morning before breakfast for a year together, if anyone would make it worth his while; and there are many departments in the arts and sciences where the field is almost as large. It is time for the inventor to boast when he has made a device that not only will work, but has worked so well as to drive all competitors off the ground; and even then he will do well to recall an observation of M. Poillon's, that even a successful invention does not prove the author to be *ipso facto* a great man. It is Charles Lamb, we believe, who describes his encounter at a wayside inn with an extremely self-satisfied person, who presently informed him that he had before him the great Twalmley, inventor of the Twalmley backing-off motion in the cotton mule. We fear there are at least as many great Twalmleys among us as in Charles Lamb's time; and that the race shows at present no sign of diminution. Again, according to M. Poillon, the inventor must be educated, otherwise he will wander like a seaman without a compass. While his ideas are utterly vague and incoherent, he will attach the most extravagant value to them, and "imagine that the whole human race is leagued in a conspiracy against him, because they do not applaud his efforts." If he has not been educated in youth, let him educate himself before he grows old, for without such education he will achieve nothing. "The fact may not be consolatory, but it is certain." Thirdly, he should study carefully the works of his predecessors, since, whatever we may say, daily experience shows that totally independent minds arrive very frequently at the same idea. For this two causes are alleged:—First, that similarity of education and ideas leads men into similar researches; and, secondly, that the natural desiderata of mankind are nearly the same everywhere at the same epoch, and that it is in the supplying of these desiderata that inventive minds naturally engage. Moreover, the study of a predecessor's work is useful, not merely to ascertain the validity of one's patent, but to avoid his leading when it has been wrong, and follow it where it has been right. A very small obstacle often makes the difference between success and failure in an invention; and the study of earlier designs will frequently show how such obstacles may be overcome. An inventor, when asked as to the first trials of his machine, mostly replies that a few practical difficulties have presented themselves, but that they are mere nothings, they will soon be disposed of, and so forth. "Quite so," observes M. Poillon, "only it is unfortunately these mere nothings which always cause the final wreck of a patent; and whilst they still remain unsettled nothing has really been done." Too much attention cannot then be given to small details, especially as it is always through the doubtful and complicated that an inventor arrives finally at the simple and the satisfactory. Another point which must be well considered by the inventor, and on which former experience may enlighten him, is the utility of his discovery. What is the use of making a machine, even a successful one, to do something which has been done better by other means, or which is not worth doing at all? On this and other points the inventor will also do well to consult his friends and the public, not indeed indiscriminately, but by placing his invention, when properly secured, before those most competent to judge of it, and carefully sifting the opinions he thus obtains. For this purpose the reading of a paper before some scientific institution offers, perhaps, the fairest chance of success.

This sketch of M. Poillon's views of the inventor and his works, with our comments thereon, has, however, extended so far that we must leave to some future occasion the consideration of the inventor's relation towards the manufacturer who gives his discovery a bodily shape, and the agent who makes it known to the world at large.

THE TAY BRIDGE.

To be provided with a roadway across the Tay, to lose it, then to be pacified with promises of a new bridge, anent which all the matters of form, such as making a design and specification, and letting a contract for its construction are gone through, and finally, to have all withdrawn, is perhaps as unpleasant a thing for the town of Dundee as for the shareholders in the railway interested. Dundee is therefore angry, and it does not quite believe in the reasons alleged for giving up the bridge, especially as there is every appearance of the arrival of the directors of the company at that stage of wisdom which years ago recommended the construction of the Glenfarg line, and the construction of a bridge higher up the river at Newburgh, or even a little more eastward, where it could be joined by a short line from Collessie. Dundee did, however, enjoy the warmth for a short time, and does not care to be shut out in the cold, or as the Dundee paper says, "shunted on to a siding." Besides, "see what we've done for it," says a head under some bonnet of Dundee. "It has helped the North British Railway most liberally on the faith of the Tay Bridge being erected. For the nominal sum of £5 a year it sanctioned the tunnelling of Dock-street, which was worth £100,000 to the North British if it was worth a penny. For £13,000 it gave the large acreage of land near the Esplanade for station purposes, for which in any similar town a ransom would have been demanded. The ground for the open cutting at East Dock-street was also given on most favourable terms. In fact, at every turn the North British has been most favourably dealt with on the assurance that the Tay Bridge connection would be formed. Dundee has therefore the strongest possible interest to demand that the bridge communication shall be restored, and we are certain that if need be the most determined opposition will be given to any manœuvre likely to lead to the abandonment of the Tay Bridge, or the postponement of its construction for a day longer than can be helped." But what if the railway company, since it has cooled down to the consideration of moderate schemes, should find it can better pay for a short bridge higher up the blasty Tay than for an engineers' monument in wrought iron opposite Dundee? The famous town must either again help most liberally, or else look upon the Perth-Dundee line as something more than a siding. Big bridges, or some of them, cost a lot of money, and even the gratitude of the North British Company to Dundee will not alter this. The town might lessen the cost by helping to get a very low level bridge sanctioned; but if a Newburgh bridge has gained hold of the minds of the directors, Dundee may whistle for a bridge, for already that worthy town discredits the idea that any action of the Board of Trade has brought about the stoppage. The clause of the Act on which it is pretended that the Board of Trade interferes is:—"The company shall abandon and cause to be disused as a railway so much of the railway as lies between the respective points of junction of railways No. 1 and No. 2 [between Fifeshire and Forfarshire], and shall remove the ruins and *débris* of the old bridge and all obstructions interfering with the navigation caused by the old bridge to the satisfaction of the Board of Trade, and the company may appropriate and use for the purpose of their undertaking all or so much of the site of the railway so abandoned as lies above low water mark." The Dundee *Advertiser* says:—"There can be no doubt whatever that when that clause was framed it must have been the intention of the company, their engineers, and advisers to abandon and cause to be disused, and to remove the ruins and *débris* of, the old bridge. Mr. Barlow's view that there are no ruins and *débris*, and that the bridge may be used for a third line, is very ingenious; but if it was really in the contemplation of parties that the old bridge should be restored for goods traffic, why was it not so put in the Bill? The plain unmistakeable intent of the Bill was that the old bridge should be cleared away, and the engineering evidence of Mr. Barlow and others all went on that assumption. It would seem, however, that Mr. Barlow has changed his mind. On this part of the question it is enough to say that the limits of lateral deviation appear wide enough to allow of the new bridge being built quite clear of the old bridge, and without being linked to it in any way." "On the other hand, it is only right that the North British Board should know that there is in this quarter a prevailing suspicion that the town and district are being entertained by a "Comedy of Errors," skilfully devised to occupy attention and amuse the public until the Bill for constructing the Glenfarg line is secured, after which it is believed that the Tay Bridge Act, plans, and contracts would all be dropped together. It is remembered what a long and ominous pause there was between the passing of the Act and the invitation for tenders for the work; how mysteriously—as is too commonly the case in North British affairs—the tenders were disposed of; how suddenly Mr. Arrol appeared on the scene and departed again; and then, after we were told that contracts were signed and a beginning was immediately to be made, how this difficulty between Mr. Barlow and the Board of Trade sprung up to bring everything to a stand! The North British must surely be one of the most unfortunate of companies if all its troubles spring from the dust." Thus it is clear that Dundee is not quite happy as to its bridge. The Tay Bridge will have a long history before it is completed.

SUBMARINE TELEGRAPHY.

Attention has been prominently drawn to the danger that submarine cables in certain places are subject to, and to some of the delays to which the vessels engaged in the laying and the repair of submarine cables are effected. It appears from a list that has been compiled that there are not fewer than twenty vessels, mostly the property of British companies, engaged in the work of cable laying and repairing. Their tonnage varies from 369 tons to 4935 tons, the total being 45,629 tons gross. This fact in itself shows the extent of the operations that must be carried on, and the greater importance and the value of the work that the cables so laid are effecting from year to year in the world. It has been suggested that it would minimise the danger to cables, that have of late been prominently brought before the public, if laws were passed to secure rights to the "first comers" on cable "ground," and that the vessels engaged in relaying or repairing should be free from certain Custom House formalities that now press upon them, and causing delay to the vessels, impede seriously the telegraphic communication and the work and commerce of the whole of the world. A case is reported where it had been necessary to land telegraphic instruments for testing, value about £120, and in addition to formalities that caused delay, dues were charged on these to the amount of £118. It is evident then that when the importance of the work of these repairing vessels is borne in mind, that they should have special privileges, for though their's is a commercial mission nominally, it is in reality one that is much more an international one—one that is for the benefit of the whole of the subjects of the nations to be connected together "under the green translucent wave." The vessels of telegraphic companies are practically little more than Queen's messengers—they are the emissaries that keep in order the means of communication between all nations, and they sought to pass unquestioned—their flags being flags of truce. It is to be hoped that in some way there may be a speedy amelioration of the laws that press on the cable vessels, and it would not be too much to express the hope that the representatives of all nations should be appealed to to facilitate this needful work. Up to the present time the owners of the cables have not received too great a return for the capital they have put into the cables, and that capital is invested in an article peculiarly subject to assaults, and yet one that is increasingly becoming the mode of communication between nations severed by the sea, but connected by the cable. It is, therefore, in the highest interest of the nations and the peoples that there should be every facility for the repairing of broken cables, and that the needful works should be gone on with without the stoppage by red tapeism. We have yet only partly reaped the benefits of the submarine cables, for as the system becomes more and more extended, so the efficiency of the whole is increased, and the value of the communication enlarged. It is possible that the cost of telegraphy under the sea may be much further cheapened, but one of the essentials to that further reduction is the facility that is now claimed, so that each cable may perform as much work as possible, and that the revenue of the companies may be increased by the cessation as much as possible of stoppages. There is a further question that may some day come up, whether the Governments of the world ought not to possess international cables of their own, by purchase; but that question can scarcely be said to be as yet "within the range of practical politics," whilst that we have alluded to is not only so, but is one that presses for early solution.

CIVIL *v.* MILITARY ENGINEERS ON INDIAN PUBLIC WORKS.

IT is probably because costly engineering blunders have been so common in India that little stir is made when it is publicly announced by a Secretary of State for India that the Government of that country annually loses hundreds of thousands of pounds in bad engineering, and that millions have been spent by the enginers of India on barracks which turned out to be mere "sun traps," so badly built as to last but a few years. These statements were, however, made by the Duke of Argyll when speaking in the House of Lords on the 15th of July last, on the Cooper's-hill College and the ideas which led the Government to establish it. These statements we gave in full when dealing with Cooper's-hill College in our impression for the 22nd July last, and should not again refer to the subject but for the prominence given to it by the correspondence just published between the Duke of Argyll and the Institution of Civil Engineers. For many years it has been known and acknowledged, by all but the heads of the Indian Government, that military engineers are not educated for or experienced in civil engineering work, and that to entrust them with it is to place them in a false position. The necessity for specially trained engineers forced the Government to start Cooper's-hill College with a view to turning out engineers as they would turn out soldiers. It has proved unsuccessful; it cannot be done. Only a comparatively small proportion of those young men, who think they would like to become engineers, ever reach that stage of competence which should be required before they are entrusted with the direction of works. They are not all fitted to be leaders any more than are all young soldiers. Yet the Government has acted upon the idea that it can make engineers to order. As well might they expect that all the students in South Kensington are capable of becoming Royal Academicians. The Government has preferred to employ military engineers to the loss annually of "hundreds of thousands of pounds in bad engineering" to recognising the fact that sufficient number of properly trained and experienced engineers can only be obtained by offering a salary equal to that which they can obtain in other employment. It is true that the military engineers are on the spot, and there is no doubt a considerable number amongst them capable of carrying out successful public works, but the majority of them had better be paid for military service only than to place them on work for which they have no qualification, merely to fill up their time. It is disagreeable enough to hear of bad engineering, at any hands, resulting in such an enormous loss, but it is even more annoying that civil engineers should be credited with it; and engineers will be pleased to find that the Council of the Institution of Civil Engineers did not allow the imputation of the Duke of Argyll to pass unnoticed. The letter of the president of the Institution is brief, as the following shows:—"I have been requested by the Council of this Institution—the session 1881-82 having commenced—to bring to your Grace's attention the enclosed copy of a *Times* report of a speech delivered by your Grace in the House of Lords on the 15th of July last, after the session 1880-81 of the Institution had terminated, and to express the great regret of the Council that your Grace, acting on erroneous information, should have charged upon civil engineers the failure of certain barracks in India, as regards design, construction, and materials. The Council trust that your Grace will be good enough to inquire into the actual facts, feeling assured that such inquiry will result in showing that the design and execution of the barracks which failed were not under the control of civil engineers." The reply of the Duke of Argyll to this letter is a lengthy one, but the part which is most interesting to engineers is the following:—"In compliance with the request conveyed in your letter of the 29th of November, I have made inquiry into the circumstances connected with the failure of certain barracks in India, and I find that you were quite right in the representation you have made that the design and execution of the barracks which failed were not under the control of civil engineers; and in particular I find that in the case of the barrack at Allahabad, which called down upon the officers concerned the severe animadversion of the Government of India, those officers were all military and not civil engineers. I make this report to you of the result of my inquiries with the greater pleasure because it was entirely by accident, and not by design, that the remarks I made last session in the House of Lords seemed to point specially against the civil as distinguished from the military branches of the Indian Engineering Service." The latter part of this letter is written in such a manner as to convey the impression that the duke would tar all the engineers with the same brush. The simple fact, however, is that civil engineers had nothing to do with the hundreds of thousands of loss per year or the millions in the useless barracks.

LITERATURE.

Hydraulic, Steam, and Hand Power Lifting and Pressing Machinery. By FREDERICK COLYER, M.I.C.E. London: E. and F. N. Spon. 1881.

THE title of Mr. Colyer's book is as above, the following is from the preface:—"The author having heard a desire expressed by many for a practical treatise upon hydraulic, steam, and hand-power lifting and pressing machinery, has been induced to undertake the task. The work is addressed to engineers whose practice has not been in this branch of engineering. Also to architects and users of such machinery, to give them an insight into the same, and to afford some help either in the design or as a guide to the adoption of machinery suitable to the special requirements of the particular case." . . . "Assuming that practical men are chiefly addressed, he has not gone into any rudimentary descriptions, but has mentioned only such details as may be useful for the purpose. Very little discussion is entered into relative to the value of certain machines for the same reasons; but the few results given from practice may prove more useful. He trusts that the work may be acceptable to those who are seeking information in this branch of practice. The work has been written in a concise form, as it was thought it would be more acceptable to those addressed to have practical facts and data expressed in as few words as possible."

This is what is found in what might be termed the promissory note of the book. But this is what we do find. There are seventy-three plates more or less illustrative of the machinery referred to above. We say more or less, because of many of the machines there is but one view, and some of them are nothing more than type or outline diagrams, and are about as illustrative as the plate of a pumping engine for hydraulic power purposes, which shows a cylinder, guide bars, piston and connecting rod, a pump barrel with a bit of pipe hanging from one end, a fly-wheel and crank disc. This is given as a type of the engine used for supplying the water at high pressure for working cranes, lifts, presses, &c. There is but one view, that above described. There is not a single dimension on any of the seventy-three plates, neither is there any scale; and on turning to the text we find but few, compared with the number of machines referred to, and there is nowhere a single bit of information which could help an engineer "whose practice has not been in this branch of engineering" to determine what size press, for instance, he would require for a given purpose, such as for pressing stearic acid or hops. Many of the plates contain sectional views often of unimportant parts, or rather of parts the form and dimensions of which could be readily imagined, and amongst the best of these are those reprinted from the "Proceedings" of the Institution of Civil Engineers. Most people taking up the book would look upon it very much in the same way as they would upon an ironmonger's pattern-book, though there is rather more descriptive matter, or at any rate letter-press, than there would be in a pattern-book. Of the letter-press relating more or less to these seventy-three plates there is about one hundred full pages. A hydraulic crane to lift 160 tons has twenty-one lines devoted to it, and these are of such a general character as to convey little more than their title. There is not one hand-power crane illustrated or described, nor are there any illustrations of the large cotton and jute presses largely made for India and elsewhere. Of the cost of lifting by hydraulic and other means, only the cost of labour is given, which is as good as nothing at all, for not one word is given as to the expense of the hydraulic power. Throughout the book there is not a single word as to the nature or value of the strains on any of the parts of the cranes or lifts illustrated. Of descriptive particulars there are more dimensions given in that relating to the commonest and simplest form of hydraulic press than anything else; but inasmuch as this is an elementary thing of this class of hydraulic tools, and any one can determine pretty accurately what is wanted for a given purpose, there is not much to thank Mr. Colyer for here. It may be acknowledged that here and there the author gives a few hints as to arrangement of plant in a general sort of way; but altogether his book is the most provokingly incomplete and bare of real information that we have seen for a long time. It is not too much to say that it is absolutely useless to an engineer, even the "practical men chiefly addressed." They could get more information from the first-class catalogues issued by several well-known makers. Some proprietors who require lifting machinery or presses might find the sort of thing they require either illustrated or referred to in the book, but they would have to go to an engineer—not one depending at all on this book—for information, to get some ideas as to size, cost, capacity, and motive power. Some time since Dr. Siemens remarked that manganese was to steel very much what charity is in religion. Some such relation seems to exist in the minds of the compilers of some books as to what the word "practical" is to an incomplete or unsatisfactory book or treatise. "Call it practical and disarm criticism" seems to be the idea. Messrs. Spon have done their part of the book well. We wish it was a good one, for there is room for such a book on lifting machinery and presses.

