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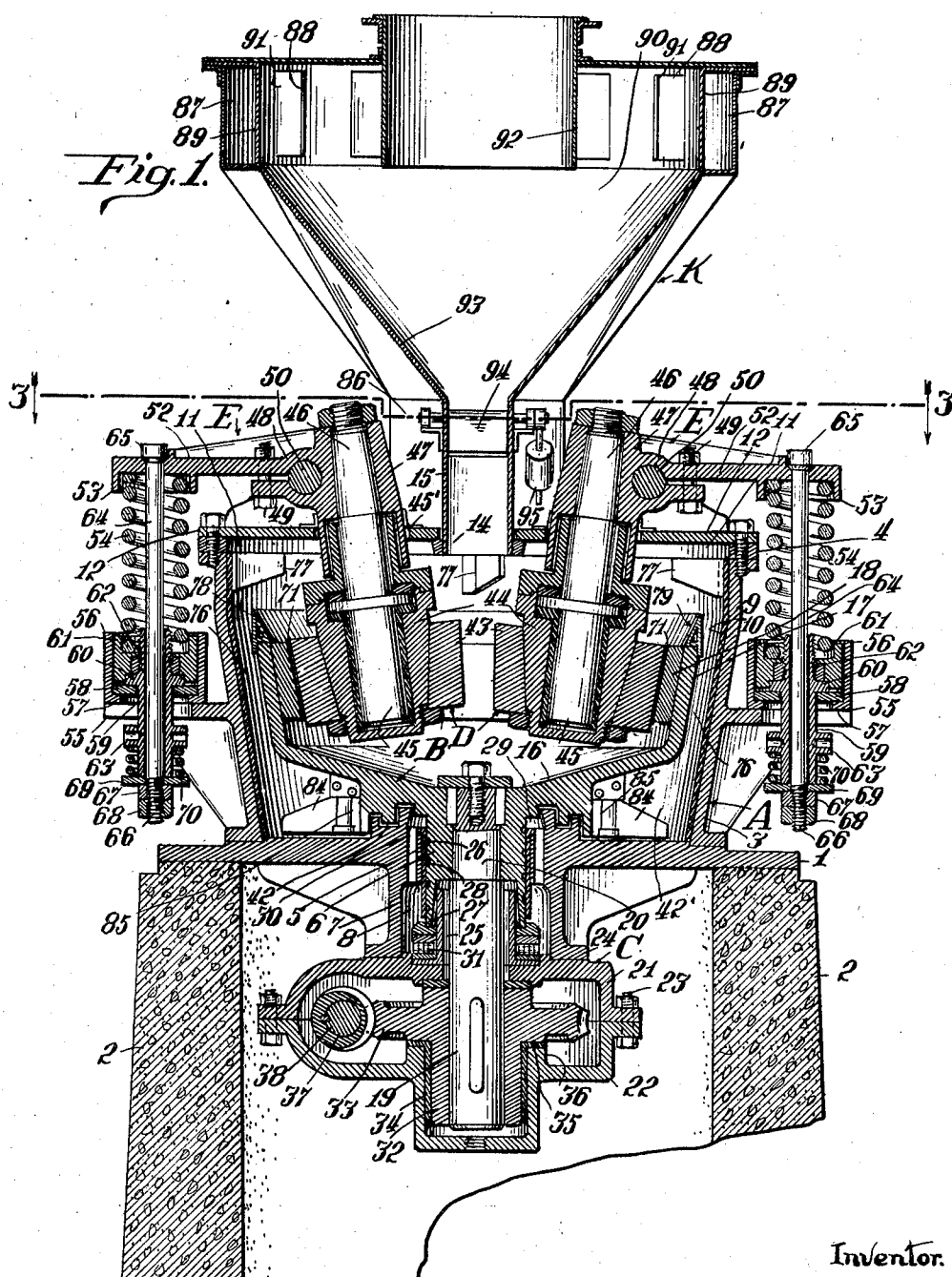
J. CRITES

