Jan. 28, 1930. R. SINCLAIR 1,744,927

PULVERIZER

Filed June 19, 1928 2 Sheets-Sheet 1

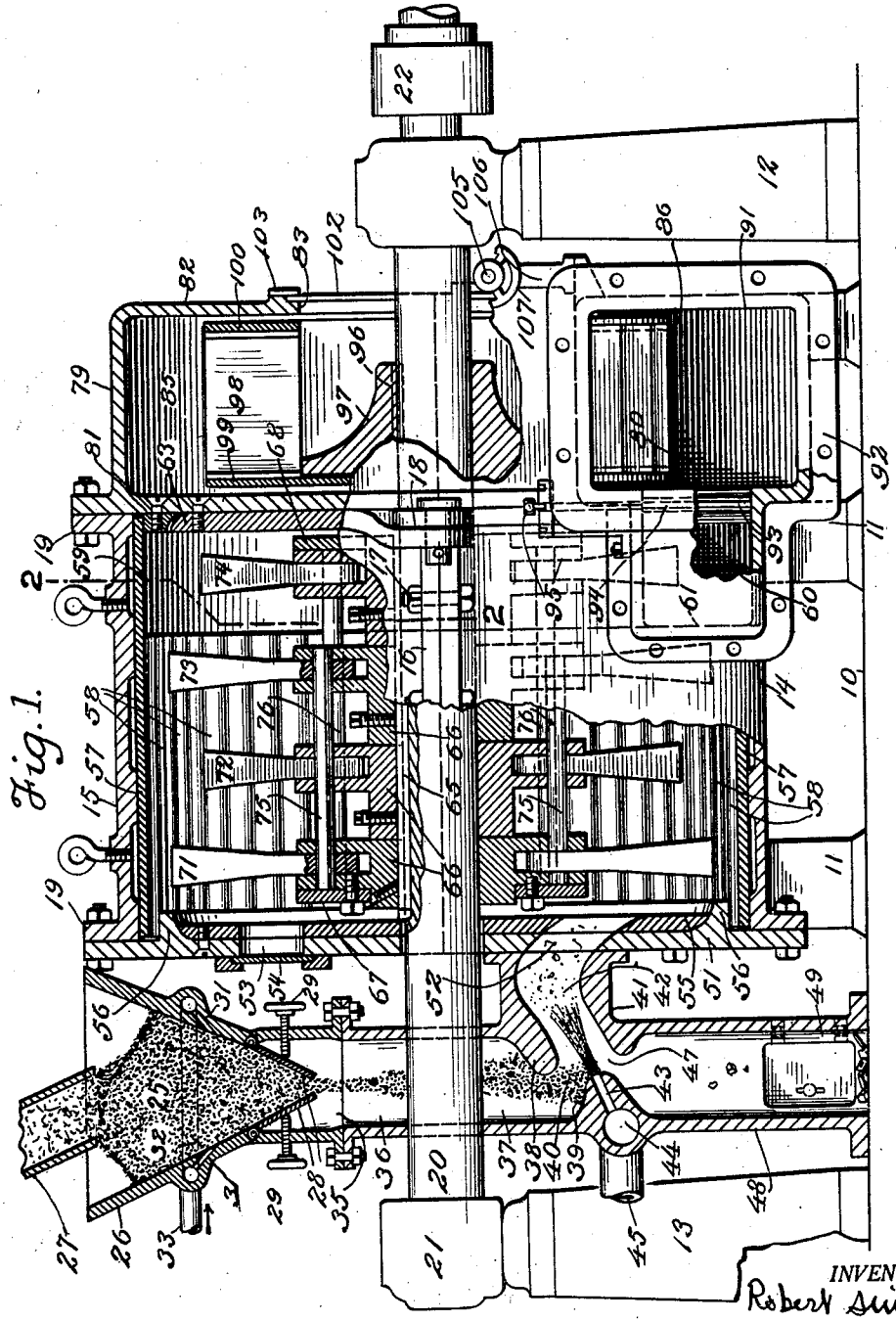


Fig. 1.

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Fig. 3.

