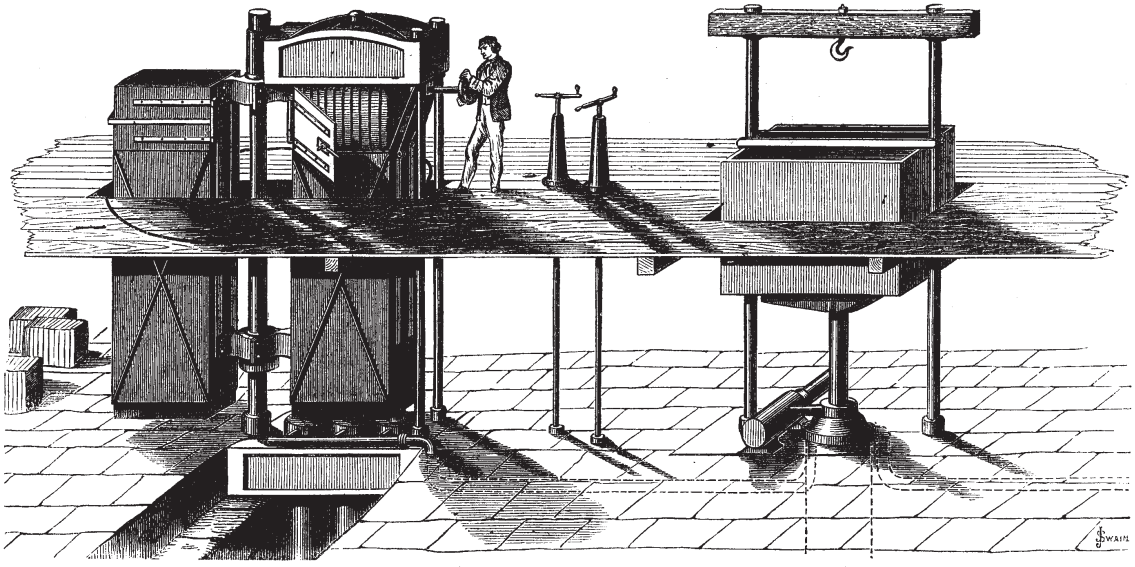
ASHCROFT'S ACCUMULATOR COTTON PRESS.

CONSTRUCTED BY MESSRS. ANDREW HANDYSIDE AND CO., ENGINEERS, DERBY.

(For Description, see Mr. Matheson's Paper.)



SOCIETY OF ENGINEERS.*

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"The Accumulator Cotton Press."

BY EWIN MATHESON.

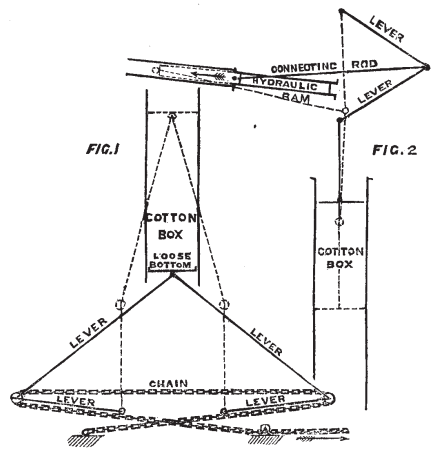
THE trade in cotton, under its many different aspects, forms so large an item in the commercial activity of this country, and is so largely increasing, that every incident and process in production and manufacture possesses a corresponding interest for all concerned.

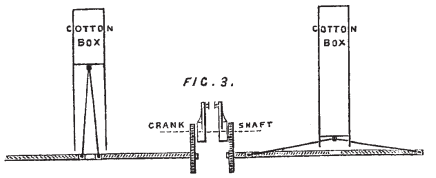
Although for very many years the importation of cotton and its manufacture into fabrics have been among the greatest industries of Great Britain, it is only more recently that the production of the raw material has engaged any considerable share of British capital and enterprise. The immense importance now, however, of the cultivation of cotton in India and the colonies, and through them to the mother country, is, of course, manifest to all. The growth of cotton in India, Egypt, and elsewhere was formerly so small in comparison with that of the Southern States of America, that it needed the artificial stimulus given to it by the American war, and consequent closing of the cotton ports, to produce a commercial success.