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BOWL MILL

Filed June 10, 1935

3 Sheets-Sheet 1



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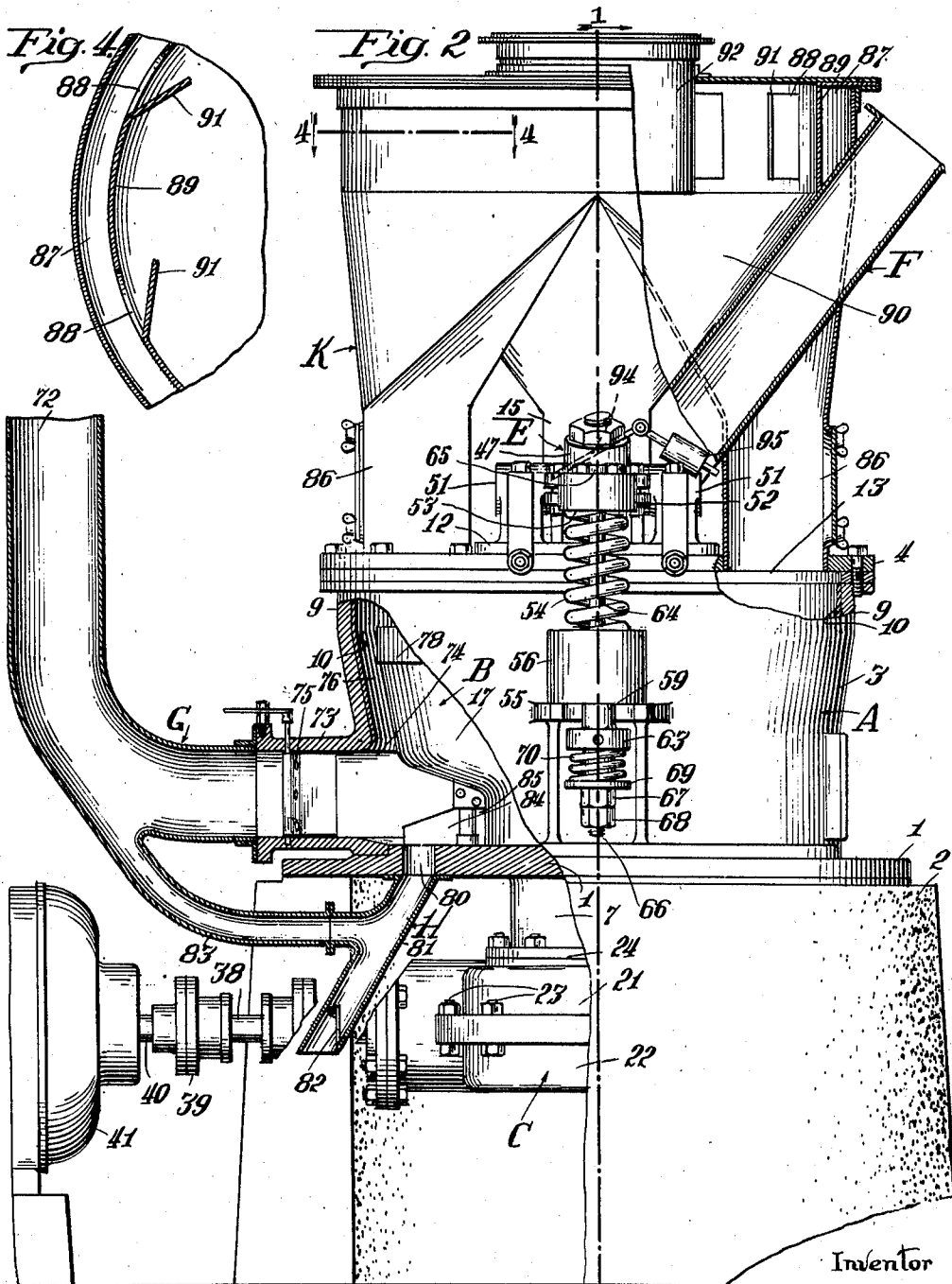
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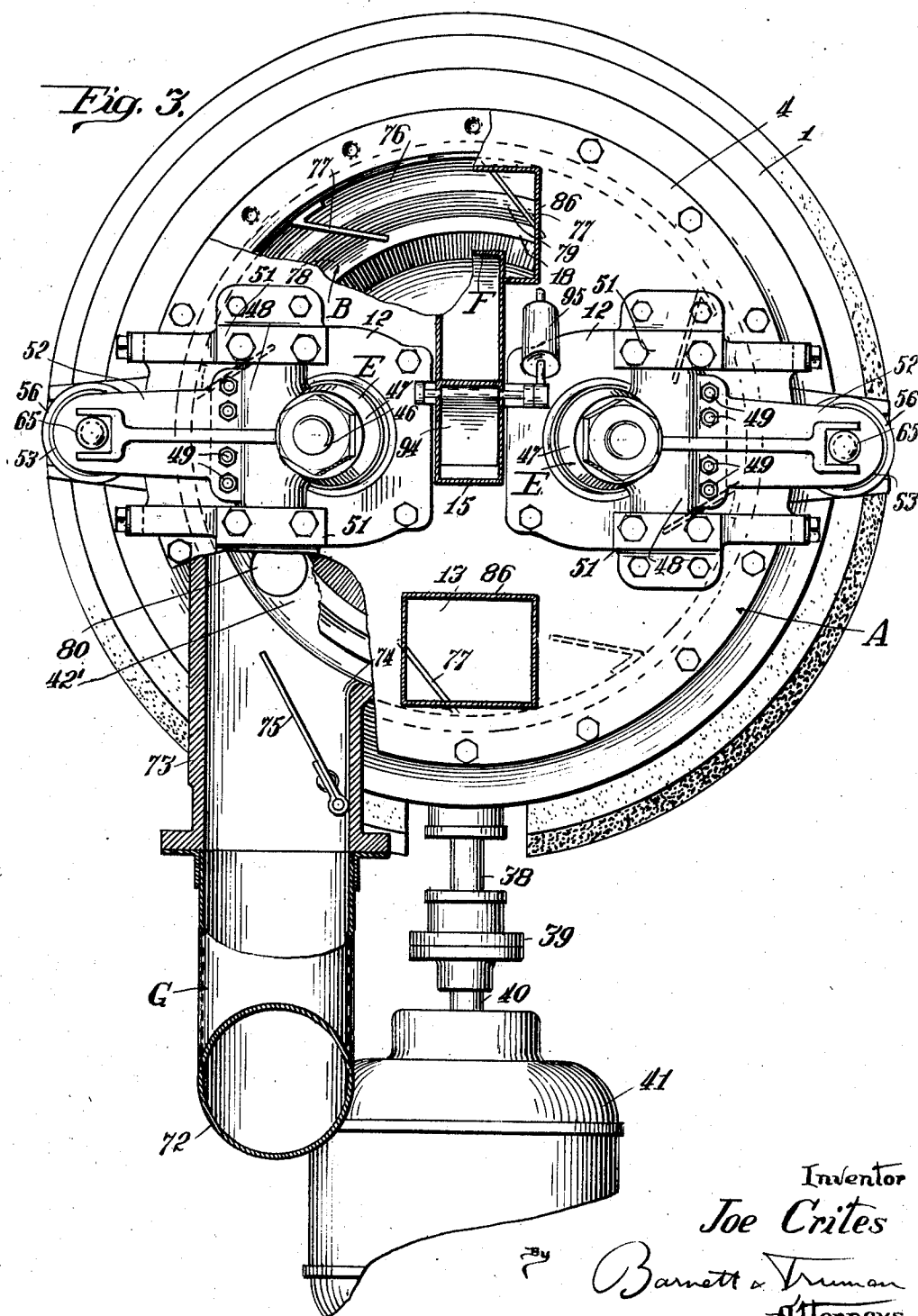
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UNITED STATES PATENT OFFICE

