Feb. 23, 1937. E. G. BAILEY ET AL 2,071,380

PULVERIZER

Filed Oct. 31, 1930 4 Sheets-Sheet 1

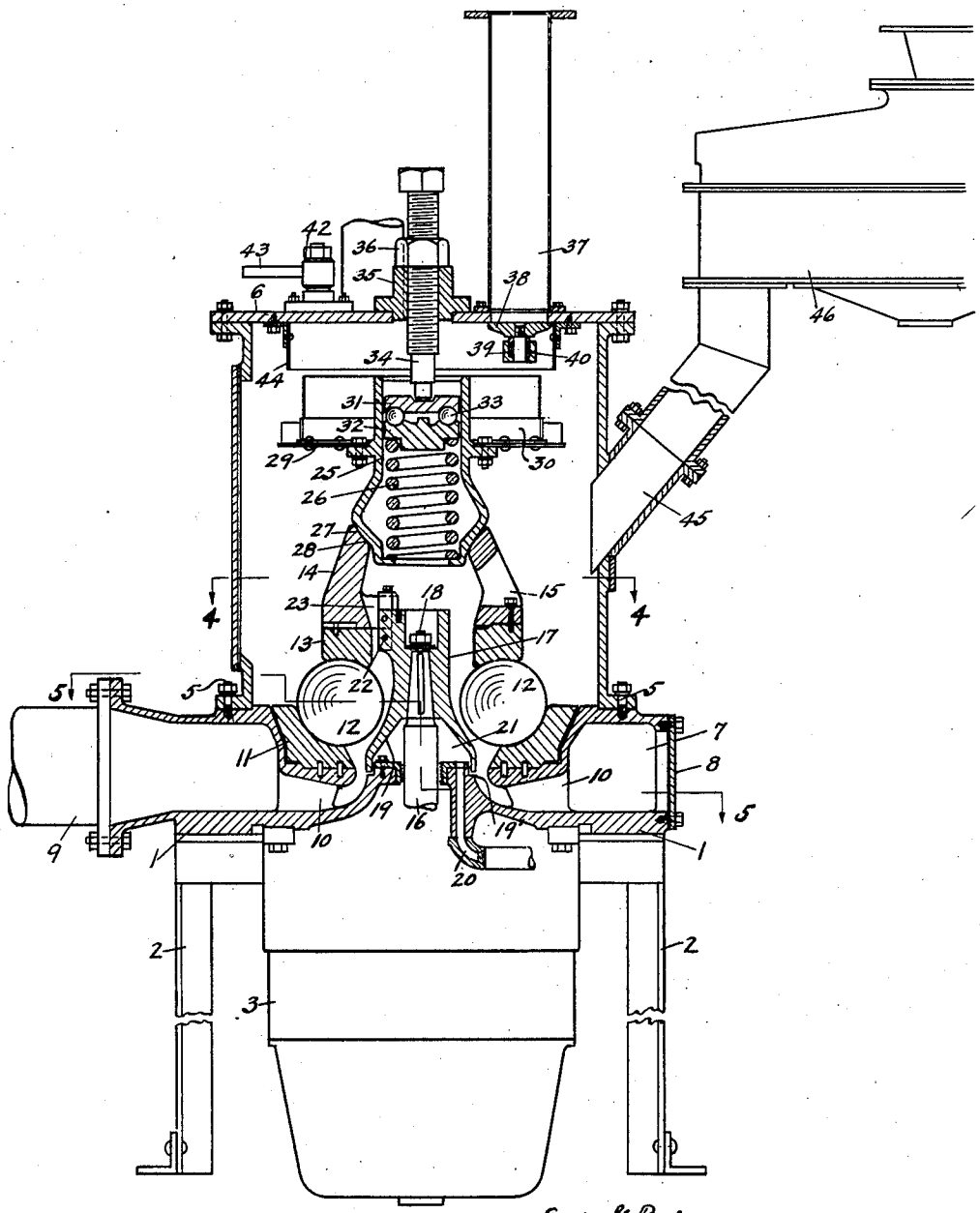


FIG. 1

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PULVERIZER

Filed Oct. 31, 1930 4 Sheets-Sheet 2

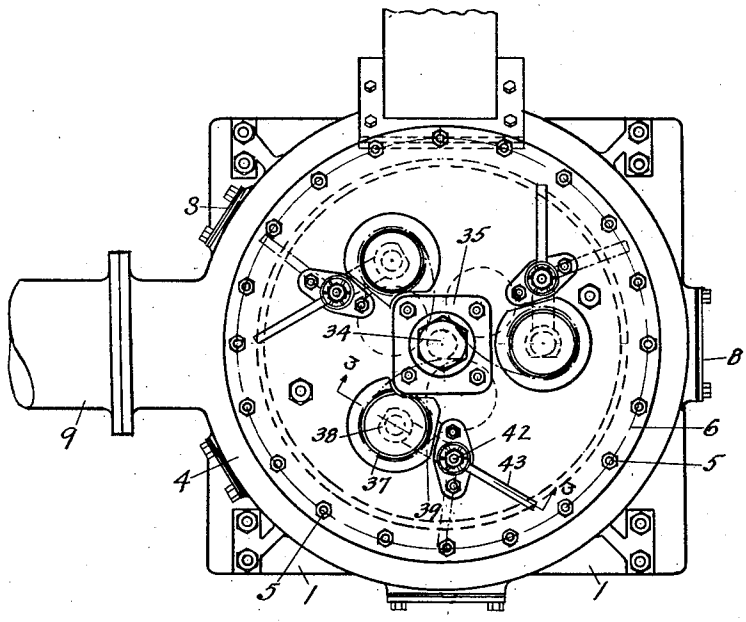


FIG. 2

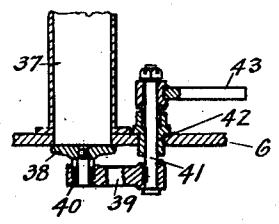


FIG. 3

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PULVERIZER

Filed Oct. 31, 1930 4 Sheets-Sheet 3

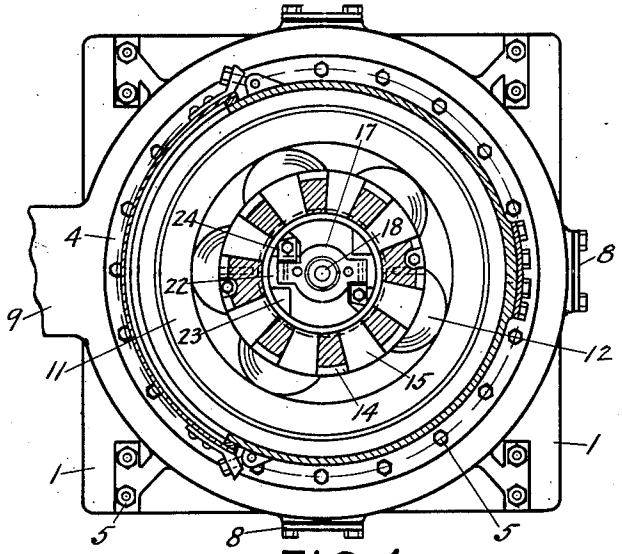


FIG. 4

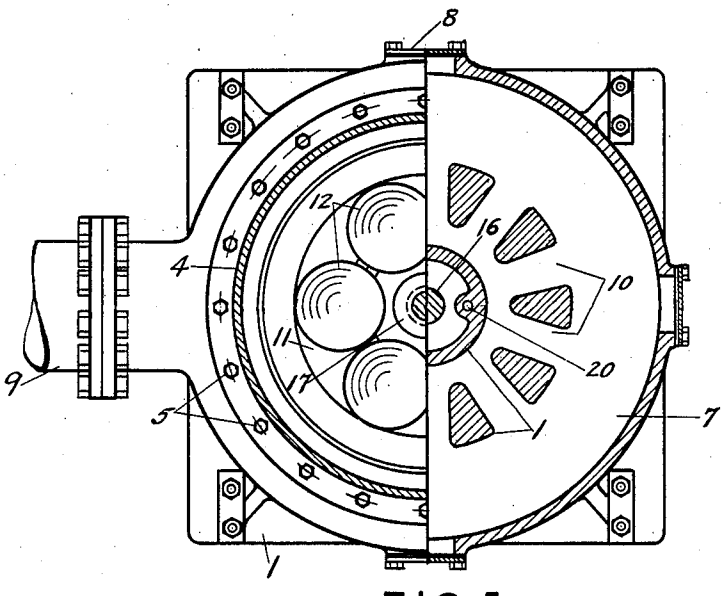


FIG. 5

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PULVERIZER

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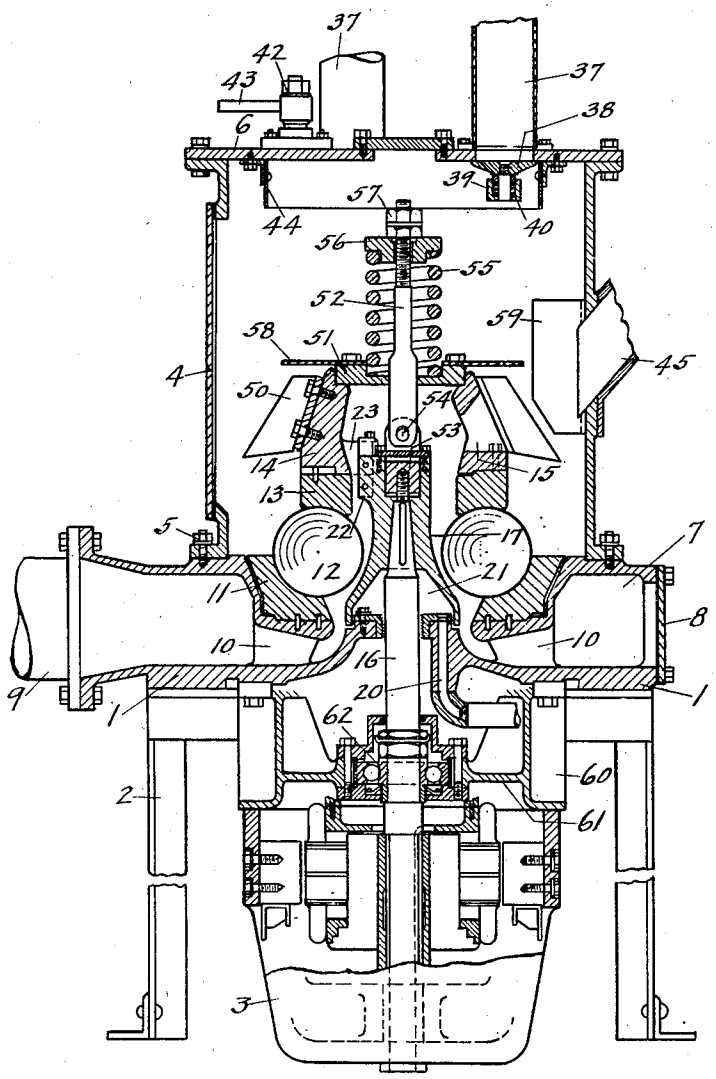


FIG. 6

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UNITED STATES PATENT OFFICE

2,071,380

PULVERIZER

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Application October 31, 1930, Serial No. 492,494

25 Claims. (Cl. 83—45)

This invention relates to the construction and operation of grinding mills or pulverizers of the type embodying a circular row of rolling grinding elements positioned between a pair of relatively movable grinding rings, to