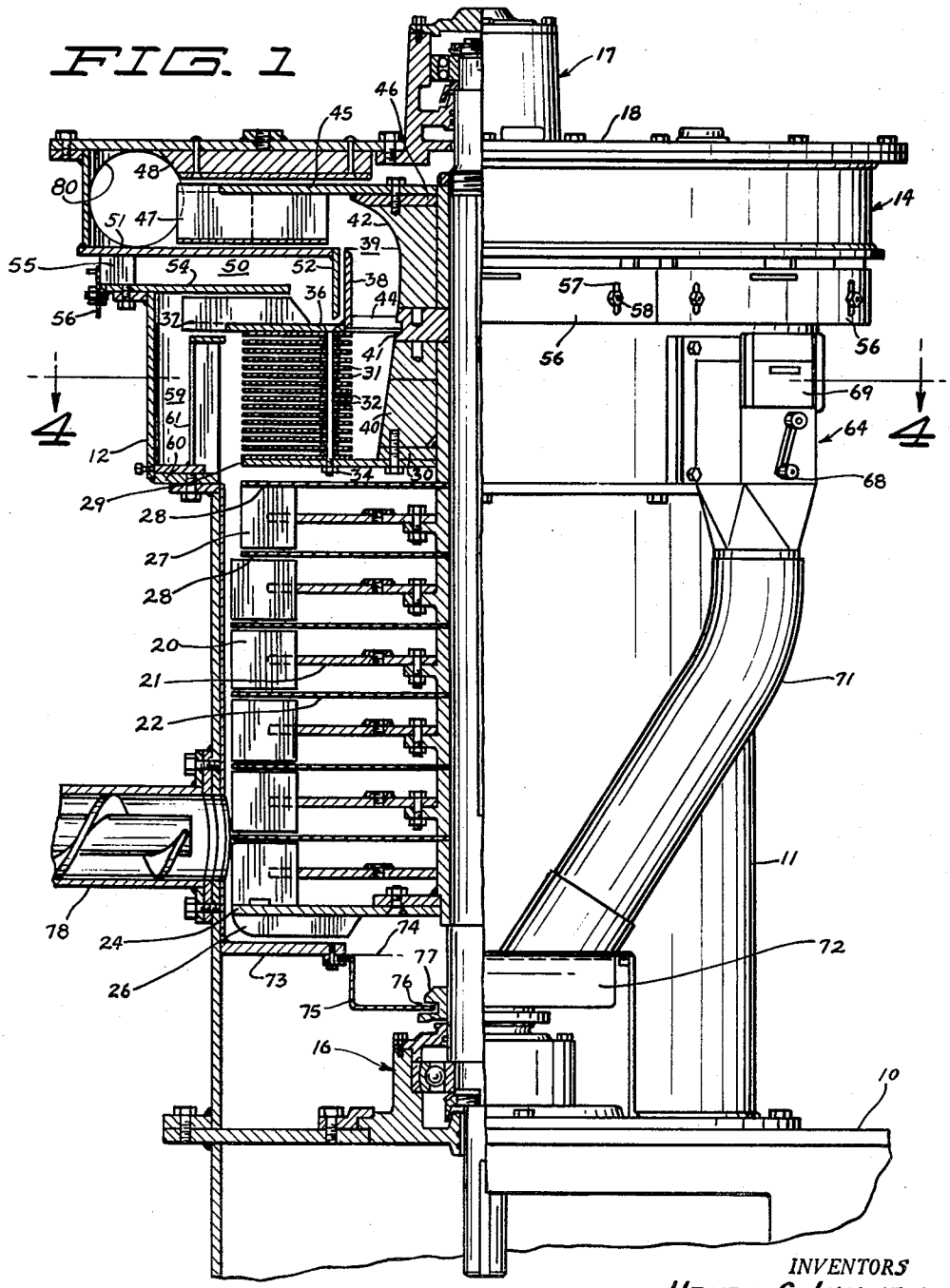
Dec. 6, 1960 H. G. LYKKEN ET AL 2,963,230

