

ON THE APPLICATION OF DIRECT-ACTING
"PRESSURE-INTENSIFYING" APPARATUS
TO HYDRAULIC PRESSES.

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The following description of an American Press was intended to be read at the Autumn Meeting 1877, in connection with Mr. Wilson's paper on English cotton and other hydraulic presses. Time however did not allow of this; and the author has since added to the description a few notes, suggested chiefly by the remarks made by various speakers during the discussion on the above paper. The immense magnitude and importance to this country of the cotton trade is sufficient justification for bringing the subject again before the members.

The estimated supply of cotton this year from India only is 1,434,000 bales; and including the entire sources of supply it is estimated that Europe may receive 5,290,000 bales, of an average weight of 411 lb. per bale. When it is considered that, even in the case of the best houses, the cost of fuel varies from $\frac{3}{4}d.$ to $2d.$ per bale, there is good reason for believing that in a great many cases much worse results are obtained; if however only a penny per bale be allowed as being saved all round by introducing the best system of pressing, a saving will be effected of £22,000 per annum; in reality it would probably amount to four or five times this sum. Any method of working therefore, which has for its object the simplifying of the parts subject to wear, without sacrificing economy and efficiency, is worthy of attention, if nothing but the cotton trade of Europe is taken into consideration; but this forms only part of the vast business which depends on the hydraulic press for its success.

As the novel features of the system about to be described consist chiefly in the "pressure-obtaining" apparatus, it is not proposed to enter into the question of the construction of the presses themselves, except in so far as improvements in this part of the gear may produce any increase in the efficiency of the press as to its speed of working, &c.

In order to show the advantages claimed for the direct-acting system, it is necessary to consider briefly the present methods of forcing water into the cylinders of cotton and other presses. The most usual method is by means of force pumps of, comparatively speaking, small stroke and diameter of plunger, driven by gearing and run at a considerable number of strokes per minute. Under these circumstances, unless a great number of pumps are used, the rate of travel of the press ram is extremely slow, notwithstanding that the number of strokes of the pump plungers is comparatively great; and thus for every single stroke of the press there are often some hundreds of beats of the pump valves on their seats, and in consequence a difficulty in keeping them tight; in some of the best examples the number of beats is 1000 to 1200 per bale pressed. With this system there is much loss of useful effect from friction of parts; and, while a considerable cost in maintenance is involved, owing to the wear and tear of the gearing, only a very slow speed in working the presses is obtained.

The desirability of substituting some more direct mode of action, with a consequent reduction in the number of working parts in motion, has been for some time recognised. Many attempts have been made to overcome the defects above alluded to. Some engineers have used accumulators, adding sometimes an intensifying arrangement, so that the pump valves are never subjected to the higher pressures; others, by using direct-acting engines with pumps of a larger size, avoid the great wear and tear already referred to as a necessary consequence of the use of small reciprocating geared pumps; others again have used steam power direct upon the presses for a portion of the stroke, and hydraulic power at the finish.

The Direct-acting Steam and Hydraulic arrangement about to be described effectually overcomes the objections referred to,

and in addition ensures further economy in speed and cost of working.

A diagram illustrating the action of the pressure-intensifying apparatus in connection with an ordinary hydraulic press is shown in Fig. 3, Plate 3. The working stroke of the press itself, which is not shown on the diagram, may be divided for the sake of illustration into six equal parts. It is assumed that the most intense pressure is required during the last one-sixth part. A and B are two steam cylinders fitted with pistons E and F, and having at their front ends the hydraulic cylinders C and D, in which work plungers G and H; the steam cylinders are of equal size, but the plungers G and H are of different area, their respective areas, as shown in the diagram, being in the proportion of 5 to 1; and the combined cubic capacity of these plungers is assumed to be at least equal to that required for a full stroke of the press ram, a certain margin being added to make up for leakage. It is clear therefore that the lifting ram of the press worked by this pumping apparatus will rise 5-6ths of its lift with one stroke of the plunger G, and that one stroke of the plunger H will complete the remaining 1-6th. The sizes of the steam pistons E and F being equal, if the pressure of steam be the same on both, the pressure per sq. in. on the water in the press will be five times greater when the piston F is forcing water in, than it will be when the piston E is acting.

Now assuming the pistons E and F to be home at the back ends of their cylinders, as shown in the diagram, Fig. 3, and the press ram also to be at the bottom of its cylinder, it is evident that, if the pipes R and the hydraulic cylinders C and D are filled with water or other fluid practically incompressible, any movements of the pistons E and F will move the press ram; and again, supposing that this ram, either by gravity or other means, is caused to return to the bottom of its cylinder, it is clear that the pistons E and F will also return to their former positions: therefore no inlet or outlet valves whatever are required, the same water being forced forwards and backwards between the press ram and the plungers G and H. The admission of steam to the pistons on the one hand, and the weight of the press ram and platen on the other, when the steam is exhausted, acting

through the interposed water as a connection, produce the same effect as if the pistons and press ram were mechanically connected together by a rigid coupling.

It is thus clear that no valves are required, excepting one clack to be afterwards described; and that, instead of the numerous strokes of the ordinary pumps, this arrangement only requires that the water which transmits the power contained in the steam be moved forwards and backwards once for each operation. If economy in the steam used be not an object, and the press to be worked be not too large, one cylinder would render even a clack valve unnecessary; but (putting aside the total loss in this case of most of the economical features of the system) a single steam cylinder would be too unwieldy to be practicable for such operations as cotton pressing, and it is even questionable whether *two* cylinders will be enough for some of the largest presses required for India.

Plate 1 shows a pressure-intensifying apparatus and cotton press in elevation, and Plate 2 the same in sectional plan.

It has already been shown how extreme simplicity is attained; and before proceeding to give the dimensions of the press represented in Plates 1 and 2, it will be shown that economy is in no way sacrificed to simplicity, but that a positive gain is effected in this direction also. It is with a view to the economical use of the steam that two steam cylinders are used, and the arrangement of steam pipes and valves thus rendered necessary will now be described. The two steam cylinders are laid alongside of each other, as shown in the plan, Fig. 2; they may be placed horizontally or vertically, but are preferably placed at a sufficient angle, as shown in Fig. 1, to cause the pistons and plungers to move readily towards the outer ends of their respective cylinders when the steam is exhausted.