one side of which grinding parts the material to be pulverized is supplied and the pulverized material swept up at the other side by a gaseous carrier medium. While pulverizers constructed in accordance with the invention can be used for grinding various materials, the preferred embodiments described are particularly designed and especially adapted for use in pulverizing coal for direct fired furnaces.

The invention will be understood from the description in connection with the accompanying drawings in which Fig. 1 is a vertical section through an illustrative embodiment of the invention; Fig. 2 is a plan view of the device; Fig. 3 is a vertical section showing some of the details; Fig. 4 is a section along the line 4—4 of Fig. 1; Fig. 5 is a section along the line 5—5 of Fig. 1 and Fig. 6 is a vertical section similar to Fig. 1 showing a modification of the invention.

In the drawings reference character 1 indicates the base of the mill that may be supported upon supports 2.

A motor casing 3 is attached to the lower side of the base 1 and the casing 4 of the mill extends upwardly from the upper side of the base 1 and may be attached thereto by means of the bolts 5. The upper end of the casing 4 is provided with a cover plate 6.

An annular opening or circular air box 7 is provided in the base 1 to form an air chamber that is provided with a plurality of access doors 8. An inlet 9 leads to the air box 7 from a source of compressed air or gas which may be preheated where a certain amount of drying of the material that is being ground is desired. Air ports or openings 10 extend from the air box 7 radially and thence upwardly terminating in nozzle shaped outlets. The ports 10 extend to the inside of the grinding ring 11, which is attached to the base 1. A row of grinding balls 12 is interposed between the lower stationary grinding ring 11 and an upper rotary grinding ring 13 that is driven as described below.

Plows may be attached to the outside circumference of the grinding ring 13, if desired, for agitating the material that is being ground and also for throwing up fine material so that it may be carried upwardly by the air or gas.

A somewhat conically shaped casting 14 is attached to the grinding ring 13 and extends upwardly therefrom. The casting 14 is provided with openings 15 through the walls thereof.

