Fig. 1.

Fig. 7.

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This invention relates to a grinding mill and blower combination. More particularly, this invention relates to a grinding mill of the type having rotating hammer means which is particularly suited to the reduction of compacted material such as hay, grain, paper, wallboard, etc., or the processing of several materials simultaneously.

Additionally, this invention relates to a grinding mill of the type aforementioned, in which provision for continuous centrifugal force blower removal of the reduced product and/or mixed products is made.

Mills of the prior art for reducing compacted material such as hay have heretofore employed a plurality of cutter knives or blades which revolve between mill teeth, and the material is reduced or chopped up by the cutting action of the blades. The problem with mills of this type, however, is that the blades, which must be kept very sharp for good results, are easily dulled, especially when the material to be reduced is somewhat abrasive or hard or foreign objects get into the mill and cannot be removed thus damaging the blades. The mill teeth or the prior art, while playing a lesser role than the blades in the reduction operation, are also subject to constant wear through abrasion and damage. As a consequence, mills of this type tend to be more difficult and costly to maintain and require greater precision to construct. In addition, mills of the prior art require an additional and separate blower unit to convey away the materials ground.

Prior mills of the aforementioned type have also failed to provide fitting and grading apparatus which can be rapidly changed to provide reduced material of a desired size. To change the fitting and grading apparatus of prior art machines has generally necessitated the disassembly of at least a portion of the mill. Such disassembly involves a considerable amount of time and precision in reassembling the mill.

It is therefore an object of this invention to provide a grinding mill having a rotating grinding means which will not become dull with use or require frequent replacement.

A further object of this invention is to reduce material such as paper, grain, etc. and/or to reduce and mix several materials simultaneously and to provide a blower structure whereby the reduced material may be continuously removed from the mill.

Another object of this invention is to provide a trap means in a grinding mill for easy removal of foreign objects which inadvertently get into the mill without disassembling it.

Still another object of this invention is to provide a grinding mill which is simpler and more economical to manufacture and to operate than those of the prior art.

A further object is to provide a centrifugal blower means in combination with the mill whereby the reduced material may be discharged from the mill as it is reduced.

Another object of this invention is to provide a grinding mill having easily removable and replaceable fitting and grading apparatus.

Still other objects and advantages of the invention will become apparent from a detailed consideration of the part of the specification which follows in which like numerals indicate like parts throughout the several views, and in which:

FIGURE 1 is a side elevational view of a grinding mill including a conveyor system which may be utilized to feed the mill;
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The plate 66 is a rotor disc plate 74 extending radially outward from the hub 66. The plate is circular and is formed on the rear surface 77 with a plurality of rotor ribs or blades 78 radiating outwardly from the hub 66 to the peripheral edge 78 of the plate 76.

On the front face 80 of the plate 74 is a like number of smaller rotor ribs or blades 82 project radially outward from a point substantially equidistant between the hub 66 and edge 78 to the edge 78. The width of the ribs 82 are substantially less than the ribs 76 as best seen in FIGURE 4.

Each of the ribs 82 and 76 of the rotor means 64 have a grinding means generally designated 84. These grinding means 84 include a plurality of arm extensions 86 which are secured to the rotor ribs 76 and 82 at the outer edge 78 and project outward beyond the ribs and plate 76. The extensions 86 on each rib are spaced apart 100 include openings 88 which are aligned with each other to receive a hinge pin 90.

Each of the pins 90 includes grooves 92 which the ends of the pins to receive a clip ring 94 which bears against washers 96 to hold the pin 90 in position.

Mounted for pivotal movement on the pins 90 are a plurality of hammer elements 98. These hammer elements are each of substantially the same configuration being preferably a generally rectangular hammer plate 100 having openings 102 and 104 adjacent the respective ends 106 and 108 of the plate 100. As is illustrated, the pin 90 passes through the openings 102 of the hammer plate 100. The openings 102 and 104 are preferably slightly greater than the diameter of the pin 90 so that the hammers may be freely rotatable in a restricted area.

To assure longer life and less need for repairs or replacement of the hammer plates 100, the ends 106 and 108 and a portion of the adjacent front and rear edges 110 and 112 are preferably hard faced. Thus, when and if the hammer plates 100 are damaged and need to be changed, the plates 100 may be reversed and the ends 106 used in the grinding operation.

In order to prevent lateral movement of the hammer plates 100, the axis of the pin 90, spacer collars 114 of varying length are employed. The illustrated form preferably shows four hammer plates 100 positioned in the pin, two between the rear and middle arm extensions 86, and two between the front and middle arm extensions 86. Between each plate 100 is a spacer collar 114.