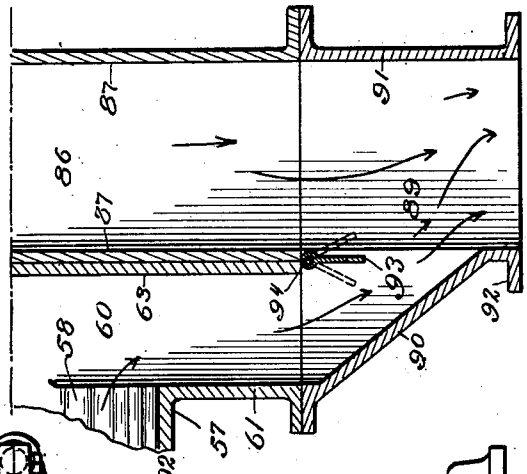
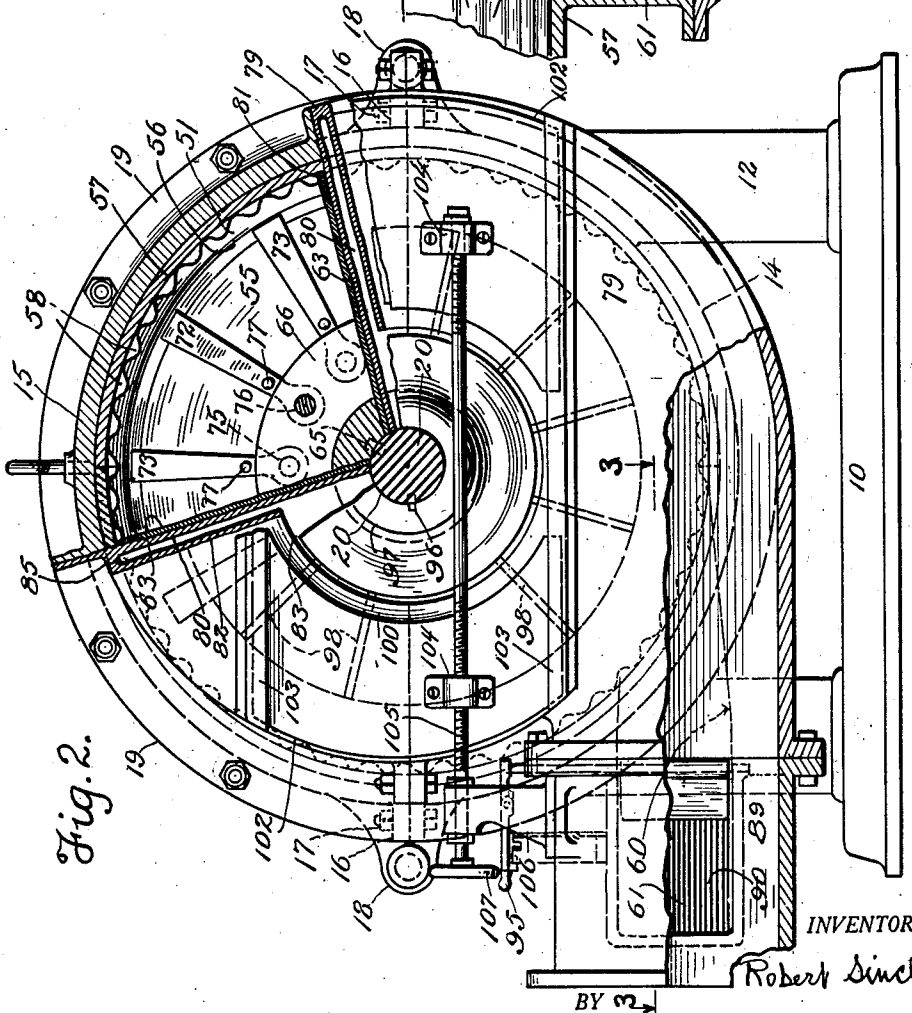


Fig. 2.



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UNITED STATES PATENT OFFICE

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PULVERIZER

Application filed June 19, 1928. Serial No. 286,500.

This invention is a novel pulverizer or machine for finely powdering coal or other fuels or materials. The particular embodiment is especially designed for the pulverization of crushed coal intended to be fed directly to a furnace or to a storage bin.

The general objects of the invention are to afford, in a pulverizing machine, an increased efficiency of action, greater fineness and uniformity of pulverization, and larger output for a given size of machine. Further objects are to afford greater ease and convenience of control and simplicity of structure, assemblage and replacement of parts. Further objects are to reduce the cost of construction of such a machine and the operating or maintenance cost thereof. Other and further objects and advantages will be explained in the hereinafter following description of an illustrative embodiment of the invention or will be apparent to those skilled in the subject of pulverizing machinery.

