Jan. 6, 1953 G. A. PARTEN 2,624,460

GAS SEPARATOR FOR GRINDING MILLS

Filed April 3, 1946 2 SHEETS—SHEET 1

Fig. 1.

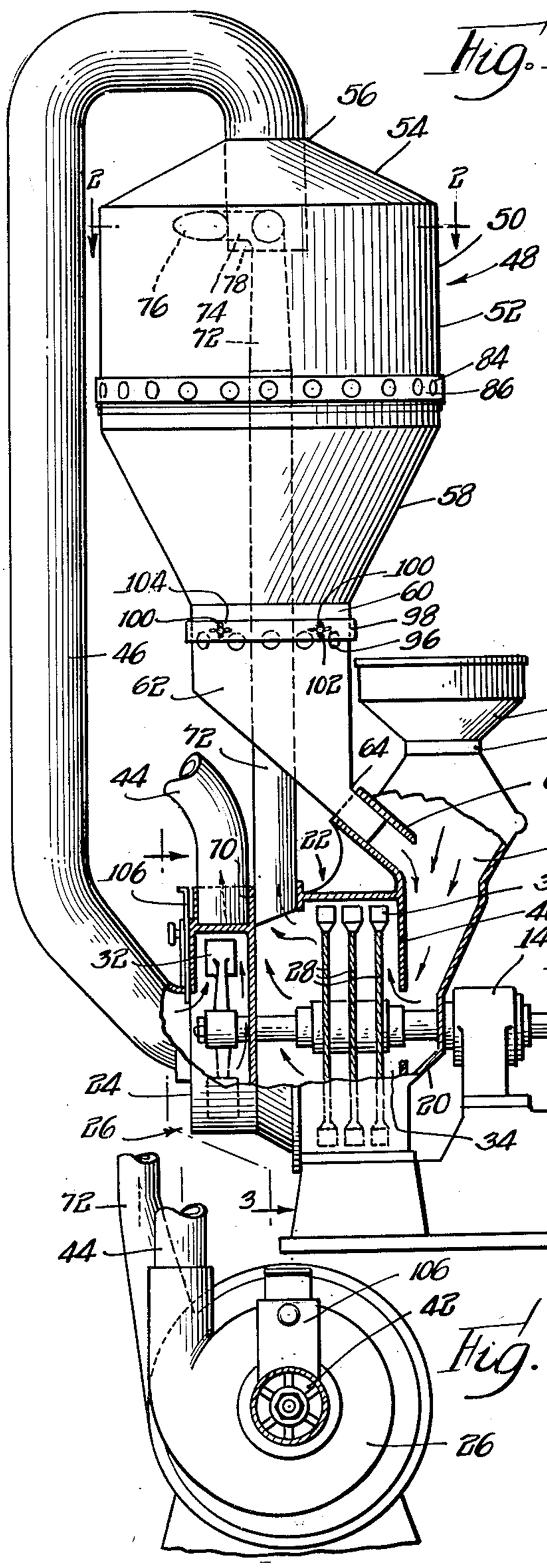

Fig. 2.