AN EXPERIMENTAL INQUIRY INTO THE RELATIVE ECONOMIC EFFICIENCIES OF A CORLISS CONDENSING AND A CORLISS NON-CONDENSING ENGINE, WORKED BY SATURATED STEAM OF NEARLY THE SAME BOILER PRESSURE IN UNJACKETTED CYLINDERS.*

By Chief Engineer ISHERWOOD, U.S. Navy.

AN important problem in steam engineering is the determination of the boiler pressure at which the economic efficiency of a non-condensing engine becomes equal to that of a condensing engine using steam of the same boiler pressure; there being included among the factors of the problem the difference in the temperature of the feed-water in the two cases, and the power required to work the air pump of the condensing engine. In favour of the condensing engine are the very much less back pressure against the piston than with the non-condensing engine, and the greater measure of expansion with which the steam can be used in consequence of that less back pressure. And in favour of the non-condensing engine are the higher temperature of the feed-water than with the condensing engine, and the saving of the power required to work the air pump.

Now, as the back pressure in the two cases may be taken as practically constant, say, for good practice, 3·5 lb. per square inch against the piston of the condensing engine, and 16 lb. per square inch against the piston of the non-condensing engine; and, as the temperature of the feed-water in the two cases may also be taken as practically constant, say 100 deg. Fah. for the condensing engine and 200 deg. for the non-condensing, there is evidently a boiler pressure—or rather an initial cylinder pressure—at which the economic efficiencies of the two types of engine become equal. From the data it would seem that the boiler pressure in question admitted of exact calculation and did not require an experimental determination, and such would be the fact were the steam used in cylinders whose material remained unaffected by heat, but as the cast iron of cylinders is greatly affected by heat, accepting and delivering it largely and with wonderful rapidity, the question passes from the abstract to the concrete form, becoming purely experimental, like all questions in physics, no confidence being due to any merely mathematical discussion of the case. One of the most important causes of steam condensation in a cylinder being the difference between the extreme temperatures in it during a double stroke of the piston, and these extremes, with constant initial pressure, being greatly affected by the back pressure, which lessens them as it increases, this latter factor influences the problem to a far greater extent than its statical value alone. The extent of that influence can only be ascertained by experiment, which, including the obscure physics of the subject, unknown to calculation, but potent on the result, is able to give a true solution when a mere mathematical treatment would lead to excessive error. As experiments have abundantly proved that no economic gain is to be obtained by using steam with measures of expansion beyond the very moderate ones easily commanded in non-condensing engines worked by steam of not less than 70 lb. boiler pressure per square inch above the atmosphere, the idea may be definitely dismissed that the possibility of carrying expansion in the condensing engine to a greater degree than in the non-condensing one, is an economic advantage. The higher temperature of the feed-water with the non-condensing engine results from the greater sensible heat of its exhaust steam which is utilised by means of a "heater" in raising the temperature of feed-water. The sensible heat thus utilisable with either engine is practically controlled by the back pressure against which the steam exhausts; the higher that pressure, therefore, the higher will be the temperature of the feed-water; and as the non-condensing engine exhausts against a much higher pressure than the condensing one, the temperature of its feed-water will be correspondingly higher. The same boiler furnishing equal weights of steam of the same pressure in equal times, but supplied with feed-water of different temperatures, will have a higher economic vaporisation with the hotter feed-water, additional to what is due to the difference of heat to be imparted in the boiler in the two cases, owing to the slower combustion of the fuel. The hotter the feed-water, the less heat is required to be imparted to it in the boiler, so that for equal weights vaporised in equal times, the slower proportionally will be the rate at which the fuel is consumed, whence results that a less quantity of heat being thrown on the heating surface of the boiler in a given time, the more of it will be absorbed. This gain would appear were the economic results of the experiments to be measured by the weight of fuel consumed per hour per horse-power developed, but it does not appear when they are measured by the number of Fahrenheit units of heat consumed per hour per horse-power. To work an air pump requires a power equal to the lifting of the water of condensation and the condensing water a certain height, to the expulsion of the air and uncondensed vapour, and to overcoming the friction of the mechanism, all of which is saved by the non-condensing engine. Comparable experiments with the two types of engine are rarely found, but being in possession of the details of the trials made in 1878 on a Corliss condensing steam engine in the city of Mulhouse, Alsace, Germany, and published in the last May and June numbers of this journal, and of the still more copious details of the excellently conducted trial made by Mr. John W. Hill of a non-condensing Corliss steam engine, in 1874, for the Fifth Cincinnati Industrial Exposition, I am able to offer an experimental determination of the boiler pressure, which in the case of the non-condensing engine gave an economic result equal to that given by the condensing engine operated with nearly the same boiler pressure. Both engines were land engines, both had precisely the same valves and valve gear, both had horizontal cylinders with the same stroke of piston, both had the same proportion of space in clearance and steam passage at one end of the cylinder to space displacement of the piston per stroke; the only dimension of importance in which they differed was the diameter of the cylinder, which was 50 per cent. greater in the condensing engine than in the non-condensing. In both engines saturated steam was used without cushioning or sensible release or lead. Neither was steam jacketted; the cylinder of the non-condensing engine had no jackets, and although that of the condensing engine had jackets, yet during the experiments with it selected for comparison—experiments B and C of the table opposite page 372 of the last May number of this journal—there was no steam in them. Both cylinders were well felted and lagged. The valves and valve gear of both engines were alike. Each cylinder had two steam valves, one at each end and upon its upper side; and two exhaust valves, one at each end and upon its lower side. The valves were all horizontal circular slides working with the steam pressure on their backs. They were operated by bell-crank levers keyed to their stems, to which levers rods were articulated connecting them with a wrist-plate oscillating on a journal supported by the side of the cylinder. The wrist-plate received its motion from a rod hooked on its arm at one end, and attached at the other to an upright lever at the side of the engine frame, which in turn received its motion from the rod of an ordinary excentric. The wrist-plate is moved through an arc of considerable extent, and owing to the manner of its connection with the excentric, has its speed of oscillation maintained after the crank has passed its dead centres; so that approximately the initial opening and final closing of the valves are performed while they are at their greatest speed. The valves when closed have a slow movement, because their connecting rods are then in a position approximately radial to the journal on which the wrist-plate oscillates. The two rods connecting with the exhaust valves have permanent articulation with the levers on their valve stems; but the two rods connecting with the steam valves are detach-

* Journal of the Franklin Institute.

able from the levers of their valve stems, the detachment being effected by the action of the governor at any point during the stroke of the piston. The steam valves, when detached, being free, are closed quickly by the fall of a weight suspended by a rod from the bell-crank on the valve stem, and working in a dash-pot beneath. This detachment and quick closing of the steam valves enables them to be used also as cut-off or expansion valves, the point of cutting off being variable by the governor. The two rods connecting the wrist-plate with the levers of the steam valves are attached to these levers by a hook on the upper side of the lower branch of what is called a "crab claw" which is jointed to the rod, and the detachment of this hook from the valve lever is effected by a cam-like projection or stop which oscillates on the valve stem bushing and is connected with the governor. The position of this stop being thus variable by the vertical movement of the governor, causes the detachment of the hook earlier or later in the stroke of the piston accordingly, and thus changes the point of cutting off the steam.

All the valve stems extend clear through the backs of the cylindrical valves, for which distance they are made flat, the backs of the valves being slotted to receive them. Thus the valves are not suspended on their stems, which latter only work but do not support them, leaving the valves free to rest directly on their seats and follow down the wear. The purpose of this valve gear is to open and close the valves with the maximum velocity. To cut off the steam by detaching the steam valves and leaving them free to close with as great velocity as can be given to them by a falling weight, the moment of detachment being variable by the action of an ordinary governor. The economic effect to be obtained being whatever might be due to the lessening of the small rounded corner on the indicator diagram where the cut-off valve closes, formed by the necessarily slow or gradual closing of that valve in any case. And also to the quick opening and closing of the exhaust valve, which allows the minimum back pressure against the piston to be obtained as quickly as possible and held as long as possible. The valve gear was also used to graduate the power, instead of a throttle valve, the graduation being effected with a constant initial cylinder pressure by the shorter or longer cutting off of the steam. And as this valve gear was contrived in the faith that every increase of expansion with which the steam was used, down to nearly the back pressure, increased its economic efficiency, the supposition was that the shorter points of cutting off, following each decrease in the load, caused a material saving of fuel. Further, the use of four valves, two at each end of the cylinder and of the slide type, reduced the space in the steam passages to the minimum, and thereby undoubtedly saved fuel to a corresponding extent; while the straightness and shortness of these passages prevented the lowering of the steam pressure and the raising of the back pressure due to longer and more tortuous passages.

Both the condensing and the non-condensing engines had been put in the best state possible for the trials, which were made with the utmost care and every precaution for exactness by competent and disinterested persons. In both cases indicator diagrams were taken every fifteen minutes from each end of the cylinders, together with a complete set of observations of the other data. The steam pressure, load, point of cutting the steam, speed of piston, and all the other conditions were maintained without sensible variation during each experiment. All the instruments and measures used were previously tested. The revolutions of the engine shaft were noted from a counter. The weight of feed-water consumed was accurately measured in tanks and there was no doubt that all this water was vaporised, and that all the steam generated from it entered the cylinders whose pistons and valves had been secured steam tight. In both experiments, the power required to work the engines, *per se*, was calculated from indicator diagrams taken from the unloaded engine with its piston at the same speed as during the experiment. Had the cylinders in the two cases been of the same diameter, and had their piston speeds been the same, the experiments would have been absolutely comparable. As it was, the non-condensing cylinder had a diameter of $16\frac{1}{16}$in., while the diameter of the condensing cylinder was 24in., which was in favour of the latter, economically, as regards the loss by cylinder condensation, for that loss, other things equal, is less with greater diameters of cylinder. The speed of the piston of the non-condensing engine was, however, greater than that of the condensing engine in the proportion, roundly, of 60 to 49, which was in favour of the former, economically, as regards the loss by cylinder condensation, for that loss, other things equal, is less with greater speeds of piston. These two differences, therefore, opposing each other as regards the same kind of loss, may be taken to neutralise each other, if not wholly, at least in great part.

In the following table will be found the data and results of these experiments. The quantities have been grouped for facility of reference, and they are so completely described on their respective lines that no further explanation is required. By the indicated horses-power is meant the power calculated for the pressure representing the mean ordinate of the indicator diagram. The net horses-power is the power calculated for what remains of the indicated pressure after deducting the pressure required to work the unloaded engine. The total horses-power is calculated for the sum of the indicated pressure on and the back pressure against the piston. The net horses-power is the only power which is commercially valuable, or applicable to external work. The temperature of the feed-water given in the table is not the experimental temperature which, in both cases, was considerably less, owing to the water being delivered into tanks for measurement, where it rapidly cooled. The tabular temperature is what it would have had, had it been pumped directly into the boiler without passing through the measuring tanks; and the number of Fahrenheit units of heat imparted to it, as given in the table, is the number that would have been imparted had it had the tabular temperature. The quantities in the table are the means of all the indicator diagrams and of all the observations taken. Those for the condensing engine are from the two experiments made on it by a committee for the Industrial Society of Mulhouse, and are the means in function of the duration of each experiment.

Table containing the Data and Results of Experiments made on two Corliss Steam Engines—one Condensing, the other Non-condensing—to determine their Economic Efficiency. In both cases Saturated Steam was used without Steam Jacketting, and there was no Cushioning in the Cylinders.

	Condensing engine.*	Non-condensing engine.†
Dimensions of cylinders :—		
Number of cylinders	1	1
Diameter of cylinder, in inches	24	16·0625
Stroke of piston, in inches	48	48
Net area of piston, in square inches ..	442·0698	201
Space displacement of piston, in cubic feet, per stroke	12·2797	5·5833
Space in clearance and steam passage at one end of cylinder, in per centum of the space displacement of its piston per stroke	2·4647	2·9158
Date of experiment	8th and 9th April, 1878.	3rd Oct., 1874.
Duration of experiment in consecutive hours	10·780 and 5·6772	8·0000
Weight of steam accounted for by the indicator :—		
Pounds of steam present per hour in the cylinder at the point of cutting off the steam, calculated from the pressure there	—	1572·1734
Pounds of steam present per hour in the cylinder at the end of the stroke of its piston, calculated from the pressure there	—	1819·6034
Pounds of steam condensed per hour in the cylinder to furnish the heat transmuted into the total horses-power developed by the expanding steam alone	—	147·6858
Sum of the two immediately preceding quantities	—	1967·2892
Engine :—		
Steam pressure in boiler, in pounds per square inch above atmosphere	66·592	70·477
Steam pressure in valve chests of cylinder, in pounds per square inch above atmosphere	63·025	67·500
Proportion of throttle valve open ..	Wide.	Wide.
Fraction of stroke of piston completed when the steam was cut off..	0·1050	0·2066
Number of times the steam was expanded	7·9033	4·3657
Pressure in the condenser, in pounds per square inch above zero..	2·0747	—
Pressure of the atmosphere in pounds per square inch above zero..	–	14·4590
Number of double strokes made per minute by the piston	49·19785	60·10833
Temperature of the feed-water, in degrees Fahrenheit	100	200
Number of Fahrenheit units of heat imparted to the feed-water	1109·3253	1009·5796
Number of pounds of feed-water pumped into the boiler per hour ..	3312·512	2186·870
Steam pressures in cylinder per indicator :—		
Steam pressure on piston in pounds per square inch above zero, at the commencement of its stroke	70·9000	78·744
Steam pressure on piston, in pounds per square inch above zero, at the point of cutting off the steam.. ..	—	71·139
Steam pressure on piston, in pounds per square inch above zero, at the end of the stroke of the piston.. ..	—	17·533
Mean back pressure against the piston, in pounds per square inch above zero, during the stroke of the piston	3·1124	15·925
Minimum back pressure against the piston, in pounds per square inch above zero, at commencement of stroke of piston	—	15·900
Mean indicated pressure on piston, in pounds per square inch	24·1451	25·3775
Mean net pressure on piston, in pounds per square inch	21·9810	23·4890
Mean total pressure on piston, in pounds per square inch	27·2575	39·8365
Pressure on piston, in pounds per square inch to work unloaded engine	2·1641	1·8885
Horses-power :—		
Indicated horses-power developed by the engine	127·2987	74·3285
Net horses-power developed by the engine	115·8939	68·7973
Total horses-power developed by the engine	143·7140	116·6777
Total horses-power developed by the expanding steam alone	—	55·7712
Economic results :—		
Number of pounds of feed-water consumed per hour per indicated horse-power	26·0216	29·4217
Number of pounds of feed-water consumed per hour per net horse-power	28·5823	31·7871
Number of pounds of feed-water consumed per hour per total horse-power	23·0493	18·7428
Number of Fahrenheit units of heat consumed per hour per indicated horse-power	28866·4192	29703·5481
Number of Fahrenheit units of heat consumed per hour per net horse-power	31707·0685	32091·6077
Number of Fahrenheit units of heat consumed per hour per total horse-power	25569·1716	18922·3485
Cylinder condensation :—		
Difference in pounds per hour between the weight of water vaporised in the boiler and the weight of steam accounted for by the indicator at the point of cutting off steam..	—	614·7966
Difference in per centum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator at the point of cutting off the steam..	—	28·1131
Difference in pounds per hour between the weight of water vaporised in the boiler and the weight of steam accounted for by the indicator at the end of the stroke of the piston ..	—	219·5808
Difference in per centum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator at the end of the stroke of the piston	—	10·0409

* Mean of two experiments made by a Committee for the Industrial Society of Mulhouse in Alsace, Germany.