To assure a complete coverage of the area between the respective outer extensions 86 the hammers 100 on each rotor rib are staggered. Thus, in FIGURE 4, one hammer 100 is shown lying against the rear arm extension 86 and none against the forward extension 86. On the next rotor rib, not illustrated, one hammer 100 would be adjacent or contacting the forward extension 86 and the spacer collars 114 are rearranged to permit the other hammer plates 100 to be spaced on a line inbetween the hammers of the rib illustrated.

While the invention has been illustrated and described with four hammer plates 100 on each rotor rib, the number may vary depending on the width of the housing 22 and the coarseness of the material to be reduced.

Mounted on the shaft 60 forwardly of the rotor means 64 is a breaker means 116 for breaking up the material received through the opening 44. The breaker means 116 comprises a breaker plate 118 abutting the forward face 80 of the rotor plate 74. The plate 118 is formed on a breaker hub 120 having a key 122 corresponding to key 68 which engages keyway 70 formed in the shaft 60.

The 100 and 118 is locked on the shaft 60 to prevent lateral movement along the axis thereof by means of a set screw 126.

Formed on the face 128 of the plate 118 are a plurality of breaker points or teeth 130 in a random arrangement. The points 130 project from the face 128 and as the plate 118 rotates and disburse the material to be reduced around the interior of the mill 20. There is further provided on the hub 120 a pre-breaker bar 132 in front of the end 60a of the shaft 60. This pre-breaker bar 132 is formed with several blunt projections 134 which extend into the opening 44 in the front plate 24 of the mill 20.

It has been found that by having a pre-breaker plate with blunt projections the compressed material entering the opening 44 will be better received and distributed. As an illustration, the blunt projections will reduce a large compressed bale of hay 48 to smaller parts and then from the prebreaking, the hay will continue inward and outward to the points 130 for further breaking before the material is ground by the hammers 100.

To activate the rotor means 64, motor means 142 are provided. The shaft 60 extends rearwardly through a pair of bearing mounts 136 to a coupling 138. The bearing mounts 136 are secured to a frame 140 which projects upwardly from base 42 and rearwardly from plate 26. The motor 142 is mounted on the frame 140 and connected to the coupling 138. The motor 142 may be any of the conventional relatively high speed electric motor means 148.

Mounted concentrically and extending 360° within the circular wall 28 and between walls 24 and 26 is a filter sizing means 144. Such a construction will provide a maximum area for filtering or sizing of material. This filter means 144 comprises a screen element 146 having upper and lower annular end reinforcing ribs 148 and 150, respectively. The screen element 146 is preferably from sheet material and has a plurality of diagonal slots 152 formed in the sheet material equally spaced from each other.

While the screen, as illustrated in FIGURE 5, is the preferred structure, the screen element 146 (seen in FIGURE 6) may be formed with a plurality of circular perforations or openings 154 to accomplish the same result. By varying either the size of the slots 152 or the openings 154, the material to be reduced may be graded and passed through the screen element 146.

Preferably, the filter means 144 are held in place by means of a plurality of bolts 156 arranged in a circular pattern as best seen in FIGURE 2. The bolts pass through openings along the axis of the pins 158 holds the bolt 156 in place.

These bolts 156 serves as guides and supports upon which the ribs 159 will ride and rest when the element 146 is inserted and positioned; these being best illustrated in FIGURES 2, 3 and 4. Additionally, to assure relative quick assembly of the filter means 144 within the housing, the screen elements 146 are preferably formed in arcuate quarters and inserted. However, it should be noted that if the screen element 146 is flexible enough, it may be a single unit.

To position the filter means 144, an opening 160 is formed in the upper part of the circular wall 28 and each quarter section of the screen element 146 is inserted through the opening 160 and guided over the bolts 156. The two lower arcuate quarters are inserted first, then the two upper remaining quarters may be guided into position. To assure that the screen element 146 are held in position, the nuts 158 are tightened so pressure of the plates 24 and 26 is exerted on the ribs 148 and 150 of the element 146.

The screen element 146 which is inserted in the upper left-hand quarter, as viewed in FIGURE 2, is provided with an enlarged opening 162 aligned with opening 160 in wall 24 which encloses the opening 160 to from a trap 166. The
cover 164 is secured to the housing 22 by hinge means 168 and extends between the walls 24 and 26 and includes a handle 170 so the cover may be raised to obtain access to the trap 166 or to allow the changing of screen elements 146.