The mode of working is as follows. Before commencing to press the bales, steam from the boiler is admitted into the cylinder B, Plate 2, by opening the valve P; this drives the piston F, and consequently the plunger H, to the other or front end of the cylinder, thus raising the press rams SS, Plate 1, through a corresponding portion of their stroke. This is however only a preliminary stroke for the

purpose of heating the cylinder and enabling the steam just delivered at the back of the piston F to be transferred to the other side of it. This is done by closing the pressure valve P, and opening the equilibrium valve Q, through which the steam in the cylinder passes into the pipe M; as it cannot get past the closed inlet valve T on the cylinder A, it passes up the pipe M to the front side of the piston F, which, partly by its own weight and partly by the pressure due to the press rams S S and their platen, transmitted through the water in the press cylinders and pipes, returns to the outer end of the cylinder B. Supposing that the bale of cotton to be compressed is now placed in the press, the steam which has thus been merely transferred from the back to the front of the piston F is allowed to enter the cylinder A by means of the valve T, and thus drive the larger hydraulic plunger G forwards. This is done by opening the valve T, when the steam passes from the cylinder B into the cylinder A, driving the piston E, and consequently its plunger G, forward until the pressure in the two steam cylinders is in equilibrium, which of course is the case when the resistance opposed by the pressure on the plunger G is equal to the pressure of steam on its piston E. As soon as the pressure of steam in the cylinders A and B is equal, the valve T falls by its own weight; and the valve P being opened, fresh steam from the boiler is admitted to the back of the piston F, driving forward the smaller plunger H, any steam on the front side of this piston being exhausted direct into the atmosphere. The increased pressure due to the smaller plunger closes the clack O (which acts as an intermediate check valve between the two water pressures); and thus the finishing pressure is given to the bale, or whatever may be in the press, and if necessary is maintained for any desired length of time.

This volume of steam last admitted, after being transferred to the front side of the piston F, furnishes the steam required for the earlier part of the next stroke of the press, which, as before, is done by the plunger G. The press ram being now raised to the height required, the equilibrium valve Q is opened, and the steam at the back of the piston F is transferred to the front of it, as before described;

H

the exhaust valve U and the clack valve O are also opened at the same time, and the steam in the cylinder A is exhausted; the pistons E and F are then in position ready to commence the next pressing operation. The valves are all worked by one man by means of rocking shafts, and suitable means are provided to prevent the pistons E and F from coming into contact with the ends of their cylinders.

Having thus described the mode of working, the author will proceed to give some of the dimensions of a cotton-bale pressing plant constructed on this principle.

The cotton press itself has two cylinders with the rams S S working upwards, Plate 1; these raise a crosshead, to which are attached strong wrought-iron links carrying the following table or platen, as shown in Fig. 1; the casting on which the cylinders rest forms the top platen, and the water being forced into the cylinders raises the lower platen on which is placed the cotton bale, and compresses the latter to the required density.

The steam cylinders are each 56 in. diameter; the pressure of steam used is 80 lb. per sq. in.; the area of each piston being 2,463 sq. in., this multiplied by 80 gives 197,040 lb. total pressure on one piston. The smaller hydraulic plunger is $9\frac{3}{4}$ in. diameter or 74.66 sq. in. area; and $\frac{197,040}{74.66} = 2,640$ lb. per sq. in. as the pressure on this plunger. The cotton press itself has two rams, each 22 in. diameter, the collective area of which = 760 sq. in.; and 760 sq. in. \times 2,640 lb. per sq. in. = 2,006,400 lb. or 895 tons total pressure on the bale, with 80 lb. per sq. in. steam pressure in the boiler. With a pressure of 3 lb. per sq. in. in the steam cylinder all the weight and friction of parts are overcome; and since each lb. per sq. in. of steam pressure represents a total pressure of $2,006,400 \div 80 = 25,080$ lb. on the press rams, the total frictional resistances amount to only 75,240 lb., or say 35 tons approximately. Deducting this from the total pressure of 895 tons, there remains 860 tons total effective pressure on the bale. It must not be forgotten moreover that a part of the dead weight raised is utilised in returning the pistons and rams after each pressing operation is over.

In calculating the *power* of the press, the second steam and water cylinders are not taken into consideration: it is to them however that the *economy* of this system, in addition to that already attained by abolishing gearing, is chiefly due; for the second cylinder accomplishes five-sixths of the stroke of the press, using only the steam exhausted from the first cylinder to do so.

The makers of these presses in America guarantee to press at the rate of 75 bales per hour, on a consumption of fuel not exceeding one ton to 300 bales, or 7·46 lb. of coal per bale—or in value about $\frac{5}{8}d.$; frequently in practice the consumption does not exceed 6 lb. per bale, giving a cost of $\frac{1}{2}d.$ per bale only. Firms using this press in the United States, at Mobile, Augusta, Charleston, &c., have turned out bales at the rate of 80 per hour; one firm has turned out 93 per hour for several consecutive hours, and on one occasion, as a trial, did 40 bales in 20 minutes, or at the rate of 120 per hour; and 25 of these bales, measured in the press, gave an average density of 46·71 lb. per cub. ft. The average on five vessels loaded by a press company at Mobile was 1,748 lb. per ton, cargo capacity, or a gain of 20 per cent. over previous cargoes done by other presses. There is however no difficulty in pressing to a greater density when required.

Ofcourse the conditions of pressing cotton in the States and in India are different, and it may be argued that the time is as much or more occupied in tying up the bales than in the pressing; but making every allowance for this, the saving to be effected in the time required for pumping up the presses, in a day's work, must be very considerable, and the simplicity and fewness of moving parts will ensure the presses being always at work—instead of their being subject to stoppages, as is now the case, on account of leaky valves, leathers, and fractured gearing.

It is evident also that, with an increase in speed of working, fewer presses will be required, and therefore less capital will be invested. Where there are a group of presses, by a simple arrangement of stop valves one pair of steam cylinders similar to those just described can work the whole group.

The author is of opinion that, where water pressure is available, one very great risk of fire in warehouses, often situated in crowded

towns, can be avoided by using this intensifying arrangement : modified, of course, to suit the different conditions of the motive power employed (water instead of steam), but retaining the simplicity due to the single stroke and absence of valves.