† Experiment made by John W. Hill for the Fifth Cincinnati Industrial Exposition.

REMARKS.

It is greatly to be regretted that, in the original report of the experiment with the condensing engine, the pressures at the point of cutting off the steam, and at the end of the stroke of the piston, were not given, for then calculations might have been made of its cylinder condensation similar to those made for the non-condensing engine, which would have revealed the cause of the equality of the economic commercial efficiencies of the two engines, notwithstanding the greatly less fraction utilised of the total pressure in the case of the non-condensing engine.

The total horse-power developed in the two cases represents the entire dynamic effect—useful and prejudicial—produced by the steam or fuel expended in equal times, and comparing the cost of the same in Fahrenheit units of heat, there appears that the total horse-power was obtained with the non-condensing engine for an hourly expenditure of 18,922·3485 Fahrenheit units, and with the condensing engine for an hourly expenditure of 25,569·1716 Fahrenheit units, the two costs comparing as 1·00000 to 1·35127—an enormous difference due to the greater cylinder condensation with the condensing engine, combined with the greater number of units of heat required for the production of a pound weight of its steam, owing to the less temperature of its feed-water. With the condensing engine there were required 9·8799 per centum more heat to vaporise a pound of feed-water than with the non-condensing engine; and diminishing the above 1·35127, there remains 1·21777 to 1·00000 for the ratio of the economic efficiencies of the non-condensing and condensing engines in function of the total horse-power, the whole of which difference was due to the less cylinder condensation in the non-condensing engine. Now with the non-condensing engine, the final cylinder condensation was 10·0409 per centum of the steam evaporated in the boiler, leaving 89·9591 per centum utilised in the production of power; dividing this latter quantity by the above 1·21777 there results 73·8720 per centum utilised in the condensing engine, which deducted from 100·0000 leaves 26·1280 per centum of the steam evaporated in the boiler condensed in the cylinder of the condensing engine. A condensation in the condensing cylinder of 26·1280 per centum of the steam evaporated in the boiler is then sufficient to account for the difference in the heat cost of the total horse-power in the two cases; and it is known from many experiments that this is about what occurs in an unjacketted cylinder of the dimensions of the condensing engine cylinder using saturated steam with an expansion of nearly eight times.

By an indirect method, with the data obtained during the series of experiments made on the condensing engine by the committee of experts for the Industrial Society of Mulhouse, the condensation in the cylinder during experiments B and C hereinbefore referred to, was determined to be 29·6290 per cent. of the steam evaporated in the boiler. (See page 435 of the last June number of the "Journal" of the Franklin Institute.)

One of the most important causes of that condensation is the difference of the extreme temperatures of the the cylinder during a double stroke of the piston. In the condensing cylinder, the initial steam pressure being 70·9 lb. per square inch above zero, and the minimum back pressure, say, 3 lb. per square inch above the same, the temperatures corresponding to which are 303·62 deg. Fah. and 141·67 deg.; this difference is 161·95 deg. In the non-condensing cylinder, the initial pressure being 78·774 lb. per square inch above zero, and the minimum back pressure 15·9 lb. per square inch above the same, the temperatures corresponding to which are 310·76 deg. Fah. and 215·10 deg.; this difference is only 95·66 deg. And besides this cause of greater condensation in the condensing cylinder, there was the greater refrigeration produced by the greater measure of expansion with which the steam was used in that cylinder, than in the non-condensing cylinder.

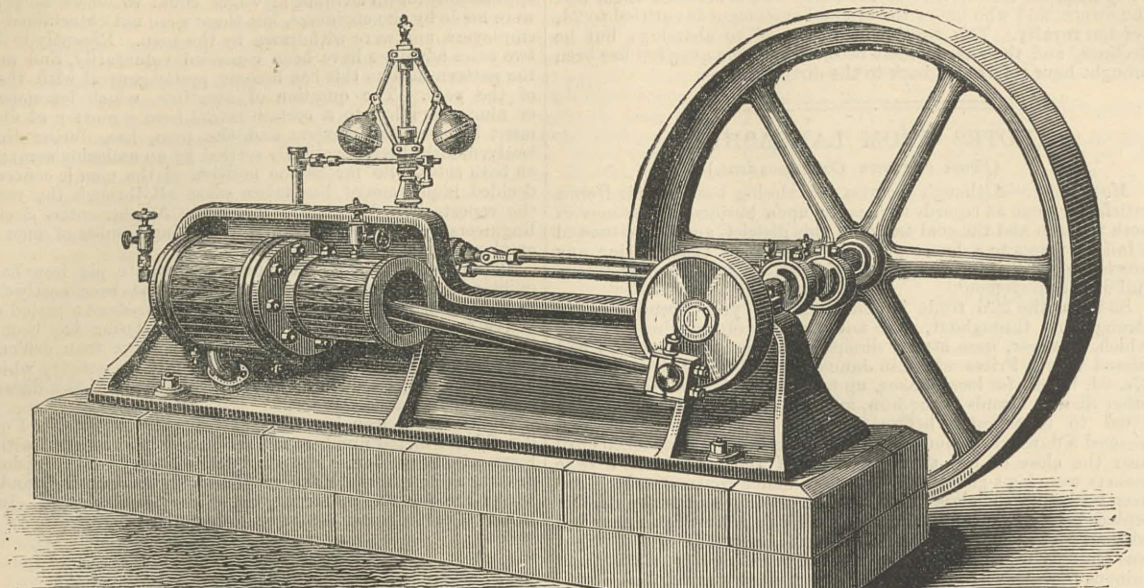
The net horse-power, representing the portion of the total horse-power developed by the engine that was commercially useful, was obtained for the consumption of 31707·0685 Fahrenheit units of heat per hour with the condensing engine, and of 32091·6077 Fahrenheit units with the non-condensing engine; and if a very small allowance be made in favour of the latter for the greater economic vaporisation in its boiler per pound of fuel, owing to the slower rate of combustion, the cost of the net horse-power in both cases will be equal; showing that a non-condensing engine with an unjacketted cylinder of the experimental dimensions, using saturated steam of $70\frac{1}{2}$ lb. boiler pressure per square inch above the atmosphere, with an expansion of nearly $4\frac{3}{8}$ times, gave the same commercial result—that is to say, the same net power for the same quantity of fuel per hour—as a condensing engine with a two and a quarter times more capacious unjacketted cylinder using saturated steam of $66\frac{1}{2}$ lb. boiler pressure per square inch above the atmosphere with an expansion of nearly eight times. Hence, under the experimental conditions, no economy would result from the employment of a condenser and air pump, when the boiler pressure was not less than $70\frac{1}{2}$ lb. per square inch above the atmosphere. If the engine works with a variable load, this must be taken for the lower limit of pressure—not the average pressure—giving equality of economic effect. Of the total pressure in pounds per square inch above zero with the condensing engine, there were utilised as net pressure $\left(\frac{21 \cdot 9810 \times 100}{27 \cdot 2575} = \right)$ 80·6420 per centum; and with the non-condensing engine $\left(\frac{23 \cdot 4890 \times 100}{39 \cdot 8365} = \right)$ 58·9365 per centum; the two comparing as $\left(\frac{80 \cdot 6420}{58 \cdot 9635} = \right)$ 1·36766 to 1·00000 or very nearly the 1·35127 to 1·00000 found as the ratio of the heat cost of the total horse-power in the two cases; so that the less fraction of the total horse-power utilised as net horse-power with the non-condensing engine just balanced the less heat cost of its total horse-power, enabling the net horse-power to be obtained for the same heat cost in both cases.

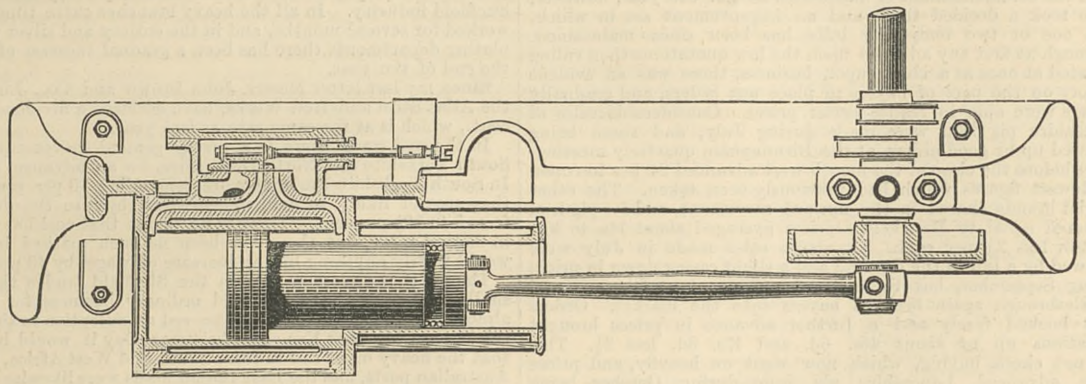
The correctness of these facts was confirmed some years ago at a large flour-making mill in New York City, which was operated by several non-condensing cylinders of moderate dimensions, unjacketted, and using saturated steam of about 90 lb. boiler pressure per square inch above the atmosphere, with a considerable measure of expansion. The proprietor was persuaded to add a surface condenser and an air-pump, and a variable cut-off, expanding the steam sufficiently more to retain the same mean cylinder pressure with the same boiler pressure, the expectation being that a marked difference in the weight of fuel consumed per hour to grind and dress the same number of bushels of wheat would result; and such, indeed, was the case, but in the opposite direction to the expectation, the power actually costing so much more fuel that the condenser and air-pump were removed and the original conditions restored. The foregoing results are true for only the precise experimental conditions, and they will be modified by any of the causes which diminish cylinder condensation, as, for example, steam-jacketting the cylinders, superheating the steam, employing large cylinders, &c., for there is a greater economic gain possible by them for the condensing than for the non-condensing engine, as the former has the most cylinder condensation to be reduced. Consequently, therefore, just in proportion as the cylinder condensation is lessened by steam jacketting, steam superheating and larger cylinders, must the boiler pressure be increased for the non-condensing engine to sustain its equality of economic performances, gaining by the resulting increase of the fraction which the net power is of the total power, what it loses in decrease of relative cylinder condensation. It is probable, however, that with a boiler pressure of from 95 to 100 lb. per square inch above the atmosphere the non-condensing engine would give the net power with fully as much economy of fuel as the condensing engine using the same steam pressure with the measure of expansion found to produce the greatest economy, even with steam jacketting, steam superheating and cylinders of the largest dimensions in both cases. For marine engines, the use of high-pressure steam is important, because it lessens proportionally the dimensions of cylinders required for a given power, the dimensions for high powers having now become inconveniently large, and because it allows the removal of the air pump and appendages. A surface condenser would still be required to furnish the boiler with distilled water, but the quantity of surface could be seriously reduced, the reduction being due not only to the fact that about one-tenth less heat is to be taken out of the exhaust steam, but that owing to the greater difference of temperature on the opposite sides of the condensing surface, a unit of this surface is proportionally more efficient for condensation. Less than nine-tenths of the refrigerating water would also be used, because the difference between its initial and final temperatures in the condenser would be very much greater, so that a portion of the power required for pumping this water with condensing air-pump engines would be saved. The power expended in working the air pump and the circulating pump in marine engines is much greater than in land engines, because of the greater resistance against which they discharge, due to the height of the outboard column of water and to the greater tortuousness of the discharging pipes. The advantages of the non air-pump engines are, of course, for the cases in which a uniform power is employed, as for merchant steamships. For naval steamships which are engined for the development of high powers during short periods at long intervals, their principal steaming being done with very low powers, the condensing air-pump engine preserves its economic superiority.

ELECTRIC LIGHTING BY WATER-POWER.—The works which have for several weeks been in progress for lighting the town of Godalming, Surrey, by electricity generated principally by water-power, were tested successfully for the first time on Thursday night, the 15th inst. The arrangements have been made by Messrs. Calder and Barrett. There are, in addition to the employment of a motor not hitherto used in this country, two or three novel points in the method by which the lighting of the town has been effected. For the lighting of the smaller streets the Swan incandescent lamps, fixed in the ordinary gas lamp-posts, are used; the current is conducted by bare copper wire attached by insulators to poles like overhead telegraph wires, and no direct return wire is employed. One of Messrs. Siemens Brothers' alternate current dynamo-machines is used with an exciter, absorbing about 10-horse power. This machine supplies seven differential arc lamps and about forty Swan lamps. Part of the town not hitherto lighted at all is now lighted by incandescent lamps.

COMPOUND ENGINE.

MESSRS. LANE AND REYNOLDS, LONDON, ENGINEERS.

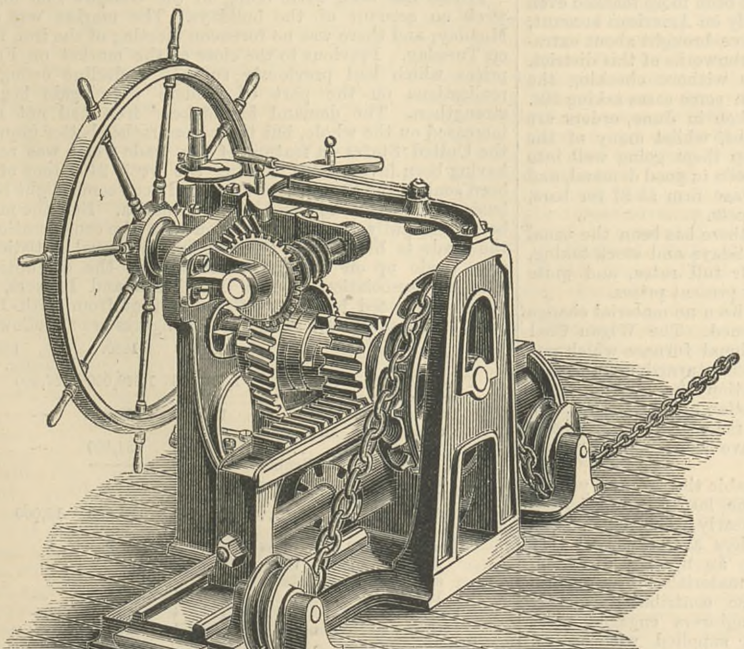




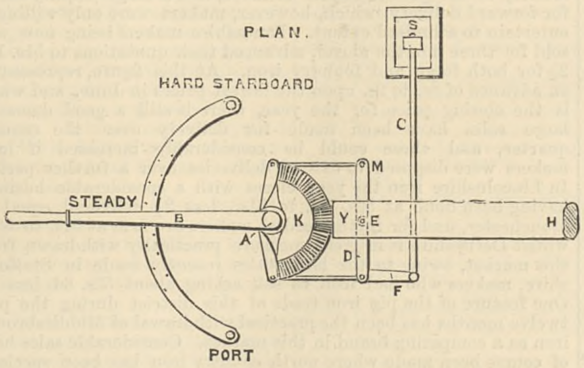
WE illustrate above a very compact compound engine made by Messrs. Lane and Reynolds, of Cranbrooke-street, Old Ford. The engravings nearly explain themselves. It will be seen that the piston is fitted with a trunk. The space between this trunk and the cylinder acts as the high-pressure cylinder, and the steam is exhausted into the space behind the piston on the return stroke. A single slide valve alone is required. Guides are dispensed with, the tubular casting in which the trunk works answering the same purpose. It is perhaps impossible to get a simpler compound engine. The only objection we know of to this method of construction, is that it is very difficult to get an equal amount of work done during both strokes, but this is after all a matter of small importance.

