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# FLOUR MILLING MACHINERY.

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HITHERTO the author has refrained from writing a paper on flour milling machinery, although frequently asked to do so. His reason for not consenting sooner, was because the question was of such magnitude that he found it impossible to deal with it in one paper; therefore, the observations he will make this evening are merely of a preliminary nature, and represent, so to speak, the foundations of another paper to be contributed at a future period. He had no hesitation in saying, from his experience of milling machinery, that to deal with it for the purpose of giving you reliable information, it would necessitate a paper upon every machine used in the milling business, as well as several papers on the treatment which the grain receives while passing through them, giving you the results, and illustrating the methods in use at present and those which are now almost obsolete.

The author's experience of milling machinery in this colony, dates from the time of his apprenticeship. At that time, a flour mill consisted of so many pairs of stones, a smut machine, a rake or mixer and a dressing machine, with the necessary sets of elevators for conveying the meal and grain from one part of the mill to another; and he thinks, that as there are many mills of this description still being worked in the colony, it may not be out of place to touch upon the system of stone milling first. In mill building, whether it is on the old stone process or the new roller process, it is absolutely necessary, in the first instance, for the mill proprietor to have his mill properly designed and constructed.

Architecture, we are told, is the art of planning and constructing buildings according to their intended use; and it is with a hope of having the mill buildings which may be constructed in the future brought more into harmony with that definition that he expresses these few words on the subject of the building, irrespective of what the plant may be. He is sure that every milling engineer who has had experience must bear him out in these remarks that it is usual, in most cases, for a mill proprietor to consult an architect as to what design the building should be, and then to call for tenders, and let the contractor carry out the plans to his satisfaction. When the building has advanced to a certain stage probably a tracing is sent to a milling engineer. The consequence is the engineer has to arrange the machinery in whatever space the architect has thought in his wisdom to be sufficient. In many instances the columns and girders have been placed in positions detrimental to the machinery, thereby creating difficulties for the milling engineer, and very frequently preventing him placing the machinery in the best position; again, in laying in wall boxes, cutting holes through the floors, and making all necessary provisions for the machinery, it entails a considerable expenditure which would be unnecessary if attention was paid to these things while the mill was being constructed. There is no doubt you will admit that by far the most economical plan would be to first consult a milling engineer as to what class of machinery should be erected, and place the matter unreservedly in his hands to design the whole of the interior of the mill, giving the length, breadth and height of floors, angle of roof; showing also where the principal timbers should be placed, and where all wall boxes for the machinery should be built in. This part of the work being completed, the architect could design the exterior of the mill, and between the two there is no doubt the proprietor would have an economical as well as a useful and ornamental building.

In all properly constructed mills there should be apertures in the floor, of sufficient size, and so arranged that they could be opened at pleasure to take up a good-sized machine without pulling it to pieces, thus saving time and expense to the proprietor.

In designing a mill, it is necessary to consider what the motive power is to be; the class of wheat to be ground; whether it is to be a commercial or a grist mill, or both combined; how the motive power is to be applied; what process or system of milling has been determined upon; how the wheat is to be received; whether it is to be received in a store and conveyed by screw to the mill, or whether it is to be received directly into the mill—all matters requiring careful consideration in planning a mill. The next important feature is a good set of plans, showing the position of each machine, so that no error can occur during erection. There is no investment that brings so good a return as a good set of plans; they save labour and material in erection, and power and labour in running—choose the process to suit your requirements, the machinery to suit the power, and the mill to fit the machinery.

A well designed stone mill should have not less than three floors, and a roller mill not less than four; but five or six would allow of greater facilities for advantageously erecting the machinery. All roller mills should have a basement or underground floor, which would be utilised by the main shaft and elevator bottoms; but under no circumstances should provision be made in the building for the storage of wheat or flour, for his experience was that when the floors are heavily laden they come down and displace the shafting and gearing which are attached to them, sometimes stripping wheels, and causing endless trouble, annoyance and expense.