The rotor of the motor in the motor casing 3 is directly connected to the shaft 16. The diameter of the ring of grinding balls 12 is sufficiently small so that no intermediate or reduction gearing is required between the rotor of the motor and the shaft 16. A driving member 17 is provided with a conically shaped opening and is placed upon the conically shaped upper end of the shaft 16 and kept in place by means of the nut 18. The driving member 17 is provided with a lower annular flange 19 that extends around a boss 19' extending upwardly from the central portion of the base 1 inside of the row of ports 10. A labyrinth passage may be interposed between the rotating flange 19 and the stationary boss 19' to prevent leakage. A port 20 from a source of compressed air may lead into the space 21 within the flange 19, preventing dust from reaching the bearings.

One or more extensions 22 may be provided on the upper end of the casting 17, each one of which projects between a pair of lugs 23 along the inside of the casing 14 to drive it and the ring 13 and permit relative vertical motion between the extensions 22 and lugs 23. Bearing inserts 24 may be provided on the lugs 23 to take the wear.

A housing 25 is provided for the compression spring 26, which can be adjusted to vary the pressure on the ring 13. An extension 27 is provided on the lower portion of the housing 25 in the shape of a zone of a sphere and a corresponding seat 28 is provided upon the upper end of the casing 14, thus making a ball and socket joint through which the housing 25 is frictionally driven from the ring 13 while permitting the ring 13 to tilt slightly. A disc-shaped plate 29 is attached to the housing 25 and is of a smaller diameter than the diameter of the casing 4, thus leaving an annular space near the inside wall of the casing 4 for the upward passage of air and ground material. Radial plates 30 to provide a fan may also be attached to the plate 29 to aid in separating out coarse particles of material by giving the air a whirling motion in the upper part of the casing 4.

Disc-shaped members 31 and 32 of a thrust ball bearing with the balls 33 between them are provided within the housing 25 and are longitudinally movable therein. A threaded rod 34 has its lower end pressing against the disc 31 and extends through a threaded member 35 attached to the cover 6 for varying the pressure on the

spring 26. A lock nut 36 is provided for the rod 34. When the rod 34 is adjusted to the desired position and the nut 36 is tightened, the discs 31 and 32 and the balls 33 prevent the upper end of the spring 26 from moving in the direction of pressure. A fixed or positive stop is thereby provided against longitudinal or axial movement of the upper portion of the spring 26, while permitting relative rotation between this spring and the rod 34.

One or more outlets 37 are provided through the cover 6. A disc-shaped valve 38 slidable along the lower side of the cover 6 is provided for each outlet 37. Each valve 38 (Fig. 3) is carried by an arm 39 and springs 40 are provided to keep the valves pressed against the lower side of the cover 6. The arms 39 are attached to rotatable rods 41 mounted in bearings 42 extending through the cover 6 and provided with handles 43 by which the valves 38 can be moved into the open and closed positions. A cylindrical extension 44 is attached to the lower side of the cover 6 and surrounds the openings 37.

A feed spout 45 passes through the side of the casing 4 and is fed from a feeder 46 located at a sufficient height above the feed spout to provide a head of coal, or a seal is otherwise provided to prevent the leakage of air or gas out through the feed spout.

The operation is as follows:

The material to be ground is fed through the spout 45 and is ground by the balls 12 between the rings 11 and 13. The pressure between the balls and rings is varied by adjusting the rod 34, which can be done while the mill is running, if desired. The spring 26 permits the ring 13 to rise when there is an increase of the rate of feed of material and the ball and socket joint between the casing 14 and housing 25 permits tilting of the ring 13 to ride over hard obstructions. The pressure of air in the space 21 prevents the ground dust from reaching the bearings.

The air under pressure in the air box 7 flows inwardly through the passages 10 below the lower grinding ring and thence upwardly at a relatively high velocity in contact with and past the lower inner sectors of the balls 12. The pulverized material leaving the inner side of the lower grinding ring is swept up by the air stream and carried upwardly at the inner side of the ball row and upper grinding ring 13. A portion of the air stream may pass outwardly between adjacent balls depending upon the level of material in the grinding zone. The portion that goes within the row of balls passes through the openings 15. The air passes upwardly through the annular space around the rim of the plate 29 and the fan blades 30 cause the larger particles to be thrown out of the whirling air, these particles falling and becoming ground again. The air carrying the particles then passes under the edge of the separator 44, separating large particles that may remain. By adjusting the valves 38 the air and fine particles may be permitted to pass out through any one or more of the outlets 37. In the use of this invention the ground particles are preferably removed from the mill by air under pressure, as this air can be forced in from a fan without passing air carrying abrasive particles through the fan. The weight of the rotating parts is sustained on the stationary grinding ring 11 so that the bearing in the motor casing merely supports the rotor of the motor, shaft 16 and casting 17.