SIMEY'S STEAM AND HAND STEERING GEAR.

THE accompanying illustrations show the construction of the steering gear of Mr. C. G. Simey, Stockton, in which the usual steam engine with two cylinders is replaced by a single cylinder, the piston of which is directly connected with a rack that gives motion to the shaft, on which is fixed the wheel for the chain or wire rope used for steering. The steering may be either done by hand with the hand wheel in gear, as shown, or it may be done by the small tiller handle on the top of the frame, the range of which is controlled by the two



pins shown in the top quadrant. Other holes in the quadrant are provided, though not shown, so as to move the pins to get greater or less range according to the course the vessel will be known to take. The connection to the small ordinary slide valve in the cylinder steam chest is by means of a lever and connecting rod which may be just seen under the top connecting piece of framing and through the hole in the left-hand piece of framing. The annexed diagram, however, gives a better idea of the arrangement. A is an upright spindle, the



top of which is seen in the perspective carrying an indicator point in front of machine. It is worked by a tiller B and carries a lever which, moving each way through 45 deg., moves the end of the crosshead D, the other end M remaining fixed. The centre of the crosshead is attached to a bell crank F to transfer the motion to the slide rod C. H is a barrel shaft with bevel pinion Y on end, which rotates quadrant K fixed on outer spindle, which carries a lever that draws back the end M of the crosshead as much as the lever D had advanced, thus shutting off the valve again. The valve is always shut whenever D and M are opposite one another. S is the slide valve.

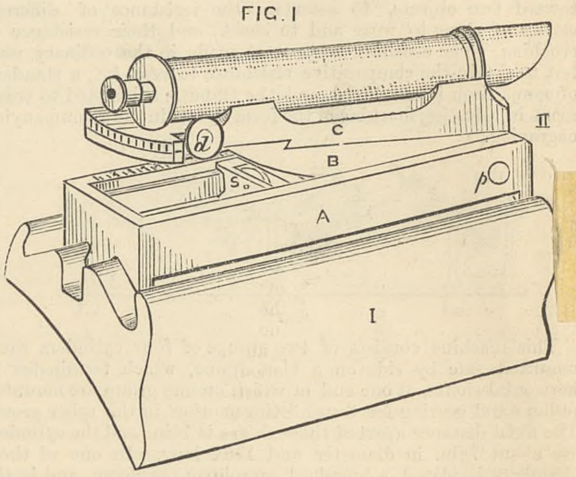
This machine is self-draining, and can thus be started at a moment's notice. The moving parts are few in number. Anyone, however inexperienced, can work it without fear of being thrown over the wheel, because when worked by hand the worm acts as a continuous pawl, and the most careless helmsman cannot move the helm from steady to hard-over in less than ten seconds. The piston yields sufficiently, or the steam behind it does, to prevent breakage of chains when a sea strikes the rudder, and it then returns automatically to its former position. There is no hip on the chains where they lead away to the ship's side, and steel wire rope is preferably used as it is noiseless, and is said to be cheaper in first cost, in wear, and to replace than chains. The amount of helm given can be controlled by the officer of the watch in the way we have described, thus preventing over steering. Messrs. R. Roger and Co., Stockton, are the manufacturers, by whom it was fitted to the s.s. Grafton, launched last month on the Wear for Messrs. E. W. Morgan and Co., and since shown in use in the Thames.

TELESCOPE SIGHT FOR GUNS.

A TELESCOPE sight for guns has been lately invented by an officer in the Royal Artillery, and has been tried at Shoeburyness with very satisfactory results. As it is not considered in official quarters that there is any present need for such an appliance, the subject remains in abeyance. All that can be expected is, that when the desirability of using a telescope sight in the laying of guns is recognised, there will be a trial of this invention along with others of a kindred nature.

The design of the instrument to which our remarks have reference is based upon practical experience in the instruction of gunners, and was produced in consequence of a strong conviction that such an instrument would confer a decided advantage upon the artillery which employed it. Experience gained with the apparatus thus designed has tended to show the value of such an appliance, and it seems to be daily becoming a more imminent question whether an instrument of this nature is not an actual necessity.

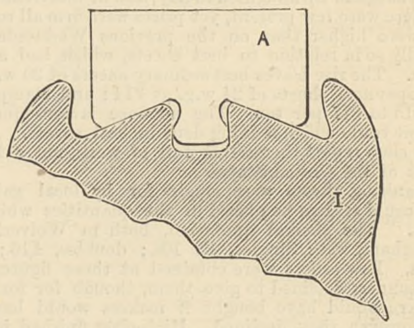
FIG. 1



It is not so much for the sake of increasing the accuracy of fire when the object is distinctly visible that an arrangement of this kind is considered valuable, though even this would be a considerable gain. The chief end in view is that of enabling artillery to be effectively employed where the naked eye is unable to discern the object which is to be fired at. With the increased range of guns, and the plan which belligerents have adopted of hiding themselves as much as possible, this condition of things is becoming daily more common. Hence arises great waste of ammunition and a serious loss of efficiency. It has been pretty conclusively proved by experiments with instruments of this description, that a very large proportion of the errors in artillery practice are due to faulty laying—apparently about 75 per cent. Now that guns are being made in which the errors due to material are reduced almost to zero, it would seem as if the elimination of the large source of error referred to would be followed by very decisive results.

The instrument we are about to describe is in a great measure remarkable for its simplicity. The inventor deprecates any complication which would tend to render it a source of trouble instead of a welcome aid. Hence he has not deemed it wise to make the instrument independent of corrections for inclination of the axis of the trunnions. He is content in this respect to let his instrument remain on terms of equality with the existing tangent sights, which are supplemented by the Fitzroy deflector. The design is mainly composed of two parts, and will be readily understood by reference to Figs. 1 and 2. I is a block

FIG. 2



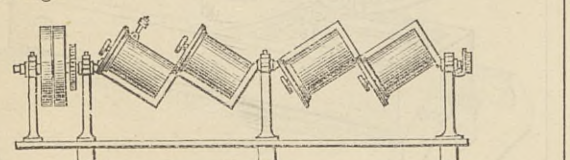
which is fixed permanently on to the gun in the most convenient position from which to lay. The upper surface of this block is cut in a peculiar form to receive II, the instrument carrying the telescope. This portion contains in itself the means of giving the necessary elevation and deflection, and is constructed especially to give an easy reading scale, while rendered as free as possible from liability to injury. It consists of a frame A, the two ends of which are shaped at the lower edge so as to articulate into the upper face of the block I. B is an arm which pivots at one end *p* between the sides of the frame. C is the bed of the telescope, which gears into the upper surface of the arm in such a manner as to enable the telescope to be inclined laterally for deflection.

The principal feature consists in the means by which the required elevation is given. This is effected by a sliding piece S, which moves along and between the sides of the frame. On the forward edge of this sliding piece rests the lower surface of the arm carrying the telescope on its bed. By moving the sliding piece or "rest," as it may be termed, nearer to or farther from the pivot of the arm, the latter is inclined more or less to the frame. The sides of the frame are graduated, so that the precise angle of inclination is indicated at once by the position of the rest. It will readily be seen that were the bearing edge of the arm straight, the graduations indicating equal angles would rapidly diminish as they neared the pivot. This edge is therefore made a curve, by which the graduations are kept equal. In the present instrument, which is only 9in. long, the range of the scale is 12 deg., with an auxiliary arrangement which adds 10 deg. to each inclination, thus making the total range 22 deg. By means of a vernier, the reading can be carried to one minute of arc. Without such aid, subdivisions to the extent of five minutes would be perfectly practicable, and this might be considered sufficient.

The telescope is of moderate power, that is to say, about 8 to 1, and is permanently focussed for long distances. The image obtained is not bright, and some aberration obtains towards the edges, but these apparent defects are thought to be no disadvantage in comparison with the difficulties which are avoided. The telescope is fitted with cross wires, and it is only necessary to have the image well defined where these intersect. The connection between the block and the instrument is effected simply by the weight of the latter, which readily drops into its place, and is lifted out again before the gun is fired. The proper adjustment once obtained, the instrument can be attached to the gun, removed, and attached again any number of times, without further trouble. It will be seen by the section, Fig. 2, that the bearing surfaces are left as small as possible, allowing space for grit and dirt to get out of the way. The bearing surfaces are of steel, so as to prevent abrasion. Protracted and severe tests have proved the practical excellence of the arrangement, and the service may be congratulated on the fact that if a telescope sight is not yet introduced, there is at least a very excellent one waiting acceptance.

TESTING BROKEN STONE.

A series of experiments conducted by officers of the Ponts et Chaussées Administration, for ascertaining the resisting power of different classes of broken stone employed in the formation and maintenance of roads, were recently described in the *Bulletin du Ministère des Travaux Publics.* These experiments were directed toward two objects, to ascertain the resistance of different classes of stone to wear and to shock, and their resistance to crushing. The crushing tests were made in the ordinary way, but to obtain the comparative resistance to wear, &c., a standard of comparison is employed, and the stone is submitted to treatment in a testing machine of the form shown in the accompanying engraving.



This machine consists of two groups of four cylinders each, mounted side by side on a bent frame, which terminates in horizontal shafts, at one end of which on one group are mounted pulleys and gearing for transmitting motion to the other group. The axial distance apart of these shafts is 16in., and the cylinders are about 7⅞in. in diameter and 14in. long. In one of these chambers is placed a standard sample of porphyry, and in the other the stone to be tested; the charge averages about 11 lb. The machine is driven with a speed of about 2000 revolutions an hour, and the stones are subjected to attrition, and also to a to-and-fro movement from end to end of the cylinder. After about five hours the cylinders are emptied and their contents are carefully washed, the fragments precipitated being divided by sifting into three classes—those which will not pass through openings 0·39in. in diameter, those decreasing from this size to 0·07in., and the dust smaller than 0·07in. The first portion is returned to the stone being tested, and the third is weighed, the relation it bears to the original charge indicating the value of the material tested. Experiments showed that the best samples yielded 2 per cent. of their weight in dust, and for this class of stone a co-efficient of 20 was adopted.

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

(*From our own Correspondent.*)

Only little iron is being made this week at the mills and forges in Staffordshire. At a few works operations were begun again after the holidays last—Wednesday—night; but work will not be steadily and generally resumed until next week. There is, however on the part of employers, a greater desire than a year ago to get the works again into full swing once more; for a larger number of orders is left over than at the earlier date, and the new business is even more promising.

On 'Change in Birmingham to-day, and in Wolverhampton yesterday, there were few present, yet prices were firm all round. Some of them were higher than on the previous Wednesday. This was especially so in relation to best sheets, which had advanced 20s. per ton. The rise leaves best ordinary sheets of 20 w.g. at £12 and £13; japanners' sheets of 24 w.g. at £14; and stamping sheets at from £15 to £17 per ton. The advance is consequent upon the excellent trade which is being done in best sheets. All the firms of this class report themselves full of work, not a little of it on account of the United States.

Galvanising sheets were sought for by local galvanisers, but orders could seldom be placed in the quantities which consumers desired. The general quotation, both in Wolverhampton and Birmingham, was: Singles, £8 10s.; doubles, £10; and lattens, £11 10s. Few orders were obtained at these figures, but mostly the consumers declined to give them, though for forward delivery they here would have bought if makers would have consented. This, however, they declined. High-class finished iron firms who produce marked bars and plates have mostly withdrawn previous quotations. £7 10s. was the price of this class of iron, but the makers would accept only small orders at this figure. The anticipation of the market was that at the quarterly meetings in Wolverhampton and Birmingham on the 11th and 12th of January the crucial price would be advanced certainly 10s., it might be 20s. In that event marked bars would not be lower than £8 up to £8 12s. 6d.; they might be £8 10s. up to £9 2s. 6d., with hoops, sheets, and plates all advanced in a like proportion.

Bars of any quality were difficult to buy at under £6 15s., the majority of brands being £7. This was the price at which minimum hoops were to be had; and hoop orders makers were more ready to accept these than orders for any other denomination. Strip, too, was quoted £7, with a good and growing inquiry at a little under that price. Inquiries for quotations by cable are coming for strip from the United States.

Wages remain unaltered for another three months at 7s. 3d. as the minimum for puddling. This follows upon the report of the official accountants to the Wages Board, whose report shows that the average net price obtained for bars in the quarter ending with November was £6 11s. 1d., which is a rise of 4s. per ton. The men are not entitled to any advance till the average reaches £6 15s. per ton.

Best tin-plates are quoted up upon the week 1s. per box. For charcoal qualities 24s. is asked.

Pig iron is unchanged upon the week. Firmness distinguished all the quotations yesterday and to-day, whether of the local makers or of the representatives of distant firms. The furnaces now in blast number 48; but they will be increased early in the new year.

For ironstone and coke higher prices are asked. There is generally a disinclination to sell forward at any prices which consumers are at all prepared to give.

Coal keeps easy on account of the open weather; but as prices of iron are rising, and the wages question still awaits a definite settlement, colliery owners will not sell forward.

The newly Federated Union of Miners for the Midland Counties met by delegates in Wolverhampton on Tuesday, and resolved:—"That this board strongly urges each district to form a Board of Conciliation and Arbitration similar to that at Cannock Chase, with an equal number of employers and men for the settlement of trade disputes, to avoid strikes and lock-outs."

The Hamstead Colliery Company, which, it will be recollected, has sunk two pits by the Chaudron process, but which pits are full of water through an irruption below the cast iron tubs which form the casing of the pits, and whose capital is all expended, has been able to make a provisional arrangement with Lord Hatherton, the owner, which the directors believe would enable them to resume, are, nevertheless, unable to complete the arrangement. They need the concurrence of the lessee who is between them and the owner, and who under the original agreement is entitled to 2d. per ton royalty. This royalty he is wanted to abandon; but he declines, and the shareholders before whom the question has been brought have referred it back to the directors.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Although the year just closing has been far from a satisfactory one as regards the results upon business operations in both the iron and the coal trades of this district, and has witnessed a fall in prices to a lower point in some cases than during any previous period, it is leaving behind it an outlook for the future full of encouragement.

So far as the iron trade is concerned the year opened with a strong tone throughout, and anticipations of reviving activity, which, however, were utterly dissipated before three months had passed over. Prices which in January were firm at 46s. 6d. and 47s. 6d. less 2½ for local makes, up to 48s. and 48s. 6d. less 2½ for other district brands of pig iron, and at about £6 for bars delivered equal to Manchester, before the end of the month had commenced a downward course which was practically unchecked until near the close of the second quarter of the year. For a time makers were kept going with deliveries under contracts which had been booked at the close of 1880, but as these ran off without being replaced, heavy stocks accumulated. Week after week prices fell without attracting buyers, until a general restriction of the output was strongly urged as the only means of arresting a continuous and ruinous reduction of prices. The lowest point was reached during June, when small sales of Lancashire pig iron were made at 42s. 6d. per ton, less 2½ delivered equal to Manchester, the lowest price ever touched by local iron; and some district brands were being offered at 1s. per ton below even this figure, whilst bars could be bought at about £5 10s. per ton, hoops at £6 5s., and sheets £7 5s. per ton, delivered into the Manchester district. With the commencement of the second half of the year, however, trade took a decided turn, and an improvement set in which, with one or two temporary lulls, has been since maintained. Although at first any advance upon the low quotations then ruling operated at once as a check upon business, there was an evident anxiety on the part of buyers to place out orders, and gradually makers were able to realise better prices. Considerable sales of Lancashire pig iron were made during July, and these being followed up by good orders at the Birmingham quarterly meeting, prices before the close of the month were advanced 2s. per ton upon the lowest figures which had previously been taken. The other district brands shared in the upward movement, and for pig iron delivered equal to Manchester prices averaged about 44s. to 45s. per ton less 2½ per cent. The large sales made in July were followed by a lull in the demand and a slight easing down in prices during September, but the upward movement at Glasgow and Middlesbrough again brought buyers into the market. Orders were booked freely and a further advance in prices brought quotations up to about 46s. 6d. and 47s. 6d. less 2½. This did not check buying, which now went on heavily, and prices again advanced, Lancashire pig iron during October being put up to 48s. and 49s.; Lincolnshire to 49s. and 50s.; and Derbyshire to 50s. and 52s. 6d. per ton, less 2½ delivered equal to Manchester. A slackening off in the demand during November brought speculative dealers into the market with iron under makers' quotations, but producers being well sold maintained their prices. The unexpected reduction in Middlesbrough stocks caused a renewed anxiety on the part of buyers to cover, and a large inquiry set in for forward delivery, which, however, makers were only willing to entertain to a limited extent. Lancashire makers being now well sold for three months ahead, advanced their quotations to 51s. less 2½ for both forge and foundry iron. At this figure, representing an advance of 8s. to 9s. upon the lowest prices in June, and which is the closing price for the year, there is still a good demand; large sales have been made for delivery over the ensuing quarter, and these could be considerably increased if local makers were disposed to extend deliveries over a further period. In Lincolnshire iron the year closes with a considerable business having been done at 50s. 6d. to 51s., less 2½ delivered equal to Manchester, and for further orders makers are firm at 51s. to 52s., whilst Derbyshire is in great measure practically withdrawn from this market, owing to the large sales recently made in Staffordshire, makers who had iron to sell asking about 52s. 6d. less 2½. One feature of the pig iron trade of this district during the past twelve months has been the practical withdrawal of Middlesbrough iron as a competing brand in this market. Considerable sales have of course been made where north country iron has been specially required, but as a marketable iron in competition with the local and district brands it has been almost entirely shut out by the comparatively high prices ruling at Middlesbrough.