As regards the practical application of this principle, Mr. John F. Taylor, of Charleston, United States, has now made some thirty-five presses varying from 300 to 1,500 tons total pressure. They have not as yet been introduced into this country or India.

In the course of the discussion upon Mr. Wilson's paper on Cotton Presses at the last meeting, the more economical working claimed for the Watson press was ascribed to the fact that the pumps used with the latter were not of the direct-acting long-stroke type. Seeing that in the direct-acting plan advocated in this paper the principle is carried out to a much greater extent, it is well perhaps to explain the author's reasons for advocating this extension of the direct-acting principle.

The great difference in the cost of working the two kinds of presses referred to in that discussion was distinctly stated not to be caused by any difference in the quality of the workmanship, nor was it attributed so much to the difference in the designs of the presses themselves ; and any economy due to this cause would, of course, be obtained quite irrespective of the mode of pumping employed. Now although, by substituting a Watson press for the form of cotton press described in this paper in connection with the pressure apparatus, there would in some cases be a further economical gain in the speed of working, due to the facility which that arrangement gives for filling the box afresh with loose cotton while the bale is being tied, yet this gain would have to be credited to the press itself ; while on the other hand, if a direct-acting system be substituted in place of the pumping arrangements now used with the Watson press, a further saving in cost and speed of working will be effected, by the pressure-generating gear, in addition to that effected in the machinery where the pressure is applied and utilised.

The question of the relative economy of the Watson and Wilson presses appeared to resolve itself into this : that the expenditure of

fuel is increased, though not in a direct ratio, as the stroke of the pumps is increased; for, while with pumps of 6 in. stroke each bale costs $\frac{3}{4}d.$ for fuel, with a stroke of 36 in. the cost of fuel is $2d.$ per bale. It was very justly urged as an advantage, that by having a considerable number of pumps it was easy to meet the increased resistance due to the increasing pressure per square inch, as the bale got nearer completion, by reducing the number of pumps, and thus to keep the engine power uniform; but the Wilson press has twelve pumps, and, although direct-acting, possesses even now nearly the same facility as the Watson press for reducing the number of the pumps at work as the pressure increases: so that the difference in the cost of fuel between the two presses cannot be due to the difference in the number of their pumps.

It was stated in the same discussion that the problem to solve, as regards the pumping apparatus, was to supply a great body of water at a low pressure to commence with, and a small quantity at a high pressure to finish with. This is done in the simplest and most direct manner by the large and small plungers described in this paper; and as to economy, seeing that the low-pressure water is forced in by the exhaust steam taken from the cylinder which has already forced in the small quantity of high-pressure water required for the previous bale, it is difficult to imagine a more direct and simple way of attaining that object.

Some other cause therefore must be sought, to account for the extra consumption; and this, according to one speaker, is to be found in the increased velocity of the water as it is driven through the pumps when of longer stroke. Assuming the two presses under comparison to be of about equal powers and speed, the quantity of water passing into them in the same time will be about equal also, and therefore the velocity may be assumed equal in the inlet pipes. Any difference in the relative velocity of the influent water must therefore occur while it is passing through the pumps. Since the difference in the cost of fuel per bale represents a difference in the horse-power required in the proportion of 0.75 to 2.00, the question is (taking the velocities given, namely 75 ft. and 450 ft. per minute in the two cases) whether the extra power required to

overcome the difference of pressure, due to this difference in velocities, can possibly account for such an increased consumption. A little consideration will show that the increased resistance in the press due to the increase of velocity in the water must be relatively small, while the weight of water to be pumped is small also. The two low-pressure cylinders in the Watson press hold about 43 gals. and the two high-pressure ones about $21\frac{1}{2}$ gals., say a total of 60 gals. approximately. It has already been assumed that the two presses work at the same speed; and assuming also that they require the same quantity of water per bale, and that the press is raised in either case in 90 seconds, we have 60 gals. or 600 lb. pumped in 90 seconds, or 400 lb. per minute; and as the difference of resistance is but small, it is clear that the difference of power per bale in the two cases is quite insufficient to account for any marked difference in the cost of fuel per bale. It thus seems clear that the difference of velocity of the water in passing through the pumps can have little to do with the cost of working, except in so far as the wear and tear of the valves is concerned; and judging from the fact that with a velocity of 75 ft. per minute spare valve-chests have always to be kept ready, it would seem that even this slow velocity does not give immunity from trouble in this respect. If it did however, the direct-acting press described in this paper has still the advantage, even on the present ground; for the velocity of the water in the arrangement shown in the diagrams, assuming the raising of the press to occupy 5 seconds, is in the low-pressure plunger 2.66 ft. per second, and in the high-pressure plunger 4.1 ft. per second: so that, so far as the coal consumption depends on the velocity of the water in the pumping apparatus, this arrangement is well designed, while the absence of any working valves renders it unnecessary to discuss the effects of the different velocities of water upon them.

The PRESIDENT regretted that Mr. Wilson, by whom the previous paper had been read at Manchester, was not able to be present now, for he thought the discussion would deal very much with the difference between the arrangements described in the paper just read, and those advocated at the last meeting by Mr. Wilson. There was one point in the paper that struck him as rather remarkable, and that was the low cost which was set down for the pressing of each bale, namely from $\frac{3}{4}d.$ to $2d.$ He scarcely thought that the interest upon outlay and other fixed charges had been calculated in that amount, as it seemed to him so excessively small. Referring to the number of beats of the valves, from 1000 to 1200, it seemed to him that that number of beats could hardly be got for so low a cost as either $\frac{3}{4}d.$ or $2d.$ per bale. There was one other point in the paper which struck him as a little obscure; that was, that the steam above the piston F in Fig. 2 was stated to be exhausted through the pipe M. He presumed by "exhausted" the writer simply meant that it was allowed to escape into the atmosphere, as there was no other means of exhaust shown. With regard to the velocity of the water pumped into the press in pressing a bale, perhaps it might have been convenient if, in the concluding paragraph of the paper, instead of the number of gallons pumped, the velocity of the water had been given in feet per minute, so that there might be the means of considering whether the velocity of the water passing through the small inlet and outlet passages had anything to do, as the writer said it had not, with the question of economy in the pressing of the bale. On this point however he should be glad to hear any observations from the members, some of whom, he had no doubt, had experience of this kind of construction.