DRY MATERIAL PULVERIZER WITH INTEGRAL CLASSIFIER

Filed June 30, 1954 4 Sheets-Sheet 1

FIG. 1



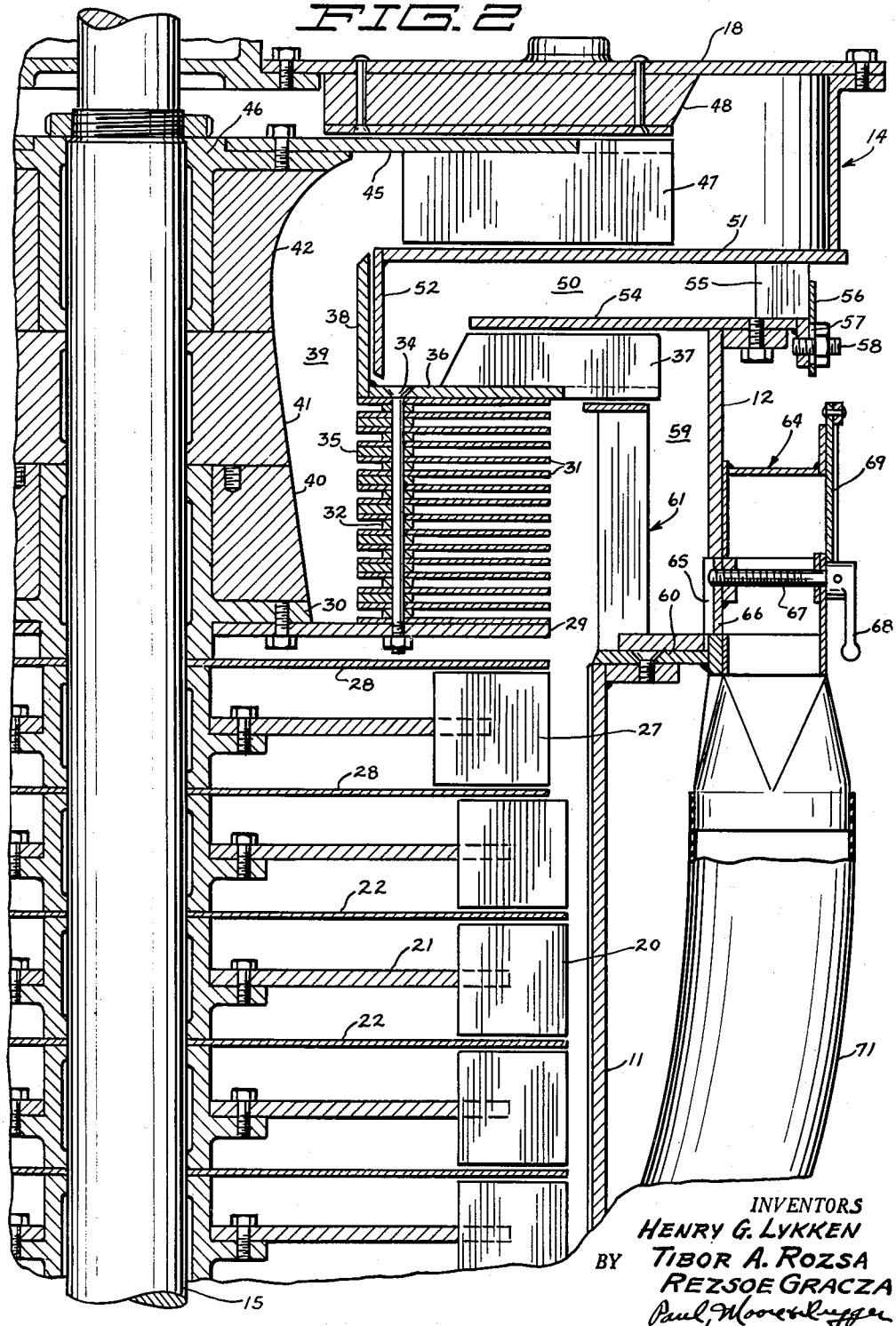
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DRY MATERIAL PULVERIZER WITH INTEGRAL CLASSIFIER