To the attainment of such objects and advantages the present invention consists in the novel pulverizer and the novel features of operation, construction, combination and arrangement herein illustrated or described. The features of novelty pertain to the various parts of a pulverizer including the casing, the impact devices or beaters, the infeed of fuel and air, the mode of maintaining progress of the materials through the machine and the manner of combining the outgoing streams of fuel laden air and supplemental air.

In the accompanying drawings Fig. 1 is in part a side elevation and in part a vertical central section of a pulverizer embodying the present invention.

Fig. 2 is a right end elevation of the same, partly broken away substantially on the section line 2—2 of Fig. 1.

Fig. 3 is a horizontal section looking from above, taken on the line 3—3 of Fig. 2.

The general parts of the machine comprise a base 10 above which extend upwardly the main pedestals 11 carrying the casing, and the fan pedestals 12 and the pedestals 13 for the shaft bearings. The main casing is preferably formed in lower and upper halves 14 and 15, together constituting a cylinder or drum which is preferably stationary. The two halves are provided with meeting flanges 16 by which they are secured together through bolts 17. Additionally the two halves of the casing may be secured together by hinge pins 18 at each side, so that either may be removed and the casing opened at the opposite side. Each casing half or casting is also shown provided at each end with an outstanding flange 19 for connection to the parts which close the ends of the pulverizing or reducing chamber within.

The operating shaft 20 may run at approximately usual speeds or sometimes faster than usual and is shown mounted in end bearings 21 located on pedestals 13, while the right end of the shaft carries a belt pulley 22 indicative of any desirable method of driving the shaft.

In Fig. 1 the left end is the supply or infeed end. Preferably crushed coal is employed, in fairy fine condition, as indicated at 25 in the V-shaped hopper 26. This feed hopper may be of square form seen from above and constantly supplied with crushed material from the supply pipe 27 leading from a bin or elsewhere. The hopper will be maintained full substantially as illustrated and the crushed coal will pass out with substantially uniform speed at the lower end. Adjustable exit plates 28 are indicated, which may be swung toward or from each other by adjusting screws 29 so as to vary the size of the exit of the hopper and thereby the speed of infeed of coal to the pulverizer. To prevent clogging or choking near the lower end of the hopper the walls thereof are shown formed with air delivering slots 31 at the two sides, each connecting with a channel 32, and these in turn being supplied by a pipe 33 with air under pressure so as to maintain a constant downward air blast, agitating the crushed material and driving it toward the exit. It is sometimes important to employ hot air for this purpose and the pipe 33 may be considered as a hot air supply pipe, the heated condition tending to dry out any moisture in the crushed material and thus minimize adherence and clogging. The pipe 33, and the pipe 45 later described may be considered

as leading from the air fan later described, or any source of air under pressure, with or without preheating in any known manner.

The lower portion of the hopper 26 has a downwardly extending and flanged extension 35 which in turn is shown secured to the flanges at the upper end of a hollow pedestal 36 containing a downward channel 37 by which the infed material is conducted to the following channels and passages. The fall of the fuel may be broken by means of baffles and an inclined baffle 38 is shown at the right wall of the channel 37. This in turn delivers upon a baffle 39, so that the fuel is compelled to pass through the passage 40 between the two baffles. The right side of the pedestal 36 is shown as having an extension 41 containing an upwardly slanted passage 42 in line with the passage 40. In order that the crushed material passing through passage 40 may be compelled to travel up the pipe 42 and thence to the pulverizer, the baffle 39 is shown provided with a slot 43 delivering a sheet of air forcibly beneath the passage 40 and into and along the passage 42. The crushed coal or similar material is thus forcibly blown upwardly to the right so as to pass through passage 42. The air slot 43 leads from a channel 44 which in turn is fed by a pipe 45 which may deliver hot air under pressure for the purposes described. There is also shown a passage 47 between the baffle 39 and the extension 41, this being so located that any excessively heavy particles may pass by gravity through the passage 47 into the receiving space 48 at the bottom of the pedestal. By this means small bits and scraps of iron or other metal are readily separated out at this point from the lighter crushed material or coal, and when the scrap material has collected sufficiently in the receptacle 48 may be removed through the door 49.