Mr. H. SHIELD observed that the press described in the present paper differed a great deal from the kind of presses which had been discussed at the last meeting, and which represented the most improved English practice at the present time; and, in order to compare it with them, it was well to bear in mind that this press was not really a cotton press at all, but was a re-pressing press. It was not a press for taking loose cotton and making it into bales for

shipment. To do that, the stroke of the press would have to be about 15 ft. to 16 ft., for enabling it to make a bale of say 450 to 500 lb. weight of cotton, of suitable shape and of the density now required. The present paper was a very interesting one in many ways, because it explained what the American practice in these matters was; but on considering the results arrived at by American cotton-pressing houses at the present time, and comparing with them the results which were being attained in India, where most of the English presses were being used, a little calculation of the details of this press would show, he believed, that it was not the kind of press that would commend itself to English users, and that in fact it rather represented a type of press which had already been abandoned in Indian practice. The cotton presses of America as a rule pressed bales to a density of about 22 lb. to 25 lb. to the cubic foot, as measured when taken out of the press. Having measured a great many bales himself, he had found this to be the ruling density; and in taking only yesterday a series of well pressed bales in one of the warehouses in Liverpool, he had found the average of those from America came to 25 lb. per cubic foot, measured out of the press. In India on the contrary bales were now almost regularly turned out, coming up to 45 lb. per cubic foot: certainly 40 lb. per cubic foot was a very usual density. That represented about double the density of the American bales in round numbers. He had exhibited at the last meeting a diagram taken from actual practice (see Proceedings 1877, Plate 69), showing the increasing pressures in a Watson press upon a bale of cotton of about 400 lb. weight at the successive portions of the stroke. From the same series of experiments he had now made out another diagram, Fig. 6, Plate 4, showing the increasing densities of the same bale at the successive portions of the stroke. On comparing these two diagrams it would be seen that the increase in the total pressures on the bale was immensely in excess of the increase in the densities corresponding with these total pressures. For instance, to compress the bale to the extreme density of 70 lb. per cubic foot measured in the press, a total pressure of about 900 tons was required; whereas to press the same bale to about half that density a

pressure of 150 tons only was required. In other words, in order to double the density of the bale, the total pressure had to be multiplied about six times, instead of only twice. In comparing the press now described with those discussed at the last meeting it was all-important to bear this consideration in mind.

The press described in the present paper, which, judging from the number made, appeared to answer the purpose it was being applied to, made bales which measured in the press about 46 lb. per cubic foot. That meant roughly, according to experiments which he had made in the matter, that the bales would measure about one-half more out of the press, that is to say their density would then be about 30 lb. per cubic foot; and this was an increase of just 20 per cent. over the average which he had obtained of the well-pressed American bales, which was the same as the increase mentioned in the paper. In comparing the machinery employed to do that work with the machinery employed in the English system to obtain a similar result, there was another point that he wished to call attention to: that was, that this being a re-pressing press, the number of bales that were done in this press could not well be compared with the number of bales that were made in a press which took the loose cotton and finished it into a bale of the required shape for shipment. In the best English practice for treating loose cotton, the presses were arranged in sets of four, and the pumps were always employed delivering water to raise the bottom follower in one press of the set, and to lower the top follower in another press, these two operations going on simultaneously. Taking on an average the time of turning out a bale to be 3 minutes—or at the rate of 20 bales per hour per press—the engine and pumps were continuously employed in supplying water to the four presses of the set, the time consumed in running up the lower follower in one press and simultaneously lowering the upper follower in another press being 40 seconds. The rest of the time was absorbed in tying the bales and in filling the boxes with cotton. While speaking of tying the bales, he might mention that the hoops used in India at the present time with these great pressures were seventeen in number for each bale, and were composed of steel or wrought-iron bands.

In order to obtain such a result as it was mentioned in the paper would be obtained by the finishing press therein described, treating it simply as a finishing press, if he had himself to design an engine and pumps to do the same work with 80 lb. steam pressure, he should provide a 20-inch cylinder engine, and twenty 3-inch pumps, in the perfect assurance that such an engine and pumps, judging from what had been done frequently and continuously, would force water enough to supply two presses, each capable of finishing 75 bales per hour of the same density as that mentioned in the paper. If the press worked by two cylinders of 60 inches diameter were compared with such a 20-inch cylinder engine, it seemed to him that really it was quite impossible the economy could be anything like the same in this direct-action press as it was in the ordinary English presses: in fact he did not think there was anything to be learnt from it in respect to economy. In reference to the President's remark, he might state that the cost of $\frac{3}{4}d.$ to $2d.$ per bale for pressing did not include the working charges, but was simply the cost of fuel. If the press described in the paper were to be used for the whole of the operation of making the bales from loose cotton, according to the method practised in India, he arrived at this conclusion from the calculations he had made: namely that, even supposing both cylinders were supplied with steam of 80 lb. pressure, a cylinder would be wanted of 62 inches diameter and 15 feet 6 inches stroke for the first part of the operation, backed up with another cylinder of 115 inches diameter and 6 feet stroke for the final part of the pressing, the two cylinders working respectively with plungers of 10 and 14 inches diameter; whereas by the other plan there would be only a 20-inch cylinder, working about twenty pumps, of which the greater number would be 2 inches and the remainder 3 inches diameter. He did not himself attribute any very great loss to the number of beats that took place in the valves; he rather thought these beats tended to keep the valve faces pretty even, and that the large number of beats could do no great harm if the valves were made of the right material. The way in which the valves did go was by the impact of the water upon them. On examining valves that had been taken out after working a long time under pressure,

they were found to be regularly eaten away, and that was how they came to leak and to require to be renewed; he did not think therefore the question of the beats was of very much consequence. On the whole, if it were attempted to employ this direct-action press for really great pressures, such as were now wanted for cotton bales of 500 lb. weight, to compress them to 50 lb. weight per cubic foot, there would be required a series of four or even six powerful steam cylinders, which would involve such an outlay both in first cost and in working expenses and fuel that he did not think the plan would recommend itself commercially.