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FIG. 2



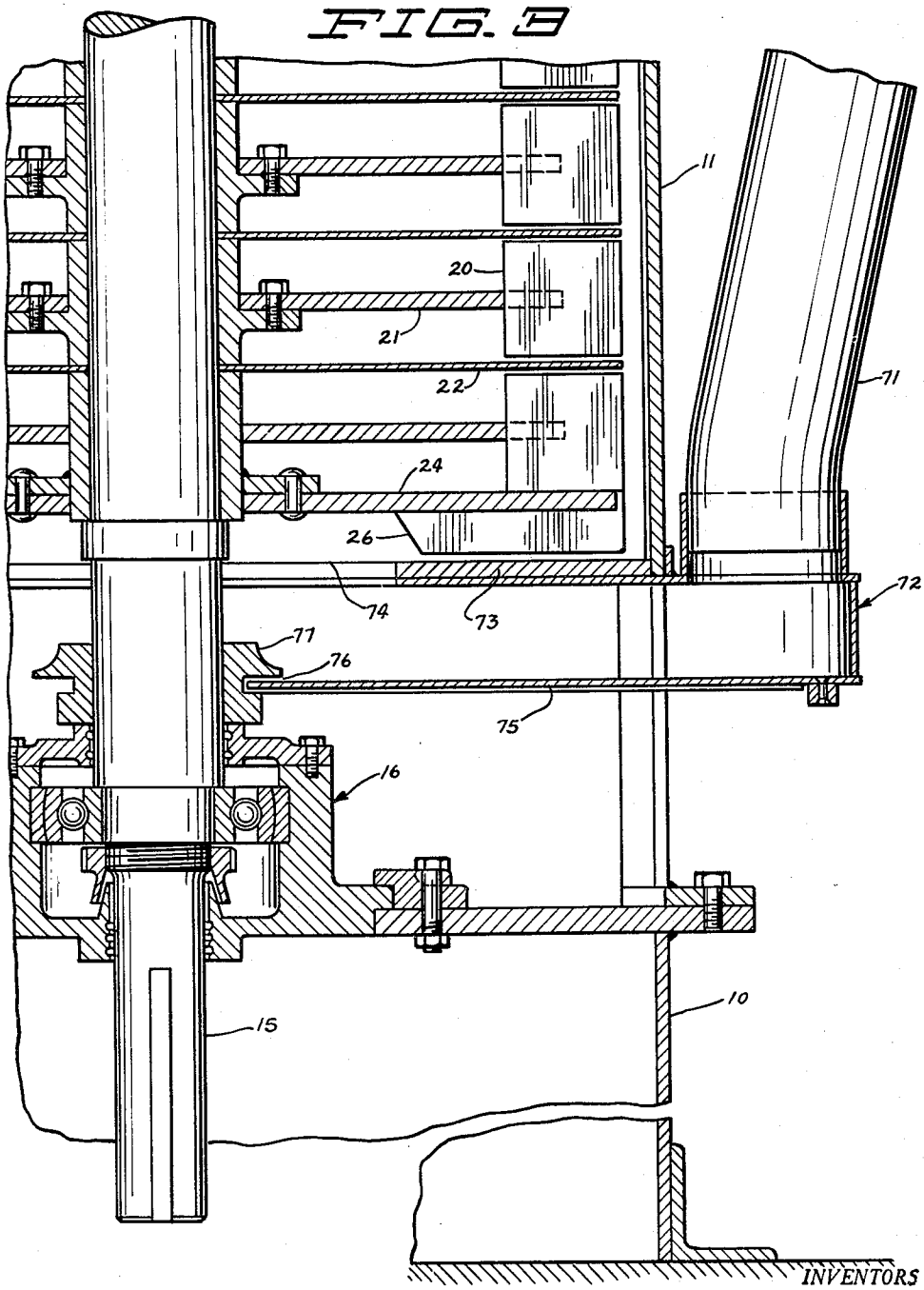
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DRY MATERIAL PULVERIZER WITH INTEGRAL CLASSIFIER