This success has survived its immediate cause, and Indian, Egyptian, and colonial cotton now take a permanent place in the British market. The rapid increase and present enormous extent of this trade may be seen from the fact that in the first six months of the year 1866, 119,000 tons of cotton were imported into the United Kingdom from India, and 30,476 tons from Egypt. The shipment from India for 1868 shows an apparent decrease; but this is owing to the fact that a great quantity of cotton that was formerly sent from Bombay to the United Kingdom for re-shipment to the Continent is now sent direct to France and elsewhere. The Indian cotton exports are really increasing annually. From Egypt, the amount exported to this country in the first six months of the present year was 7000 tons more than in 1866, and the present crop promises to allow a still further increase.

There are several disadvantages with which India has to struggle. Assuming that the first cost of tillage and agricultural labour is the same, there then remains the immense difference between India and America in distance and time of transit from the port of departure to the port of arrival. From New Orleans to Liverpool the distance is 6000 miles, and twenty days' voyage for a steamer. From Bombay to Liverpool (round the Cape) the distance is 12,000 miles, and takes 120 days. Thus in the race India is heavily handicapped. The carriage of the cotton costs more, and the time expended in the voyage from India to England renders unproductive for a longer time the money represented by the cotton bales; and four months' interest is of no small consequence in these days of close competition. It will be seen, therefore, that the cotton producer in India must study every item of expense, and that every detail of cost and incidental outlay is of greater importance to him than to his more highly favoured rival in the United States. If the Suez Canal were but open, the voyage by the Cape would be avoided; but opinions differ as to the ultimate success of that scheme, and the route certainly does not exist at present. The Isthmus Railway was intended for the same purpose, but the cost of transshipment and land carriage is so great that there is practically little advantage in bringing cotton that way, and till lately it was only silk and other expensive goods that were brought overland. Recently a considerable amount of cotton has been sent across the Isthmus, but until better arrangements are made for its transport by the Suez Railway, only an inappreciable quantity of cotton will come by that route.

It will be seen, therefore, there is every inducement to save, if possible, in the cost of freight. Now, the freight payable on bales of cotton is calculated by the ton of measurement, and not by the ton of weight; and therefore the more cotton that can be compressed into a bale of given size the lower the rate becomes per lb., and the greater becomes the amount of profit.





The foregoing preface shows the important service that can be rendered by powerful baling presses; and while this is especially the case with India and Australia, it is true also for Egypt and other less distant places, where the expenses of irrigation and tillage may form a large proportion of the total cost. Moreover, it is desirable that no time should be lost at the port of shipment, but that the packing process should be performed speedily.

Considering that for many years America had almost the monopoly of the cotton supply, it might be expected that as the trade grew up in India and Egypt, all the designs for the requisite apparatus could be at once copied from America.

* For Mr. Baldwin Latham's paper on "The Application of Steam to the Cultivation of the Soil," read on the same evening, see page 521.

As is well known, invention does not sleep in the United States, and it might be presumed that for any production in which the people are engaged, the best appliances would soon be discovered and made use of in that country. It is not surprising, therefore, to hear that for all the details of pressing cotton a great variety of plans have been tried. As has been shown, however, there is no such urgent inducement to the merchant in America to compress so much cotton into a bale for the short voyage to England. The cotton itself also differs from that produced in India. It is, as a rule, cleaner and more elastic, and would require much more power to compress the same number of pounds into a cubic foot than is necessary with Indian cotton.

While the cotton culture in India was in its infancy, the quantity produced was too small to create a demand for any special apparatus. Baling machines were sent out from England, but they were of a very primitive kind. Screw presses, something like those used for making cheese, were contrived. The next step was to work the vertical screws by bevel gearing and a winch. Then, as the cotton trade grew in importance, there was devised a number of inventions and contrivances, some by engineers, and others by the cotton growers, whose ingenuity was stimulated by necessity, the mother of all invention. Levers, screws, and wedges were tried alone and in combination. The use of hydraulic pressure natually suggested itself for trial, but it was not very successful; no very great power was obtained, and the process by pumping was slow.