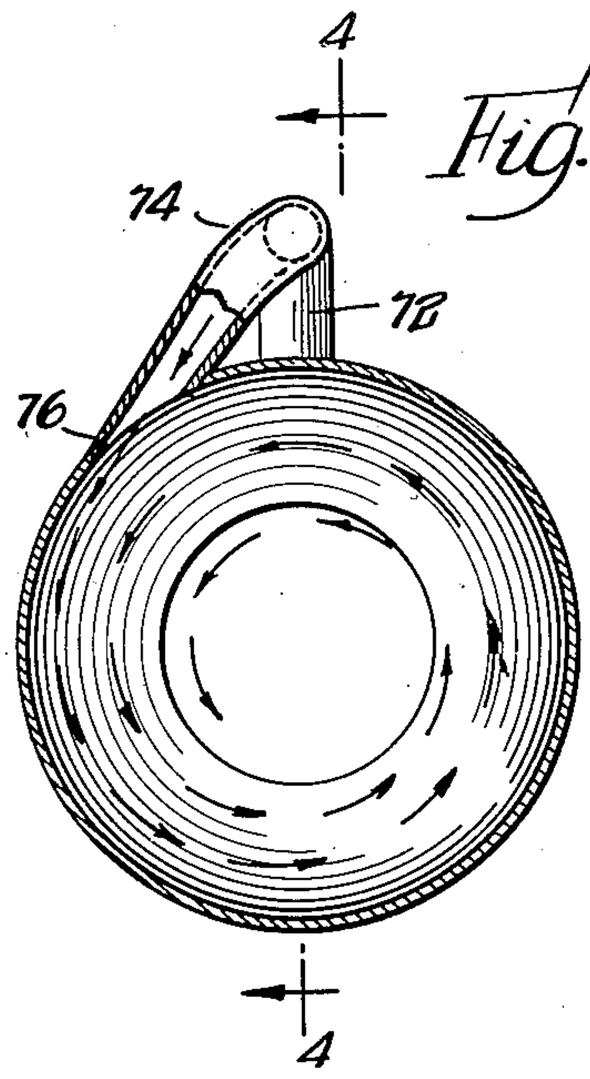

Fig. 3.

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Fig. 4.