In the finished iron trade the improvement which set in towards the close of the second half of the year has been more marked even than in pig iron. Heavy shipments, largely on American account, and a steadily enlarging home demand have brought about extraordinary activity throughout the finished ironworks of this district. Prices have also gone steadily upwards without checking the demand, and although makers are now in some cases asking 30s. per ton above what they would have taken in June, orders are being freely offered at the advanced rates, whilst many of the forges have work in hand which will keep them going well into spring. Bars, hoops, and sheets have all been in good demand, and for these the closing prices of the year are firm at £7 for bars, £7 10s. for hoops, and £8 15s. to £9 for sheets.

With the closing market of the year there has been the usual curtailments of business owing to the holidays and stock-taking, but with sellers exceedingly firm at their full rates, and quite indifferent about booking further orders at present prices.

In the output of this district there has been no material change during the year so far as pig iron is concerned. The Wigan Coal and Iron Company have blown in an additional furnace which was first put upon spiegeleisen but has since been turned upon hematite, and the company have in contemplation the blowing in of another furnace in January for the production of spiegeleisen. In the finished iron trade there has been more development, and several large works previously lying idle have been restarted within the last few months.

A steady improvement has been noticeable through the year in the engineering trades, which during the last six months has developed into considerable activity over nearly all sections of this branch of industry, although so far as prices are concerned very little headway has yet been made in an upward direction, notwithstanding the increased cost of materials. The general activity in shipbuilding has of course contributed largely in giving increased employment, and engineers engaged upon marine work have generally been well supplied with orders. Tools for marine, and also for the general class of work have been in good demand, and in these there has been a considerable amount of work stirring, both for export and home requirements. Locomotive builders have also been fairly well engaged, and the year closes with a considerable quantity of work in hand at the principal establishments in this district. Boiler makers have been fairly supplied with orders, which have been increasing of late, and although founders have for the most part been only moderately employed, many of them have for some months past been pretty full of work for constructive purposes. The Lancashire cotton trade, although tolerably active during the year, has not brought much local work into the hands of machinists, who have consequently been compelled to seek orders abroad. For these they have had to compete at very low figures, but generally they have been able to secure sufficient work to keep them well employed. There has been an absence of any serious dispute with regard to wages. During June and July, when the improvement in trade began to make itself apparent, applications for an advance of wages equal to about 2s. per week were made by the engineers, but these were not entertained by the employers, and were withdrawn by the men. Recently in one or two cases advances have been conceded voluntarily, and amongst the pattern-makers this has become pretty general with the close of the year. The question of overtime, which for some eight or nine years has to a certain extent been a matter of disagreement between the masters and the men, has, during the past twelvemonth, been practically settled by an amicable arrangement on both sides. So far as the position of the men is concerned, a decided improvement has taken place all through the year, and the reports issued each month by the Amalgamated Society of Engineers have shown a steadily decreasing number of men out of employment.

Barrow.—The week's business in hematite pig iron has been quiet, as the attention of buyers and sellers has been mostly directed to holiday making. The New Year will introduce a period of very active trade, and although the year now closing has been a vast improvement on recent experiences, it is more than evident that 1882 will be marked with a briskness and an activity which has never been surpassed since the producing power of this district was so largely increased.

Bessemer pig iron is selling at 64s. per ton for No. 1 quality, 62s. 6d. for mixed numbers of this description of metal, with No. 3 forge at 62s. per ton. The steel trade is very well furnished with orders, although the steel, shipbuilding, engineering, and other works are for the moment stopped for the holidays. Iron ore brisk. Coal in better demand and at fuller prices.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Very little work has been done in the Sheffield district this week, the period from Christmas Eve to the opening of the new year being invariably held as a holiday. The year closes with abundant employment for workmen in nearly every department of Sheffield industry. In all the heavy branches extra time has been worked for several months, and in the cutlery and silver plate and plating departments there has been a gradual increase of orders to the end of the year.

Since my last letter Messrs. John Brown and Co., Limited, of the Atlas Steel and Iron Works, have declared a dividend of 5 per cent., which is at the same rate as last year.

In the coal trade there is a pretty general movement, both in South Yorkshire and North Derbyshire, for an advance of wages. In South Yorkshire the miners are demanding 10 per cent., which they are not likely to get; in North Derbyshire the demand is from 5 to 12½ per cent. There is no doubt that coal has increased in market value, but there has been no such marked increase as would justify anything like an increase of wages by 10 per cent.

Though it is almost a rule in the Sheffield trades that stocks shall be taken at Christmas, and ordinary business for the time almost suspended, this year has proved an exception to the general rule. On Christmas Eve and Christmas Day it would be noticed that the heavy mails ran in from South and West Africa, two from Australian ports, and the East Indian mails were likewise above the average of ordinary weeks. Advices from these have been very reassuring. West African buyers are sending in produce which will be realised in the London and Liverpool markets, and along with this produce good orders for cutlery. Business on the coast has been stagnant for six months past, but now appears to be reviving. The principal gainers by this resumption of trade will be Lancashire cotton manufacturers and Sheffield cutlery firms. Australian merchants are buying cutlery freely both for orders to hand and on consignment, and the East Indian trade is also better. Large orders are in hand for files for East Indian deliveries. Best classes of cutlery are selling freely, and this will cause prices of bone, ivory, and horn to further advance.

Prices of Bessemer steel are firmer than a fortnight ago, and the following may be taken as a fair index of prices. But it must be noted that manufacturers of special Bessemer makes are not inclined to book forward, or even to guarantee deliveries under three months excepting from stock, or from what is known in the trade as "job lots." Quotations are as follow for cash:—Best marked billets for file purposes, £13 to £14 per ton; ordinary for cutlery, £9; billets of leading makes, £6 15s. to £6 17s. 6d. Sellers require latter figure. Scrap from ditto, £2 10s. to £3 per ton. There is every indication that these prices will be upheld during the ensuing quarter. As Sheffield ironworkers are governed by Staffordshire rates, the recent award of the Staffordshire arbitrators will benefit the Sheffield hands.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

There has been little doing in the Glasgow iron market this week on account of the holidays. The market was closed on Monday, and there was no forenoon meeting of the iron merchants on Tuesday. Previous to the close of the market on Friday, the prices which had previously suffered a decline owing to large realisations on the part of holders were again beginning to strengthen. The demand for makers' iron had not materially increased on the whole, but there were rather better inquiries from the United States—a feature of the trade which was regarded as having been favourable. During the week 2400 tons of pigs had been sent to the States, and there had been some slight renewal of business with Canada and South America. But the market has been principally occupied this week with the consideration of how the trade is likely to be affected by the annual statistics. These were made up on Tuesday afternoon by the committee of the Glasgow Association of Iron Merchants and Brokers, and the period embraced by the statistics is that from 25th December, 1880, to the same date in 1881. The figures are as follows:—

	1881.	1880.	1881. Increase.	1881. Decrease.
Production	1,176,000	1,049,000	127,000	—
Consumption—				
In foundries	180,000	189,200	—	—
In malleable and steel works	217,000	194,800	—	—
(Quantity of malleable iron and steel made—1881, 361,000; 1880, 292,000)	397,000	384,000	13,000	—
Exports—				
Foreign, 369,115 — less English iron tran-shipped (estimated), 13,000	356,115	440,200	—	—
Coastwise	193,414	200,848	—	—
Railway to England, about	28,471	29,952	—	—
Stocks—				93,000
In Connal's stores	627,186	495,850	131,336	—
Estimated quantity in makers' hands	312,814	243,150	69,664	—
	940,000	739,000	201,000	

With reference to these figures it should be explained that the consumption and the shipments have been arrived at as usual from the returns actually received. Some difficulty was, however, experienced in the making up of the production, and the stocks remaining in makers' hands. This arose in consequence of a difference of opinion among the ironmasters as to the channel through which the figures should be communicated, and the committee was therefore under the necessity of resorting to an estimate which must be regarded as pretty accurate. It has been usual for some time of late to calculate that the furnaces were producing at the rate of 200 tons each per week as the average, but the committee took 195 as the average. In this way the production was ascertained to have amounted to 127,000 tons more of Scotch iron than in the preceding year. The consumption in foundries shows a decrease of 9200 tons, but in malleable and steel works, on the other hand, there is an increase of 22,200 tons, giving a total increase in the home consumption of Scotch pigs of 13,000 tons. It is worthy of note that 361,000 tons of malleable iron and steel have been made in Scotland, as compared with 292,000 in 1880. Deducting 13,000 tons of English iron which were brought to Scotland and transhipped abroad, the foreign shipments amount to 356,115 tons, a decrease of 84,085 tons, as compared with those of last year. The coastwise shipments are 7434 lower, and the consignments by rail to England about 1481 lower than in last year, and it thus appears that the exports, as a whole, exhibit a decline of 93,000 tons. The stock in Messrs. Connal and Co.'s stores has increased 131,336 tons, and the quantity of pigs in makers' hands 69,664, making altogether a total addition to stocks during the year to 201,000 tons. The entire stocks are thus 940,000 tons, by far the largest on record. The average price of mixed numbers of warrants during the year has been 49s. 1½d., against 54s. 6d. last year, the average number of furnaces in blast 116, against 106; the lowest price of warrants was 45s. on the 23rd May last, and the highest 53s. 9d. on the 14th January. The probability is that the disclosure of such a large amount of iron in store, notwithstanding the fact that 16 blast furnaces have been out by arrangement during the past three months, will have for the time at least a rather depressing effect upon the market.

Business was done in the warrant market on Friday at 52s. 4d. cash. As above stated, there was no market on Monday. On Tuesday afternoon transactions were effected at from 51s. 3d. to 51s., and again at 51s. 3½d. cash, and from 51s. 6½d. to 51s. 3d. one month. On Wednesday the market was irregular, with business between 50s. 9d. and 51s. 2d. cash and 51s. 4d. to 51s. 5½d. one month. The tone was slightly firmer to-day—Thursday—with transactions from 50s. 10½d., and 51s. 2d. cash and 51s. 3d. to 51s. 6d. one month.

The malleable iron trade continues very busy. The quantity of Cleveland and Cumberland pig iron consumed locally in Scotland during the year has amounted to 240,000 tons in foundries, and 180,000 tons in malleable ironworks and steel works. The prices of manufactured iron continued very moderate during the greater part of the year, but a decided increase has been experienced during the past two months in consequence of the large demand that has set in in course of that time.

The coal trade is active at present. Stocks have been accumulating very rapidly, but prices, which were easy for all qualities with the exception of dross, are a few pence higher per ton, and the prices of dross, are somewhat firmer. As far as regards the amount of the consumption, the coal trade during the year has been very satisfactory. Prices have, however, been low and profits comparatively small.

The tonnage launched from the Clyde shipbuilding yards during the past year amounts to 341,022 as compared with 248,666 in 1880. The highest tonnage produced in any previous year was 262,430 in 1874. It is estimated that there is now under contract shipbuilding to the extent of about 207,000 tons, of which 50,000 tons are to be vessels constructed of steel. It may be interesting to note that 18,000 tons of steel vessels were built in 1879; 42,000 in 1880, and 66,609 in 1881.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

As might have been expected, the iron market held at Middlesbrough on Tuesday last was but poorly attended, many ironmasters, merchants, and others being absent. Under these circumstances but little business was done. The great feature of the market was the announcement at the end thereof of the annual statistics relating to the Scotch pig iron trade. It appears that there has been a total increase of stocks of 201,000 tons. The production increased 127,000 tons; the local consumption increased 13,000 tons, but the exports decreased 93,000. The local consumption of Cumberland and Cleveland iron increased 85,000 tons, and the total stocks now amount to 940,000 tons. These results seem to indicate that the Cleveland iron trade is in a much healthier condition than its northern rival, and justifies the opinion which has often been expressed, that the recent combination to restrict the output was a great mistake as regards Cleveland. In two months' time the period for which that restriction was undertaken will expire, and it will then have to be decided whether it is to be continued, and, if so, subject to what modifications, if any. It is now becoming more and more clear that Cleveland stocks would have diminished, and Cleveland prices would have risen without any combination, and that but for the combination a restriction, either voluntary or compulsory, must have taken place on the Clyde.

There is now a prospect of more works being set going in Cleveland. The Norton furnaces have fallen into new hands, and are about to be put into working order, if, indeed, operations have not already been commenced. In a few months it is expected they will be contributing at least 1500 tons of pig iron per week to the general output. Several other furnaces are being relined, and will shortly be ready for action. It is impossible to believe that the Cleveland ironmasters will continue to work on slack blast while new firms and new furnaces are on all hands entering into fresh competition with them. It must eventually come to be a battle of positions and of districts, and then the survival of the fittest. This final result can only be delayed provided, and so long as, the price of pig iron remains high enough to yield a profit for all. With regard to the stocks of Cleveland iron for the present month, it is believed that they will be found to have slightly accumulated, owing to somewhat diminished shipments and the holidays at the rolling mills.

The price of No. 3 g.m.b. for prompt f.o.b. delivery was on Tuesday 43s. per ton, and for the first three months 43s. 6d. per ton; No. 3 Connal f.o.b. Warrants are now sold at 43s. 6d. per ton.

The finished iron trade is firm but quiet. Prices are the same as last week, viz., from £7 to £7 5s. for plates, and £6 10s. for bars and angles. Puddled bars are £4 15s.

A terrible disaster occurred upon the railway near the Erimus Works at Stockton on Monday, whereby five men were killed. As far as can be at present ascertained it arose from the collapsing of the top of the inner copper fire-box of a locomotive belonging to and built by the North-Eastern Railway Company. The engine was standing at the time waiting for signals. It is said that the tension stays were screwed and rivetted in the fire-box, and were of copper, and that the plate was torn away from them. No doubt exact evidence will be forthcoming at the inquest.

The chemical works situated at Middlesbrough, and carried on for many years by Messrs. Wm. Jones and Co., have just been purchased by Dr. Sadler, proprietor of the adjoining works, and who is well known as an extensive and successful chemical manufacturer. The chief products which Messrs. Wm. Jones and Co. have made have been sulphate of soda, oxalic acid, Epsom salts, and barium sulphide, while Sadler's works have been chiefly occupied with the manufacture of dyes from ammoniacal liquors.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

WITH reviving prospects Swansea is taking a decided step in advance. An energetic movement is on foot to revive the Chamber of Commerce; and with that and the vigour shown in new railway speculations, the local industries, and shipping, signs are good at this port. I have previously referred to the increase of the coal trade between this port and Ireland. Last week this was very strongly shown. Swansea, when supplied with the best seams of the Rhondda, will do a large trade both with France and Ireland. The total coal shipments from Wales last week were slightly under 150,000 tons, of which Cardiff sent 104,000. The three leading ports could have done much more than this but for the delay of incoming vessels by the storms. During the preceding week there was a good deal of spurt manifested in house coal and steam, the colliers doing their utmost to make provision for the Christmas. Travellers journeying by the Taff Vale must have noticed at one or two leading collieries a great storage of coal going on. This is easily explained. Some of the principal coalowners are steadily refusing business, except at an advanced rate, and it is very probable that they will succeed.