Gradually improvements were made in the lever presses, and these were generally preferred. Some of them may be mentioned. A Mr. McComb took great pains to make a good baling machine, and patented several of his improvements. His cotton was forced up by two compound levers, drawn together by a chain worked by hand or steam, (see Fig. 1).

Mason's press (Fig. 3) had somewhat the same principle of levers, but was worked in a different way. A horizontal engine drove two machines, the crank-shaft running right and left from the engine. By gearing, a shaft parallel to the crank-shaft was driven at a reduced speed, and by means of right and left hand screws on these shafts two powerful levers were drawn together and forced upwards against the follower of the cotton box. Both these presses are still in favour, and are used in considerable numbers; yet, however well they may be made, it is obvious that there must be severe strains upon the points through which the power is transmitted—strain, it must be remembered, which are excessively heavy at each occurrence of the final pressure to a bale. There are in Bombay companies formed specially for pressing cotton, and the leading merchants also have pressing factories of their own, and the different kinds of presses are held to be best by their respective owners. A machine known as Hodgart's cotton press embodies a very ingenious combination of hydraulic and lever powers. Fig. 2 shows the method by which the pressure is put upon the cotton by the force of the hydraulic ram on the levers. The process by pumping being in ordinary presses slow, it was here endeavoured to reduce the quantity of water necessary to be pumped by having a ram of small area, and by multiplying the power so gained by the levers. This press, at its usual rate of speed, will pack ten bales per hour, and it is possible to do fourteen; but this is too severe labour for the men. At the time of the Abyssinian expedition hay was packed for the troops at the rate of fifteen bales per hour; but this was an exceptional and extraordinary speed that could not well be repeated. It is considered, in Bombay, good work to pack eight to ten bales per hour with the presses generally used. All the machines that have been here described are compound in their action, and are subject to severe and varying strains. The Bombay Press Company uses Nasmyth's press, which is one of the best that has yet been invented.

No diagram is necessary to show its action, which is extremely simple. The pressure is effected by three hydraulic rams placed side by side. At the beginning of the stroke, while the cotton is in a pliable state, the power is applied by one cylinder only. Toward the end of the stroke the other two rams are also set in motion, the two cylinders having been previously filled with water, so as to save time in pumping when the power is supplied to them.

Mr. George Ashcroft, having given this subject much attention, invented and patented a machine in which he obtained the power of hydraulic pressure combined with rapidity. The first and easy pressure on the cotton was rapidly effected by a steam piston, only the final and severe pressure being given by a hydraulic ram. This press worked satisfactorily, and would probably have been pushed to success by the inventor, had he not thought of something better. If the first evolving of a simple but important mechanical principle be a great thing, the extension of it to processes in which it has not been adopted before is of almost equal practical importance. Mr. Ashcroft determined to apply the accumulator to a cotton press, and has most successfully done so.

Before describing this machine, the writer would remark that he had very much wished to obtain accurate information of the machines used in America, and felt that no discussion would be complete that ignored the practice of the greatest cotton-growing country in the world. He had failed in procuring drawings from the United States, but has had a long letter from an engineer in New York, who has given this subject his special attention for many years, and who sends home some very interesting particulars. As might be expected, there are in America a vast number of inventions for all processes connected with cotton. In the various cotton states there are differences of custom as to the size of the bales, and so in Texas, North and South Carolina, Georgia, and Florida, there are different kinds of baling machines used. Levers and screws, hydraulic and steam presses, have been combined in many different ways, and with varying success. Wood is more used in America than in England in the construction of machines, and machines so made would probably not find favour elsewhere. Very likely English machines would be condemned there. As one of the incidents arising out of the war, when the Southern ports were shut out from the rest of the States, the blockade runners took over English made presses, and, among others, some of McComb's, but they found no purchasers. Every other detail of cotton packing is studied by inventors in the States, and the correspondent before referred to says that there are some fifty different patents even for modes of fastening the baling hoops. In the London Patent Office the writer has seen more than a dozen specifications on the same subject. It would be interesting if the printing of the present paper were to result in the supplying definite information from America on the whole subject.