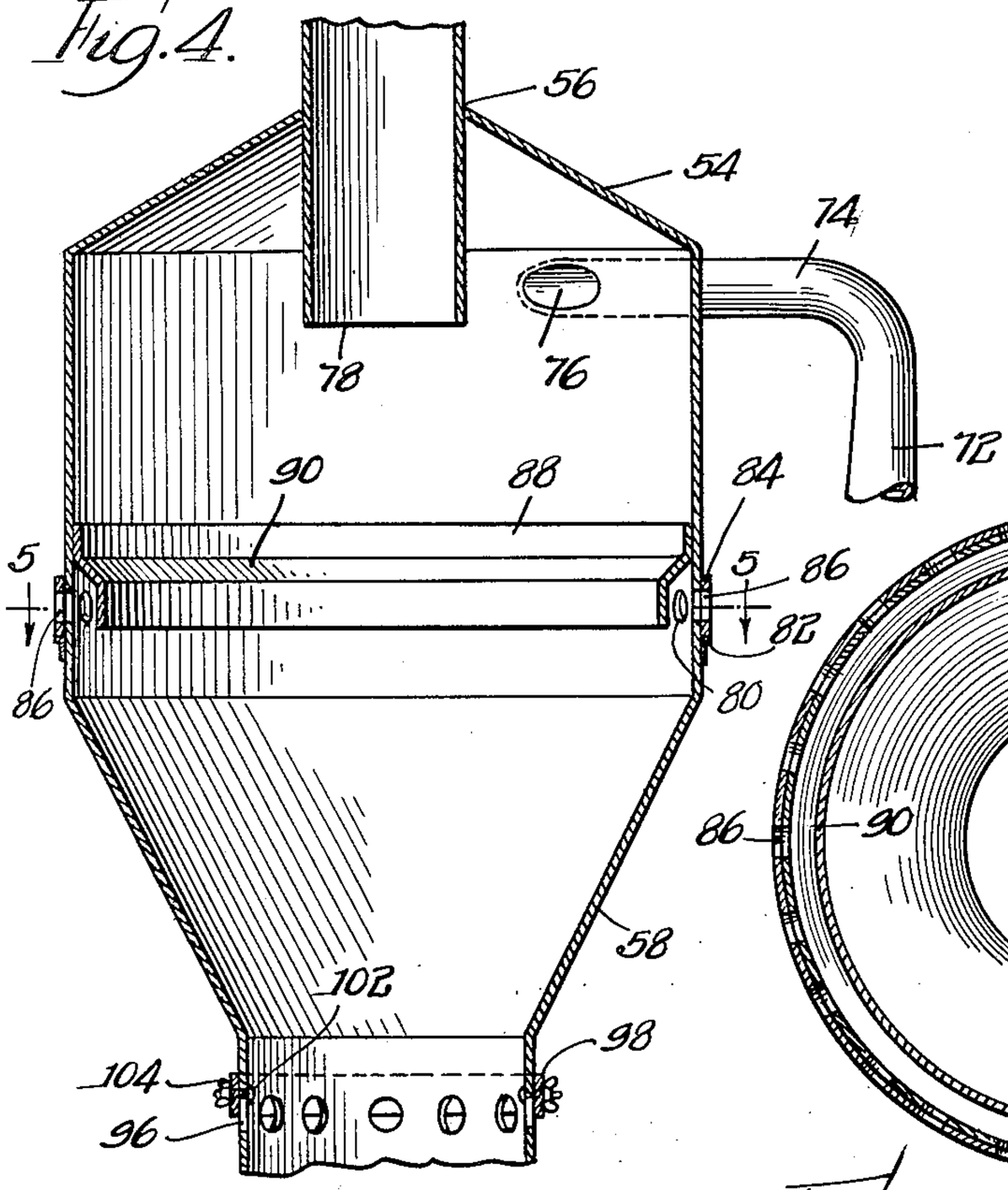


Fig. 5.

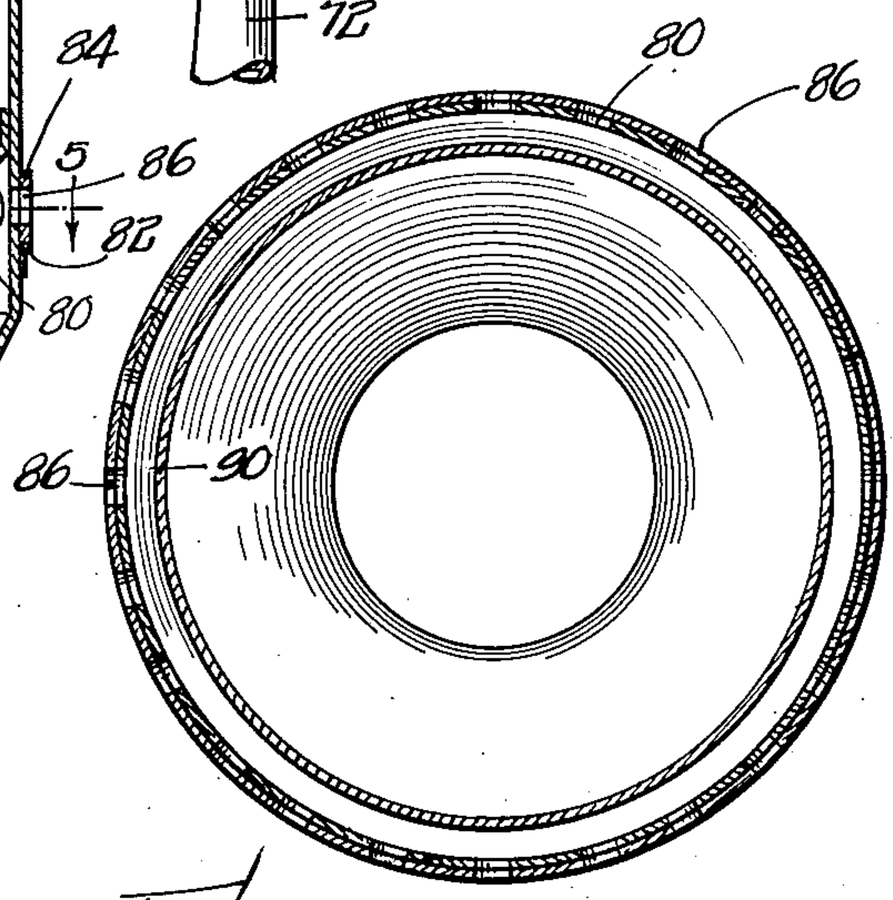


Fig. 6.