The same withholding characterises also the iron trade. Great caution is exercised in the acceptance of orders, and offers for large quantities steel, bar, or pig, for future deliveries, are regarded with a good deal of hesitation. The steel trades may be summarised generally as "good." The time is now getting near for the settlement of the Pentyrch and Melingriffith properties, and a good deal of interest is exhibited in the neighbourhood, and Cardiff, as to the proceeding of the new proprietary. The various departments are under able hands, but one can see at a glance that an expenditure of capital would be a wise step. The proximity of the place to Cardiff, and the rich coal beds of its own, make the property of special value. I should not be surprised at the old Anchor Works falling to the new company; five mills for tin-plate of the latest design could be constructed there.

The tin-plate trade is rather quiet, but late advances have been maintained.

In patent fuel Swansea and Cardiff are briskly employed, and this industry exhibits a continuance of firmness in price which is gratifying to makers.

The Bilbao ore trade continues good. Stocks are low owing to the numerous shipping casualties amongst the vessels engaged in this trade, and the tendency of prices is to advance. Welsh ore is still used in driblets, and that is all. It is not likely that when stocks are exhausted any old sinkings will be re-worked or new ones attempted. More than this, if anyone watches minutely the course of incidents for the next few years, he will see considerable transformation work in the leases of mineral property. With Welsh ore—which was at one time of paramount consideration to coal—now a drug, a thorough revision of all mineral property is imperative.

Extensive changes are again spoken of at Rhymney for the more complete development of this important industrial centre. Its position, commanding two ports with great railway facilities, give the place great advantages.

Mr. Inskip, has been appointed to the vacant directorate of the Taff Vale Railway.

The drain on the Rhondda coal fields has received another illustration. On the average 1300 tons of coal are sent up daily from Clydach Vale Colliery. This valuable property belongs to Messrs. Thomas and Riches; the seam is 9ft., and is described as being like a quarry of limestone.

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 and address of the communicating party are printed in italics.

20th December, 1881.

5563. FURNACES, W. L. Wise.—*(G. E. Palmer and A. Worthington, Chicago, and G. Rowell, Brooklyn.)*
5564. REVOLVING FIRE-ARMS, W. Stringfellow, Mistley.
5565. FLUSHING FURS, T. Potter and G. Rice, London.
5566. PRODUCING ELECTRICITY, A. Millar, Glasgow.
5567. BRACELETS, B. W. Fase, London.
5568. BOILERS, J. Dickson, jun., Liverpool.
5569. REVOLVING FIRE-ARMS, W. R. Lake.—*(J. H. Wesson, Springfield, U.S.)*
5570. COMPOUND ENGINES, A. Clark.—*(G. Massey, U.S.)*
5571. FLOOR COVERINGS, A. Clark.—*(C. & V. Meyer, U.S.)*
5572. ADJUSTABLE SUPPORTS, E. A. Brydges.—*(N. Weiderer, Germany.)*
5573. TELEPHONES, W. R. Lake.—*(J. H. Rogers, U.S.)*
5574. FUEL BLOCKS, J. Imray.—*(G. S. Page, U.S.)*
5575. LOCOMOTIVES, J. Quick & J. Quick, jun., London.
5576. HEADS and GRATINGS, H. S. Cregeen, Bromley.
5577. ELECTRIC TELEGRAPHS, J. Anderson and B. Smith, London.
5578. TRANSMITTING MOTIVE POWER, W. G. S. Mockford, London.
5579. REMOVING IRON from FERRUGINOUS SOLUTIONS, C. Semper and C. Fahlberg, Philadelphia, U.S.
5580. PROTECTING BAGS, &c., C. E. Buck, U.S.
5581. SEWING MACHINES, N. Wilson, London.

21st December, 1881.

5582. TRANSPORTING MINERALS, H. Grafton, London.
5533. PRODUCTION of NATURAL FORCES, W. E. Gedge.—*(E. T. Champin, Lyons.)*
5584. EXPLOSIVE COMPOUND, H. Lake.—*(S. Divine, U.S.)*
5585. REGULATING GEAR, H. J. Haddan.—*(B. Boussille, France.)*
5586. COLOURING MATTERS, F. Wirth.—*(E. Oehler, Germany.)*
5587. BARBED FENCE WIRE, E. G. Brewer.—*(T. H. Dodke and C. G. Washburn, U.S.)*
5588. MOTORS, E. G. Brewer.—*(G. Grange, Paris.)*
5589. REFINING IMPURE COPPER, H. H. Lake.—*(C. T. J. Vautin, Australia.)*
5590. DOOR CHECKS, H. H. Lake.—*(L. C. Norton, U.S.)*
5591. CLARIFYING LIQUIDS, C. H. Roeckner, Newcastle-on-Tyne.
5592. BAND SAWS, J. Johnson.—*(H. Tuyssuxien, Paris.)*
5598. DYNAMO-ELECTRIC MACHINES, L. S. Powell.—*(J. M. A. G. Lescuyer, Paris.)*
5594. KNITTING MACHINES, B. J. B. Mills.—*(N. W. Westcott, Providence.)*
5595. ELECTRIC CALLS, A. W. Lake.—*(W. Lockwood, U.S.)*
5596. CARTRIDGES, H. H. Lake.—*(S. R. Divine, U.S.)*
5597. CALORIC ENGINES, A. M. Clark.—*(J. Schweizer, Switzerland.)*
5598. PHOTOGRAPHIC CAMERAS, W. Lawley, London, and H. S. Starnes, New Thornton Heath.
5599. INSULATED CONDUCTORS, W. Smith, London.
5600. ELECTRIC LIGHTING APPARATUS, S. Pitt—*(E. T. Starr, Philadelphia, U.S.)*
5601. ELECTRICAL BRUSHES, J. N. Aronson, London.
5602. FILES, A. M. Clark.—*(M. A. Howell, jun., U.S.)*

22nd December, 1881.

5603. OPEN FURNACES, O. Trossin, London.
5604. GALVANIC BATTERIES, E. B. Burr, Walthamstowe, and W. T. Scott, Stratford.
5605. AMBULANCE STRETCHERS, A. K. Irvine, Glasgow.
5606. ILLUMINATING CANDLES, H. J. Haddan.—*(R. F. W. Loper and C. McKeone, U.S.)*
5607. LOCKS, C. Zender, Berlin.
5608. BOXES, W. R. Lake.—*(J. M. Douarin, Paris.)*
5609. PREVENTING RADIATION of HEAT, C. Napier and J. Paterson, Aberdeen.
5610. BISCUITS, F. Boucher, Plaistow.
5611. ROLLING MILLS, E. Edwards.—*(G. Erkenzweig, Germany.)*
5612. REVOLVING BUOY, F. M. Duncan, Glasgow.
5613. FIRE-ARMS, B. J. B. Mills.—*(J. H. McLean, U.S.)*
5614. BORING ROCKS, J. T. Jones and J. Wild, Leeds.
5615. CABLES, J. N. Culbertson, Antwerp, and J. W. Brown, London.
5616. REFINED SUGAR, J. H. Johnson.—*(M. Weinrich, Vienna.)*
5617. CYANURETS, J. H. Johnson.—*(V. Alder, Vienna.)*
5618. ELECTRIC LIGHT HOLDER, D. Graham, Glasgow.

23rd December, 1881.

5619. NET HAULING WINCHES, C. R. Mitchell, Aberdeen.
5620. LIFTING SAFETY VALVES, T. Rogers, Smethwick.
5621. TREATING GASES, F. Wirth.—*(H. Roessler, Frankfort-on-the-Main.)*
5622. AUTOMATIC HARMONICA, W. P. Thompson.—*(M. Harris, New York.)*
5623. MEASURING ELECTRIC CURRENTS, C. A. Carus-Wilson, London.
5624. NAILS, J. W. Summers, Stalybridge.
5625. COOLING AIR, J. J. Coleman, Glasgow.
5626. BLEACHING YARN, J. Auchinvole, Glasgow.
5627. ELECTRIC CALL SIGNALS, H. J. Haddan.—*(G. W. Foster and F. B. Wilson, Paris.)*
5628. KNITTING MACHINES, L. A. Groth.—*(G. Grosser, Germany.)*
5629. SHIFTING GRAIN, E. J. Power.—*(W. Power, U.S.)*
5630. REEDS, J. B. Hamilton, Greenwich.
5631. SECONDARY BATTERIES, J. S. Sellon, London.
5632. INCANDESCENT LAMPS, J. S. Sellon, London.
5633. SPREADING SAND, R. G. Garvie, Aberdeen.
5634. SHEAR STEEL, H. Eadon & C. Yeomans, Sheffield.
5635. LAMPS, F. S. Kendrick, Balsall Heath.
5636. KEYLESS WATCHES, C. H. Errington, Coventry.
5637. CONTROLLING MARINE ENGINES, R. J. Smith, Sunderland.
5638. EXHIBITING PICTURES, E. Webster and T. M. Williams, London.
5639. ELECTRICAL ALARM, D. S. Garau, London.
5640. PRINTING MACHINES, A. Godfrey, London.
5641. ROTARY ENGINES, B. J. Mills.—*(P. d'Orto, Genoa.)*
5642. REFRIGERATORS, G. C. Roberts, London.
5643. WORKING SIGNALS, A. Gough, Buckingham.

24th December, 1881.

5644. RAILWAY RAILS, A. J. Acaster, Sheffield.
5645. SPINNING COTTON, J. Walker, Hyde.
5646. MUSICAL INSTRUMENTS, W. P. Thompson.—*(M. Harris, New York.)*
5647. STEAMSHIPS, W. Thompson.—*(G. Cochrane, U.S.)*
5648. NAILS, J. Grimshaw. Leeds.
5649. GAS BURNERS, W. T. Sugg, London.
5650. ALUM, P. and F. M. Spence, Manchester.
5651. ELECTRIC CURRENT METERS, St. G. Lane-Fox, London.
5652. WINDING-UP WATCHES, A. Burdess, Coventry.
5653. TRICYCLES, J. Harrington, Kensington.
5654. RIFLING GUN BARRELS, P. Mauser, Wurtemburg.
5655. HEATING WATER, B. Mills.—*(L. Robin, sen., Paris.)*
5656. ELECTRIC CLOCKS, E. G. Brewer.—*(C. Buell, U.S.)*
5657. FISHING VESSELS, J. & C. Eskriett, Great Grimsby.
5658. PICKERS, E. Hollingworth, Dobcross.
5659. GAS PRESSURE ACCUMULATORS, F. H. F. Engel.—*(W. Klinkerfues, Gottingen.)*
5660. ELECTRIC LAMPS, L. S. Powell.—*(J. M. A. Gerald. Lescuyer, Paris.)*
5661. PIPES, J. Johnson.—*(C. Labye and L. de Locht-Labye, Paris.)*
5662. SHAFTS, A. M. Clark.—*(A. V. Sillière, Paris.)*
5663. EXTINGUISHING FIRE, W. Lake.—*(H. Maxim, U.S.)*
5664. PRODUCING TRAVERSE, W. W. Hulse, Manchester.
5665. PRODUCING ELECTRIC LIGHT, S. Varley, Hatfield.
5666. PROPELLING BOATS, A. Burdess, Coventry.
5667. COLLECTING ELECTRIC CURRENTS, S. Varley, Hatfield.

26th December, 1881.

5568. ELECTRIC CURRENTS, W. Thomson, Glasgow.
5669. DESTROYING INSECTS, H. H. Lake.—*(La Société La Reconstitution Viticole, Paris.)*

Inventions Protected for Six Months on deposit of Complete Specifications.

5543. BRICK-MOULDING MACHINES, C. F. Schlickeysen.—*17th December*, 1881.
5569. REVOLVING CYLINDER FIRE-ARMS, W. R. Lake, London.—A communication from J. H. Wesson, Springfield, U.S.—*20th December*, 1881.
5570. COMPOUND ENGINES, A. M. Clark, London.—A communication from G. B. Massey, New York, U.S.—*20th December*, 1881.
5579. REMOVING IRON from FERRUGINOUS SOLUTIONS, C. Semper and C. Fahlberg, Philadelphia, U.S.—*20th December*, 1881.
5580. PROTECTING BAGS, &c., C. B. Buck, Wilmington, U.S.—*20th December*, 1881.
5584. EXPLOSIVE COMPOUND, H. H. Lake, London.—A communication from S. R. Divine, New York.—*21st December*, 1881.
5589. REFINING IMPURE COPPER, H. H. Lake, London.—A communication from C. T. J. Vautin, North Fitzroy, Australia.—*21st December*, 1881.
5590. PREVENTING the SLAMMING of DOORS, H. H. Lake, London.—A communication from L. C. Norton, Boston, U.S.—*21st December*, 1881.
5596. CARTRIDGES, H. H. Lake, London.—A communication from S. R. Divine, New York.—*21st December*, 1881.
5600. ELECTRIC LIGHTING, S. Pitt, Sutton.—A communication from E. T. Starr, Philadelphia, U.S.—*21st December*, 1881.
5602. FILES, A. M. Clark, London.—A communication from M. A. Howell, jun., Chicago, U.S.—*21st December*, 1881.

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

5204. SPEAKING TUBES, P. W. Barlow, Castle Hill.—*19th December*, 1878.
5207. SMOKE-CONSUMING APPARATUS, W. J. Chubb, Greenwich.—*19th December*, 1878.
5227. DRYING WOOL, J. Petrie, jun., and J. Fielden, Rochdale.—*20th December*, 1878.
5235. UNLOADING SUGAR, &c., J. Craig, Greenock.—*21st December*, 1878.
5263. ROLLING METALS, S. Fox, Deepcar.—*24th December*, 1878.
5277. CRUSHING, &c., ORES, &c., D. Stevens, Crowan, and R. Vivian, Camborne.—*24th December*, 1878.
12. SEWING MACHINES, J. Keats, Wood Green.—*1st January*, 1879.
43. COLOURING MATTER, F. Wirth, Frankfort-on-the Main.—*3rd January*, 1879.
4960. GENERATING ELECTRIC CURRENTS, A. V. Newton, London.—*4th December*, 1878.
5216. OIL CAKES, J. McDougall, London.—*20th December*, 1878.
5219. SPINDLES, T. Marsh and J. Clayton, Ashton-under-Lyne.—*20th December*, 1878.
5222. TREATING RAILWAY SLEEPERS, E. T. Hughes, London.—*20th December*, 1878.
5226. BLEACHING COTTON, &c., F. Wilkinson, Manchester.—*20th December*, 1878.
5228. LUBRICATORS, J. Lumb and J. Haigh, Elland.—*20th December*, 1878.
5300. APPLYING PRESSURE, J. F. Meade, Eastwood.—*28th December*, 1878.
139. PLAYING MUSICAL INSTRUMENTS, E. Hunt, Glasgow.—*13th January*, 1879.
5249. SANITARY COMPOUND, W. Jeyes, Birmingham.—*3rd December*, 1878.
5285. SEWING MACHINES, J. and G. Watson and E. Jackson, Oldham.—*27th December*, 1878.
5291. PURIFYING COAL GAS, F. Versmann, London, and J. von Quaglio, Brompton.—*27th December*, 1878.
5330. KNEADING MACHINES, P. Pfleiderer, Norwood.—*31st December*, 1878.
76. CONDENSING STEAM, H. W. Buckley, New York.—*8th January*, 1879.
5245. PNEUMATIC RAILWAYS, T. W. Rammell, London.—*23rd December*, 1878.
5253. BOBBINS, W. Wood, Dukinfield.—*24th December* 1878.
5278. PRESSING PAPER, A. M. Clark, London.—*24th December*, 1878.
5286. ANCHORS, J. Scott and J. H. Riddel, Glasgow.—*27th December*, 1878.
5287. CUT-OFF GEAR, J. Turnbull, jun., Glasgow.—*27th December*, 1878.
5297. REAPING MACHINES, P. C. and P. Evans, Brimscombe, & H. King, Newmarket.—*27th December*, 1878.
5332. SAND MOULDS, W. Darling and R. V. Sellers, Keighley.—*31st December*, 1878.
5254. STEAM GENERATORS, J. Blake, Manchester.—*24th December*, 1878.
5269. LOOMS, R. C. Stevenson, Bradford.—*24th December*, 1878.
5274. CHROMATIC PRINTING, W. R. Lake, London.—*24th December*, 1878.
5329. DOVETAILING MACHINES, M. Benson, London.—*—31st December*, 1878.

