April 22, 1930. W. J. CLEMENT 1,755,573

METHOD OF AND MECHANISM FOR GRINDING AND SEPARATING MATERIALS

Filed April 7, 1928 2 Sheets-Sheet 1

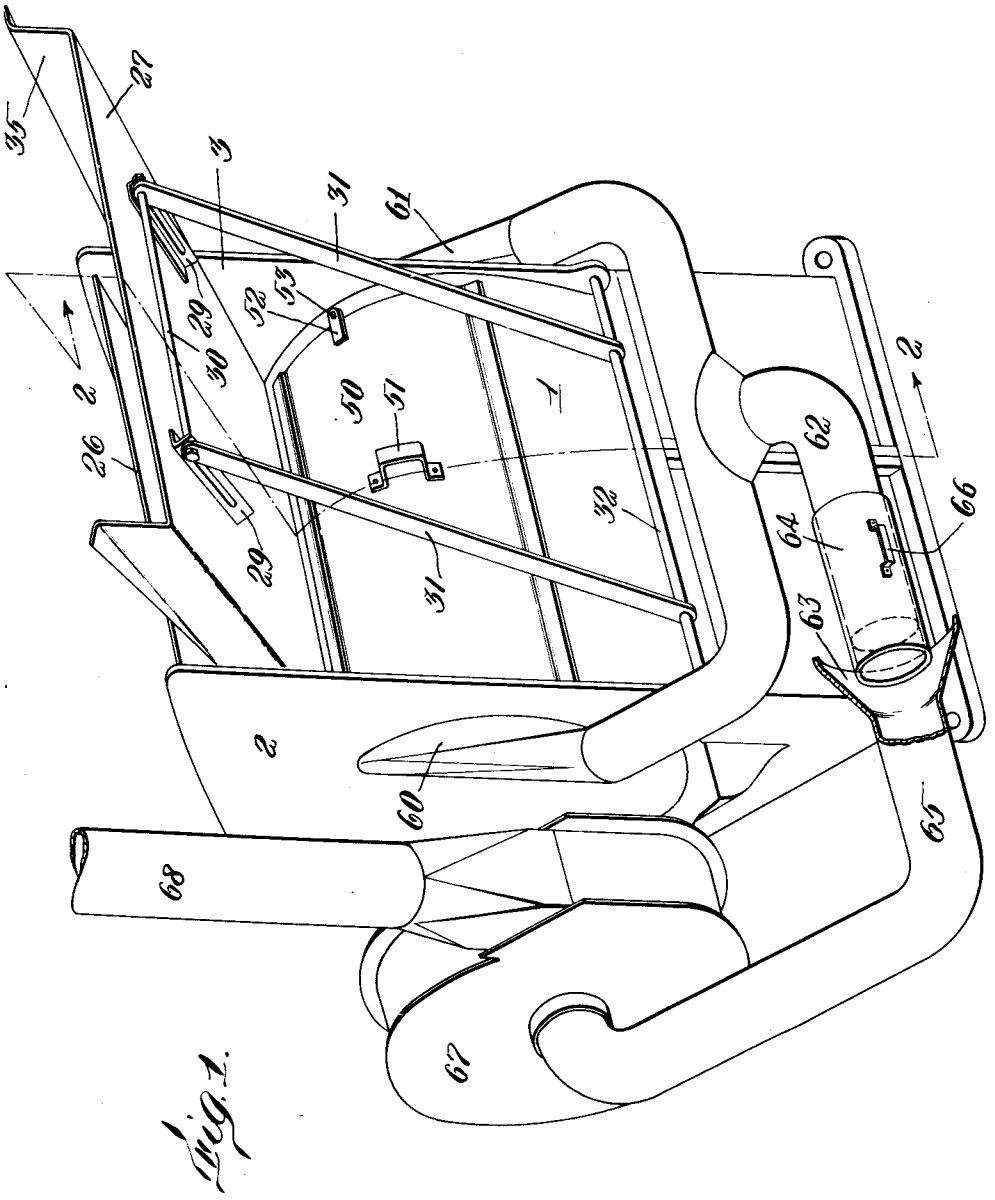


Fig. 1.