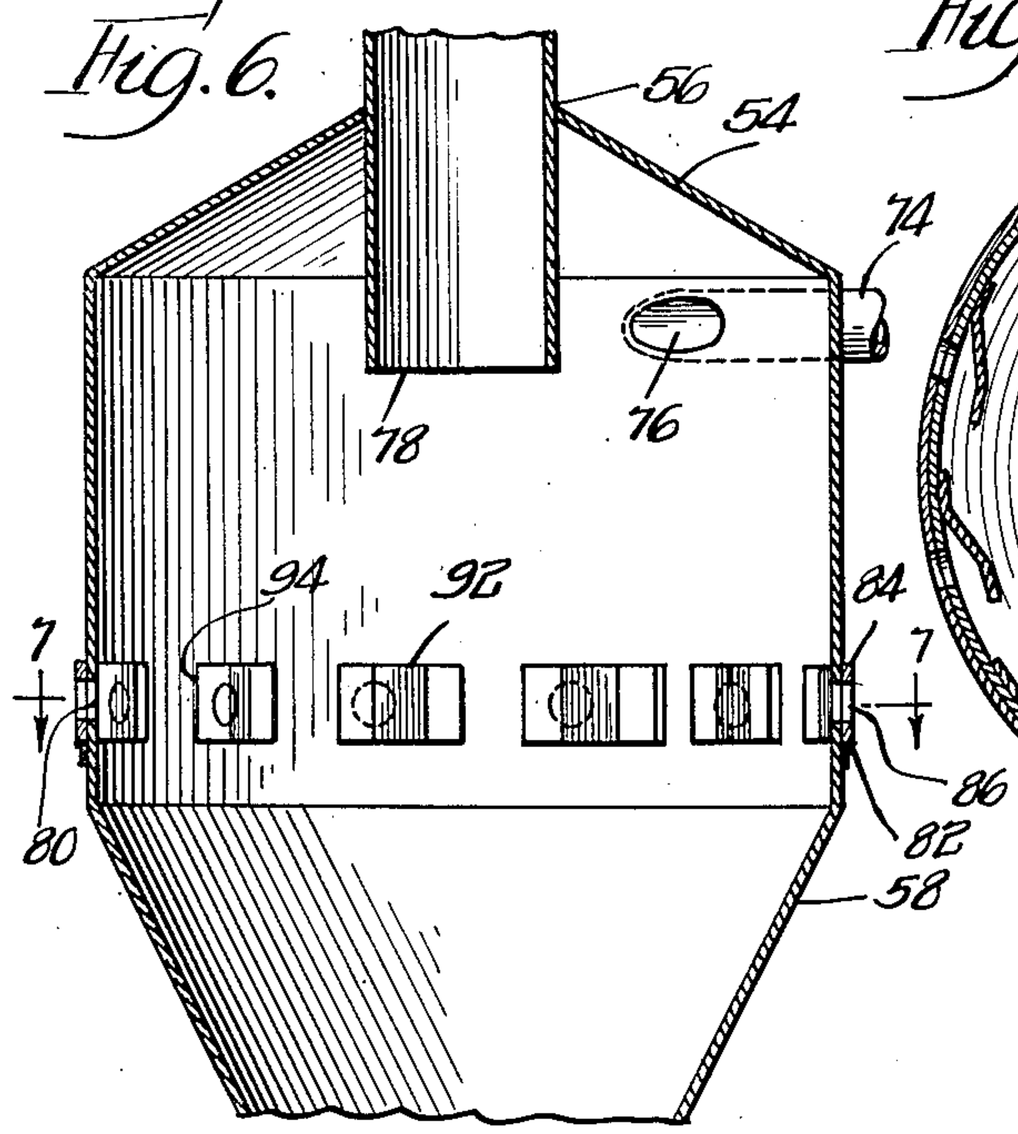
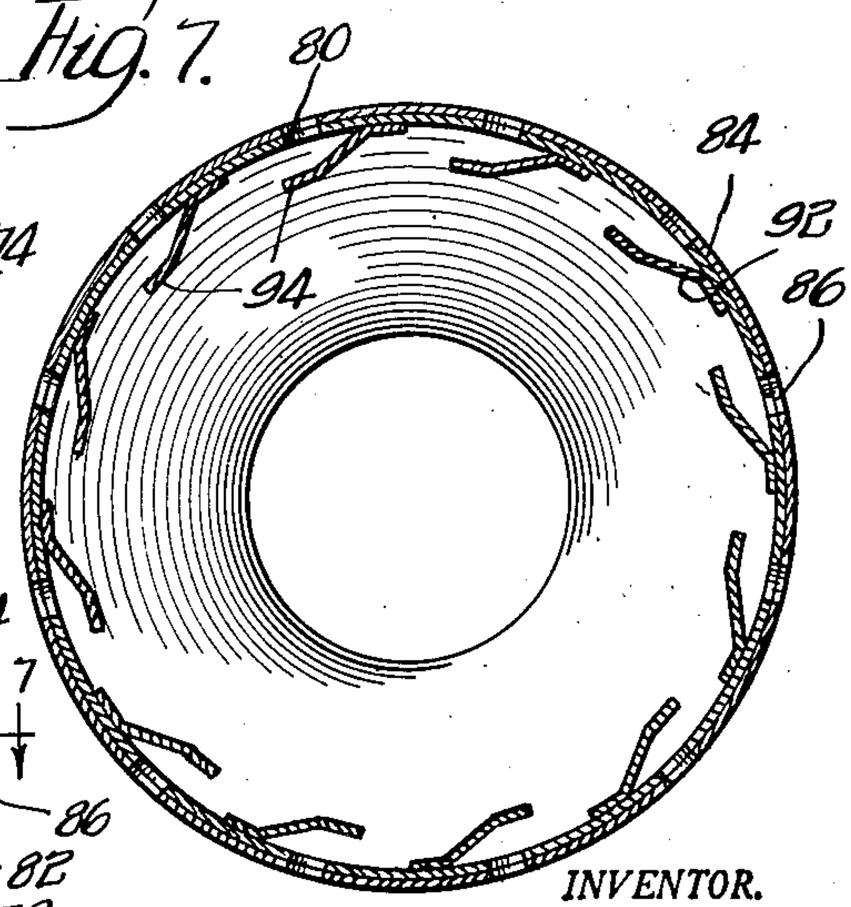