The Accumulator Cotton Press is the invention of Mr. George Ashcroft, who designed the machine to fulfil the two main requisites of great power and of speed. While in theory there is no limit to the force that can be exerted by hydraulic pressure, in practice the difficulties commence at a certain point. So far as these machines have been used hitherto, a maximum pressure of two tons to the square inch has been employed; but even with this enormous pressure, it is necessary to have a very considerable area of ram to obtain the required total, and to get this with one cylinder involves practical difficulties, well known to engineers. It at all times requires great care and skill to cast cylinders capable of taking high hydraulic pressure, and the risk increases very rapidly with the diameter of the cylinder. While with a small diameter, a moderate thickness of metal will successfully endure enormous pressure, cylinders of large diameter must be made of strength to resist fracture. But as beyond a certain thickness cast-iron becomes spongy and porous, such casting would be liable to unsoundness and the water would ooze through to the surface. Moreover the castings would be inconveniently heavy and difficult to transport. In the present invention the required area is obtained by placing three cylinders with 8 in. rams side by side, and these giving a total area of 150 in., a force of 300 tons is produced by the pressure before named. If necessary this pressure could be increased, as, in fact, a much higher degree had been obtained with hydraulic presses.

The box in which the cotton is pressed is in plan of the dimension usual for a marketable bale, and in height sufficient to hold enough loose cotton to give a bale of the required thickness when pressed. The box is made entirely of wrought iron, strongly framed, and the upper part of it, where the ultimate pressure is received, is of considerable thickness. This part of the box is planed all over, so as to present a true and smooth surface to the cotton. The doors are made so that three of the four sides can open. One of the special points in this invention, for which a separate patent has been secured, is seen in the revolving boxes, the advantages of which will be apparent when the operation of the machine is described. The "accumulator" is of the well-known simple kind, consisting of a cylinder and ram, the latter supporting a box which, as the ram ascends and descends, moves up and down in guides. This box can be made either of wood or iron, and can be filled with any heavy substance, such as stone, iron, or gravel.

There are a set of three hydraulic pumps of equal size, driven by a pair of horizontal engines. From these pumps there are communicating pipes to the accumulator and press rams, and to the small differential cylinder.

The mode of working is as follows: The house consists of a ground floor and two floors above. Upon the ground floor are fixed the steam-engine, the pumps, and the press and accumulator cylinders; but the latter might, if necessary or convenient, be place a hundred yards away. The framework of the press reaches through the floor to the top of the chamber above. In the uppermost chamber the loose cotton is stored, and when the baling takes place at the port of shipment the ginned cotton generally arrives in loosely packed bales. On the centre floor are the handles for working the valves, and here is posted the engineer who has control of the machine.

During the whole time of pressing and baling the cotton the engines and pumps are at work. The dead load in the accumulator box is forced up with a pressure on the ram of less than one ton to the inch, the exact weight in the box determining the precise degree of pressure which has to be exerted upon the ram. This accumulated power having been obtained, the apparatus is ready for work.

The men upon the top floor having placed the bagging in the box, and filled it with loose cotton, which they trample down, the men below push the revolving boxes round, so that the cotton-filled box is over the rams. The boxes revolve upon the strong vertical column, the weight being taken on balls, which rest upon the collar, the bearing surfaces above being turned and bored to fit.