Mr. E. B. ELLINGTON mentioned that in a very ingenious and beautiful cotton press which had been extensively used in India the difficulty of the length of stroke was entirely overcome. In West's press, to which he alluded, the pressing was done by a ram of about 20 inches diameter and only about 3 feet stroke; the pressure from the ram was communicated through a system of levers acting upon the rising platen, and so proportioned that, while a uniform pressure was maintained upon the ram, the pressure upon the bale corresponded exactly with the curve shown at the last meeting. If that press were used with such an arrangement of steam cylinders as had been described in the present paper, it would probably remove a great deal of the objection urged in reference to the cost and size of the steam cylinders, because it would be possible to maintain a comparatively uniform pressure in the cylinder and on the working rams. Some years ago a firm in South Africa were putting down machinery for wool-pressing, and of course the same question arose there; the pressure at the end of the pressing process required to be much greater than at the commencement. The plan adopted in that instance was to have two sets of pumps, one set delivering into an accumulator loaded to about 700 lb. per sq. in., which was sufficient for the first part of the pressing, and for working the hydraulic hoists in the building. The other set of pumps delivered into a hydraulic main always in communication with the presses, but alternately connected and disconnected with the accumulator. Hydraulic mains were carried from the accumulator to the various

hoists throughout the building; and both presses and hoists were in connection with the accumulator so long as the pressure in the presses did not exceed 700 lb. per sq. in. But between the presses and the accumulator was a check valve similar to that described in the paper, which, when the pressure in the presses rose above 700 lb. per sq. in., closed by its own weight; the second set of pumps continued to pump into the presses only, and worked up to the final pressure required, while the first set of pumps continued to pump into the accumulator. That plan answered perfectly, and overcame some of the difficulties which the employment of a great number of pumps was designed to obviate. The pressure produced on the bale in West's press was 1500 tons, but in pressing cotton he believed there had been some objection raised to that pressure on the ground that the cotton had been injured.

As to the loss of power consequent upon a large number of valves, he agreed in the main in thinking that this did not amount to very much; but the difficulty of keeping the valves in order was known by everyone who had to do with such machinery to be very great, and any apparatus that would reduce the number of the valves must certainly be worthy of careful consideration.

The PRESIDENT observed that, with regard to the pressure put upon the cotton, the same question had been raised in Manchester with reference to the direction in which the cotton was squeezed in the press; and it had been stated that if it were squeezed throughout in one direction the pressure would never hurt it, whereas if it were squeezed in two directions it was found to be much damaged when the bale was opened, and considerable loss was sustained. He thought therefore the practice at Manchester did not bear out Mr. Ellington's view.

Mr. E. A. COWPER believed that was the case at Manchester; but he had also heard it stated on good authority that it was possible to press cotton too heavily. With regard to cross-packing, that was certainly most injurious to the cotton: it made a bad bale, which would not hold together. What was required was that the cotton

should be squeezed down flat like a pancake, and then these pancakes tied one another together; the bale so made would not burst out sideways, and a hoop tied round it kept it together. But if it were pressed first in one direction and then in another, the bale was composed of a number of rounded pieces that would not hold together; therefore it was impossible to make a sound bale out of cross-pressed cotton: as had been found in reference to several presses designed some time ago to press in directions at right angles to each other.

The press described in the present paper, as he understood, was not an ordinary cotton press: it was a press that might be applied for re-pressing cotton bales which had been partly pressed before. It was not anything like the height required for pressing cotton from the commencement, which, as had been stated, required a stroke of 13 ft. 6 in. in a 15 ft. press to bring the bale down to the requisite size; the necessary quantity of cotton could not be got into the bale unless the press were made of that height. The press now described however was for re-pressing cotton bales that had been previously pressed to a certain extent: in India a very common plan was to press cotton in a moderately light press, then lay hold of the bale with an "extractor," put it in a second press, and press it with a heavier hydraulic pressure; that answered the purpose very well. The time of five seconds mentioned in the paper would he thought be far too short for pressing a bale up through such a distance as 13 ft. 6 in. out of 15 ft. total length; the cotton would take fire, and would actually burn. It had been said again and again that when a press was run up very quickly the cotton was injured; if not actually set on fire it was charred. One way of preventing that was to make a number of holes all the way down the sides of the press for letting the air out; the injury arose from the air confined in the cotton being so suddenly compressed, as in the little German tinder syringes in which the tinder was lighted by the sudden compression of the air. The air being let out through the holes in the sides of the press, the injury was not so likely to take place; but it might possibly take place, and he thought five seconds was too short for compressing the cotton to such an extent. If it were desired to press cotton in a tall press by the arrangement described in the paper, he presumed several steam

cylinders would have to be employed. If he were going to work on that principle he should have three or four different sized cylinders: one for the lightest pressure during the first 5 or 6 feet, which required very little pressure; the next cylinder giving a little more pressure; and finishing up with a heavy pressure. That seemed to him to be the proper legitimate application of the system for pressing cotton from the loose. All steam cylinders, he considered, ought to be steam-jacketed.

Mr. H. SHIELD had little doubt that, if it were tried to the utmost by a heavy pressure to injure the cotton, it would be possible to do so. A density of 56 lb. per cubic foot was however all that was wanted to make the weight and the measurement the same; and it was not likely that any one would go to the trouble and expense of making the cotton measure less than it weighed. In point of fact 50 lb. per cubic foot was quite an advantageous density for freight and stowage; and he was quite sure cotton was not injured—especially short-staple cotton—by being pressed to 50 lb. density measured out of press. By way of trial he had himself pressed some American bales to about twice their original density, and had given samples to some brokers in Liverpool, by whom they had been valued at a better price than the original cotton.

Mr. T. HAWKSLEY thought that in all cases of this kind, where the pressing of fibrous substances was involved, the imposition of a very great pressure must necessarily injure the fibre; and in this way. Cotton was not a fluid; and consequently, if it happened that any one part of the matter pressed was in a denser condition (as was unavoidable) than other parts, it must spread laterally in order to occupy the space where the density and pressure were less, and in the course of making that movement some of the fibres must necessarily be torn; and the result would be that, though on the whole the majority of the fibres would retain to the end the full length which they had when originally put into the press, there would be a good many amongst them that would be very seriously shortened. Therefore he thought it was undesirable (as a question

of manufacturing, not of pressing) to put too great pressure upon the cotton, merely with a view of bringing it into a denser condition for the purpose of carriage. As a mechanical question he thought it was inevitable that many of the fibres must be separated in pressing, otherwise uniformity of density throughout the mass could not be obtained.