Fig. 7.



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GAS SEPARATOR FOR GRINDING MILLS

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2 Claims. (Cl. 209—144)

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This invention relates to a device for grinding solids to a fine state of subdivision. More particularly it relates to a grinder for solids which includes a separator in which the finer portion of the ground solids is separated from the more coarse portion. In order to grind solids to a relatively uniform state of subdivision it is ordinarily necessary to withdraw the material from the grinder after it is only partially ground and effect a separation of the solids ground to the desired degree of fineness from the coarser particles, the latter being preferably returned to the grinding means again for further grinding. The efficiency and accuracy of this separation step determines in large part not only the particle size distribution in the finished product but also the capacity of the device to produce a product of given particle size distribution.

It is an object of this invention to provide a device for grinding solids to a fine state of subdivision in which the particle size in the finished product may be more closely controlled in a separator having improved control means for that purpose.

Still another object is to provide a device for grinding solids to a fine state of subdivision in which the separator is provided with inlet and outlet conduits relatively disposed to assist in delaying the passage of the solids therethrough whereby better separation is obtained.

Other objects will appear hereinafter.

The means by which the foregoing objects have been accomplished are embodied in the illustrative devices shown in the accompanying drawings which form a part of this specification and in which:

Figure 1 is an elevation of the improved grinder with a portion broken away to show the details of the grinding chamber and blower;

Figure 2 is a horizontal cross sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a vertical cross sectional view taken on the line 3—3 of Figure 1;

Figure 4 is a vertical cross sectional view taken on the line 4—4 of Figure 2;

Figure 5 is a horizontal cross section on the line 5—5 of Figure 4;

Figure 6 is a vertical cross section similar to Figure 4, but showing an alternative construction; and

Figure 7 is a horizontal cross sectional view on the line 7—7 of Figure 6.

As shown in Figure 1, the grinder includes a base 10. Supported on this base are two bearings 12 and 14 for a shaft 16. Between the bearings 12 and 14 the shaft 16 carries a driving pulley 18.