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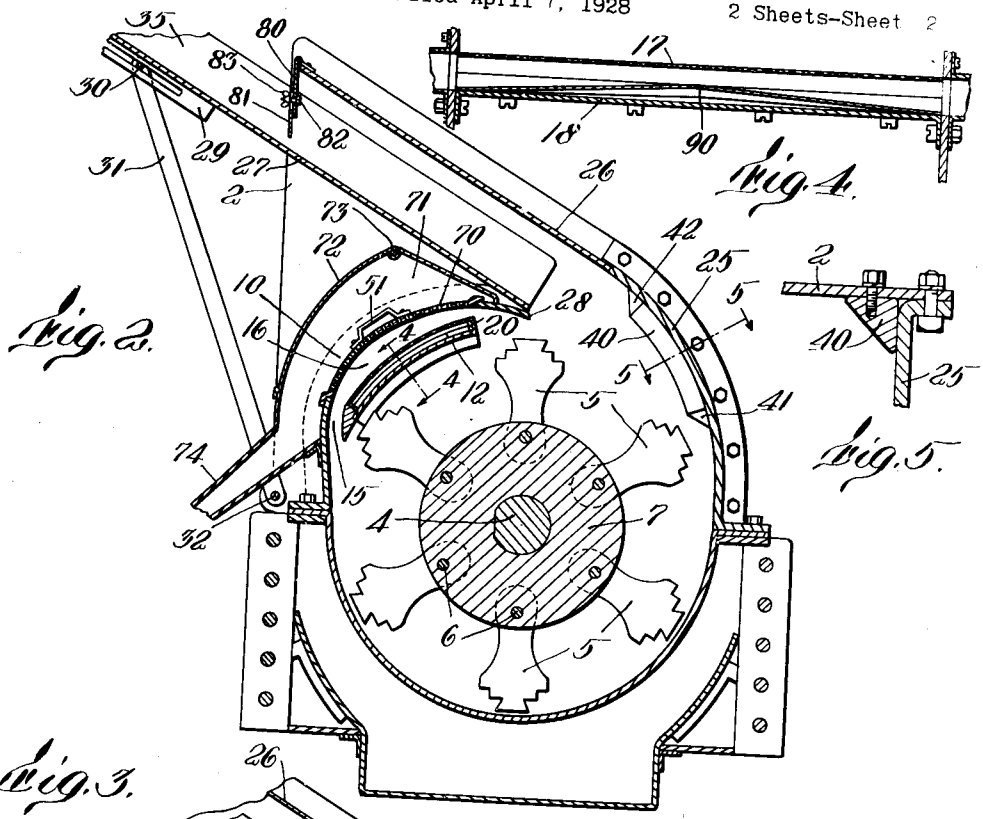


Fig. 2.

Fig. 5.

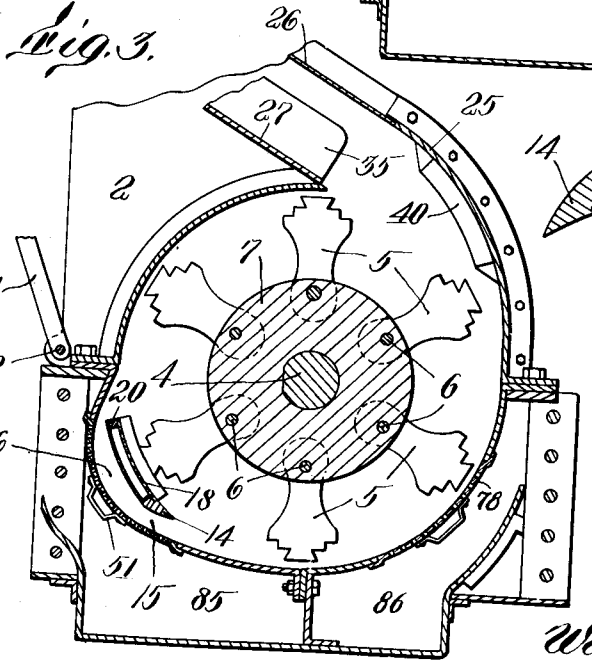


Fig. 3.