In the modification shown in Fig. 6 the same parts already described are referred to by the same reference characters. In this modification the thrust due to compression of the spring is not carried by the cover 6, but is transmitted through the driving shaft to a thrust bearing. In this modification fan blades 50 are provided on the casting 14, and a circular bearing plate 51 for the compression spring is seated in an annular recess at the upper end of the casting 14. A rod 52 is connected to a clevis 53 attached to the upper end of the casting 17 by means of a pivot pin 54, extending through a hole in the rod 52 larger than this pin, so that universal movement between the shaft 16 and rod 52 is provided to permit slight tilting of the grinding ring 13. A compression spring 55 is provided between the bearing plate 51 and the washer 56, which is adjustable on the rod 52 by means of the nuts 57 to vary the compression of the spring 55.

A disc-shaped plate 58, similar to the plate 29 in Fig. 1, is attached to the plate 51 and one or more baffles 59 are provided at the end of the feed spout 45 to prevent incoming material from being picked up by the whirling current of air or gas that is set up by the fan blades 50.

A housing 60 for a thrust bearing is attached to the lower side of the base 1 between it and the motor casing 3. The housing 60 is provided with a spider 61 for the ball thrust bearing 62. The thrust of the spring 55 is transmitted through the rod 52 and shaft 16 to the thrust bearing 62.

The operation of this modification is similar to that already described. The pressure on the grinding balls is varied by adjusting the nuts 57 and the cover plate 6 is relieved of any pressure due to the spring.

While in accordance with the provisions of the statutes we have illustrated and described herein the best forms of our invention known to us, those skilled in the art will understand that changes may be made in the form of the apparatus and character of the carrier medium disclosed without departing from the spirit of the invention covered by our claims, and that certain features of our invention may sometimes be used without a corresponding use of other features. In our claims, the term "air" is used generically to cover any gaseous carrier medium suitable for removing pulverized material in the manner described.

We claim:

1. In a grinding mill, a grinding ring, a circular row of grinding elements in contact with said ring, a pressure ring in contact with said grinding elements, spring means for pressing said pressure ring, and a ball and socket pressure transmitting joint between said spring and pressure ring, said pressure ring having air ports therethrough.

2. In an air-swept pulverizing mill, a mill casing having a material outlet opening formed in a wall thereof, an external conduit connected to said opening, means for controlling the discharge of material through said opening comprising a bodily swingable valve plate within said casing and movable across said opening, means externally of said casing for moving said valve plate, and a material separating baffle surrounding said valve plate and opening.

3. In an air-swept pulverizing mill, a mill casing having a material outlet opening formed in the top wall thereof, an external conduit connected to said opening, and means for controlling the discharge of material through said opening

comprising a bodily swingable valve disc within said casing and movable across said opening in a plane parallel to said casing wall, a pivot for said disc, and means externally of said casing for moving said valve disc, and a material separating baffle depending from said top wall and surrounding said valve disc and opening.

4. A pulverizing mill having a mill casing, a lower grinding ring in said casing, a circular row of rolling grinding elements supported on said lower ring, an upper grinding ring supported on said row of elements, a vertical drive shaft fixed against vertical movement arranged to extend upwardly within said row of elements and having a drive connection with one of said rings, drive means connected to the lower end of said drive shaft, and means for applying a grinding pressure on said grinding elements including a single compression spring coaxial with said drive shaft and arranged between a stop member carried by the upper end of said drive shaft and the upper part of said upper ring.

5. A pulverizing mill having a mill casing, a stationary lower grinding ring in said casing, a circular row of rolling grinding elements supported on said lower ring, a rotary upper grinding ring supported on said row of elements, a drive shaft fixed against vertical movement extending upwardly within and beyond said row of elements and having a drive connection with said upper ring, means for feeding material to be ground to the outer side of said row of grinding elements, and means for applying a grinding pressure on said grinding elements including a single compression spring coaxial with said drive shaft and having its lower end seated in said upper ring and its upper end engaging a stop member carried by the upper end of said drive shaft.