2,079,155

BOWL MILL

Joe Crites, Evanston, Ill., assignor to Raymond Brothers Impact Pulverizer Company, Chicago, Ill., a corporation of Illinois

Application June 10, 1935, Serial No. 25,789

9 Claims. (Cl. 83—45)

This invention relates to certain new and useful improvements in a bowl mill adapted to grind and pulverize solid materials, such as coal, rock, ore, etc.

5 Briefly described, the mill is of the type including an upwardly opening bowl or container which is rotatable about a central vertical axis within a substantially closed housing. One or more grinding rollers, each freely rotatable about
10 its own axis, are suspended within the bowl so as to be forced under pressure toward the upwardly and outwardly projecting inner side wall of the bowl, or the material carried thereby, the rollers being rotated by contact with this material. The side walls of the bowl are spaced
15 from the side walls of the container so as to provide an annular air passage around the bowl, air being admitted to the lower portion of the casing and drawn or forced under pressure through the annular passage, and thence over
20 the bowl and through outlets in the upper wall of the casing to a separator. Sufficiently pulverized material is carried in suspension in the air stream from the casing into and through the separator. The material to be pulverized is introduced from above into the central portion of
25 the bowl, and insufficiently pulverized material is also returned from the separator into the central portion of the bowl. Improved deflecting means is positioned in the upper and outer portion of the casing to return insufficiently pulverized material thrown from the bowl into the bowl for further treatment. Heavier waste materials fall through the annular passage into the
30 lower portion of the casing or housing, and scrapers carried by the rotating bowl direct this material toward a discharge opening in the bottom of the casing. Preferably, air under pressure, is delivered upwardly through this discharge opening to return finer material and carry it
40 back into the mill for further treatment.