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

18. METALLIC BUTTONS, G. T. Bousfield, Sutton.—*1st January*, 1875.
4427. HYDRAULIC PRESSES, W. T. Mann, Liverpool.—*23rd December*, 1874.
4446. PULLEYS, E. R. Wethered, Woolwich.—*24th December*, 1874.
4478. COPYING PENCIL, P. Jensen, London.—*30th December*, 1874.
4440. REGULATING SUPPLY of AIR, T. S. Prideaux, Blackheath.—*24th December*, 1874.

Notices of Intention to Proceed with Applications.

Last day for filing opposition, 13th January, 1882.

3611. LOADING COAL, T. Hancock, Rugeley.—*19th August*, 1881.
3621. AIR-COMPRESSING MACHINES, V. Haurie, London.—Partly a communication from F. Windhausen.—*19th August*, 1881.
3622. HOT-AIR, &c., MACHINES, V. Haurie, London.—Partly a com. from F. Windhausen—*19th August*, 1881.
3626. WHEELS, J. Mansell, Birmingham.—*20th August*, 1881.
3638. CORE BARS, H. S. Stewart, Bridge-street, Westminster.—*20th August*, 1881.
3642. FIRE-BARS, T. Nash, Nether Edge, Sheffield.—*22nd August*, 1881.
3657. CASTS, &c., of PATTERNS, J. S. Sachs, Sunbury.—*22nd August*, 1881.
3659. LOCOMOTIVE ENGINES, W. Morgan-Brown, London.—A communication from F. M. Stevens and J. H. Pearson.—*23rd August*, 1881.
3660. DRYING SUGAR, &c., W. Morgan-Brown, London.—Com. from C. and F. Hersey.—*23rd August*, 1881.
3661. VALVE STEM SUPPORTS, W. Morgan-Brown, London.—Com. from G. H. Richards.—*23rd August*, 1881.
3664. PHOTOGRAPHIC PICTURES, P. M. Justice, London.—Communication from J. Dewé.—*23rd August*, 1881.
3687. SLIDE VALVES, C. de Lucia, Naples.—*24th August*, 1881.
3724. SHIPS, A. M. W. Samson, Northolt, near Southall.—*26th August*, 1881.
3768. RAILWAY SIGNALLING, W. Morgan-Brown, London.—A communication from O. Gassett and I. Fisher.—*30th August*, 1881.
3773. TOILET BOX, W. R. Lake, London.—A communication from S. Haslett.—*30th August*, 1881.
3888. BICYCLES, H. Haes, Wednesbury.—*8th September*, 1881.
4050. DOOR SPRINGS, A. Martin, Woolwich.—*20th September*, 1881.
4121. DRIVING BICYCLES, T. E. Heath, jun., Penarth.—*24th September*, 1881.
4162. PAPER PULP, H. Olrick, London.—A communication from M. L. Keen.—*27th September*, 1881.
4229. COMPOSING TYPE, H. J. Haddan, London.—A com. from C. G. Fischer.—*30th September*, 1881.
4292. MALT LIQUORS, A. E. Wood, Wavertree.—*4th October*, 1881.
4629. GLAND STUFFING-BOXES, J. G. Stidder, London.—*22nd October*, 1881.
4787. STOVES, J. Dunnachie, Lanark, N.B.—*2nd November*, 1881.
4810. NON-CONDUCTING COMPOSITION, L. Masebe, Hamburgh.—*3rd November*, 1881.
4813. TIN ROLLERS, W. Gledhill, Mossley.—*3rd November*, 1881.
4840. CONCRETE, J. B. Spence, London, and E. Ormerod, Belvedere.—*4th November*, 1881.
5031. SUPPOSITORIES, B. J. B. Mills, London.—A com. from E. H. Gibbs.—*16th November*, 1881.

5254. PICKS, &c., T. N. Robson, Newbottle.—*1st December*, 1881.
5256. LUBRICANTS, J. Davis, Great Dover-street, London —*1st December*, 1881.
5338. SECONDARY BATTERIES, D. FitzGerald, C. Biggs, and W. Beaumont, London.—*6th December*, 1881.
5394. DRIVING VELOCIPEDES, R. H. Berens, Sidcup.—*9th December*, 1881.

Last day for filing opposition 17th *January*, 1882.

3652. COILING MACHINE, C. Clarke and J. Leigh, Manchester.—*22nd August*, 1881.
3663. FIRE-BARS, J. G. Galley, Upton.—*23rd August*, 1881.
3669. DEVICES for POCKET-BOOKS, W. Lake, London.—A com. from J. W. Meaker.—*23rd August*, 1881.
3670. COOLING AIR, W. R. Lake, London.—A com. from J. P. and O. G. Burnham.—*23rd August*, 1881.
3676. VALVES, J. Smith, jun., and S. A. Johnson, Millwall, London.—*23rd August*, 1881.
3678. POLISHING SPOONS, &c., E. W. Lay and S. Martin, Hampstead.—*23rd August*, 1881.
3682. MEASURING LIQUIDS, W. B. Healey, Westminster.—A com. from W. L. Hunt.—*24th August*, 1881.
3684. DRIVING GEAR for VELOCIPEDES, W. G. Hammon, Coventry.—*24th August*, 1881.
3688. SEWING MACHINES, A. Watkins, London.—*24th August*, 1881.
3697. BICYCLE LAMP, G. R. Godsall and J. C. C. Read, Birmingham.—*25th August*, 1881.
3698. TUYERES, C. J. Brock, London.—A communication from H. Walker.—*25th August*, 1881.
3699. SEWING MACHINES, J. Sefton, Belfast.—*26th August*, 1881.
3703. SECURING RAILS in CHAIRS, T. Matthews, Stoke Newington, London.—*25th August*, 1881.
3728. OZONISED OXYGEN, E. Hagen, Ealing.—A com. from L. Q. and A. Brin.—*26th August*, 1881.
3730. SPINNING COARSE YARNS, J. Barbour and A. Combe, Belfast.—*26th August*, 1881.
3737. RAMMING APPARATUS, H. Knoblauch, Berlin.—A com. from E. Dietrich.—*27th August*, 1881.
3741. REFRIGERATING APPARATUS, O. Möcke, Leipsic.—Com. from L. L. von Lesser.—*27th August*, 1881.
3742. FEEDING STEAM BOILERS, E. Fromentin, Paris.—*27th August*, 1881.
3745. ETCHING GLASS, J. Fahdt, Dresden, Saxony.—*27th August*, 1881.
3741. HYDRATE of STRONTIA, C. F. Claus, Mark-lane, London.—*27th August*, 1881.
3752. EASEL, J. Kellett, Bradford.—*29th August*, 1881.
3753. MOTOR, J. Kellett, Bradford.—*29th August*, 1881.
3758. CUTTING-OUT FABRICS, J. Fox, Milton-street, London.—*29th August*, 1881.
3765. PRESERVING COTTONSEED, F. R. Lanier, Liverpool.—*30th August*, 1881.
3789. STENTERING, &c., FABRICS, C. Barlow, Manchester.—A com. from E. Welter.—*31st August*, 1881.
3841. MINCING MEAT, F. J. Gardner, Birmingham.—*3rd September*, 1881.
3902. PACKING CHLORIDE of LIME, J. C. Steele, Glasgow.—*8th September*, 1881.
3939. WORM GEARING, A. Shaw, Lockwood, near Huddersfield.—*12th September*, 1881.
4032. SEWING MACHINES, C. Snow, Washington, U.S.—A communication from F. Altman and F. Pommer.—*19th September*, 1881.
4094. PUMPS, F. P. Preston, J. T. Prestige, and E. J. Preston, Deptford, E. W. De Rusett, Anerley, and J. A. Fowler, Deptford.—*22nd September*, 1881.
4127. FIRE-ALARM WIRE, B. J. B. Mills, London.—A com. from P. A. Charpentier.—*24th September*, 1881.
4203. HEATING, J. T. Goudie, Glasgow.—*29th September*, 1881.
4464. COMBING WOOL, &c., W. Terry and J. Scott, Dudley Hill, near Bradford.—*13th October*, 1881.
4608. GAS ENGINES, W. Watson, Leeds.—*21st October*, 1881.
4742. CABINET DESKS, F. H. F. Engel, Hamburg.—A com. from J. Kuhlmann.—*29th October*, 1881.
4948. ELECTRIC LAMPS, G. G. André, Dorking.—*11th November*, 1881.
5061. STEAM ENGINES, H. J. Coles, Southwark.—*19th November*, 1881.
5098. HEATING BLAST, T. F. Harvey, Dowlais.—*22nd November*, 1881.
5156. ROTARY ENGINES, A. Brossard, Paris.—*25th November*, 1881.
5196. COCKS and VALVES, D. R. Ashton and J. N. Sperryn, London.—*28th November*, 1881.
5201. MOTIVE-POWER ENGINES, W. W. Tonkin, London.—*29th November*, 1881.
5216. HYDRAULIC MOTORS, J. Liardet, Brockley, and T. Donnithorne, London.—*29th November*, 1881.
5224. WINDOW SASHES, E. V. Harris, Winchester.—*29th November*, 1881.
5251. WASHING MACHINES, W. B. Brooker, Bootle.—*30th November*, 1881.
5285. FURNACES, J. Redgate, Nottingham. — *3rd December*, 1881.
5311. PULLEY BLOCKS, T. H. Ward, Tipton.—*5th December*, 1881.
5335. PILLOW LACE, W. R. Lake, London.—A communication from C. Jamnig —*5th December*, 1881.
5376. FRAMES for MUSIC, &c., J. F. Walters and J. H. Rosoman, London.—*8th December*, 1881.
5463. DIES, W. R. Lake, London.—A communication from G. Dunning.—*14th December*, 1881.
5570. COMPOUND ENGINES, A. M. Clark, London.—A com. from G. B. Massay.—*20th December*, 1881.
5579. REMOVING IRON from ALUMINOUS SOLUTIONS, C. Semper and C. Fahlberg, U.S.—*20th December*, 1881.
5580. PROTECTING BAGS, &c., C. E. Buck, Wilmington, U.S.—*20th December*, 1881.
5602. FILES, A. M. Clark, London.—A communication from M. A. Howell, jun.—*21st December*, 1881.

Patents Sealed.

List of Patent Letters which passed the Great Seal on the 23rd *December*, 1881.)

910. METALLIC PENS, M. Turnor, Birmingham.—*3rd March*, 1881.
2458. DISPLAYING ADVERTISEMENTS, H. H. Banyard, London —*4th June*, 1881.
2761. ELECTRO-MAGNET INDUCTION MACHINE, L. A. Groth, London.—*24th June*, 1881.
2762. ADJUSTING ACTION for CHAIRS, T. Barnby, Birmingham.—*24th June*, 1881.
2765. MOTIVE-POWER ENGINE, J. Levassor, Paris.—*24th June*, 1881.
2775. GAS APPARATUS, J. Woodward, Manchester.—*25th June*, 1881.
2777. RAILWAY SIGNALLING, G. Brockelbank, Anerley.—*25th June*, 1881.
2787. DRYING, &c., SUBSTANCES, J. C. Mewburn, Fleet-street, London.—*25th June*, 1881.
2790. EVAPORATING APPARATUS, G. W. von Nawrocki, Berlin.—*25th June*, 1881.
2809. CEMENT, W. Joy, Aylesford.—*27th June*, 1881.
2810. SEPARATING FLUIDS, F. H. F. Engel, Hamburg.—*27th June*, 1881.
2825. SEPARATING IRON, &c., E. Hunt, Glasgow.—*28th June*, 1881.
2838. PURIFICATION of COAL-GAS, C. F. Claus, Mark-lane, London.—*28th June*, 1881.
2850. TREATING FISH, S. D. Cox, Woolwich.—*29th June*, 1881.
2867. TELEPHONIC APPARATUS, W. E. Potter, Liverpool.—*1st July*, 1881.
2882. PREPARING VEGETABLE SUBSTANCES, R. G. Perry, Rathdowney, Ireland.—*2nd July*, 1881.
2886. MAKING CASKS, F. McClure Scott, Liverpool.—*2nd July*, 1881.
2909. CRUSHING and GRINDING MILLS, W. N. Nicholson and W. Mather, Newark-upon-Trent. -*4th July*, 1881.
2928. ATTACHING HARNESS to CARRIAGES, C. D. Abel, London.—*5th July*, 1881.
2933. VALVE GEAR, W. Hargreaves and W. Inglis, Bolton.—*5th July*, 1881.
2982. BINDING CORN, W. Woolnough and C. Kingsford, Kingston.—*8th July*, 1881.
2986. TELEPHONIC SIGNALLING, J. Imray, London.—*7th July*, 1881.
3009. MONEY TILLS, B. W. Webb, Harrington-square, London.—*8th July*, 1881.
3336. METALS and METALLIC ALLOYS, W. L. Wise, Westminster.—*2nd August*, 1881.
3376. ARTIFICIAL IVORY, F. W. Cottrell, Calthorpe-street, London.—*4th August*, 1881.
3944. TELEPHONES, W. E. Irish, Sunderland.—*12th September*, 1881.
3984. PITCH CHAINS. A. H. Wallis, Basingstoke.—*15th September*, 1881.
4612. STEAM PRESSES, L. A. Schmiers, Leipzig, Saxony.—*21st October*, 1881.

List of Specifications published during the week ending December 24th, 1881.

4226, 2d.; 1021, 2d.; 2049, 4d.; 2120, 6d.; 2161, 2d.; 2171, 4d.; 2215, 6d.; 2223, 6d.; 2224, 6d.; 2224, 2d.; 2232, 6d.; 2233, 2d.; 2236, 2d.; 2237, 6d.; 2240, 2d.; 2241, 2d.; 2242, 2d.; 2243, 2d.; 2244, 6d.; 2245, 2d.; 2247, 4d.; 2248, 2d.; 2250, 2d.; 2251, 6d.; 2252, 6d.; 2254, 6d.; 2257, 6d.; 2259, 4d.; 2261, 6d.; 2262, 6d.; 2263, 6d.; 2266, 6d.; 2267, 2d.; 2268, 4d.; 2269, 2d.; 2270, 2d.; 2271, 2d.; 2272, 4d.; 2273, 2d.; 2274, 4d.; 2275, 1s.; 2277, 10d.; 2279, 1s. 2d.; 2280, 6d.; 2281, 4d.; 2282, 6d.; 2284, 6d.; 2285, 2d.; 2286, 2d.; 2287, 2d.; 2288, 6d.; 2289, 2d.; 2290, 2d.; 2291, 6d.; 2292, 6d.; 2223, 6d.; 2294, 6d.; 2296, 6d.; 2297, 2d.; 2298, 2d.; 2299, 6d.; 2300, 4d.; 2301, 2d.; 2302, 2d.; 2305, 6d.; 2306, 2d.; 2307, 4d.; 2308, 10d.; 2309, 6d.; 2311, 2d.; 2313, 4d.; 2315, 2d; 2316, 6d.; 2317, 6d.; 2318, 6d.; 2319, 6d.; 2320, 4d.; 2321, 2d.; 2322, 2d.; 2323, 2d.; 2324, 6d.; 2325, 6d.; 2326, 6d.; 2329, 6d.; 2330, 6d.; 2332, 2d.; 2336, 2d.; 2338, 6d.; 2340, 6d.; 2341, 6d.; 2343, 6d.; 2344, 8d.; 2345, 4d.; 2349, 4d; 2354, 4d.; 2357, 4d.; 2362, 6d.; 2369, 4d.; 2378, 1s.; 2386, 2d.; 2387, 6d.; 2311, 4d.; 2418, 6d.; 2446, 4d.; 2499, 6d.; 2687, 4d.; 2830, 6d.; 2963, 6d.; 2998, 6d.; 3943, 4d.; 3985, 6d.; 3995, 2d.; 4233, 4d.; 4289, 4d.; 4293, 8d.; 4363, 6d.