A portion of the floor revolves with the boxes. The hooping irons having been placed in recesses at the top of the press, the engineer opens the valve which admits the high pressure water to the rams. At once the accumulator box descends, and the three rams of the press ascend, forcing the loose bottom of the box upon the cotton. But as the accumulator box descends, the pumps being still at work, in some measure restore the height of the water column, and the accumulator ram gently ascends and descends as the water is thus withdrawn and restored. When the cotton is compressed upwards as tightly as the rams can force it, the engineer shuts the valve which admits the water from the accumulator and the pumps, and opens one which admits the water from the differential cylinder. By means of rams of different diameters the pressure given by the pumps is in this cylinder multiplied. The superior power thus produced forces up the three rams, and with them the cotton, the last few inches of the stroke to the ultimate point desired. One of the doors of the box is then opened, the hoops are fastened, and then the other doors being opened, the water in the cylinders is let to waste, and the rams descend. The elastic cotton at once expands into the small distance allowed by the hoops, and with but slight assistance from the workmen the bale tumbles from the box and falls down a shoot to the floor below. Meanwhile the other box having been filled with cotton, it is pushed round into its place over the rams, and is in its turn subjected to the pressure of the water, and so the process is repeated without intermission.

The merits claimed by the inventor for his machine are as follows: It being acknowledged that of all mechanical appliances hydraulic pressure exerts the greatest force, full advantage is taken of the fact by having a large area of rams and a high pressure. More than 30 lb. of cotton per cubic foot can be compressed and held within the hoops for shipment, and as after pressing, the elastic cotton expands, and slightly stretches the hoops, a larger quantity than 30 lb. has to be squeezed at the final moment of pressing to obtain the above result. The simplicity and smoothness of the process obviates the excessive wear and tear which is unavoidable in machines where the pressure is obtained by levers or screws. The friction on the packing leathers is extremely small. Great uncertainty existed until recently on this point, and all makers of hydraulic presses differed from each other on the subject. Professor Rankine gave 10 per cent. of the total load as the amount wasted by the friction of the leathers, but the whole question has been most successfully investigated by Mr. Hicks, of Bolton, who by his experiments, which are recorded in his admirable little treatise published last year, proves that the friction of the leathers on an 8 in. ram is about $\frac{1}{20}$th part of the total load, the decimal varying from 0.33 to 0.50 according as the leathers are more or less worn, and well or sparingly lubricated.

Speediness of Action.—The principal of the accumulator is well known, and for working cranes, opening dock gates, and many other purposes, has been in operation some time. It is probable that sooner or later some one would have applied it to cotton baling presses, but at any rate Mr. Ashcroft has *done* it, and he only. Instead of the power, whether it be that of steam, water, men, or cattle, having to be applied as is necessary in other presses, with concentrated energy during the short time of the actual compression of the cotton, in the present case during the whole time of filling the boxes, changing them, and hooping the bales, the pumps are quietly at work forcing up the accumulator box, which at the proper moment gives forth all its power and does all that is required in a few seconds. The revolving boxes are an ingenious part of the machine, and by their arrangement obviously save much time. Twenty-five or more bales can be packed and hooped per hour.

Endurance.—The power being direct acting, there are few parts that are liable to need repair, and the occasional renewal of the packing-leathers entails but a small expense.

In Alexandria the accumulator press is in full operation, and at Bombay also it is exciting much interest among the cotton merchants, some of whom are now in treaty with a view to its adoption there.

In conclusion, the writer would remark that the importance of the cotton trade having been the cause of so many attempts to make good presses, the same cause is no less a stimulus now. The cotton trade is increasing so rapidly in India, Egypt, and elsewhere, that the best machines will undoubtedly have to be adopted by all those who wish to keep pace with the age. The railways that are being opened remove one great hindrance to the cotton grower. Hitherto, the cotton has been packed loosely in the growing districts by the natives, and has had to be repacked at the port, the merchant not daring to send to England bales that might be filled with dirty cotton, or with stones to increase the weight. The inland carriage of the cotton is very expensive, and like the freight by ship, is calculated by the bulk occupied by the cotton. It has been almost impossible to take up country the heavy machinery necessary for pressing bales in a marketable condition, but as the railway system is developed, it is probable that in the centre of the growing districts proper presses will be established. Mr. Ashcroft is now giving his attention to a village press, the particulars of which he may possibly send home to the society.