The principal object of this invention is to provide an improved bowl mill of the type briefly described hereinabove and disclosed more in detail in the specifications which follow.

Another object is to provide improved means for returning into the bowl for further treatment by the grinding elements material which
50 has been thrown from the rotating bowl.

Another object is to provide an improved means for rejecting waste materials from the mill.

Another object is to provide improved means
55 for withdrawing pulverized material from the

mill and returning insufficiently pulverized material.

Another object is to provide improved means for directing the suspension air through the mill and separator.

Another object is to provide improved means for mounting and rotating the bowl.

Another object is to provide improved means for supporting the grinding rollers and applying adjustable pressure thereto.

Other objects and advantages of this invention will be more apparent from the following detailed description of one approved form of mill constructed and operating according to the principles of this invention.

In the accompanying drawings:

Fig. 1 is a central vertical section through the improved mill assembly, the view being taken substantially on the line 1—1 of Fig. 2.

Fig. 2 is a side elevation of the mill assembly, some parts being broken away to show the interior construction.

Fig. 3 is a horizontal section taken substantially on the line 3—3 of Fig. 1, portions being broken away to show parts in section on lower planes.

Fig. 4 is a detail horizontal section taken substantially on the line 4—4 of Fig. 2.

The mill portion of this assembly comprises the casing or housing A, the rotatable bowl or container B which is driven and supported by the mechanism indicated generally at C, the grinding rollers D, and the mechanisms indicated generally at E for supporting and exerting adjusted pressure on the rollers. The means shown at F feeds material to be ground into the mill, and the conduit system indicated generally at G delivers air under pressure into the lower portion of the mill housing. At H is indicated generally the device for discharging waste materials from the mill, while at K is shown the separator through which the sufficiently pulverized material is carried out in suspension and from which insufficiently pulverized material is delivered back into the bowl B.

The enclosing casing or housing A comprises the base plate 1 which rests upon the concrete pedestals or foundation 2, the annular side wall 3, and the closure or cover plate 4. The base plate 1 comprises the central bearing portion 5 in which the hub 6 of bowl B is journaled, and a downwardly extending sleeve portion 7 which encloses the oil-well 8. The annular side wall 3 expands upwardly or increases slightly in diameter through the greater portion of its height

and then terminates in a cylindrical portion 9, to the upper edge of which the cover plate 4 is secured. This side wall may be provided with a suitable liner 10. The cover plate 4 is provided with a plurality (here shown as two) of openings 11 closed by individual cover plates 12. Each opening 11 permits the insertion or removal of one of the roller assemblies D, and the roller supporting mechanism E is carried by the cover plate 12. The main cover plate 4 is also provided with a plurality of outlet openings 13 (hereinafter referred to more in detail) which communicate with passages leading up into the separator K. A central opening 14 in cover plate 4 communicates with the lower end of the chute 15 through which material to be ground is fed into the housing and thence into the central portion of bowl B. Except for the openings referred to above, the top of the casing may be entirely closed.

The bowl or container B comprises a central shallow table portion 16 formed by a disc-like bottom wall which slopes upwardly and outwardly at a small angle to the horizontal from the central axis of rotation, and an annular grinding wall formed by an upwardly projecting outer flange portion 17 which also flares outwardly at a small angle to the vertical. Preferably the inclination of the outer bowl wall 17 is substantially the same as that of the adjacent wall 3 of the housing A. Preferably a separate annular grinding track or ring 18 is mounted on the inner surface of the inclined side wall 17.