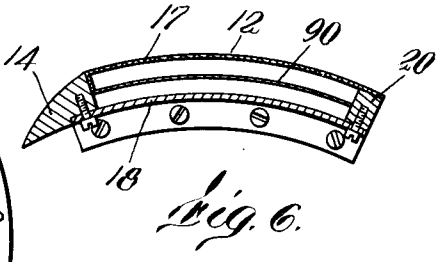


Fig. 6.

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UNITED STATES PATENT OFFICE

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METHOD OF AND MECHANISM FOR GRINDING AND SEPARATING MATERIALS

Application filed April 7, 1928. Serial No. 268,300.

This invention relates to separation or grinding and separation of materials, more particularly where the grinding is effected by means of rapidly rotating hammers contained in a casing into which the material to be ground is introduced. More particularly also the problem dealt with by the present invention relates to the separation of different classes of material after the grinding has progressed to the desired extent, these classes being distinguished sometimes by size of particles and sometimes by other differentiating characteristics as will later more fully appear.

The invention further relates to the processing of certain materials by such a mechanism.

The rapid rotation of the hammers causes the mass of material being treated to rotate or whirl rapidly within the casing about the central axis thereof, and according to this invention advantage is taken of the centrifugal force thus imparted to the particles of the mass to cause them to fly out beyond the hammer path where the casing is extended for the purpose, an air suction in this space beyond the hammer path on the concave side of the path serving to remove material of one class in opposition to the effects of centrifugal force, while materials of one or more other classes is either returned to the hammer path or removed from the casing by centrifugal force against incoming air currents, the particular action desired depending on the particular materials being treated.

As heretofore constructed the ground material has been removed from the casing through a perforate metal casing wall outside of the path of rotation of the hammers. In such cases the mass of material is impelled by centrifugal force to rub around the interior face of the casing and with many classes of material this results in rapid wear of the casing and this perforate wall. Where the material is to be ground to an extremely fine condition so that a netting of a relatively fine mesh is required for this perforate wall to hold back the larger particles, the life of the netting is extremely short where it is subjected to this wear. Where the fine material is removed by suction exerted on the concave side of an arcuate path and thus in a direction opposed to the effects of centrifugal force, however, this rubbing does not take place to any considerable extent where the suction is exerted and consequently the life of the screen is greatly prolonged. It has been found in practice that a very much greater yield of fine material may be produced by this method than by the methods heretofore employed, beside avoiding destructive wear to the more delicate parts of the mechanism.

A further object of this invention is to improve the feed of material so that tendency to clog at the ends of the mill beyond the hammer paths is minimized.

For a more complete understanding of this invention, reference may be had to the accompanying drawings in which

Figure 1 shows in perspective a hammer mill embodying this invention.

Figure 2 is a vertical section on line 2—2 of Figure 1, but showing a slight modification in certain parts and certain parts broken away or omitted.

Figure 3 is a similar view showing a further modification.

Figures 4 and 5 are detail sections on lines 4—4 and 5—5, respectively, of Figure 2.

Figure 6 is a section similar to a portion of Figures 2 and 3, but drawn to a larger scale.

Referring to these drawings, the mill comprises a substantially cylindrical casing 1 having end walls 2 and 3. Extending coaxially of the casing therethrough is a rotary shaft 4 on which is supported in any suitable way a rotating mechanism by which material in the casing may be whirled about its inner face, which mechanism as shown comprises a plurality of hammers 5 which pulverize as well as whirl the material. These may be mounted in any suitable way, this forming no part of the present invention, but as shown they are pivoted on rods 6 which extend through disks 7 fixed to the shaft 4. A series of these disks 7 is positioned along the shafts 4 so that the hammers extend substantially from end to end of the casing and as the shaft rotates they describe circular paths, there being sufficient hammers so that these paths occupy substantially all the volume de-

fined by the cylindrical casing. At one or more portions the casing wall is outwardly bulged beyond the cylindrical contour as at 10 so that the inner wall of this bulged portion forms an extension of the interior of the chamber defined by the casing walls. This bulged portion is shown as extending from end to end of the casing and positioned inwardly of this bulged portion is a duct 12. This duct is substantially arcuate in cross section, its inner wall forming substantially a continuation of the major unbulged portion of the casing wall.