Mr. E. H. CARBUTT remembered some ten years ago seeing a press somewhat on the principle described in the paper, a direct-acting steam and hydraulic press, used in the neighbourhood of Birmingham for punching plates for gasometer making; and it had been found to work very well. The boiler was not very much larger than the steam cylinder, and for punching a plate the steam was turned on at the back of the piston; the piston-rod formed the plunger of the hydraulic press in which the punching was done.

Mr. T. R. HETHERINGTON thought the alleged injury to the cotton by pressing would hardly be found to be a matter of any moment. At the time when the present small bales first came over from the East Indies, he remembered it had been thought desirable, in order to get the staple to something like the form in which it came from America, to steam the cotton from the Indian bales; but that was now altogether abandoned, and he never heard any complaint made about the cotton being injured by the pressure; and from his own experience he did not think any harm was done to the staple in pressing the bales. As regarded the density of the bales, he supposed up to a certain point it was an advantage for freight purposes to get the cotton into the smallest possible bulk; but beyond that there would not be any gain as to freight by a further reduction in bulk. Up to the density at which the weight and measurement were equal, he believed the East Indian cotton might be pressed without doing any harm to the staple. Cotton of very fine fibre came as a rule either from America or from Egypt; for this a rather lighter pressure was desirable than that used in the presses in India.

Mr. R. H. TWEDDELL said his wish in writing the paper had been to elicit discussion on the question of pumps, direct-acting or otherwise: without reference to the matter of cotton pressing and the best way of doing it. It was true that the press described in the paper was intended for re-pressing; but that in no way affected the point at issue as regarded the two modes of pumping. As to the question why there should be the difference between $\frac{3}{4}d.$ and $2d.$ in the cost of fuel for pressing, he had no reason to doubt the accuracy of these figures, which had been given at the previous meeting as those obtained by two different forms of press. This difference was then said to be due to the pumps, which differed chiefly in their length of stroke; no reason had been given to account for such a difference, from any consideration of the different styles of pumps; and unfortunately this discussion had confined itself to the subject of the press itself, while the paper was directed more to the question of pumping. With regard to the President's questions, any steam not already exhausted from the first cylinder was allowed to escape by a separate valve; and the velocities of the water were, as stated in the paper, 75 ft. and 450 ft. respectively per minute, or only 1.25 ft. and 7.5 ft. per second. No one was more aware than himself of the merits of the Watson press described at the last meeting, which was worked on the principle advocated by Mr. Shield; but he certainly thought that with the addition of direct-acting pumps on the system described in the present paper, or some similar system, the results would be still more satisfactory. In reference to the remark as to the great size of cylinder required with such an arrangement as that shown in the drawings, he did not agree with the calculations given by Mr. Shield; it was a mere question of cubic capacity of cylinder, and there were of course different ways of obtaining this capacity: it might be got by increasing the number of cylinders, or by a longer stroke. But he failed utterly to see the loss which would result from having a cylinder 60 inches diameter, or even 115 inches; he would rather have a cylinder of 60 inches diameter and one large forcing plunger, than have twenty small pumps and one cylinder of 20 inches diameter. That was however a matter of opinion and experience; but up to the present time his

own views had not been in the slightest degree modified as regarded the economy he believed capable of being produced by using the direct-acting process. Presses had already been made with steam cylinders up to nearly the diameter shown in the drawings, the Ashcroft press described at the last meeting having a steam cylinder of 45 inches diameter. The number of cylinders was not limited to two, but could be altered as might be necessary; and the requirements illustrated by the very interesting pressure diagrams, shown by Mr. Shield at the last meeting and also on the present occasion, could be better met, he thought, by this system than by any other or by any number of small 'pumps. The discussion had not turned, as he had hoped it would, upon the best modes of pumping the water, which he thought was a subject well deserving attention: it seemed to him, if there were any loss due to the pumping apparatus, as stated at a previous meeting, it must certainly occur where there were a number of reciprocating pumps, and where the motion of the water was reversed every 6 inches, the water passing through a considerable number of tortuous passages, and being thus opposed at every turn in its course towards the press. In the application of the direct-acting press for punching plates, which had been referred to, there was nothing novel, as it had been done in a great number of instances. The chief novelty in the plan described in the paper was the economical arrangement whereby the exhaust steam from the first cylinder was used in the second cylinder to do the earlier part of the following stroke, during which less power was required; that was the secret of the economy, which, as observed by Mr. Cowper, would be further increased by jacketing the steam cylinders.

The PRESIDENT was sure this question of pumping for hydraulic presses was most important in every point of view, not only to cotton pressers, to whom perhaps it was of the highest importance, but also in regard to a number of applications such as had been referred to, for pressing jute, wool, and other fibrous substances. They were therefore indebted to Mr. Tweddell for bringing the subject forward

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again at this meeting; and also to Mr. Shield for calling attention to any weak points in the views advocated by the author.

He proposed a vote of thanks to Mr. Tweddell for his paper, which was passed unanimously.