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FIG. 3



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DRY MATERIAL PULVERIZER WITH INTEGRAL CLASSIFIER

Filed June 30, 1954 4 Sheets-Sheet 4

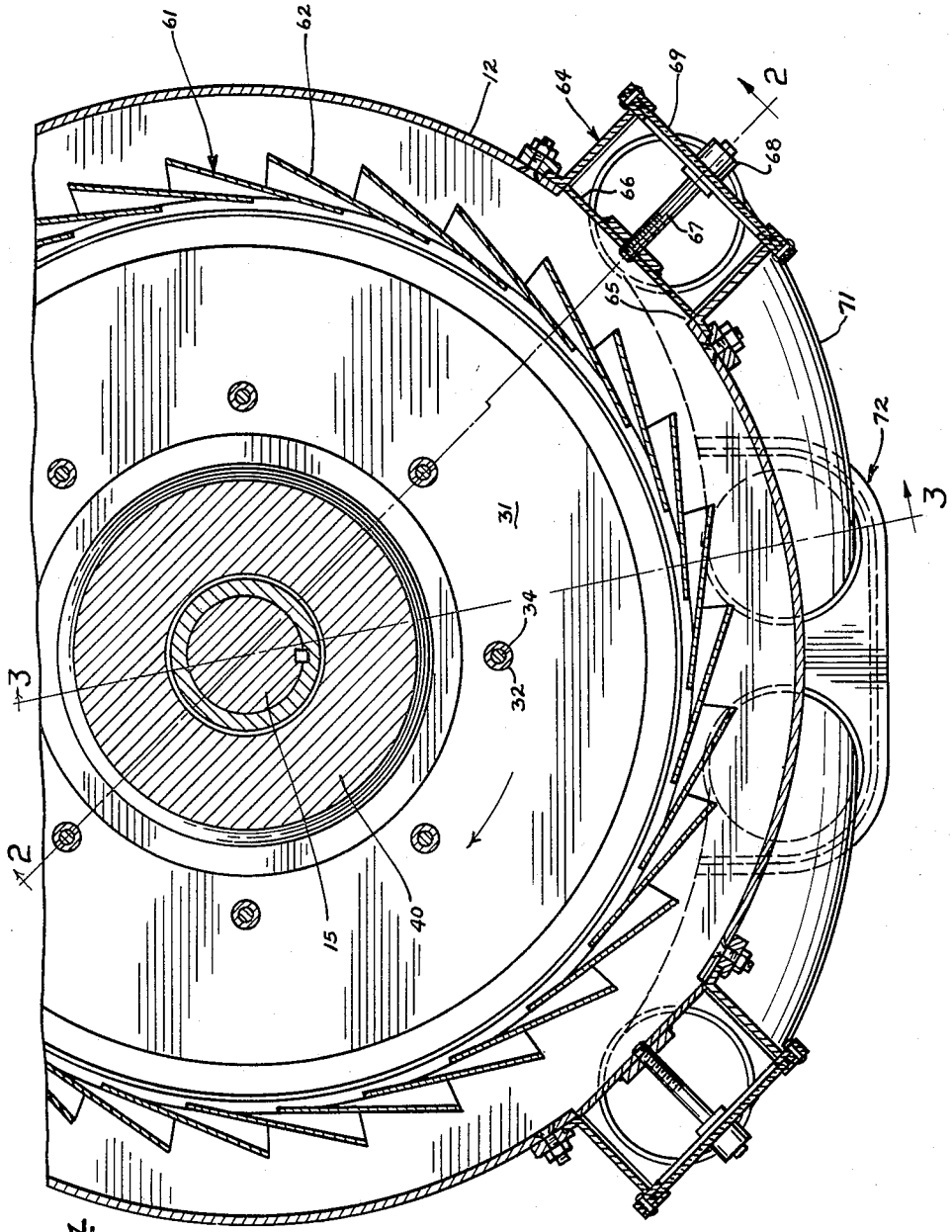


FIG. 4

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DRY MATERIAL PULVERIZER WITH INTEGRAL CLASSIFIER

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Filed June 30, 1954, Ser. No. 440,432

10 Claims. (Cl. 241—50)

This invention relates to a new and improved means for classifying dry pulverant material. More particularly, this invention relates to a new and improved classifier means adapted for use with a pulverizer of the general type having a vertical axis, an air inlet and air inlet fan at the bottom of the mill housing, a grinding rotor in the mill housing, a material feeding means associated with the housing, a classifying means above the grinding rotor and a mill outlet fan above the classifying means. One form of such a pulverizer is disclosed and claimed in U.S. Patent No. 2,440,285, issued on April 27, 1948, to Henry G. Lykken, one of the co-inventors of the classifying means of this application, and William H. Lykken.

It is the principal object of this invention to provide classifier means integral with a vertical axis pulverizer providing for controlled air flow and scavenging effect in the grinding zone for continuous selective withdrawal of the finished material from the grinding zone into the classifier zone and the return of the oversize to the grinding zone.

It is another object of this invention to provide classifier means having classifier air inlets for controlling air flow to the mill and classifier.

Another object of this invention is to provide an improved classifier having means for regulating air flow through the grinding zone, so as to continuously draw the wanted particle sizes out and up into the classifier zone.