6. A pulverizing mill having a mill casing, a lower grinding ring in said casing, a circular row of rolling grinding elements supported on said lower ring, an upper grinding ring supported on said row of elements, a vertical drive shaft arranged within said row of elements and having a drive connection with one of said rings, means for feeding material to be ground to one side of said row of grinding elements, and means for applying a grinding pressure on said grinding elements including a compression spring seated on said upper ring and a spring rod tiltably connected to said drive shaft and engaging the upper end of said spring.

7. A pulverizing mill having a mill casing, a lower grinding ring in said casing, a circular row of rolling grinding elements supported on said lower ring, a rotary upper grinding ring supported on said row of elements, a drive shaft extending upwardly within said row of elements and having a drive connection with said upper ring, means for feeding material to be ground to one side of said row of grinding elements, and means for applying a grinding pressure on said grinding elements including a single compression spring arranged coaxially of said drive shaft and seated on said upper ring, a spring rod having a universal joint connection with said drive shaft, and means on the upper end of said spring rod for adjustably compressing said spring.

8. A single stage air-swept pulverizing mill having a mill casing with a material outlet opening formed in the upper part thereof, a lower grinding ring mounted within said casing, a circular row of grinding balls contacting with said lower ring, an upper grinding ring contacting with said balls, a drive shaft arranged axially of said ball row and having a drive connection with one of said rings, resilient means arranged above said ball row and engaging the upper side of said upper ring for applying a grinding pressure between said balls and rings, means for feeding material to be ground to the outer side of said ball row, and means for directing an air blast below said lower grinding ring and thence upwardly in contact with and past the lower inner sectors of said balls to sweep up pulverized material.

9. A single stage air-swept pulverizing mill having a base formed by an annular air-box, a mill casing supported on said air-box and having a material outlet opening formed in the upper part thereof, a stationary lower grinding ring mounted on said air-box within said casing, a circular row of grinding balls contacting with said lower ring along substantially the entire lower outer sectors of said balls, a rotary upper grinding ring contacting with said balls, a drive shaft extending upwardly axially of said ball row and having a drive connection with said upper ring, resilient means arranged above said ball row and engaging the upper side of said upper ring for applying a grinding pressure between said balls and rings, means for feeding material to be ground to the outer side of said ball row, and means for directing an air blast from said air-box upwardly in contact with and past substantially the entire lower inner sectors of said balls to remove pulverized material.

10. An air-swept pulverizing mill having a mill casing with a material outlet opening formed in the upper part thereof, a lower grinding ring mounted within said casing, a circular row of grinding balls contacting with said lower ring along substantially the entire lower outer sectors of said balls, an upper grinding ring contacting with said balls, a drive shaft extending upwardly axially of said ball row and having a drive connection with one of said rings, resilient means for applying a grinding pressure between said balls and rings, means for feeding material to be ground to the outer side of said ball row, means for directing an air blast upwardly in contact with and past substantially the entire lower inner sectors of said balls to remove pulverized material, and a series of ports formed in the upper part of said upper ring for the outward flow of material-laden air.

11. An air-swept pulverizing mill having an annular air-box, a mill casing having a material outlet opening formed therein, a stationary lower grinding ring mounted within said casing, a circular row of rolling grinding elements supported on said lower ring, a rotary upper grinding ring supported on said elements, a drive shaft extending upwardly axially of said row of elements and having a drive connection with said upper ring, means for applying a grinding pressure between said elements and rings, means for feeding material to be ground to the outer side of said row of elements, means for directing an air blast from said air box upwardly past the inner side of said row of elements to remove pulverized material, and a series of ports formed in the upper part of said upper ring for the outward flow of material-laden air towards said material outlet opening.

12. An air-swept pulverizing mill having a base formed by an annular air-box, a mill casing supported on said air-box and having a material outlet opening formed therein, a stationary lower

grinding ring mounted on said air-box within said casing, a circular row of rolling grinding elements supported on said lower ring, a rotary upper grinding ring supported on said elements, a drive shaft extending upwardly axially of said row of elements and having a drive connection with said upper ring, means for applying a grinding pressure between said elements and rings, means for feeding material to be ground to the outer side of said row of elements, means for directing an air blast from said air box upwardly past the inner side of said row of elements to sweep up pulverized material, and a series of ports formed in the upper part of said upper ring for the outward flow of material-laden air towards said material outlet opening.

13. An air-swept pulverizing mill having a mill casing with a material outlet opening formed therein, a lower grinding ring mounted within said casing, a circular row of rolling grinding elements supported on said lower ring, an upper grinding ring supported on said elements, a drive shaft arranged axially of said row of elements and having a drive connection with said upper ring, resilient means for applying a grinding pressure between said elements and rings, means for feeding material to be ground to the outer side of said row of elements, means for directing an air-blast upwardly past the inner side of said row of elements to remove pulverized material, a series of ports formed in said upper ring for the outward flow of material-laden air towards said material outlet opening, and baffle means for directing the flow of air from said ports towards the sides of said casing before passing to said material outlet opening.