The driving assembly C comprises a central vertical drive shaft 19, the reduced upper end portion 20 of which is keyed within the hub 6 of bowl B. The upper and lower members 21 and 22 of a gear casing are secured together by bolts 23, and the upper member 21 of the gear casing is supported from outwardly extending flange 24 at the lower end of housing 7 projecting downwardly from base plate 1. The shaft 19 projects freely downward through sleeve 25 secured at its lower end in casing member 21, thereby completing the annular oil well 8 which will be filled with suitable lubricant to a height somewhat less than that of the sleeve 25. The hub 6 of the bowl is journaled in the bearing sleeve or bushing 26 mounted in bearing 5 of the base plate. The lower end 27 of the hub 6 is hollowed out to form a skirt extending downwardly over the sleeve 25. The outer surface of hub 6 is provided with a spiral oil groove 28 which serves to lift lubricant from well 8 between the contacting surfaces of hub 6 and bushing 26, the oil overflowing at the top into chamber 29 and thence flowing downwardly through passages 30 into the well 8. The lower end of skirt 27 is supported by an anti-friction thrust bearing 31 mounted on the upper casing member 21. It will be noted hereinafter that most of the grinding thrust is exerted outwardly instead of downwardly so that the thrust bearings do not carry much more than the weight of the bowl B and the material therein. The hub 32 of worm gear 33 is journaled in bushing 34 mounted in the lower gear casing 22. The lower face of gear 33 is also provided with a thrust bearing at 35 on the upper face of collar 36 of the gear casing. The driving worm 37 which meshes with worm wheel 33 is mounted on horizontal shaft 38 journaled in the gear casing and connected through coupling 39 with shaft 40 of driving motor 41. While other types of driving gearing might be used, the worm drive just described is

preferable, since it permits the use of a relatively small high speed motor to rotate the bowl B at the desired speed, for example 100 R. P. M.

The lower face of rotating bowl B, and the upper face of base plate 1 are provided with a plurality of interlocking annular ribs and grooves indicated generally at 42 which minimize the entrance of material from chamber 42' below the bowl into the bearing spaces about hub 6.

There may be one or more of the grinding rollers D depending on the size of the mill, there being two of these rollers in the example here shown. These rollers are preferably positioned diametrically opposite one another so as to properly distribute the thrusts on the grinding bowl B. Of course, if a greater number of rollers are used they will be equally spaced about the central axis. Each roller D comprises a removable and renewable grinding tread 43 carried by the sleeve assembly 44 which is freely rotatable on the non-rotary supporting shaft 45. This type of grinding roller is well known in the art and need not be here described in detail. The roller 43 is rotatable by contact with the grinding ring 18, or more properly by contact with the material to be ground, which is interposed between the roller 43 and track 18, as will be hereinafter apparent. The shaft 45 projects up through an opening 45' in cover plate 12 and the tapered upper end portion 46 of shaft 45 is secured in the hub 47 of the lever mechanism, indicated generally at E, by means of which the roller assembly is supported and adjusted. The lever comprises a split hub 48 which is locked at 49 on the central portion of a short horizontal shaft 50 which is journaled at its ends in brackets 51 projecting upwardly from the cover plate 12. The outwardly projecting end portion 52 of the lever E is formed on its lower side with a cup 53 for centering the upper end of a compression spring 54. A slotted bracket arm 55 projecting outwardly from casing wall 3 supports the cylindrical guide cup 56 having a lower inwardly projecting flange or collar 57 which supports the ring or washer 58. The sleeve 59 projects downwardly through cup 56 and ring 58 and is supported by means of the outwardly projecting collar 60 which rests on the ring 58. The sleeve or cup 61 which supports and centers the lower end of compression spring 54 is guided for vertical movement within cup 56 and has a threaded engagement at 62 with the upper portion of sleeve 59. Sleeve 59 is provided with collar 63 which may be engaged by a suitable tool to rotate the sleeve. When sleeve 59 is rotated, the cup 61 will be moved up or down to adjust the compression of spring 54. The rod 64 projects downwardly through lever 52, spring 54, and sleeve 59. A head 65 on the upper end of this rod engages the upper surface of lever 52. The lower end of the rod is threaded at 66 to receive the adjusting nut 67 and lock nut 68 which hold the ring or washer 69 in adjusted position on the rod. It will now be apparent that ring 69 will engage the lower end of sleeve 59 to limit the upward expansion of spring 54. A smaller compression spring 70 is confined about sleeve 59 between the collar 63 and washer 69.

It will be apparent that spring 54 tends to swing the lever E about its pivot so as to move the roller D toward the grinding ring 18. As material to be ground finds its way between roller D and grinding ring 18, the spring 54 will yield to permit the roller to swing inwardly, but will exert a predetermined outward pressure on this material, the pressure being determined by the ad-

justment of cup 61 which supports the lower end of the spring. Preferably washer 69 will be so adjusted that the roller tread 43 cannot be moved quite into actual engagement with the ring 18, there remaining a very small clearance between these parts, as indicated at 71. This is to prevent hammering of the rollers on the grinding ring and thus reduce the noise and wear on the grinding surfaces.

It will be understood that the above description is of one of the roller units D and E, each of these units consisting of an assembly such as just described hereinabove. By removing the individual cover plate 12, each of these grinding units can be removed and the roller lifted out of the housing through opening 11.