A further object of this invention is to provide a classifier having a circular louvered wall disposed between the air inlets and classifier rotor whereby the larger part of the classifying air stream is directed inwardly, generally tangentially, to the classifier rotor in its direction of rotation entraining the pulverant material circulating on the inside wall of the louver curtain and drawing the wanted fines into and through the rotor, rejecting the oversize back into the grinding zone from the classifier zone.

Other objects of the invention will become apparent as the description proceeds.

To the accomplishment of the foregoing and related ends, this invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

The invention is illustrated by the drawings in which the same numerals refer to corresponding parts and in which:

Figure 1 is a vertical section of the improved classifier of this invention shown adapted for use in vertical axis pulverizer. The view is partly broken away to show the construction of the interior of the mill and classifier;

Figures 2 and 3 are fragmentary vertical sections taken

along the lines 2—2 and 3—3, respectively, of Figure 4 and in the direction of the arrows, Figure 2 being of the upper portion of the apparatus showing details of construction of the classifier and air intake means, and Figure 3 being of the lower portion of the apparatus showing details of construction of the means for introducing air to the bottom of the mill;

Figure 4 is a horizontal section through the classifier taken on the line 4—4 of Figure 1 and in the direction of the arrows.

Broadly stated, this invention comprises (1) the method of grinding and classifying dry solid material which includes the steps of introducing a fluidal stream of finely divided ground material entrained in a gas spirally upwardly from a grinding zone into the bottom of a generally annular classifying zone, whirling the fluidal stream of particles at high speed in an arcuate vorticose path around the annular classifying zone, at the same time introducing a plurality of streams of added gas substantially uniformly around the perimeter of said classifying zone, said added streams of gas being introduced inwardly into the annular classifying zone generally tangentially to the perimeter of that zone in the direction of rotation of the arcuate path of the whirling particles, separating the heavier and coarser particles thrown outwardly against the outer periphery of the annular classifying zone and returning these particles to the grinding zone for further reduction, entraining the lighter and finer wanted particles in the added gas streams and drawing them inwardly through the inner periphery of said annular classifying zone and axially upwardly and outwardly from the center of that zone and then separating the particles from the gas; and (2) one form of apparatus for carrying out the method.

Referring now to the drawings and particularly to Figure 1, there is here shown a vertical section of a mill embodying the improved classifier means of this invention. The apparatus comprises generally a base structure 10 upon which is mounted a cylindrical housing 11 enclosing the grinding zone of the mill, a cylindrical housing 12 of greater diameter mounted on the housing 11 enclosing the classifying zone of the mill and a fan housing 14 mounted on the classifier. A shaft 15 is mounted vertically for rotation within the housings journalled in any suitable bottom bearing structure 16 mounted on base 10 and top bearing assembly 17 mounted on top plate 18 of fan housing 14.

Mounted on shaft 15 is a grinding rotor section composed of a plurality of stacked rotor units each comprising a plurality of spaced apart vertical blades 20 held in slotted annular plates 21 and separated by annular rotor disks 22. The lowermost rotor disk forms a bottom plate 24 and is provided on its lower surface with fan blades 26 for assisting in drawing air into the grinding zone. The grinding blades 27 of the uppermost grinding unit are shorter than blades 20 and rotor disks 28 are of lesser diameter to enlarge the outlet of the grinding zone and to facilitate in this way the free return of coarse particles to the grinding zone. The details of construction of the grinding rotor per se form no part of this invention and are amply described in other Lykken patents and applications, including the aforementioned U.S. Patent No. 2,440,285.

Mounted on shaft 15 above the grinding rotor units is a classifier rotor and fan unit. The classifier rotor is mounted on an annular disk 29 forming a base plate for the classifier and supported by a collar 30 keyed to the shaft. Stacked on disk 29 are a plurality of thin classifier disks 31 held spaced apart by washers 32 on bolts 34 which serve to hold the disks together as a unit. Alternatively, as shown in Figure 2, the area of air flow through the classifier rotor may be varied by substituting annular

spacer rings 35 for certain of washers 32. The top plate 36 of the classifier rotor, being of greater diameter than the rotor disks, extends out beyond the edge of the classifier rotor and the louvered wall. Disk 36 is slotted to receive blades 37 which assist in drawing air into the mill. A cylindrical extension 38 upward from top plate 36 forms part of an annular axial passage 39 between the inner edges of the discs of the classifier rotor and spacer collars 40, 41, and 42 mounted on shaft 15. As shown in Figure 1, cylindrical ring member 38 is preferably also supported by at least three spline members 44. Spline members are slanted such way that they are vanes for the aerosol flow in the annular axial passage 39. Since velocities in the annular axial passage due to vortex action are of higher values than peripherial velocities of the spline points, splines cannot be shaped as fan blades having no chance to impart energy to the aerosol stream. In case spline vanes 44 are not properly set, turbulence is created behind them, which enables particles to settle out from the aerosol this way plugging the annular axial passageway.