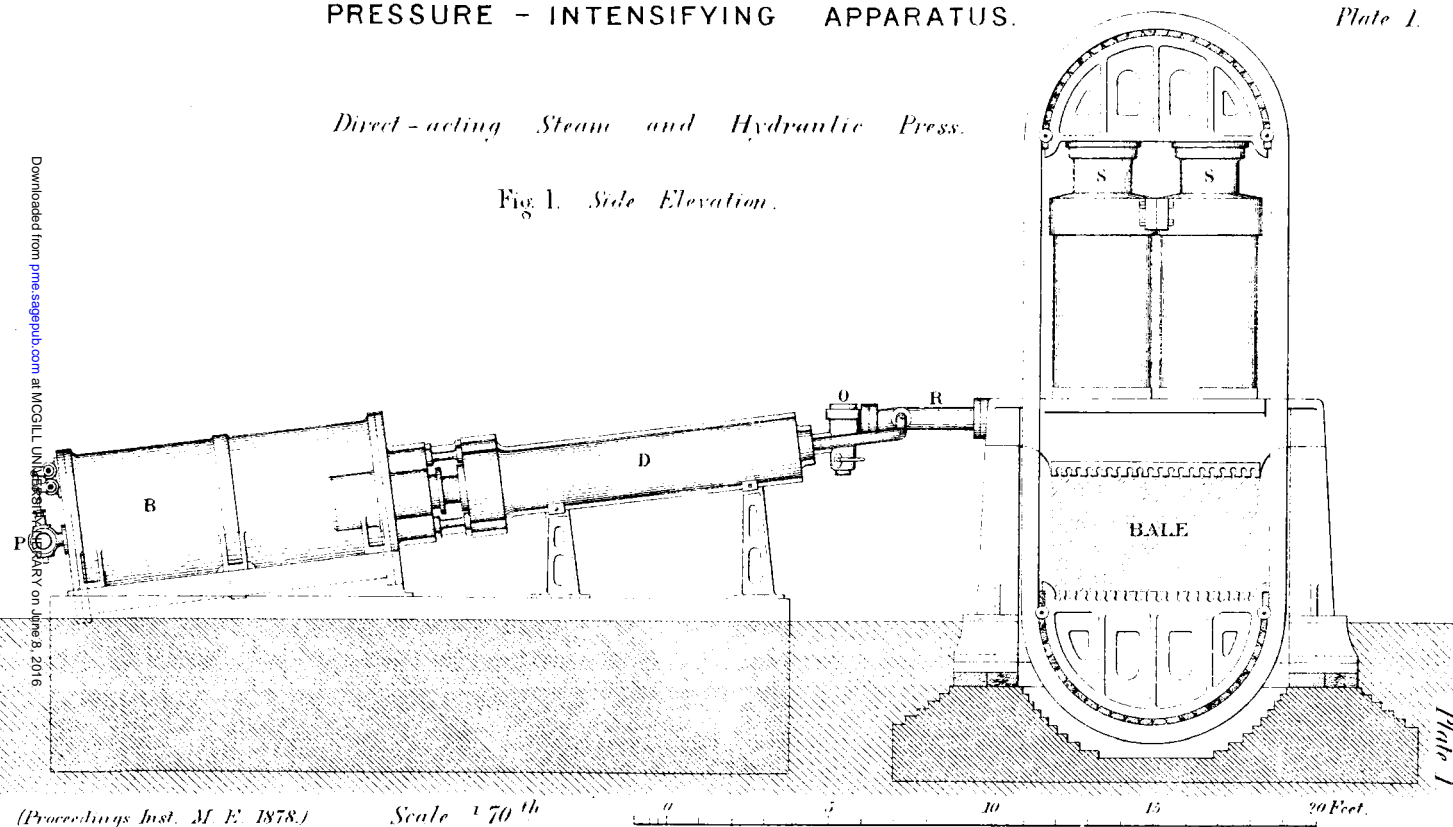
The following paper was then read :—

PRESSURE - INTENSIFYING APPARATUS.

Plate 1.

Direct-acting Steam and Hydraulic Press.

Fig 1. *Side Elevation.*



(Proceedings Inst. M. E. 1878.)

Scale 1/70th

0 5 10 15 20 Feet.

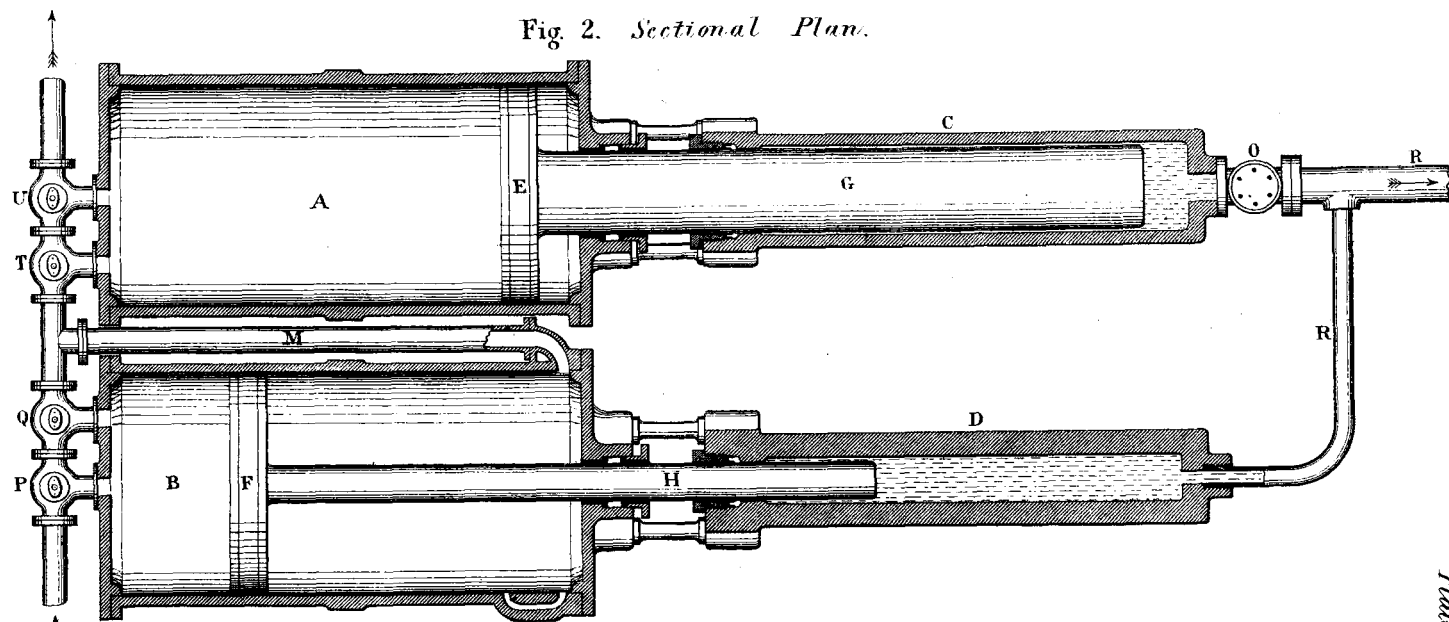
Plate 1

PRESSURE - INTENSIFYING APPARATUS.

Plate 2.

Direct-acting Steam and Hydraulic Press.

Fig. 2. Sectional Plan.