Beyond the bearing 14 the shaft 16 extends through the housing 20 of a hammer mill or grinding means 22 and into the housing 24 of a blower 26. Within the housing 20 a set of three discs 28 carrying hammers or beaters 30 are secured on the shaft 16 and within the housing 24 a set of blower blades 32 are mounted on shaft 16. The hammer mill 22 is of known construction and includes a cylindrical grinding chamber 34 in which the hammers 30 rotate. Solid material to be ground is filled into a hopper 36 provided with a throat 38 having suitable feed control means therein to control the rate at which the material to be ground is directed into the grinding chamber 34 through an opening in baffle 40 adjacent the axis of the grinder.

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As best seen in Figure 3, the blower or fan 26 is of the centrifugal type, having an inlet 42 at its axis and exhausting tangentially through a pipe 44. Conduit means in the form of a pipe 46 (Figure 1) connects the inlet 42 of blower 26 with the upper part of a gas separator 48. The separator 48 is enclosed by a tubular housing 50 forming a tubular chamber, said housing having a central cylindrical portion 52 above which there is a portion 54 of gradually decreasing diameter which terminates in an upper opening 56 through which the pipe 46 extends. The lower portion 58 of the housing 50 also decreases gradually in diameter downwardly until it terminates in a short cylindrical portion 60. Below the cylindrical portion 60 is a trough 62 the lower end 64 of which extends into an opening 66. As may be seen in Figure 1 the opening 66 communicates with a chamber 68 through which solids to be ground are fed from the hopper 36 to the hammer mill 22.

Between the grinder 22 and the blower 26 there is an opening 70 in the top of the casing 20. A pipe 72 extends upwardly from this opening alongside the tubular separator housing 50. The pipe 72 near the upper part of the cylindrical section 52 of the housing 50 is connected to a horizontally extending pipe 74 which opens into the housing 50 at 76. As best seen in Figure 2 the pipe 74 is so directed that air or other material passing therethrough enters the chamber enclosed by housing 50 in a direction which is substantially tangential to the wall of the central cylindrical section 52. Attention is directed at this point to the fact that the pipe 46, connecting the blower 26 with the separator 48 through an opening 56 in the top of the latter, extends through the opening 56 and down inside the chamber enclosed by the housing 50. The lower end 78 of pipe 46 is preferably just slightly below the level of the opening 76.

Extending entirely around the lower portion of the cylindrical housing section 52 is a series of small holes 80. Just below these openings 80 a flanged ring 82 is secured to the outside of the housing 52. Above and supported by the flange on ring 82 is a collar 84 having a series of holes 86 therein corresponding to the series of holes 80. This collar 84 is rotatable about the housing 52

so that it can be positioned to close the openings 80 or to open them to any desired degree.

Within the housing 52 in the embodiment shown in Figure 4 an annular baffle 88 is secured to the housing 52 just above the openings 80. This baffle 88 includes a portion 90 extending inwardly from the housing 52 and then downwardly and terminating below the lower edge of the holes 80.

A slightly different baffle construction is illustrated in Figures 6 and 7. In this arrangement a series of separate baffles 92 are secured around the inside of the housing 52 between the openings 80. As shown in Figure 7, these baffles 92 are each so located that the portion 94 thereof extending inwardly from the housing 52 and then generally parallel to the housing 52, is located opposite a hole 80 and terminates between this hole 80 and the next adjacent hole. Still another series of holes 96 are formed in the lower cylindrical portion 60 of the housing 50. The series of holes 96 extend entirely around the housing 60. Also extending about the housing 60 is a collar 98 which is provided with four vertically extending slots 100. A series of four bolts 102 secured on the housing 60 extend through these slots 100 and receive wing nuts 104 which can be turned up tight against the collar 98 to support it in any desired vertical position. The collar 98 is adjustable from an upper extreme at which the openings 96 are unobstructed, to a lower limit where they are completely closed, and of course may be located at any desired intermediate position where the openings 96 are only partially closed.