The majority of our mill buildings are bad in design, exceedingly low between the floors, and evidently built on a supposed economical principle and not at all adapted for carrying on a very ordinary milling business. Having said so much on the building, he would now make a few observations on the grain which is to be ground. A knowledge of the physical formation and chemical construction of whatever you are going to treat, should be the basis for construction of the machinery you are going to work. Knowing that which is chemically most valuable in a grain of wheat, we are better able to construct machinery which will save and properly treat it, and at the same time separate and eject such parts as injure the character and value of the desired product. In order that our knowledge of cereals should be complete, it is necessary, you will therefore see, to study the chemical and physical properties of the grain; by the first method, we should be able to place a valuation upon the special elements, and parts of the grain structure, by the second, know where are located the most valuable parts of the cereal, while chemically we may discover what bodies are most valuable. It is of the utmost importance that these valuable parts be localised, hence the necessity of the physical study of the grain structure.

Delacroix gives an analysis of wheat examined by him as follows:—

"Water 14.90, gluten 20.64, albumen .99, starch 46.99, gum 1.52, sugar 1.50, oil .87, vegetable 12.59; total, 100 parts." The constituents named and classified by him may be divided into two classes, viz.:—Nitrogenus and non-nitrogenus bodies; but as it is milling machinery he was dealing with, he would defer making any more comments upon the grain, and simply call your attention to an enlarged longitudinal section of a grain of wheat, magnified 450 times. (Plate VIII.)

This will give you some idea of its formation, showing the various tissues, of which, including the outer coats, there are ten. Having made a few remarks on the grain, we will now pass to the question of converting it into flour.

For this purpose, there are several descriptions of mill stones used; but that which is considered best, and which is the only one used in this colony is the French burr. The burr stone in texture is cellular, as well as being irregular in shape and size, oftentimes closed by fine flakes, or by cross fibres of silex. It is about as hard as flint, and varies in its nature from the most open to the closest possible. In quarrying the stone it is not wise, and it is seldom done, to quarry a stone out of a solid block. For commercial purposes the French burr is quarried out in wedges of from 75lbs. to 100lbs. in weight in the rough, and measuring roughly 12″ x 20″ and 14″ x 8″. After being quarried, it is laid to dry or season for one or two years before it is used in building mill stones. The quality varies considerably with the depth from which it is taken—the clear white or variegated stone resembling marble, is generally thought the best for all uses, being free and hard, and holding its edge well. In constructing a mill stone, it is essential to select burrs of the same nature and of equal hardness, so as to ensure regularity of wear. When the stone is in use it is less trouble to keep on face, and therefore does better work.

In constructing a mill stone, which, in this colony is generally four feet diameter, the blocks before mentioned are first faced on one side and the two edges, and laid face down on a plate; the joints should be close throughout, and if possible, all the stone should extend from the skirt to the eye; as each block is placed against the other, a layer of cement or plaster of Paris is laid between, and so on, until the stone is completed. Sometimes a stone is made in as many parts, as it is intended to lay the stone out in quarters when putting the work in, by this means the joint would run through the master furrow, which is an advantage. When all the stones are cemented in position, the back is filled in and coated over with cement. The next duty is to make its face perfectly true, then to decide what class of work is best suited to the class of wheat to be ground. This is a point on which it is very rare that two millers agree. The important points to be considered are first, the eye, the breast, and the skirt on the surface of the stone, the furrows and the land. In all the foregoing, a diversity of opinion exists. The author will not therefore occupy your time by going into details upon the relative qualities of the dress. The eye of a stone should be at least 12″ diameter in the runner or top stone, and tapered outward at the bottom, the breast is always kept lower than the skirt in order to allow the grain easy access, so that the grinding may be gradually performed, and by the time the grain reaches the skirt, it is completely reduced and the operation is completed on the skirt. To explain the laying out of the stone we will allow in this case, that we have twelve quarters and 3 furrows to the quarter, technically twelve threes with a draft line of 5″. The circle in the centre (Plate IX., Fig. 1) represents the draft circle, and the usual system is to first divide the skirt of the stone into as many parts as quarters required, and apply a staff which is called a "spline." We will now allow the stone is constructed and ready for the mill, the next consideration is to place it in its position on the stone hurst. The stone hurst is a massive timber frame or a neatly designed iron one, upon the top of which the bed stone is laid. The hurst should stand, if possible, free from the walls of the building. In the eye of the bed stone is laid the neck bush, a casting having three moveable brasses fitted in recesses on the side; this in conjunction with the toe step enables the miller to regulate the spindle, so that it shall stand at right angles to the face of the stone. It is not necessary to go into further details of the fittings connected with mill stones; but simply take you through the mill, allowing you an opportunity to see how the whole process is carried out in a stone mill.