*** 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.*

1021. MOUNTS FOR TOBACCO PIPES, &c., *D. O. Sandheim, London.—9th March*, 1881.—*(Not proceeded with.)* 2d.

The spigot of the pipe or holder is formed with a spiral groove, and the inside of the mount is provided with studs, which take into the groove.

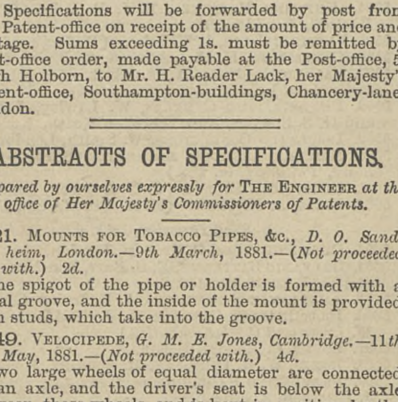
2049. VELOCIPEDE, *G. M. E. Jones, Cambridge.—11th May*, 1881.—*(Not proceeded with.)* 4d.

Two large wheels of equal diameter are connected by an axle, and the driver's seat is below the axle between these wheels, and is kept in position by the weight of a small portmanteau fixed in front, or by a small wheel resting on the ground behind.

2120. THRASHING MACHINES, *F. Wirth, Frankfort-on-the-Maine.—14th May*, 1881.—*(A communication from S. Moser, Frankfort-on-the-Maine.)* 6d.

This relates, First, to the apparatus whereby the straw is delivered sidewise, consisting of a sieve-shaped inclined plane in connection with a "cross"

2120



C, which by its arms takes hold of the straw and throws it out of the machine; Secondly, to a screw conveyor S placed in a trough, and arranged to convey the thrashed grain together with the chaff into a blast or current of air produced by suitable blowing apparatus, whereby the separation of the grain and chaff is effected.

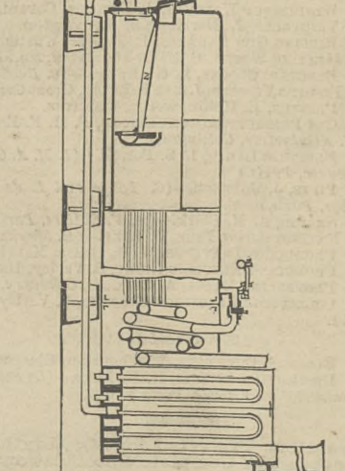
2161. DRIVING MECHANISM FOR TRICYCLES, *A. Burgess, Coventry.—18th May*, 1881.—*(Void.)* 2d.

One friction wheel is fitted to the crank axle, and another is carried on a pin sliding in a slot in the frame, while a third is attached to the driving wheel, and is actuated by a crank lever jointed to the frame, and also connected to the second wheel. This lever can be raised or depressed and locked in any desired position, and if raised a spring acts on the second wheel and brings it into contact with the other two.

2223. STEAM GENERATORS, *N. G. Kimberley, London.—21st May*, 1881. 6d.

The drawing is a longitudinal section of a multitubular boiler fitted with an improved apparatus. The invention consists, First, in the combination in a steam generator of any known blower and the hot air supply pipe or channel in the waste heat chamber or

2223



flue leading to the fire-box and an adjustable valve or damper; Secondly, in the alternative combination with the blower, hot air supply pipe, and adjustable valve, of the feed-water pipe in the waste heat chamber or flue.

2215. IMPROVEMENTS IN COUPLINGS FOR ELECTRICAL CONDUCTORS, *F. R. Allen, Southwark.—20th May*, 1881. 6d.

This invention refers to the adaptation of existing vacuum or other brake couplings on railway trains, for forming connections in wires used for lighting or other purposes in the said trains. The couplings are made to carry the contact points of the conductor attached to each carriage, the contact being made by the bodies of the couplings themselves, or by other devices, such as plungers. To keep the contacts clean and free from dust, &c., they are made to rub over a rough surface of some kind every time the coupling is connected or disconnected. The specification is accompanied by drawings showing the different form of coupling adapted to the various tube systems.

2171. EXTRACTION OF METALS FROM THEIR ORES, AND BURNING LIME, CEMENT, BRICKS, &c., *R. Stone, London.—18th May*, 1881. 4d.

This relates to improvements on patents No. 2535, A.D., 1879, and No. 2070, A.D. 1880, and consists in forming above the furnaces employed a large space into which air is forced, and acquires the necessary pressure to operate as a powerful blast. In some cases jets of steam or oil may be injected into the blast so as to increase its temperature. When smelting ores inclined slabs of terra-cotta are used, down which the molten metal is run and air mixed with annealing substances caused to impinge thereon, after which the metal enters a settling tank from which it is drawn into moulds or dies, and afterwards acted upon by rolls. The heat in the blast after passing through the furnace may be utilised to burn bricks or other articles. When smelting flint, spar, or other hard material, a flux composed of pearl ash, nitre borax, or leneal cyrolite, alum, and saltpetre is employed. Suitable colouring matters are added, and when melted the composition is run into moulds or dies.

2224. MANUFACTURE OF SWEETMEATS OF VARIOUS FORMS, *F. Wilding, London.—21st May*, 1881.—*(A communication from Thiele and Holzhause, Magdeburg, Germany.)* 6d.

This relates to production of spherical sweetmeats from sticks of sugar, and consists of a roller with grooves on its circumference of semicircular shape, the ridges between which are brought to a knife edge. In conjunction with this roller is a semicircular segment of larger inside radius than the outside of the roller, and this is channelled circumferentially inside the grooves, and knife edges corresponding to those of the roller. The roller is caused to revolve and the sugar is acted upon between it and the segment which is excentrically arranged around it, so that its lower end is nearer to the roller than the upper end.

2225. PREPARATION OF HAIR FOR UPHOLSTERING PURPOSES, &c., *P. M. Justice, London.—21st May*, 1881.—*(A communication from J. G. Stephens, Jersey, U.S.A.)—(Not proceeded with.)* 2d.

The hair is crimped or corrugated instead of being twisted, and is also hardened and stiffened by heat, the object being to render it more substantial and lasting. The crimping is effected by rolls.

2232. FRAMES AND TUNING PINS OF PIANOFORTES, *T. J. Brinsmead, London.—21st May*, 1881. 6d.

The metal-tuning pins are screwed and run parallel with the strings and pass through a metal plate and are secured by nuts, by turning which the tension of the strings is regulated. The portion of the piano which takes the strains of the strings is made of one solid piece of metal so as to ensure the instrument remaining in perfect tune in any climate for a much longer period, and also ensuring the frame never giving way through exposure to damp or extreme heat.

2233. PIGEON SHOOTING TRAP, *A. Holledge, Beckenham.—21st May*, 1881.—*(Not proceeded with.)* 2d.

The trap is preferably of sheet iron, and resembles when closed a quarter of a circle. The door is in front, and is made at right angles to and in a piece with the floor, the two working on an axle. In front of the door is a spring, and through the back a pin passes and acts as a stop to the door, but on removing the pin the floor is released and revolving with the door, not only allows the bird to escape, but imparts an impetus to it.

2236. PORTEMONNAIES, &c., *F. Wirth, Frankfort-on-the-Main.—21st May*, 1881.—*(A communication from G. Brumm and P. Luft, Offenbach-on-the-Main.)—(Not proceeded with.)* 2d.

This consists in fitting the portmonnaie with a double fastening, consisting of an ordinary fastening to allow the portemonnaie to be wholly opened, while the other permits only a partial or restricted opening of the same, so that coins could not be readily withdrawn.

2237. DISPLAYING CLOTHING, &c., IN SHOP WINDOWS, &c., *P. Thompson, Liverpool.—23rd May*, 1881.—*(A communication from P. de Ligne, Brussels.)* 6d.

This consists in arranging the parts to carry the different articles, so that they may be readily adjusted in height and turned to the desired position or inclination.

2240. PROPELLING VESSELS, &c., *L. A. Groth, London.—23rd May*, 1881.—*(A communication from A. E. Müller, Passau, Germany.—(Not proceeded with)* 2d.

This relates to apparatus in which jets of water are forced through pipes in the opposite direction to that in which the vessel is to move, and it consists in the use of two cylinders with pistons secured to the same rod, and in one of which the steam acts, whilst in the other the water is acted upon.

2241. IRON FURNITURE, *G. Octave, Geneva.—23rd May*, 1881.—*(Not proceeded with.)* 2d.

This relates to a combination of parts so that the article can be made to form a bedstead, couch, an arm chair, a long chair, a lavatory or washstand, and a night table.

2242. MUSIC TRANSPOSING INSTRUMENT, *A. Digeon, Toulon, France.—23rd May*, 1881.—*(Not proceeded with.)* 2d.

Two movable dial plates are mounted on annular bearings concentrically one within the other, the outer one marked with divisions of keys of, say, seven octaves of notes, and the inner with corresponding divisions or keys. By turning either dial the notation will not correspond, and the key may thus be changed and read off or printed on a paper disc below the dial keys.

2243. DIMINISHING AND DRAW-OFF VALVES, *W. C. Brett, Homerton.—23rd May*, 1881.—*(Not proceeded with.)* 2d.

This relates to the application of an automatic arrangement for reducing the pressure of the water or steam from a high to any required low pressure. As applied to a screw-down valve a tube is applied to the body, and passing through a stuffing box, opens into a receiver of larger diameter than that of the valve, and in which works a piston connected to the tube.

2244. REAMERS AND LATHE CUTTERS, &c., *H. Lindley, Salford.—23rd May*, 1881. 6d.

The reamers are formed with two longitudinal flutings or recesses to admit oil to the cutting edges and provide means for ready removal of shavings. A slot is made in the reamer and extends from flute to flute to receive the cutting plates which are fixed therein with the faces leaving the cutting edge together, and therefore at the centre of the tool. They are secured by means of countersunk set screws. The improvements in lathe cutters are applicable to spring tools requiring an amount of resiliency in the shank, and consists in making the cutters of such appliances removable and separately from the shank, so that the latter may be used for different forms of cutters.

2245. COMBINED RECLINING BOARD OR BEDSTEAD AND CHAIR, &c., *T. Hort, Ealing.—23rd May*, 1881.—*(Not proceeded with.)* 2d.

A reclining board is supported on hinges and is balanced by weights or springs, and provided with adjustable parts to form arms, a seat, and a foot-board, when the apparatus is to be used as a chair. Means are also provided to support the invalid under the arms, and also for raising the reclining board into a vertical position.

2247. CARPETS AND RUGS, *A. Webb, Worcester.—23rd May*, 1881. 4d.

The object is to provide a greater scope for the designer to form patterns by using, in combination with spun horse hair, materials that are capable of receiving brighter and more effective colours, and which are susceptible of being woven in any desired pattern without detracting from the durability of the rug. The coloured yarns are formed by combining spun horsehair with spun wool or mohair in a doubling or twisting machine.

2248. ROTARY ENGINES, *H. E. Newton, London.—23rd May*, 1881.—*(A communication from Cloarec and Cochrand, Paris.)—(Not proceeded with.)* 2d

A horizontal cylinder with end covers bolted thereto is mounted on a base plate, and within it is a T-shaped piston, the shaft of which is mounted on the cylinder axis, and projects through the covers where it is fitted with a fly-wheel. Within the cylinder a second cylinder is mounted, excentrical in grooves in the end covers, and in its periphery is an opening to allow the piston to slide in and out of the steam chamber at each revolution formed between the two cylinders.

2250. ICE, *P. Westfield, Lewisham.—24th May*, 1881.—*(Not proceeded with.)* 2d.

This relates to the manufacture of clear blocks of ice, and consists in fitting in about the middle of the moulds a perforated partition mounted in vertical grooves. The moulds are caused to rock to and fro, causing the water to pass from one side of the partition to the other, whereby all air is liberated and clear ice produced.

2251. BREECH-LOADING MECHANISM FOR ORDNANCE, *G. Quick, Uckfield, Sussex.—24th May*, 1881. 6d.

This relates, First, to means for affording greater facilities in loading; Secondly, to cause the breech to be opened by one movement for loading, and to close the breech by one movement ready for firing; and Thirdly, to an effective gas check or obturator; and it consists, First, in the combination of a gun having a transverse slot or carriage way in the breech, such carriage way having numerous parallel lands and grooves on its upper and lower surfaces formed at right angles to the bore of the gun, with a sliding carriage having corresponding grooves and lands fitting into those of the carriage way; such carriage having a screw fitted therein to close the powder chamber, and a loading hole through which the gun is loaded, the breech screw having a lever on its rear end, by which the screw is actuated and the gun having a guide or pin as a fulcrum for the lever, by means of which the latter can be used to move the sliding carriage into or out of the loading position by one movement; Secondly, in mounting on the forward part of the breech screw of a gas check ring presenting a convex surface to the powder pressure.

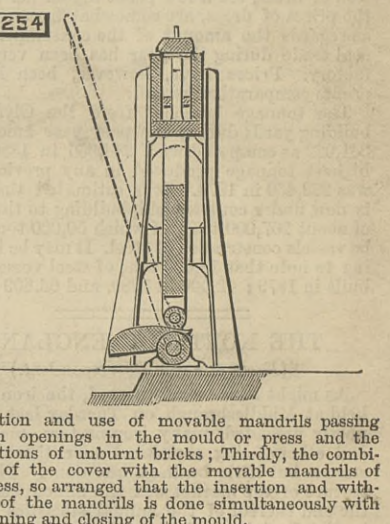
2252. ANNEALING FURNACE, *E. James, Tipton, and E. Handley, Birmingham.—24th May*, 1881. 6d.

This consists in dividing the grate room for the better equalisation and diffusion of heat in the furnace, and rendering combustion more complete, each grate being supplied with superheated hydrogen, so as to increase the temperature when required, the supply being adjustable; also in the arrangement of the horizontal and vertical or upcast flues for causing and imparting to the boxes containing the articles requiring annealing a more equal distribution of heat.

2254. BRICK-PRESSING MACHINE, *H. Wedekind, London.—24th May*, 1881.—*(A communication from O. Hoffman and H. Dueberg, Berlin.)* 6d.

This consists, First, in the arrangement of one or more stationary mandrils on the pressing mould used for pressing perforated bricks in combination with a singly or doubly perforated piston; Secondly, the

2254



application and use of movable mandrils passing through openings in the mould or press and the perforations of unburnt bricks; Thirdly, the combination of the cover with the movable mandrils of said press, so arranged that the insertion and withdrawal of the mandrils is done simultaneously with the opening and closing of the mould.

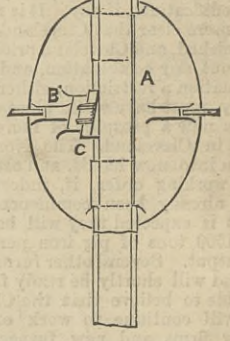
2257. REVOLVING STANDS FOR BOOKS, &c., *J. S. Kirwan, Reform Club, Pall-mall.—24th May*, 1881. 6d.

This relates to means for preventing revolving stands for books being top-heavy and easily overturned when the books are removed from the lower compartments. The base is supported on castors, and on its top surface is a circular rail or track for rollers on the body of the case to run on, such case turning round a central pillar, from the top of which it is preferably suspended. The backs of the shelves are made adjustable, so as to suit different sized books.

2261. RAILWAYS AND TRAMWAYS, *J. Livesey, London.—24th May*, 1881. 6d.

This relates to supporting and fixing a flanged rail

2261



and consists in the use of a cast sleeper having a butting and clipping rib A and a spring jaw B in combination with a serrated key C. Modifications are described.

2259. FOG-HORN APPARATUS, *H. J. Haddan, Westminster.—24th May*, 1881.—*(A communication from O. C. Hansen, Norway.)* 4d.

This consists in combining a fog-horn and blowing apparatus in a case fitted with treadles to actuate the blowing apparatus, which consists of a case supplied with a trumpet and divided into three compartments, one to hold air admitted through valves, and serving to inflate the bellows, the second acting as an air