As shown best in Figure 6, the duct is provided at one edge with a nose portion 14 tapering to present a pointed edge to the material carried around by the hammers in their rotation and serving to define with the adjacent portion of the bulged wall an opening 15 extending throughout the length of the casing and through which the material carried by the hammers may be projected by centrifugal force into a passage 16 defined by the inner face of the bulged portion and the outer wall 17 of the duct. Along the opposite edge of the duct its outer wall 17 and its inner wall 18 are fixed to an end wall member 20. The duct is thus positioned outwardly of the paths of the hammers and defines with the bulged portion, a passageway for material which may enter at 15 and may return to the hammer paths between the member 20 and the casing.

As shown in Figure 2 this bulged portion is arranged above the axis of rotation, but if desired it may be arranged in other angular positions, as shown, for example in Figure 3 where it is arranged below the axis.

Another wall portion of the casing as at 25 is extended outwardly of the casing to merge with the upper wall 26 of a chute through which material may be supplied to the interior of the casing. The lower wall of this chute is shown as formed by a trough member 27, the inner end of which extends beneath the wall 26 and rests on a casing wall portion 28 opposite thereto, and as shown the inclination of this trough from the horizontal may be adjusted. For this purpose it is shown in Figures 1 and 2, as provided on its under face with a pair of slotted angle brackets 29 in the slots of which may be adjustably fixed a cross rod 30 supported in the upper ends of a pair of spaced bars 31, the lower ends of which are supported from a rod 32 carried by the end frame members 2 and 3. The trough member 27 is shown as provided with upwardly and outwardly flaring sides 35.

Beneath the lower end of the trough 27 the interior of the casing may be provided with means for deflecting the material entering through the chute away from the ends of the casing into the hammer paths. As shown this means comprises the arcuate deflector members 40 which are fixed in the corners between the end walls 2 and 3 and the side wall of the casing where the material entering from the chute may impinge thereon. The inner ends of the deflectors are shown as beveled off as at 41 to clear the hammers and the outer ends 42 may be made similarly beveled in order to minimize obstruction to the entry of the material.

As the material is struck by the hammers and carried around therewith, it follows the inner face of the casing and is thrown by centrifugal force in a direction to enter the opening 15 and traverse the arcuate passage between the outer face 17 and the inner face of the bulged portion 10. The outer face 17 of the duct may be more or less open to permit material to be drawn away from the arcuate stream passing between the bulged portion and the duct. The particular character of this outer wall will be determied by the nature of the material being treated and the nature of the material which it is desired to draw from the passing stream. For example, if the material to be drawn is very fine, the wall 17 may be composed of a fine screen, while if the material to be withdrawn is of a somewhat coarser nature, the openings in the screen may be larger, or in some instances it might be desired to leave this wall entirely open, or to use other types of partial coverings.

In order that the outer face of the duct may be made accessible so that the facing material for the duct may be changed as desired, the bulged portion of the casing wall may be provided with a removable section or cover 50 which is shown as provided with a handle 51 and may be held in closed position as by securing lugs 52 either pivoted as at 53 so as to be swung into and out of engagement with the outer face of the portion 50 or removably secured to the casing in any suitable manner.

Air may be withdrawn from the duct to take the desired parts of the material therewith and it is therefore connected to an exhaust fan of any suitable description. As shown the ends of the duct communicate through the end walls 2 and 3 with pipe connections 60 and 61, which as illustrated in Figure 1, are brought together into a pipe 62 and lead to an exhaust fan at 67, which may if desired have its rotor fixed to one end of the shaft 4 outside of the casing. A pipe 68 may lead from this fan through which the material drawn from the interior of the casing by the fan is ejected. It is usually desirable to provide means for adjusting the amount of suction produced. For this purpose the pipe 65 leading directly to the intake of the fan 67 is shown in Figure 1 as provided with a draft adjusting mechanism. The pipe 65 is provided with a flaring end 63 into which extends to an adjustable extent a pipe section 64 which is slidable on the

extremity of the pipe 62. A handle 66 on this sliding section facilitates the adjustment of this pipe section with its end extending toward the smaller diameter portion of the pipe 65 to a greater or less extent. Not only is the size of the screen or openings in the duct at 17 a determining factor in the size or character of material withdrawn through the duct, but the amount of suction is also a determining factor, the heavier the suction the larger and heavier being the particles drawn through for the same size of screen opening. For this reason, therefore, the suction adjustment may be of considerable importance.