14. An air-swept pulverizing mill having a mill casing with a material outlet opening formed therein, an air-box, a lower grinding ring mounted on said air-box and within said casing, a circular row of rolling grinding elements supported on said lower ring, a rotary upper grinding ring supported on said elements, a drive shaft arranged axially of said row of elements and having a drive connection with said upper ring, means for applying a grinding pressure between said elements and rings, means for feeding material to be ground to the outer side of said row of elements, means for directing an air blast upwardly past the inner side of said row of elements to remove pulverized material, a series of ports formed in said upper ring for the outward flow of material-laden air towards said material outlet opening, and baffle means mounted on and rotatable with said upper ring for directing the flow of air from said ports towards the sides of said casing before passing to said casing outlet.

15. An air-swept pulverizing mill having a base formed by an annular air-box, a mill casing supported on said air-box and having a material outlet opening formed in the top thereof, an externally operable valve arranged in said casing to close the lower end of said outlet, a stationary lower grinding ring mounted on said air-box within said casing, a circular row of grinding balls supported on said lower ring, a rotary upper grinding ring supported on said balls, a drive shaft extending upwardly axially of said ball row and having a drive connection with said upper ring, means for applying a grinding pressure between said balls and rings including a compression spring arranged coaxially of and seated on said upper ring and a spring rod tiltably connected to said drive shaft and engaging the upper end of said spring, means for feeding material to be ground to the outer side of said ball row, means for directing an air blast from said air-box upwardly past the inner side of said ball row to remove pulverized material, and a series of ports formed in the upper part of said upper ring for the outward flow of material-laden air towards said material outlet opening.

16. An air swept pulverizing mill having a mill casing with a material outlet opening formed in the upper part thereof, a horizontally arranged grinding ring in said casing, a horizontal circular row of rolling grinding elements contacting with said grinding ring and cooperating therewith to form an annular grinding area, a vertical drive shaft extending axially of said row of elements and providing relative movement between said elements and grinding ring, means for causing a stream of air to sweep up material pulverized in said grinding area and carry it upwardly to said casing outlet, and a material classifying fan immediately adjacent said casing outlet for causing separation of coarse material from said air stream and the return thereof throughout said grinding area and having a series of passages between the fan blades leading to said casing outlet.

17. An air swept pulverizing mill having a mill casing with a material outlet opening formed in the upper part thereof, a horizontally arranged grinding ring in said casing, a horizontal circular row of rolling grinding elements contacting with said grinding ring and cooperating therewith to form an annular grinding area, a vertical drive shaft extending axially of said row of elements and providing relative movement between said elements and grinding ring, means for causing a stream of air to sweep up material pulverized in said grinding area and carry it upwardly to said casing outlet, and rotary classifying means adjacent said casing outlet for causing separation of coarse material from said air stream and return thereof throughout said grinding area comprising a horizontally arranged plate positioned below said casing outlet, and fan blades vertically mounted on said plate and having a series of passages therebetween leading to said outlet.

18. An air swept pulverizing mill having a mill casing with a material outlet opening formed in the upper part thereof, a horizontally arranged grinding ring in said casing, a horizontal circular row of rolling grinding elements contacting with said grinding ring and cooperating therewith to form an annular grinding area, a vertical drive shaft extending axially of said row of elements and providing relative movement between said elements and grinding ring, means for causing a stream of air to sweep up material pulverized in said grinding area and carry it upwardly to said casing outlet, and rotary classifying means adjacent said casing outlet for causing separation of coarse material from said air stream and return thereof throughout said grinding area comprising a horizontally arranged circular imperforate plate operatively connected to said drive shaft and positioned below said casing outlet, and fan blades vertically mounted on said plate at an angle to the circumference thereof and having a series of passages therebetween leading to said outlet.