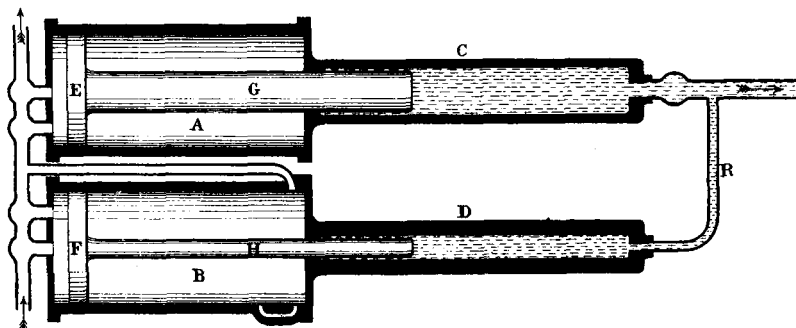
(Proceedings Inst. M. E. 1878.)

Scale $\frac{1}{50}^{th}$

PRESSURE - INTENSIFYING APPARATUS. *Plate 3.*

Direct-acting Steam and Hydraulic Press.

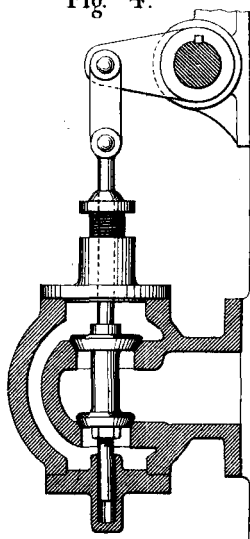
Fig 3. *Diagram to illustrate Working of Rams.*



Details of Valves.

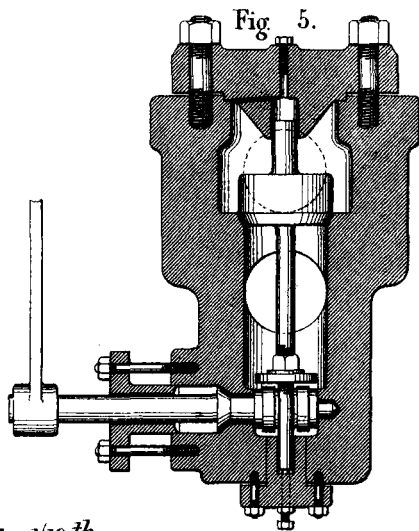
*Steam
Equilibrium Valve.*

Fig. 4.



*Hydraulic
Clack Valve.*

Fig. 5.



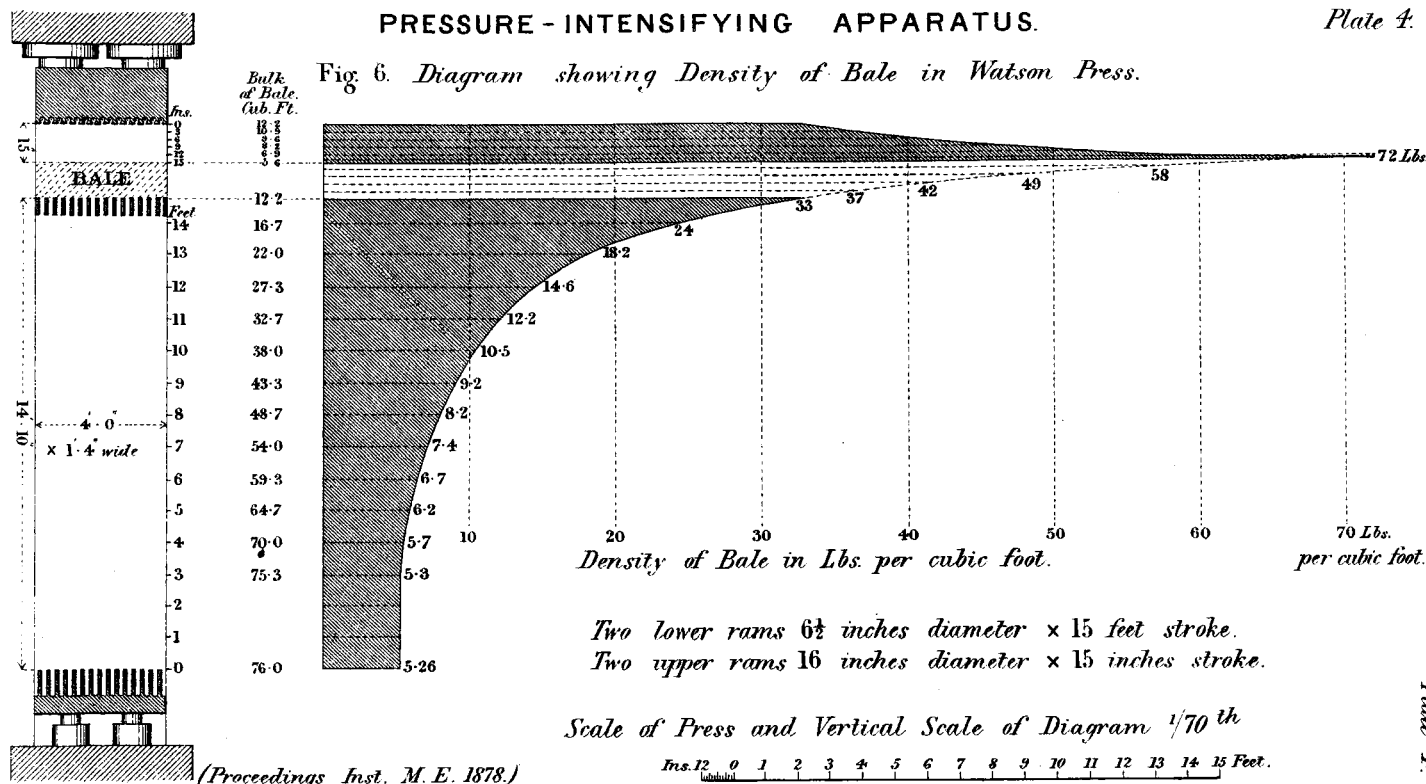
Scale $\frac{1}{12}^{th}$

Ins. 12 9 6 3 0 1 2 Feet.

PRESSURE - INTENSIFYING APPARATUS.

Plate 4.

Fig. 6. Diagram showing Density of Bale in Watson Press.



(Proceedings Inst. M.E. 1878.)