Air from any suitable source is delivered through pipe or conduit 72 into the pipe extension 73 of casing wall 3. This air passage extends tangentially into the lower portion of the mill housing through inlet opening 74 so as to create a whirling movement of the air within the housing. This air is delivered into the housing under pressure, but preferably this pressure is created by a suction at the outlet of separator K, as will be hereinafter described. Preferably a pivoted valve 75 is mounted in passage 73 so as to regulate and direct the flow of air into the housing. This air stream, the whirling movement of which will be increased by the rotation of bowl B, which rotates in a clockwise direction as viewed from above, passes upwardly through the annular channel 76 between the rotating bowl and the side wall 3 of the casing, thence inwardly over the bowl and out through the openings 13 in the cover plate into the separator K.

The rough material to be ground and pulverized is fed into the housing through chute F which communicates with the lower portion of the chute 15, already described, and thence through opening 14 down into the central portion of the rotating bowl B.

The material in bowl B will move by centrifugal force toward the outer walls 17 of the bowl and will be ground and pulverized between the rollers D and the grinding ring 18. Due to the small outward inclination of the outer walls 17 of the bowl, centrifugal force will hold a compact bed of the material against the grinding ring, through which bed of material the rollers D grind and this material will move slowly upwardly before being thrown or discharged from the bowl. A plurality of deflectors 77 are positioned at spaced intervals circumferentially of the housing in the upper and outer portion thereof adjacent the side wall 9 and top wall 4. These deflectors are in the form of substantially vertical vanes which extend diagonally inward from the outer wall 9 in the direction of rotation of the bowl. A movable annular deflector 78 is mounted on the upper edge portion of the side wall 17 of the bowl. The inner surface 79 of this deflector slopes upwardly and outwardly toward the stationary deflectors 77. The material from the bowl which would otherwise be thrown substantially horizontally by centrifugal force will be directed upwardly and outwardly by the sloping wall 79 toward the stationary deflector vanes 77. Due to the rather rapid rotation of the bowl B, this discharged material will be thrown forwardly or tangentially substantially in the direction of rotation of the bowl, and at the same time will be directed upwardly so as to contact with the stationary deflectors 77. This material is also projected through the air stream which is moving spirally upwardly through the annular

passage 76, this air stream assisting the centrifugal force imparted by the bowl to carry the material forwardly and upwardly into engagement with the stationary deflectors. This air stream is of sufficient volume and velocity to carry sufficiently pulverized material in suspension and such material will be sustained in suspension by the air stream and eventually carried out through the upper outlet openings 13. The larger particles of material which have not been sufficiently pulverized or reduced in size and which are too heavy to be carried out in suspension in the air stream will be thrown back through the air stream by the deflectors 77 into the central portion of the bowl B and thus returned through the grinding cycle. The heavier or larger particles of material, which cannot be ground in the mill and are to be rejected, are thrown outwardly from the bowl in a more horizontal direction and fall back through passage 76 into the lower chamber 42' beneath the bowl.

A discharge opening 80 extends from the lower outer portion of chamber 42' through the base plate 1, and the discharge chute 81 of mechanism H extends downwardly and outwardly from opening 80. A downwardly opening one-way valve 82 permits this waste material to flow out through chute 81, while minimizing the inflow of air through this chute. Preferably an air inlet pipe 83 extends from the supply pipe 72, or some other suitable source of air under pressure, into an intermediate portion of the discharge chute 81. A plurality of scrapers 84 are pivotally mounted at their inner ends 85 on the lower portion of bowl B so as to swing outwardly by centrifugal force as the bowl is rotated. These scrapers carry material deposited in chamber 42' around into position to be discharged through opening 80. Any lighter material stirred up by these scrapers will be carried up by the whirling air stream through passage 76 and thence returned into the mill. Any lighter material that finds its way into the discharge opening 80 and chute 81 will be carried up by the upwardly flowing air stream discharge from pipe 83 into the chute 81 and thence returned into the upper portion of the mill. In this way the loss of grindable material through chute 81 will be minimized.