The impeller fan unit for assisting in drawing air through the mill and for discharging the wanted classified fine pulverant material comprises an annular fan plate 45 supported an a sleeve 46 on shaft 15 and slotted at its periphery to receive fan blades 47. A spacer ring 48 is mounted on the inner surface of top plate 18 of the fan housing 14. Shaft 15 and the grinding rotor, classifier rotor and fan assembly carried on it may be driven by any suitable power means.

An annular air inlet chamber 50 is formed in the space between bottom plate 51 of the fan housing 14, a cylindrical wall 52 depending from the inner periphery of plate 51 and an annular ring 54 disposed between the fan housing and the classifier. Ring 54 is supported by a plurality of radial splines 55 depending from the lower surface of plate 51 and by the top edge of classifier housing 12. Flow of air into air inlet chamber 50 is regulated by means of a plurality of arcuate dampers 56 disposed around the periphery of ring 54. Dampers 56 are mounted for adjustment up and down to vary the size of the air inlet opening, as by means of slots 57 and stud bolts 58.

An annular plenum chamber 59 is formed in the space between classifier housing wall 12, ring 54, a further ring 60 mounted on the top of mill housing 11 and an annular louvered wall 61 mounted on ring 60. The individual louvers 62 of wall 61 are positioned to direct the flow of air inwardly generally tangentially in the direction of rotation of the classifier rotor. A plurality of air outlet boxes 64 are disposed around the periphery of the classifier housing 12 in direct fluid communication by means of openings 65 with plenum chamber 59. Flow of air from the plenum chamber to the outlet box is controlled by regulating gates 66 slidably disposed in openings 65 and actuated by screws 67 and any suitable cranks or operating handles 68. The top of outlet boxes 64 are provided with transparent sliding closures 69 for observation and temporary admission of free air to clear the bottom of the mill when necessary.

Air from outlet boxes 64 flows through conduits 71 to air inlet boxes 72 at the bottom of the mill below bottom plate 73 and through annular entry 74 to the bottom of the mill. The bottoms 75 of the air inlet boxes are slidably mounted in brackets for easy removal. The inner edges of the opposing inlet box bottoms are cut away to fit into the annular channel 76 of sealing collar 77 on shaft 15.

The material to be ground is fed at a regulatable rate into the lower portion of the grinding zone through any suitable adjustable feeding means 78. Fan housing 14 is provided with a suitable discharge 80 to a collection system for the wanted fine particles.

In the operation of the improved classifier of this invention in association with a vertical axis pulverizer the dry solid material to be ground is introduced by feeder 78 at a predetermined rate such that the grinding load remains thoroughly airborne and fluidal. At the same time, air is drawn into the pulverizer through circumferentially spaced air inlet ports on top of the classifier into air inlet chamber 50. The flow of air is controlled by vertical adjustment of segmental dampers 56. The air is induced into the mill by fan blades 37 and discharged into the annular plenum chamber 59 between classifier housing wall 12 and circular louvered wall 61.

A small portion of the air drawn into the annular plenum chamber is withdrawn through outlets 65 into outlet boxes 64 and thence through ducts 71 to air inlet boxes 72 at the bottom of the mill and through the bottom mill opening 74 to bottom inlet fan 26, as scavenging air in the grinding zone for maintaining the material to be ground in an airborne state and continuously lifting the sufficiently ground material out and upwardly in a spiral ring into the classifying means above the grinding zone. The flow of air to the bottom of the mill is adjusted by means of regulating gate 66 which is adjusted for sliding movement in opening 65 by actuating screw 67 and operating handle 68. When necessary to clear the bottom of the mill, additional free air may be admitted into outlet boxes 64 by opening sliding observation ports 69.

The mechanism by which grinding takes place as a result of attrition induced by contact of particle against particle, particle against the mill housing wall and/or particle against the grinding rotor blades due to intra-blade vortex actions is well understood and is described in detail in other Lykken and Lykken et al. applications and patents, notably U.S. Patent No. 2,294,920, issued on September 8, 1942.