In a well-appointed stone mill, the grain in the first instance is emptied into a hopper, upon the mill verandah, from which it is taken by a set of elevators inside the mill, and conveyed to what is commonly termed a stock hopper; from here it is taken by a screw or conveyor to a separator, which takes out all the larger impurities, after which it is deposited in a bin erected over a smut machine. The smutter which is in general use is a vertical frame and cylinder, with a perforated steel casing surrounding it, and a strong exhaust fan attached. The wheat is fed into the cylinder on the top, the drum travelling at a speed of 600 to 700 revolutions per minute, which thoroughly scours the wheat and relieves it of any particles of dust which may have adhered to it, the exhaust fan immediately withdrawing all the dust and depositing it in a dust room. From the smutter the grain passes into a machine similarly designed, with the exception, that instead of having beaters on the vertical drum it has brushes. This thoroughly scours the wheat again, and the fan in this case, as before, carries off all impurities which are released from the grain. There is also another design of wheat brush which does good work. It consists of two circular brushes, about three feet in diameter, one being stationary and the other revolving at a high velocity. The grain is fed in at the eye or centre of the stationary brush. The centrifugal force of the revolving brush carries the grain outward, and is thoroughly cleansed whilst passing between the two brushes. A fan is attached to the spindle, which exhausts the air from the centre of the brush, and extracts all the dust and light impurities. This machine is to be recommended as a well-made and effective wheat brush. The wheat then travels from the bottom of this machine direct to the bins or hoppers over the stones. Here it is ready for grinding. In many well-appointed mills a small contrivance, somewhat similar to a surface condenser, called a wheat heater, is erected directly under the floor, and the spout from the wheat bin is led into it. A steam pipe from the boiler enters at the top, and a relief pipe at the bottom conveys the condensed water away. By this means the heater can be brought up to any temperature the miller requires for his wheat. The object of this is as follows: Should the grain be damp, a certain amount of moisture is extracted; if, on the other hand, the grain is too dry, the heater will draw a certain amount of moisture from the centre or kernel of the grain into the skin or bran, and the grain is thus toughened or softened, as required, which prevents it being cut into small particles whilst going through the mill stones, consequently keeping the flour from being specky. There is a diversity of opinion respecting this appliance; but the author's experience is, that with judicious usage, good results are obtained. From the wheat hoppers the grain passes on to the mill stones. The wheat passes down from the wheat hopper direct into the silent feed over the stones, falling upon a saucer-shaped casting on the top of the spindle; the velocity of the spindle gives a centrifugal action, causing the grain to spread itself evenly round the eye of the stone. The wheat is then gradually received into the breast of the stone, and so the operation of grinding goes on. In the speed of the mill stones there is a wide divergence of opinion. He had known millers who would not drive a pair of four feet stones more than 100 revolutions per minute; yet his experience was that better results both as to quantity and quality are obtained in running them from 140 to 160 revolutions per minute on wheat. It stands to reason that if, in running a pair of stones 100 revolutions per minute, you can put through a certain number of bushels, you must by increasing the speed to 160 revolutions put 50 per cent. more through. There are various methods for keeping the stones cool; sometimes the eye of the stone is enlarged, and a sheet-iron plate is secured on the eye to create a draft; in other instances an exhaust fan is used to exhaust air from the stone casing—this has a very good effect. It is often carried to a greater extreme than this, for sometimes milling engineers not only exhaust the air out of the stone case, but insert a blast as well. The dust extracted from the mill stones whilst working is the ingredient which has caused so many large mills in America and other parts of the world to be destroyed by fire. It is very inflammable, and the fact of bringing a light in contact with the inside of a stive room—a room where this dust is deposited—is, to say, the least exceedingly dangerous.