In operation, the motor 142 is activated causing the rotor means 64 to revolve in a clockwise direction at a relatively high speed. With the relatively high speed, the rotor ribs 76 will centrifugally push the air radially outward in a clockwise manner through the screen elements 146 to the circular wall 28 along the wall 28 and up the flue 30. With the air within the housing 22 being evacuated, air will be drawn in through the opening 56 in the chute 52 and through the opening 44 as illustrated by the arrows in FIGURE 4.

The grinding or ultimate reducing operation is as follows: The bale of hay 45 is moved along the conveyor 172 or other means to the opening 44 where the partial vacuum created in housing 22 will suck the hay 48 against the pre-breaker projections 134 which will break up the bale into smaller pieces and throw the hay against the breaker plate where the pieces 130 will reduce the bale further and force the hay radially outward into the hammer plates 100.

With the rotor rotating the centrifugal force will cause the hammer plates 100 to extend outwardly on a plane with the respective ribs and remain in such position during activation, and as the hammer plates, it will be further broken up and reduced until it can be filtered through the screen element 146 to the wall 28. The centrifugal force created by the rotor means will urge the reduced hay up and out of the flue 30 to a conically obtainable cyclone (not illustrated) or other storage structure. The hammer plates 100, being blunt, literally knock the material apart as opposed to cutting as accomplished by prior art blades.

If it is desired to simultaneously mix and reduce several types of grain or other material, the opening 56 may be used to add ingredients to the material entering through opening 44.

The vacuum created at the opening 44 can be regulated by the amount of air which is allowed into the chute 52 through the air damper 54.

It will thus be seen that with the staggered hammer plates 100 on the respective rotor ribs, the entire cross section of the housing 22 may be covered to effect a complete hammering, chopping or milling of the hay.

An important advantage of the hammer element construction is the pivot feature which, under normal operating conditions, will allow the hammers to remain extended to mill, but will pivot out of contact should they encounter a foreign object which has become mixed with the hay or other material. It is not uncommon when baling hay and other grain to include rocks and other foreign objects which can damage an ordinary grinding mill if allowed to enter the mill.

With the present device any foreign object encountered by the hammers will cause them to pivot and give way when there is contact. Because of the speed with which the hammers 100 move, the object will ride clockwise around the screen element 146 and be thrown out the opening 162 in the element 146, through the opening 160 in the wall 28 and into the trap 166. After the milling and blowing operation are complete, the cover 164 may be opened and the foreign objects removed.

While the invention is primarily for use in grinding and blowing hay and other grains, the mill may be used equally well in reducing other material such as paper.

An additional feature of the opening 56 in chute 52 is for attaching a hose 58 to be used as a vacuum to pick up material which has spilled around the mill 20.

While the instant invention has been shown and described herein in what is conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of the invention which is therefore not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices.

Having thus described my invention, I claim:

1. A material reducing mill and removing apparatus comprising: a closed housing, said housing including a generally circular end wall and a pair of generally parallel side walls spaced apart by said end wall; an exhaust flue communicating with said housing which interrupts said circular end wall; a trap receptacle communicating with said housing and interrupting said circular end wall adapted to receive foreign objects centrifuged within said housing; an intake port in one of said side walls which is aligned with the axis of said circular end wall, said intake port being adapted to receive compacted masses of material to be reduced; rotor means mounted in said housing having its axis adjacent said intake port, said rotor means including a plurality of ribs circumferentially arranged around said axis and radiating outward therefrom, said ribs being of sufficient cross-sectional area, when rotated, to generate a flow of air to impel reduced material toward said circular end wall and around said wall in the direction of rotation of said rotor means through said exhaust flue and said ribs adapted to create a low pressure condition at the intake port to accelerate feeding of material therethrough; reducing means carried on the peripheral ends of each of the ribs of said rotor means, said reducing means including a plurality of hammer elements pivotally connected to said ribs, said hammer elements being movable from an at rest position to an extended position when said rotor means starts to rotate at a relatively high speed, yet said hammer elements being yieldable from said extended position when encountering foreign objects within said material to be reduced; a filter means including a generally circular screen interposed between said circular end wall and surrounding said reducing means to grade the material being reduced to a predetermined size; material breaker means mounted on said rotor means at said intake port adapted to partially reduce and radically distribute said material in said housing wherein said material breaker means includes a disc having a plurality of projections protruding toward said intake opening, said disc being carried by said rotor means within said housing forward of the ribs on said rotor means and a pre-breaker bar having blunt projections protruding into said intake opening, said bar being axially carried by said rotor means forward of said disc and being of such a length that when rotated its ends do not touch the interior of the intake opening; and a power source exterior of said housing connected to said rotor means for imparting relatively high speed rotation to said rotor means.