The main casing 14 is shown as having its first or left end closed by a plate 51, the periphery of which is bolted to the flange 19 of the casing. The end plate 51 is centrally apertured to receive the shaft 20. It is also formed with a hole 52 in line with the passage 42 and leading into the pulverizing chamber. The plate is also provided with a hole or aperture 53 for admitting supplemental air near the upper part of the casing, under control of a damper 54. A removable wear plate 55 is shown suitably secured to the inner side of the end plate.

The end plate 51 is shown formed with an inwardly extending circular flange 56 giving support to and confining in place the generally cylindrical lining 57 of the casing. This lining preferably consists of four quadrantal sections separately removable from the casing. Thus the cylindrical lining and the end wear plates may be replaced as often as required by the inevitable wear occurring in the machine, and the life of the machine thus indefinitely prolonged at minimum expense and difficulty.

Instead of a simple smooth lining I prefer a lining which is fluted or formed with ribs and grooves as shown at 58. While the flutings are indicated as extending longitudinally and parallel with the axis of the casing I contemplate shaping these with a longitudinal helical form. This tends to improve the pulverizing action and gives a convenient method of determining the effect of the lining as respects the accelerating or retarding of the progress of the fuel laden air through the pulverizer. Thus if the flutings or grooves are given a helical incline trending in the same direction as the rotation of the shaft and beaters this will accelerate the axial flow; while a reverse incline or trend will retard the flow. The preferred shape and size of the flutings is well indicated in Fig. 2, but may be indefinitely varied according to the conditions.

The chamber is shown as containing four successive sets of beaters and therefore four reducing or pulverizing spaces or chambers, and preferably the flutings 58 are continued from the first end of the casing to and beyond the semi-final beater, so that the final beater rotates in the portion 59 of the casing, having a slightly enlarged diameter and a smooth or unfluted surface. A fan action will take place in the final reduction chamber, which is shown as having a tangential outlet 60 at its lower portion, bounded by suitably formed walls 61. The fan action of the final beaters however is only supplemental to the fan proper, yet to be described. At the right end of the reducing chamber, protecting the adjacent wall of the fan chamber, is a wear plate 63 analogous to the wear plate 55 at the other end.

Within the reducing chamber, and attached to the shaft 20 by a key or keys 65, are the hub or hubs 66 for the successive reducing devices or rotary beaters. Removable wear plates 67 and 68 are shown protecting the first and last of the beater hubs, these being readily removable and replaceable as with the wear plates 55 and 63, and the chamber lining 57; so that substantially all parts which are exposed to excessive abrasion are readily and cheaply renewable. Four separate hubs 66 are shown carrying respectively the series of beaters 71, 72, 73 and 74, the last mentioned coming within the enlarged bore 59 at the right end of the reducing chamber and operating to produce rapid rotation for delivery through the tangential outlet 60.

It will be noticed that the successive beating or reducing devices are spaced substantially from each other in a longitudinal direction. This gives an opportunity for redistribution of particles and better turbulence and reduction. Also the successive

beating devices are in staggered relation. Thus the individual hammers or beaters 72 of the second device are shown spaced or stepped halfway between the beaters or hammers 71. The third set of beaters 73 are in line with the beaters 71 and the fourth set 74 are in line with the beaters 72. This staggered relation also improves turbulence and reducing action. Each set of beaters is pivoted to the hub thereof in a manner to permit limited swing. Stud or studs 75 may be employed for securing the beaters 71 and 73 removably in place and studs 76 similarly for the beaters 72 and 74, thus permitting ready removal and replacement of worn beaters. Each beater is provided with a stop pin 77 permitting a slight swinging motion but preventing execssive motion.

The fan is in a separate casing 79, the inner wall 80 of which may be the wall closing the right end of the main or reducing chamber. A leftward projecting flange 81 on the wall 80 gives support to and confines the cylindrical lining sections 57. The right hand or outer wall 82 of the fan casing is formed with a large axial air opening 83. The fan chamber 85 is substantially circular, but has a tangential outlet passage 86 substantially parallel to the tangential outlet 60 of the reducing chamber. The outlet 86 is formed by walls 87. The two tangential outlets, lying adjacent to each other are arranged so that the delivery passages join each other in a combining or mixing chamber 89. It will be noted that at the confluence of the streams of fuel laden air, and supplemental air, the two streams travel substantially parallel so that the high speed forcible delivery from the fan tends to create an induced draft assisting the advance of the stream traveling through the reducing chamber and out of the tangential delivery 60. The combining chamber 89 is shown as having one or more slanted walls 90 giving a converging travel, and other lateral walls 91, all of which at their extreme outer end are formed with a connecting flange 92 to receive the piping delivering to the furnace or other desired point.