After leaving the stones, the meal is received into a screw conveyed on to a set of elevators, and, in some instances, delivered into what is termed a meal room; in others direct into a silk machine. The silk dressing machine consists of a hexagon reel varying from 3 to 4 feet in diameter, and from 10 to 30 feet in length. In many instances the centres of the reels are made of timber of hexagon section with wood arms morticed through and six longitudinal pieces morticed on the end of these arms. The reel is perfectly true and the outer surface of the ribs is rounded so as not to destroy the silk, when working. Over these ribs the silk is laced according to the degree of fineness required, the coarser numbers at the head and the finer at the tail, with the exception of that which is intended for sharps and pollard. Underneath the reel is a screw extending the full length of the machine, with division wards between the flour, sharps, pollard, and bran, the screw being driven so as to convey the result of the dressing towards the head of the machine; thus the whole of the flour is conveyed to the head, the sharps next, then the pollard, and the bran over the tail.

From the dressing machine the flour goes direct to the flour packer; or, in most of the old style of mills, the ordinary sack jumper, an appliance on to which the sack is hooked, and by means of a lever the flour is dumped into a bag. There are many features connected with these machines which the author might have mentioned, but as this class of machinery is becoming obsolete he does not think it wise to deal too minutely with it; yet he felt compelled to touch upon the stone mill before he could bring under your notice the more recent improvements in milling machinery.

Before closing his remarks on the stone mill, he would like to point out an improvement which has recently been made, and which has given very good results. Mill proprietors, whose capital is not sufficiently large to warrant them throwing out the whole of their plant, have combined excellent results by combining rollers with stones. Many of our country millers have adopted this system and work as follows:—They grind high with the stones, pass the meal through a dressing machine, as before described, and dress off in the ordinary way, but they add a length of silk on the dressing machine so as to obtain all the sharps they possibly can. You will understand that by grinding high the miller must make considerably more sharps or middlings, as they are termed, than by grinding low. These sharps are passed on to a machine called a middlings purifier; here all the small fibrous matter is abstracted by a current of air passing through the silk. The middlings when thoroughly purified pass on to a set of smooth rollers; here they are softened and conveyed to a machine called a centrifugal, a class of dressing machine largely used in roller milling. The result of this is a whiter and stronger flour. Many of our stone millers have succeeded in holding their own in the market by this method. The author will not go into details of these three last machines as they form portion of a roller mill, and it was not his intention to go into the details of the roller mills in this paper; but he will upon some future occasion take up the subject and give you full information on the process, although, as he remarked at the commencement of this paper, it is impossible to do full justice to the subject except by a series of papers; and, as there are so few of our members whose calling brings them into contact with this class of machinery, he questioned if it would be wise to have many papers on milling machinery. Before closing, he would call your attention to the chief item in roller milling, which is the flow sheet. The first duty for a milling engineer, on the modern process, is to produce a flow sheet according to the number of bags of flour to be produced in 12 hours. Plate VII. is the flow sheet of a five-bag plant recently erected by our firm at Hillston, and giving every satisfaction; and Plate IX., fig. 2, for flow sheet of a fifteen-bag plant he recently designed for a firm who anticipated making extensive strides in the milling business. This is the first duty of the milling engineer before designing his mill or deciding upon his machinery. After the flow sheet is designed, the question of constructing the mill follows.

Arrangement of machines for fifteen bag roller mill. (Plate IX., Fig 2.)

WHEAT CLEARING MACHINERY.

| | | |
|---|---|---|
| 2 | Tarars ... ... ... ... | No. 1 |
| 1 | Eureka ... ... ... ... | „ 2 |
| 1 | Endingstone ... ... ... | — |
| 1 | Brush Machine ... ... ... | „ 3 |
| 1 | Magnet Machine ... ... ... | „ 4 |

MILLING MACHINERY.

| | | |
|---|---|---|
| 1 | Break Roller ... ... | Nos. 5 & 6 |
| 5 | „ „ ... ... ... | No. 7 |
| 6 | Smooth Roller ... ... ... | „ 8 |
| 2 | „ „ ... ... ... | „ 9 |
| 8 | Reels, largest size ... ... | „ 10 |
| 3 | „ middle „ ... ... | „ 11 |
| 1 | „ small „ ... ... | „ 12 |
| 1 | Centrifugal ... ... ... | „ 13 |
| 5 | „ ... ... ... | „ 14 |
| 2 | „ ... ... ... | „ 15 |
| 3 | Purifiers, pattern Buhlman... | Nos. 16, 17 & 18 |
| 3 | „ „ Besser ... | Nos. 19, 20 & 21 |