As is already indicated above, solid material to be ground is introduced into the hopper 36 and through the gate 38 to the chamber 68. From this chamber 68 it passes through the central opening in the baffle 40 into the grinding chamber 34. The pulley 18, driven by any suitable means (not shown), is caused to turn the shaft 16 at high speed, thus revolving the beaters or hammers 30 and the fan blades 32 at high speed. The material to be ground is broken up or pulverized to a fine state of subdivision in the chamber 34.

The operation of the fan 26 causes a reduction in pressure throughout the entire system which extends back through the pipe 46 to the separator 48 and thence through pipes 74 and 72 to the grinding chamber 34. Consequently air flows from the chamber 34 up through the pipe 72 carrying with it the solid material which has been ground by the mill 22. The air carrying the ground solids passses up through pipes 72 and 74 and enters the separator 48 through the opening 76 in a direction which is substantially tangential to the cylindrical housing 52. As indicated by the arrows in Figure 2, this air carrying the fine solids circulates around within the separator 48 and during this time the coarser solids gravitate downwardly in the separator 48 while the finer solids still remain suspended. These coarse solids eventually drop into the trough 62 which directs them through the opening 66 into the chamber 68, thus returning them to the mill 22 for further grinding. The finer solids, however, remain suspended in the air in separator 48 and eventually are drawn out the top of the separator 48 through the pipe 46. From the pipe 46 the air carrying these fine solids enters the blower 26 and is discharged through the pipe 44 into a cyclone finished product bin, not shown, in which the solids are collected.

In the light of the foregoing description it will be apparent that the admission of the current of air, carrying the solids to be separated into the chamber in a direction substantially tangential to the walls 52 thereof, serves to give a more uniform movement of the solid-laden air through the separator 48, thus producing a more uniform separation. In cooperation with this tangential admission of air carrying solids to be separated, the pipe 46 extending down into the chamber 48 below the opening 76 further aids in producing better and more uniform separation. This lower end of pipe 46 serves as a baffle means to prevent the passage of air laden with the fine solids directly from the opening 76 into the pipe 46 and also provides an upper section in the chamber 48 where the air can circulate for a time before it finally is drawn out through the pipe 46, thereby providing a uniformly longer time for separation of the coarse solids.

The baffles 88 and 92 also cooperate with the tangential admission of the solid-laden air to prevent solids in the rapidly swirling air from being thrown out through the openings 80. The choice as to whether the baffle 88 or the baffles 92 will be used depends upon the degree of agitation desired in the air swirling about in the separator 48. The baffle 88 presenting a smooth surface to the swirling air causes very little or no agitation whereas the baffles 92, providing a discontinuous surface to the swirling air, tend to cause agitation. Where the particles to be separated are relatively large or dense, the agitating type of baffle is preferred and where the coarser particles to be separated are relatively fine or light the nonagitating type gives better results.

The row of openings 80 admits a current of air which, moving upwardly through the separator 48, prevents fine, light material from being carried downwardly by the coarser particles gravitating out of the separator 48. Opening these holes tends to increase the average particle size of the product passing out through pipe 46, and closing these openings tends to decrease this average particle size. The series of openings 96 serve a purpose generally similar to that of the openings 80. Some of the air entering through these openings may pass upwardly to carry with it the fine particles and the remainder of the air will pass downwardly with the coarse particles to the grinder 22. Admission of air through openings 96 thus decreases the tendency for air in the separator 48 to flow out through opening 66 from above the openings 96. Opening and closing the openings 96 by means of the collar 98 has an effect on the separation in chamber 48 similar to that produced by opening and closing the openings 80. The quantity of air drawn through the system may also be regulated by the gate valve 106 at the inlet to the blower 26.

While the invention has been illustrated by a device including a hammer mill, it will be understood that any other desired grinder construction may be employed. Similarly the invention is not intended to be limited to the mounting of the operating parts of the grinder and blower on the same shaft. Any desired means for drawing the air through the system may be used in place of the blower 26, and this means may be driven entirely independently of the grinder 22. Moreover, although, in the embodiment of the invention illustrated, the gas employed in the separator system is air, any other desired gaseous medium may be used. Air is, of course, more convenient to use and is preferred where it is

suitable. It is within the scope of the invention, however, to use any other desired gaesous medium to convey the fine solids through the separator system.