Not only may the walls 17 be more or less open to permit material to be drawn from the concave side of the arcuate stream, but if desired the opposite side 18 may be more or less open to draw material directly from the mass within the casing (see Figure 3). Whether or not this is desirable will depend on the particular materials being ground and the results desired.

It may also sometimes be desirable to remove not only the material which can be drawn out by suction through the duct, but also to remove other material from the casing. For example, this mechanism may be used for the delinting of cotton seed hulls. The cotton seed hulls and adhering lint is introduced into the casing through the chute and is struck and pulverized by the hammers and carried around therewith. As it becomes sufficiently pulverized the lint is torn away therefrom and the lint and hulls passed together through the arcuate passageway between the outer face of the duct and the bulged casing wall. The suction from the duct draws the lint thereinto while the hulls freed from lint continue to be projected by centrifugal force against the bulged portion of the casing wall and may escape through a suitable screen in that or some other portion of the casing wall. The air which carries away the lint then passes laterally through the stream of material projected through the passageway.

Thus in place of the imperforate cover member 50 shown in Figure 1, a perforate cover member 70, as shown in Figures 2 and 3 may be substituted, the perforations permitting that portion of the hulls which are ground to sufficient fineness to pass therethrough, while the larger hull particles are returned to the interior of the casing and into the paths of the hammers where they are further pulverized. When a perforate cover 70 is employed it may be desirable to provide means for collecting the material escaping through this cover. For this purpose (Figure 2) a collecting chamber 71 may be provided, preferably having a portion 72 which may be opened to give access to the cover 70, and when the cover is removed, to the duct 12. As shown in Figure 2 the portion 72 is hinged as at 73 and the chamber is provided with a chute 74 through which the material escaping from the casing and entering thereinto may be conducted therefrom. The cover 70 may be replaced by the imperforate cover 50 whenever this is desired and a perforated plate may be inserted elsewhere in the casing wall as, for example, as shown at 78 in Figure 3.

Not only may the suction be regulated as by means shown in Figure 1 in the exhaust pipe, but it is also often desirable to control somewhat the supply of air to the interior of the casing. For this purpose it is often desirable to close off to an adjustable extent the entrance chute. To this end a plate 80 is shown as fixed to the upper end of the portion 26 (Figure 2) to which is adjustably fixed a skirt plate 81 so that the space between the lower edge of this skirt plate and the upper edge of the trough 27 may be adjusted as desired. The skirt plate and the plate 80 are shown as adjustably fixed to each other by bolt and slot connections 82, the bolts being provided with wing nuts 83.

Where the bulged portion is arranged below the shaft 4, as shown in Figure 3, the material which may pass through the perforate cover of this bulged portion may escape into a suitable chamber 85 from which it may be withdrawn as desired. Similarly if a perforated plate at 78 is employed, the material may pass into a chamber 86.

In order also that the suction may be substantially uniform throughout the entire length of the duct it may be provided, if desired, and as shown in Figures 4 and 6, with a wall portion 90 sloping upwardly from its ends toward its center so as to narrow the air space toward the center of length of the duct. This, of course, is suitable only where the exhaust is connected to both ends of the duct and serves to substantially equalize the exhaust pressure over its entire length.

A mechanism of this description is well able to operate on a great variety of materials widely differing from each other in character. For example, it has been found to be highly effective in the pulverizing of flake material such as graphite where it is desired to remove the material in an extremely fine condition and where screens of sufficient fineness to permit this when inserted in the outer faces of hammer mill drums have been found to clog quickly and to have very short life. It is also particularly applicable to the grinding of corn or similar grains, the exhaust air duct facilitating the substantially complete removal of the bran, the ground material being passed out through the perforate portion of the casing. Thus a highly purified product may be produced. Cement clinker may also be ground very satisfactorily in a machine of this character, hammer mills as heretofore constructed be-

ing unsatisfactory for handling this class of material in view of the very great wear on the interior of the casing which quickly destroyed the fine mesh material necessary to properly separate the ground cement from the clinker, where the material is swept across the screen under the heavy contact pressure resulting from the centrifugal forces developed in operation of the material. Many other materials of widely differing nature such as coal, sugar, chocolate, wood shavings, lime, gypsum, etc. also can be handled to great advantage in a mill constructed according to this invention and in most instances in a much more satisfactory manner than in mills as heretofore constructed.