2. A material reducing mill and removing apparatus comprising a closing housing formed by a generally parallel vertical front wall and back wall spaced apart and separated by a generally circular end wall, an upwardly projecting exhaust flue extending tangentially from and interrupting said end wall communicating with said housing, a trap receptacle adjacent the upper side of said exhaust flue communicating with said housing through said end wall, said front wall having a primary intake opening aligned with the axis of said circular end wall for receiving material to be reduced, said rear wall having a secondary intake opening for adding other material to said housing and for regulating the pressure therefrom, said rear wall having a shaft opening aligned with the axis of said circular end wall, a rotor drive shaft axially projecting horizontally through said shaft opening into said housing, said shaft terminating within said primary intake opening, a power source axially connected to said shaft adapted to rotate it at relatively high speed, a rotor means axially mounted on said shaft within said housing including a circular rotor disc plate radially extending from said shaft, said disc having an area.
greater than the area of said primary intake opening and being formed with a plurality of ribs on both its front and rear faces that radiate outwardly to the peripheral edge of said plate, said ribs, alone, being wide enough to centrifugally push the air within said housing radially so as to impel air out said exhaust flute and create suction in the primary and secondary intake openings when said rotor disc plate is rotated, a generally circular filter screen means removably mounted concentrically within said circular end wall and spaced so as to extend 360° within said circular end wall, said filter screen means having an enlarged opening aligned with said trap receptacle, grinding means attached to the peripheral ends of each of said ribs, said grinding means including a plurality of arm extensions which carry a pivot pin axially parallel with the axis of said rotor drive shaft, a plurality of spaced blunt hammer elements pivotally mounted on said pivot pin for free swinging movement adjacent the interior of said filter screen means, the lateral spacing between said hammer elements extending from each rib being staggered relative to the adjacent rib so as to substantially cover the area adjacent the periphery of said hammer elements as they are rotated, and breaker means axially mounted on said shaft forwardly of said rotor means which includes a breaker disc abutting the forward part of the rotor disc plate, a plurality of breaker teeth projecting from the face of said breaker disc, and a breaker bar disposed in front of the breaker disc and having a plurality of blunt projections on its forward face extending into the primary intake opening of said front wall of the housing, said break means adapted to partially reduce and radially distribute material received within said housing as the material enters the housing.

3. A material reducing mill and removing apparatus as defined in claim 2 wherein a damping means is provided which cooperates with the secondary intake opening to regulate the pressure in said housing.

4. A material reducing mill and removing apparatus as defined in claim 2 wherein said hammer elements each include relatively flat front edge surfaces facing the direction of rotation of said rotor means, a similar substantially parallel flat edge back surface, and means formed in said hammer element for reversing the location of its pivotal mounting so that said flat edge back surface faces the direction of rotation of said rotor means.

5. A material reducing mill and removing apparatus comprising; a closed housing, said housing including a generally circular end wall and a pair of generally parallel side walls spaced apart by said end wall; an exhaust flute communicating with said housing which interrupts said circular end wall; a trap receptacle communicating with said housing and interrupting said circular end wall said trap receptacle having a closed end remote from the position where it interrupts said circular end wall and positioned circumferentially directly adjacent said circular end wall so that foreign objects centrifuged within said housing will tangentially fly directly into said trap receptacle and be held in the closed end thereof and adapted to receive foreign objects centrifuged within said housing; an intake port in one of said side walls which is aligned with the axis of said circular end wall said intake port being adapted to receive compacted masses of material to be reduced; rotor means mounted in said housing having its axis adjacent said intake port, said rotor means including a plurality of ribs circumferentially arranged around said axis and radiating outward therefrom, said ribs being of sufficient cross-sectional area, when rotated, to generate a flow of air to impel reduced material toward said circular end wall and around said wall in the direction of rotation of said rotor means through said exhaust flute and said ribs adapted to create a low pressure condition at the intake port to accelerate feeding of material theretobough; reducing means carried on the peripheral ends of each of the ribs of said rotor means, said reducing means including a plurality of hammer elements pivotally connected to said ribs, said hammer elements being movable from an at rest position to an extended position when said rotor means is moved at relatively high speed, yet said hammer elements being yieldable from said extended position when encountering foreign objects within said material to be reduced; a filter means including a generally circular screen interposed between said circular end wall and surrounding said reducing means to grade the material being reduced to a predetermined size; material breaker means including at least two axially mounted separately spaced breaker plates, each of which have a plurality of blunt projections extending toward said intake port said breaker plates being mounted on said rotor means at said intake port and adapted to partially reduce and radially distribute said material in said housing; and a power source exterior of said housing connected to said rotor means for importing relatively high speed rotation to said rotor means.

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