One feature of this invention is the control of the relative proportions and speeds of the two streams issuing respectively from the reducing chamber and the fan chamber. The fan chamber is wholly exterior to and independent of the reducing chamber and the two streams only meet at the exterior point or combining chamber 89 as stated. At the point of confluence is shown a device for relatively regulating the respective delivery rates and speeds. This might take various forms, but is shown as a simple vane 93 swinging with an axle 94 extending to an exterior point where it is provided with an adjusting handle 95. By this arrangement the vane may be swung in either direction as indicated by the dotted lines. When the vane is swung further into the stream of fuel laden air this tends to retard and decrease the rate of delivery from the reducing chamber and at the same time slows down the speed of travel of supplemental air, thus in both ways tending to decrease the proportion of fuel and increase the proportion of air. When swung in the opposite direction the opposite adjustment is affected. This permits a delicate control of the proportions and composition of the combined outgoing stream.

Within the fan chamber, attached to the shaft 20 by a key 96, is the fan hub 97 on which are supported a system of fan blades 98 by means of a disk 99 extending outwardly from the hub, with a ring 100 at the other side to strengthen and brace the blades. This form of fan gives a very effective delivery of supplemental air.

In addition to regulating the proportion of air by the damper 54 at the infeed end of the reducing chamber and by the vane 93 at the confluence of the two streams, it is desirable to have regulation of the supplemental air passing into and through the fan chamber. This is herein effected by means of a diaphragm or shutter so constructed and adjustable as to maintain substantially the concentric shape of the entrance opening 83. Thus a plurality of diaphragm plates 102 are shown, two being sufficient for purposes of illustration. Each of these has a curved inside contour, and is guided in fixed guides 103. Each plate is formed with a threaded projection or nut 104 and the two projections or nuts are shown engaged by a right and left threaded screw or rod 105, the forward end of which is mounted in a standard or bearing 106 and provided with a hand wheel 107 by which the rod may be rotated so as to symmetrically adjust the diaphragm plates, thus giving a very fine adjustment of the inlet aperture and the amount of supplemental air delivered by the fan without altering its concentric location.

The operation has been sufficiently indicated in the above description of the apparatus. At the inlet end the downward passage below the hopper may be described as curving laterally and then branched into a lateral or upwardly inclined passage to the reducing chamber and a downward passage for the separation of relatively heavy objects, in cooperation with the air jet for driving the lighter material into the lateral passage and chamber. The first and second baffles slow down the speed of descent of the crushed material and deliver it uniformly to the curved passage mentioned. The sets of beaters, spaced longitudinally and staggered circumferentially permit an effective turbulent action adjacent to the fluted lining and give very fine pulverization. The material being ground is not caused to travel as a relatively dense body along in contact with the cham-

ber lining. On the contrary there is a tendency, through the flutings and by gravity, for the particles to be thrown inwardly, permitted by the spaced and staggered arrangement of the beaters, so that the number of impacts and efficiency thereof are greatly increased. When the material has progressed to the last reducing space or chamber, it is acted on by the final set of beaters, which have a further reducing action, but which tend also to speed up greatly the whirling travel of the particles and thence deliver them through the tangential exit. Thus a very effective reducing is afforded, with delivery of a regulated quantity of air ladened with the pulverized material, this issuing from the reducing chamber and meeting with the independently produced supplemental air from the fan chamber, as fully described. Regulation of the action at every point is afforded and the apparatus as a whole is well adapted for the purposes of unit pulverization and delivery of fuel to a furnace, or for other purposes of reduction of materials.

It will thus be seen that there has been described a pulverizer embodying the principles and attaining the objects and advantages of the present invention. Since many matters of operation, construction, combination and arrangement may be variously modified without departing from the principles of the invention it is not intended to limit the same to such matters except so far as set forth in the appended claims.

What is claimed is:

1. In a fuel pulverizer, a casing, reducing means rotatable therein and means for feeding crushed material thereto comprising walls forming a downward passage curving laterally and branched into a lateral passage to the casing and a downward passage to a dead space for separation of relatively heavy objects, and a separate passage for admitting forced draft to carry the crushed fuel from the downward into the lateral passage.