Having thus described certain embodiments of this invention it should be evident to those skilled in the art that various changes and modifications might be made therein without departing from its spirit or scope as defined by the appended claims.

I claim:

1. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially of said casing, a plurality of hammers carried by said shaft to swing in circular paths in said casing and adjacent to the inner face thereof, said casing having its inner face extending outwardly beyond its cylindrical outline through a portion of its circumference, a duct extending lengthwise within said casing out of the paths of said hammers at said outwardly extended portion and defining therewith a passage for material out of the path of said hammers, the outer face of said duct having openings through which material in said passage may be drawn, and means for exhausing air from said duct.

2. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially of said casing, a plurality of hammers carried by said shaft to swing in circular paths in said casing and adjacent to the inner face thereof, said casing having its inner face extending outwardly beyond its cylindrical outline through a portion of its circumference, a duct extending lengthwise within said casing out of the paths of said hammers at said outwardly extended portion and defining therewith a passage for material out of the path of said hammers, the outer face of said duct having openings through which material in said passage may be drawn, and means for exhausting air from said duct, said outwardly extended portion having openings therethrough to permit the passage of other material from said casing.

3. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially of said casing, a plurality of hammers carried by said shaft to swing in circular paths in said casing and adjacent to the inner face thereof, said casing having its inner face extending outwardly beyond its cylindrical outline through a portion of its circumference, a duct extending lengthwise within said casing out of the paths of said hammers at said outwardly extended portion and defining therewith a passage for material out of the path of said hammers, said duct having openings therein through which material may be drawn from said casing, and means for exhausting the air from said duct.

4. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially of said casing, a plurality of hammers carried by said shaft to swing in circular paths in said casing and adjacent to the inner face thereof, said casing having its inner face extending outwardly beyond its cylindrical outline through a portion of its circumference, a duct extending lengthwise within said casing out of the paths of said hammers at said outwardly extended portion and defining therewith a passage for material out of the path of said hammers, said duct having openings therein through which material may be drawn from said casing, means for exhausting the air from said duct, a chute for delivering material to the interior of said casing, and means for closing off said chute to an adjustable extent.

5. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially of said casing, a plurality of hammers carried by said shaft to swing in circular paths in said casing and adjacent to the inner face thereof, said casing having its inner face extending outwardly beyond its cylindrical outline through a portion of its circumference, a duct extending lengthwise within said casing out of the paths of said hammers at said outwardly extended portion and defining therewith a passage for material out of the path of said hammers, said duct having openings through its inner and outer faces, and means for exhausting the air from said duct.

6. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially of said casing, a plurality of hammers carried by said shaft to swing in circular paths in said casing and adjacent to the inner face thereof, said casing having its inner face extending outwardly beyond its cylindrical outline through a portion of its circumference, a duct extending lengthwise within said casing out of the paths of said hammers at said outwardly extended portion and defining therewith a passage for material out of the path of said hammers, said duct having openings through its inner and outer faces, and means for exhausting the air from said duct, said outwardly extended portion having openings there-

through to permit the escape of other material from said casing.

7. In a mechanism of the class described, means for projecting material in an arcuate path, and means positioned on the concaved side of said path for drawing off some of such material from said path in a direction opposed to the effects of centrifugal force.

8. In a mechanism of the class described, means for projecting material in an arcuate path, means positioned on the concaved side of said path for drawing off some of such material from said path in a direction opposed to the effects of centrifugal force, and means for removing other material from the convex side of said path.