The air flow through the grinding zone is so regulated that the wanted particle size is continuously drawn out and up into the classifier zone, and more particularly into the annular classifying space between the circular louvered wall 61 and the outer peripheries of disks 31 comprising the classifier rotor. In this space, the finely ground material circulates near the louvered wall and the wanted fine particle sizes are withdrawn, through the rotor discs while the oversize coarse particles are thrown outwardly against the wall 61 and returned by gravity to the grinding zone for further reduction.

The feed material with the air stream enters the bottom of the classifier spiraling upwardly through an annular ring intermediate of the coarse removing channel and the fine removing channel, that is, between the outer periphery of the classifying rotor and the louvered wall. As indicated above the fine particles are drawn inwardly into the rotor and withdrawn and the coarse particles are thrown outwardly against the wall. Some coarse particles may work their way up to the top of the classifying zone and escape out through the clearance space between disk 36 and the top of the louvered wall. These coarse particles will be returned to the mill through the plenum chamber, the skimmer outlet box and the recirculation duct. Similarly, any fine particles which escape classification and removal during their first pass through the classifier will be returned to the mill along with rejected coarse particles.

Referring to the louvered wall, specifically, the blades of the louvre curtain are forming an angle with the tangent of the inside louvre circle. Louvre angle influences the value of centerward drag by the air stream and the value of centrifugal force on the particles.

A further modification of the louvered wall disposed between the plenum chamber and classifier rotor consists in arranging the louvre blades on a conical surface in such a way that the top diameter of the louvre circle can be either larger or smaller than the bottom diameter. In this way the progress of the entrained pulverant material circulating on the inside wall of the louvre curtain may be respectively promoted or retarded. In

short, elevation (pitch) of the spiraling line (screw line) of the aerosol on the inside wall of the louvre curtain can be partially controlled with the conical arrangement of the louvre blades. With an upwardly opening cone arrangement elevation (pitch) of the screw line increases and with an upwardly closing cone arrangement elevation (pitch) of the screw line decreases.

The practical importance of this arrangement is that with upwardly opening cone arrangement of the louvre blades capacity of the classifier can be increased but at the expense of less perfect classification. With the upwardly closing cone arrangement of the louvre blades material is kept for a longer time in the classifier zone and can be more perfectly separated from the wanted fines resulting in more perfect classification, but at the expense of a lower rate of feed.

The larger portion of the air, that remaining after withdrawal of the scavenging air, is forced, and/or induced, through the circular louvered wall **61** generally tangentially to the classifier rotor and in its direction of rotation. The air passing through the louvered wall induced by fan blades **47** entrains the ground pulverant material circulating the wall, draws the wanted fines into and through the classifier rotor into the axial duct **39** and out through the mill fan to any suitable collector system.

The classification itself is a function of the classifier rotor, its rotative velocity, the generally tangential entrance of the air through the louvre curtain entraining the particles from the grinding zone, and the like. By the spacing of the disks the free area of entrance can be changed. As the free entrance area decreases, the radial component of velocity increases between the spaced disks. The tangential component of velocity does not increase due to the cross section change of entrance since the pressure potential between the center and periphery of the vortex which keeps the flow of aerosol in its channel, tends to diminish through the least resistance i.e., in the direction of the radius, but not in tangential direction resulting in velocity increase only in radial direction.

The sudden increase of radial velocity by the proportion of the free entering area to the disk-reduced entering area will instantly increase the drag at the entrance area representing a pick-up potential for the classifier's rotating disk assembly. In short, if a particle will be picked up at the entrance area it will be delivered to the fine fraction.

Although air is referred to throughout this specification as the gaseous medium, it will be obvious to one skilled in this art that, as the requirements of the specific materials being ground may dictate, other gaseous fluids may be used and are contemplated within the scope of this invention.

While the classifying means which is the subject matter of this invention, has been described with reference to and in association with a particular pulverizer, this is exemplary only of the typical general type of pulverizer with which this invention may be employed. In general, the classifier of this invention is adapted for use with any vertical axis mill having an air inlet and air inlet fan at the bottom of the housing, a grinding rotor in the mill housing, a classifier above the grinding rotor and a mill outlet fan above the classifying means.