The separator K comprises the passages or conduits 86 which extend upwardly from the outlet openings 13 and then expand upwardly, outwardly and circumferentially to merge into the annular chamber 87 at the upper end of the separator. This annular chamber 87 communicates through a series of openings 88 in its inner wall 89 with the central expansion chamber 90. The vanes or deflectors 91 at the sides of openings 88 impart a whirling movement to the air entering expansion chamber 90. This air stream, carrying the sufficiently pulverized material in suspension, will be drawn out through the central conduit 92 which projects down at its lower end into expansion chamber 90, and which connects at its upper end with a suitable pipe or conduit leading to a separator or other place of discharge where the pulverized material is withdrawn from the air stream. Insufficiently pulverized material drops out of the air stream in the expansion chamber 90 and is directed by the conical lower wall 93 of this chamber into the chute 15. A downwardly opening valve or damper 94 in this chute 15 is normally held closed by the adjustable weight 95 so as to prevent an upward flow of air from the mill housing through this chute, but

the valve will open downwardly to permit solid material to pass down through the chute into the bowl B.

It will now be seen that the original material introduced through feed chute F is recirculated within mill housing A by means of the cooperating deflectors 77 and 78 until the material has been sufficiently pulverized to be carried out in suspension in the air stream. Waste materials are discharged through chute H. Since some oversize material will be carried out from the mill housing A in suspension in the air stream, the separator K is used to grade this material and return the oversize material into the mill through chute 15 for further treatment. The upwardly flowing air stream in annular passage 76, together with the cooperating deflectors 78 and 77, very effectively retain the greater portion of the material within the bowl B or the upper portion of the mill housing, and for the most part only waste materials find their way into the lower chamber 42' and are thence discharged by scrapers 84 into and through the discharge chute H. Of the small quantity of desirable material that finds its way into the lower chamber 42', the greater portion is returned by the air stream into the upper portion of the mill, and thence eventually carried out through the separator K.

It will be noted that the grinding pressures are so balanced and directed that the pressure on the supporting bearings for bowl B are minimized, and furthermore the air stream does not pass in contact with any of the lubricated bearings.

I claim:

1. A mill comprising a closed casing, a substantially bowl-shaped container mounted within the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, means for introducing material to be ground into the central portion of the container, freely rotatable grinding rollers suspended within the bowl in position to be rotated by contact with material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing wall of the casing, an inlet conduit leading substantially tangentially in the direction of rotation of the bowl into the lower portion of the casing through which air is delivered under pressure thus providing an annular air stream whirling upwardly through the passage past the peripheral edge of the bowl, an outlet opening for the air stream in the upper portion of the casing, and non-rotary means positioned in the casing at the outer side of the passage for deflecting material thrown thereagainst from the periphery of the bowl back through the air stream into the bowl.

2. A mill comprising a closed casing, a substantially bowl-shaped container mounted within the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of the bottom and flaring outwardly at a small angle to the vertical, means for rotating

the bowl, means for introducing material to be ground into the central portion of the container, freely rotatable grinding rollers suspended within the bowl in position to be rotated by contact with material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing wall of the casing, an inlet conduit leading substantially tangentially in the direction of rotation of the bowl into the lower portion of the casing through which air is delivered under pressure thus providing an annular air stream whirling upwardly through the passage past the peripheral edge of the bowl, an outlet opening for the air stream in the upper portion of the casing, and non-rotary deflecting vanes positioned in the casing upwardly and outwardly from the periphery of the bowl and at the outer side of the air passage for deflecting material thrown thereagainst from the bowl back through the air stream into the bowl.

3. A mill comprising a closed casing, a substantially bowl-shaped container mounted within the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, means for introducing material to be ground into the central portion of the container, freely rotatable grinding rollers suspended within the bowl in position to be rotated by contact with material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing wall of the casing, an inlet opening in the lower portion of the casing through which air is delivered under pressure, an outlet opening for the air stream in the upper portion of the casing, deflecting vanes positioned in the casing at the outer side of the passage and at a higher level than the peripheral edge of the bowl for deflecting material thrown thereagainst from the bowl back through the air stream into the bowl, and an annular member mounted on the peripheral edge of the bowl for directing material from the bowl through the air stream toward the vanes.

4. A mill comprising a closed casing consisting of upper, lower and annular side walls, a substantially bowl-shaped container mounted within the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, means for introducing material to be ground into the central portion of the bowl, freely rotatable grinding rollers suspended within the bowl in position to be rotated by contact with the material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing side wall of the casing, an air inlet conduit leading tangentially into the lower portion of the casing through which air is delivered under pressure thus providing an annular air stream whirling upwardly through the passage past the peripheral edge of the bowl, members positioned within the casing at the

outer side of the annular passage for deflecting certain material thrown thereagainst from the bowl back through the stream into the bowl, and outlet passages for the air stream and suspended material leading from the upper wall of the casing.