9. A mechanism of the class described comprising a substantially cylindrical casing, a shaft extending axially of said casing, hammers carried by said shaft to swing in circular paths within said casing as said shaft is rotated, said casing having a lengthwise extending portion bulged outwardly from true cylindrical contour, a duct extending lengthwise within said casing spaced from said bulged portion to define a passage therebetween and having its inner wall positioned outwardly of said paths, said duct having a screened wall opening into said passage, a fan fixed to said shaft outwardly of said casing, and pipe connections from said fan to said duct.

10. A mechanism of the class described comprising a substantially cylindrical casing, a shaft extending axially of said casing, hammers carried by said shaft to swing in circular paths with said casing as said shaft is rotated, said casing having a lengthwise extending portion bulged outwardly from true cylindrical contour, a duct extending from end to end of said casing spaced from said bulged portion to define a passage therebetween, the inner wall of said duct lying out of the paths of said hammers, said duct having a screened wall opening into said passage, an exhaust fan fixed to said shaft outwardly of said casing, pipe connections from said fan to opposite ends of said duct, and a pipe for discharging from said fan.

11. A mechanism of the class described comprising a substantially cylindrical casing, a shaft extending axially of said casing, hammers carried by said shaft to swing in circular paths within said casing as said shaft is rotated, said casing having a lengthwise extending portion bulged outwardly from true cylindrical contour, a duct extending from end to end of said casing spaced from said bulged portion to define a passage therebetween, the inner wall of said duct lying out of the paths of said hammers, said duct having a screened wall opening into said passage, an exhaust fan fixed to said shaft outwardly of said casing, pipe connections from said fan to opposite ends of said duct, means in said pipe connections for adjusting the suction in said duct, and a pipe for discharging from said fan.

12. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged axially of said casing, hammers carried by said shaft and describing circular paths in said casing as said shaft is rotated, said casing being bulged outwardly at one side of said shaft from end to end of said casing, a duct extending from end to end of said casing inwardly of said bulged portion and defining a passage for material therebetween, said duct being positioned out of the paths of said hammers and having openings leading into said passage, means for applying suction to the interior of said duct, said bulged portion having openings therethrough, and means for collecting material passing through said casing openings.

13. A mechanism of the class described comprising a substantially cylindrical casing, a shaft arranged coaxially in said casing, rotary mechanism carried by said shaft in said casing, said casing having an outwardly bulged portion a duct within said casing at said bulged portions and defining therewith an arcuate passage, said duct being positioned outwardly of the path of rotation of said mechanism and opening into said passage, and means for drawing air through said duct from said casing.

14. A mechanism of the class described comprising a substantially cylindrical casing, a shaft arranged coaxially in said casing, rotary mechanism carried by said shaft in said casing, said casing having an outwardly bulged portion, a duct within said casing at said bulged portions and defining therewith an arcuate passage, said duct being positioned outwardly of the path of rotation of said mechanism and opening into said passage, said bulged portion being provided with a removable section to permit access to said duct from without said casing, and means for drawing air through said duct from said casing.

15. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially in said casing, hammers carried by said shaft and describing circular paths in said casing as said shaft is rotated, a chute leading to the interior of said casing along its length, and means for directing material supplied from said chute inwardly from the ends of said casing.

16. A mechanism of the class described comprising a substantially cylindrical casing, a rotary shaft arranged coaxially in said casing, hammers carried by said shaft and describing circular paths in said casing as said shaft is rotated, a chute leading to the interior of said casing along its length, and

baffles positioned in the corners between the ends and side walls of said casing in position to deflect material from said chute toward the paths of said hammers.

17. The method of separating materials which comprises projecting such materials in stream formation through an arcuate path, and drawing off certain of said materials in a direction opposed to the effects of centrifugal force by suction at the concave side of said path.

18. The method of separating materials which comprises projecting such materials in stream formation through an arcuate path, drawing off certain of said materials by suction at the concave side of said path in opposition to centrifugal force, and permitting other material to escape at the convex side of said path.

19. The method of delinting cotton seed hulls which comprises pulverizing and projecting said hulls in stream formation in an arcuate path, removing the freed lint by suction applied to the concave side of said path in opposition to centrifugal force, and permitting the pulverized hulls substantially free from lint to escape by centrifugal force from the convex side of said path.

In testimony whereof I have affixed my signature.

WALTER J. CLEMENT.