One special feature of the new and improved classifier of this invention provides for controlled air flow and scavenging effect in the grinding zone for continuous selective withdrawal of the finished material from the grinding zone into the classifier zone and the return of the over-size to the grinding zone by gravity.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that we do not limit ourselves to the specific embodiments therein.

We claim as our invention:

1. A classifier comprising a vertically disposed cylindrical classifier housing, a classifier rotor journalled vertically for rotation within said housing, said rotor comprising stacked spaced apart annular disks, an annular axial passageway through said rotor, said passageway being closed at the bottom, open at the top and in communication with the spaces between said disks, a circular louvered wall around said rotor within the classifier housing, an annular plenum chamber between said classifier housing and said louvered wall, an air inlet chamber disposed above and in communication with the annular plenum chamber for introducing air into said chamber, and fan means disposed above the classifier rotor and in communication with said axial passageway for drawing at least part of the air in said plenum chamber through said louvered walls into the classifier rotor and out through said axial passageway.

2. A classifier according to claim 1 further characterized in that the louvers of said louvered wall are directed generally tangentially inwardly in the direction of rotation of said classifier rotor.

3. A classifier comprising a vertically disposed cylindrical classifier housing, a classifier rotor journalled vertically for rotation within said housing, said rotor comprising stacked spaced apart annular disks, an annular axial passageway through said rotor, said passageway being closed at the bottom, open at the top and in communication with the spaces between said disks, a circular louvered wall around said rotor within said classifier housing, a fan housing mounted above said classifier housing and spaced apart therefrom, said fan housing being in direct communication with the axial passageway of the classifier rotor, an annular air inlet chamber in the space between the classifier housing and fan housing, an annular plenum chamber between said classifier housing and said louvered wall, fan means on said classifier rotor at the top of the classifier housing between said air inlet chamber and plenum chamber for assisting in inducing flow of air from the air inlet chamber into the annular plenum chamber, and fan means in said fan housing for drawing at least part of the air in said plenum chamber through said louvered wall into the classifier rotor and out through said axial passageway.

4. A classifier according to claim 3 further characterized in that the louvers of said louvered wall are directed generally tangentially inwardly in the direction of rotation of said classifier rotor.

5. A classifier according to claim 3 further characterized in that said annular air inlet chamber is provided with circumferential segmental adjustable dampers for regulating the air flow.

6. The combination of a vertical axis mill for pulverizing dry solid material comprising a grinding rotor in a mill housing, a material feeding means associated with said housing and an air inlet and air inlet fan at the bottom of the mill housing; a classifier mounted above and in communication with said mill to receive pulverized dry solid material therefrom, said classifier comprising a vertically disposed cylindrical classifier housing, a classifier rotor journaled vertically for rotation within said housing, said rotor comprising stacked spaced apart annular discs, an annular axial passageway through said rotor, said passageway being closed at the bottom, open at the top and in communication with the spaces between said spaced apart discs, a circular louvered wall around said rotor within said classifier housing, a fan housing mounted above said classifier housing and spaced apart therefrom, said fan housing being in direct communication with the axial passageway of the classifier rotor, an annular air inlet chamber in the space between the classifier housing and fan housing, an annular plenum chamber between said classifier housing and said louvered wall, and fan means in said fan housing for drawing at least part of the air in said plenum chamber through said louvered wall into the classifier rotor and out through said axial passage-

way; and at least one air outlet box supported on the outside of said classifier housing, said outlet box communicating through an opening in said classifier housing wall with said plenum chamber and an elongated air duct extending from said outlet box outside of said mill housing to the air inlet at the bottom of the mill housing for withdrawing part of the air from said plenum chamber and introducing it as scavenger air at the bottom of the mill.

7. The combination according to claim 6 further characterized in that the louvers of said louvered wall are directed generally tangentially inwardly in the direction of rotation of said classifier rotor.

8. The combination according to claim 6 further characterized in that said annular air inlet chamber is provided with circumferential segmental adjustable dampers for regulating the air flow.

9. The combination according to claim 6 further characterized in that said opening in said classifier housing wall between said air outlet box and said plenum chamber is provided with an adjustable closure operable from outside said outlet box for regulating flow of scavenging air through said opening and outlet box to the air inlet at the bottom of the mill housing.

10. The combination according to claim 6 further characterized by fan means on said classifier rotor at the top of the classifier housing between said air inlet chamber and plenum chamber for assisting in inducing flow of air from said air inlet chamber into said plenum chamber.

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