19. An air-swept pulverizing mill having a casing provided with an outlet opening in the upper part thereof, a stationary grinding ring horizontally arranged in said casing, a horizontally arranged circular row of rolling grinding ele-

ments contacting with said stationary grinding ring, a horizontally arranged rotary grinding ring contacting with and supported on said row of grinding elements, a vertical drive shaft in said casing extending axially of said row of grinding elements, means forming a floating drive connection between said shaft and rotary grinding ring, a compression spring exerting pressures in opposite directions on said drive shaft and rotary grinding ring and acting on said rotary grinding ring to exert a grinding pressure on said row of grinding elements, means for supplying material to be pulverized to one side of said row of grinding elements, said rotary grinding ring having a passage formed therein for the passage of pulverized material to the upper part of said casing, and means for directing a current of carrier air below said stationary grinding ring and past the material discharge side of said row of grinding elements and thence through said rotary grinding ring passage towards said casing outlet.

20. An air-swept pulverizing mill having a casing provided with an outlet opening in the upper part thereof, a stationary grinding ring horizontally arranged in said casing, a horizontally arranged circular row of rolling grinding elements contacting with said stationary grinding ring, a horizontally arranged rotary grinding ring contacting with and supported on said row of grinding elements, a vertical drive shaft in said casing extending axially of said row of grinding elements, means forming a floating drive connection between said shaft and rotary grinding ring, a compression spring acting on said rotary grinding ring to exert a grinding pressure on said row of grinding elements, means for supplying material to be pulverized to one side of said row of grinding elements, said rotary grinding ring having passages formed therein for the passage of pulverized material in the upper part of said casing, means for directing a current of carrier air past the material discharge side of said row of grinding elements and through said rotary grinding ring passages towards said casing outlet, and fan blades mounted on said rotary grinding ring adjacent the discharge end of said grinding ring passages.

21. In an air-swept pulverizing mill, a mill casing having a group of material outlet ports formed in the top wall and spaced from the side walls thereof and having a material flow thereto adjacent the side walls of said mill casing, means for independently controlling the discharge of material through each of said outlet ports including a plurality of bodily swingable valve plates within said casing, each plate being movable in a horizontal plane across a corresponding outlet port, and means externally of said casing for independently moving each of said valve plates, and a material separating baffle depending from the top wall of said casing and surrounding said group of outlet ports and valve plates.

22. In a grinding mill, a casing, a rotating grinding ring, balls rotatable by said ring, a shaft for driving said ring, a pressure spring between said casing and ring for exerting a grinding pressure on said ring and balls, and a ball and socket joint between said spring and grinding ring and independent of said drive means and through which the thrust from said spring is transmitted to said balls.

23. A single stage air-swept pulverizing mill comprising a stationary grinding ring, a circular row of rolling grinding elements contacting with said stationary ring, and a rotary grinding ring contacting with said row of grinding elements, drive means having a drive connection with said rotary grinding ring for moving said grinding elements relative to said stationary grinding ring, resilient means mounted for rotation with and exerting a continuous thrust on said rotary grinding ring towards said row of grinding elements, means for delivering material to be pulverized to one side of said row of grinding elements, said rotary grinding ring having a passage formed therein for the flow therethrough of material-laden air, and means for directing a stream of carrier air below said stationary grinding ring and thence past the discharge side of said row of grinding elements for conveying pulverized material leaving said row of grinding elements upwardly through said rotary grinding ring passage.

24. A single stage air-swept pulverizing mill comprising a lower grinding ring, a circular row of rolling grinding elements supported on said lower ring, and an upper grinding ring supported on said row of grinding elements, drive means having a drive connection with said upper grinding ring for rotating said upper grinding ring relative to said lower grinding ring, resilient means mounted for rotation with and exerting a continuous downward thrust on said upper grinding ring, means for delivering material to be pulverized to the outer side of said row of grinding elements, said upper grinding ring having a passage formed therein for the flow therethrough of material-laden air, and means for directing a stream of carrier air below said lower grinding ring and thence upwardly past the inner side of said row of grinding elements for conveying pulverized material leaving said row of grinding elements through said upper grinding ring passage.

25. A single stage air-swept pulverizing mill comprising a casing having an outlet in the upper part thereof for pulverized material, a lower grinding ring, a circular row of rolling grinding elements supported on said lower ring, and an upper grinding ring supported on said row of grinding elements, drive means including a drive shaft arranged axially of said row of grinding elements and fixed against axial movement and having a floating drive connection with said upper grinding ring for rotating said upper grinding ring relative to said lower grinding ring, resilient means mounted for rotation with and exerting a continuous downward thrust on said upper grinding ring, said casing having an inlet for the delivery of material to be pulverized to the outer side of said row of grinding elements, said upper grinding ring having a series of passages formed therein for the flow therethrough of material-laden air, and means for directing a stream of carrier air below said lower grinding ring and thence upwardly past the inner side of said row of grinding elements and through said upper grinding ring passages to said casing outlet.

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