2. In a pulverizer, a casing, reducing means rotatable therein and means for feeding crushed material thereto comprising walls forming a downward passage curving laterally and branched into a lateral passage to the casing and a downward passage and chamber for separation of relatively heavy objects, and means for producing an air jet for driving the material into the lateral passage and casing without opposing the descent of heavy objects into the chamber.

3. In a pulverizer, a casing, reducing means rotatable therein and means for feeding crushed material thereto comprising a downward passage, a baffle at one side thereof, a second baffle at the opposite side, a forced draft nozzle for producing a jet to drive the material from the second baffle at an upward incline, a passage conducting such material to the casing, and a dead space for receiving heavy materials not driven by such jet.

4. In a pulverizer a cylindrical drum enclosing a reducing chamber and having heads at its ends, series of impact beaters rotating therein, said drum being fluted opposite part of such beaters, but opposite the final beaters being smooth and having a tangential exit, and a suction fan beyond the exit head having a tangential exit joining with the tangential exit of the drum.

5. In a pulverizer a reducing chamber with tangential delivery, a separate fan chamber with delivery parallel to said delivery, a common passage into which both deliveries discharge, and an adjustable vane or swinging deflector arranged to increase one delivery while reducing the other and vice versa.

6. In a pulverizer a main casing, a rotary shaft therein, a plurality of sets of beaters thereon, the final set operating to deliver peripherally from the casing, the casing having a peripheral delivery passage opposite the final set, a fan casing enclosing a separate fan chamber, a fan therein, the fan casing having a peripheral delivery passage, and said delivery passages arranged to meet, whereby the flow from the fan casing induces flow from the main casing, and the pulverized material is excluded from contact with the fan.

7. In a machine for pulverizing fuel a main casing having heads at its inlet and outlet ends, a rotary shaft therein, a plurality of sets of beaters thereon, the final set operating also to promote delivery, the main casing having a tangential delivery passage opposite such final set, a fan casing beyond the outlet head of the casing, a fan therein on said shaft, the fan casing having a tangential delivery passage adjacent the delivery passage of the main casing, and said passages arranged to conjoin whereby the flow from the fan casing induces flow from the main casing.

8. In a pulverizer a main casing, a rotary shaft therein, a plurality of sets of beaters thereon, the main casing having a peripheral delivery passage opposite the final set of beaters, a fan casing, a rotary fan therein, and fan casing having a delivery passage adjacent the delivery passage of the main casing, and said delivery passages arranged to join whereby the flow from the fan casing induces flow from the main casing, and means for regulating the relative flow from the two delivery passages.

9. In a pulverizer a main casing, a rotary shaft therein, a plurality of sets of beaters thereon, the main casing having a peripheral delivery passage opposite the final set of beaters, a fan casing, a rotary fan therein, the fan casing having a delivery passage adjacent the delivery passage of the main casing, and said delivery passages arranged to join whereby the flow from the fan casing induces

flow from the main casing, and means for regulating the relative flow from the two delivery passages, comprising a shiftable member at the junction of flow and means for adjusting its position.

10. In a pulverizer, casing walls enclosing adjacent reducing and fan chambers with a separting wall between them, a common shaft extending through said chambers, reducing means on the shaft in the reducing chamber, a fan on the shaft in the fan chamber, said chambers having adjacent peripheral exits shaped for confluence of the two streams.

11. In a pulverizer, casing walls enclosing separate reducing and fan chambers with no communication between them, a common shaft, reducing means on the shaft in the reducing chamber, a fan on the shaft in the fan chamber, said chambers having adjacent tangential exits shaped for confluence of the two streams at an exterior point, whereby the pulverized material is excluded from the fan.

12. In a pulverizer, casing walls enclosing separate reducing and fan chambers, and a wall separating them to exclude pulverized material from the fan, a common shaft, reducing means on the shaft in the reducing chamber, a fan on the shaft in the fan chamber, said chambers having adjacent exits shaped for confluence of the two streams and an adjustable member at such confluence for regulating the relative flow.

13. In a pulverizer, a casing containing reducing and fan chambers, rotatable beaters in the first chamber, a fan in the second chamber, the fan chamber having a central opening for admission of air, and an adjustable device for regulating such air, comprising a plurality of diaphragm plates movable on the exterior wall of the fan chamber toward and from the axis for varying the inlet opening, opposite slideways for guiding the plates, and a common device for adjusting such plates symmetrically.

In testimony whereof, I have affixed my signature hereto.

ROBERT SINCLAIR.