5 5. A mill comprising a closed casing consisting of upper, lower and annular side walls, a substantially bowl-shaped container mounted within
10 the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of
15 the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, means for introducing material to be ground into the central portion of the bowl, freely rotatable grinding rollers suspended within the bowl in
20 position to be rotated by contact with the material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing side wall of the casing, an air inlet
25 conduit leading tangentially into the lower portion of the casing, deflecting vanes positioned in the casing at the outer side of the annular passage and at a higher level than the peripheral edge of the bowl for deflecting certain material
30 thrown thereagainst from the bowl back into the bowl, an annular member mounted on the peripheral portion of the bowl for directing material from the bowl through the air stream toward the vanes, and outlet passages for the air
35 stream and suspended material leading from the upper wall of the casing.

6. A mill comprising a closed casing consisting of upper, lower and annular side walls, a substantially bowl-shaped container mounted within
40 the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of
45 the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, means for introducing material to be ground into the central portion of the bowl, freely rotatable grinding rollers suspended within the bowl in
50 position to be rotated by contact with the material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing side wall of the casing, an inlet
55 opening tangentially into the lower portion of the side wall of the casing through which air is delivered under pressure, thus providing an annular air stream whirling upwardly through the passage past the peripheral edge of the bowl, members positioned within the casing at the outer
60 side of the annular passage for deflecting certain material thrown thereagainst from the bowl back through the air stream into the bowl, outlet passages for the air and suspended material leading from the upper wall of the container, a discharge
65 opening in the lower wall of the casing, and scrapers carried by the lower portion of the rotating bowl to direct material in the bottom of the casing toward the discharge opening.

70 7. A mill comprising a closed casing consisting of upper, lower and annular side walls, a substantially bowl-shaped container mounted within the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding
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wall projecting upwardly from the periphery of the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, means for introducing material to be ground into the central portion of the bowl, freely rotatable grinding rollers suspended within the bowl in position to be rotated by contact with the material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing side wall of the casing, an inlet opening tangentially into the lower portion of the side wall of the casing through which air is delivered under pressure, members positioned within the casing at the outer side of the annular passage for deflecting certain material thrown thereagainst from the bowl back into the bowl, outlet passages for the air and suspended material leading from the upper wall of the container, a discharge opening in the lower wall of the casing, and scrapers pivotally carried by the lower portion of the rotating bowl to direct material in the bottom of the casing toward the discharge opening.

8. A mill comprising a closed casing consisting of upper, lower and annular side walls, a substantially bowl-shaped container mounted within the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, means for introducing material to be ground into the central portion of the bowl, freely rotatable grinding rollers suspended within the bowl in position to be rotated by contact with the material held by centrifugal force against the inner surface of the outer wall of the bowl, there being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing side wall of the casing, an inlet opening tangentially into the lower portion of the side wall of the casing through which air is delivered under pressure, members positioned within the casing at the outer side of the annular passage for deflecting certain material thrown thereagainst from the bowl back into the bowl, outlet passages for the air and suspended material leading from the upper wall of the container, a discharge opening in the lower wall of the casing, a discharge chute leading downwardly from this opening, scrapers carried by the lower portion of the rotating bowl to direct material in the bottom of the casing toward the discharge opening, and means for directing air under pressure upwardly through the chute to return lighter material into the casing.

9. A mill comprising a closed casing, consisting of upper, lower and annular side walls, a substantially bowl-shaped container mounted within the casing for rotation about a central vertical axis, said container comprising a central disc-like bottom wall and an outer annular grinding wall projecting upwardly from the periphery of the bottom and flaring outwardly at a small angle to the vertical, means for rotating the bowl, a chute projecting through the upper wall of the casing for introducing material to be ground into the central portion of the bowl, freely rotatable grinding rollers suspended within the bowl in position to be rotated by contact with material held by centrifugal force against the inner surface of the outer wall of the bowl, there
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being an annular passage between the outwardly and upwardly extending outer wall of the bowl and the enclosing side wall of the casing, an inlet opening in the lower portion of the casing through
5 which air is delivered under pressure, deflecting members positioned within the casing at the outer side of the passage and adjacent the side and upper walls of the casing for deflecting certain material thrown thereagainst from the bowl back

into the bowl, an annular member positioned on the peripheral edge portion of the bowl and having an upwardly and outwardly sloping inner surface for directing material from the bowl toward the stationary deflecting members, and outlet openings leading at spaced apart intervals
5 from the upper wall of the casing.

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