Although the tangential admission of air carrying solids into the separator 48 does cooperate with the baffling action of the pipe 46 extending down into the separator, and with the baffles 88 or 92, it is to be understood that the invention contemplates the use of each of these either separately or in any combination. Thus, however the air carrying the solids is admitted to the chamber 48, and even in the absence of pipe 46 extending down into the chamber, the baffles 88 and 92 prevent fine solids from being thrown out through the openings 80. Similarly, the pipe 46, extending down into the chamber 48 across the direct path between the opening 76 and the opening 56, prevents the solid-laden air from moving directly from opening 76 to opening 56 and thus produces better separation whether or not the solid-laden air is admitted tangentially, and whether or not the baffles 88 or 92 are employed. Lastly, the tangential admission of air, even in the absence of the section of pipe 46 extending down into the chamber 48, and in the absence of the baffles 88 and 92, still promotes better separation by causing the air to swirl around in the chamber 48 and move out more uniformly.

It should also be understood that extension of the pipe 46 down into the chamber 48 is merely a convenient way of providing a baffle across the path between opening 76 and opening 56. Any other desired baffle means may be extended across this path in place of the pipe 46 although the cylindrical baffle construction provided by pipe 46 is preferred since it does not interfere with the swirling movement of the air and provides more uniform movement of air out of the chamber 48 than would be provided by a simple flat plate, for example, extending across the path between opening 76 and opening 56.

Although for most purposes it is preferable to return the coarse solids separated in separator 48 to the mill for regrinding, it is within the scope of the invention to return only a part or none of these coarse solids. They may, if desired, be recovered without further grinding.

It will be apparent from the foregoing description that the mill for grinding fine solids disclosed herein exhibits increased efficiency and capacity as compared with similar mills heretofore known. This is accomplished in general by providing for better separation of the coarse solids from the finer solids following grinding. A further advantage of the improved grinder disclosed herein is that better control of the particle sizes in the finished product is possible.

It is apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof and it is therefore not intended to be limited except as indicated in the appended claims.

The invention is hereby claimed as follows:

1. A gas separator adapted for use with a grinding mill, and comprising an upper cylindrical separator casing, a lower inverted frusto-conical separator casing terminating in a depending outlet conduit for non-separated coarser solids, a tangential supply opening adjacent the top of the upper cylindrical separator casing for tangentially directing entering ground solids, an exhaust opening through the top of said upper cylindrical separator casing for exhausting the separated finer solids, a continuing series of openings disposed peripherally through the bottom portion of said upper separator casing for admitting a ring of air adjacent the bottom of the upper separator casing for mixing with the material gravitating out of the bottom of the upper separator casing, and into the lower conical separator casing, baffle means secured around the inner surface of the upper separator casing and including wall means offset slightly inwardly to closely overlie the openings in spaced substantially parallel relation to the adjacent surface of the upper separator casing whereby to minimize obstruction within the upper separator casing while preventing escape of solid particles through the said openings, an apertured control ring mounted exteriorly of said upper separator casing around the peripheral series of openings therethrough for controlling the size of the air passages through said openings whereby to control the average size of particles to be separated, a series of openings disposed peripherally through the depending outlet conduit below the reduced end of said lower separator casing admitting additional air to reduce any tendency for air with finer solids to pass through said outlet conduit, and a control ring mounted on said outlet conduit and shiftable relative to the peripheral openings therethrough for controlling the amount of air admitted through the said openings.

2. A gas separator as claimed in claim 1, wherein the baffle means includes separate baffle members, one for each opening, and each baffle member including an inwardly offset wall portion overlying its associated opening and extending generally in the direction of movement imparted to the entering solids by the tangential supply opening but spaced from the adjacent baffle members on both sides thereof whereby to increase agitation within the adjacent portion of the upper seeparator casing and effect separation of coarser solids.

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