Feb. 18, 1936. D. VAN LAW 2,031,289

GRINDING MILL

Filed Jan. 19, 1932

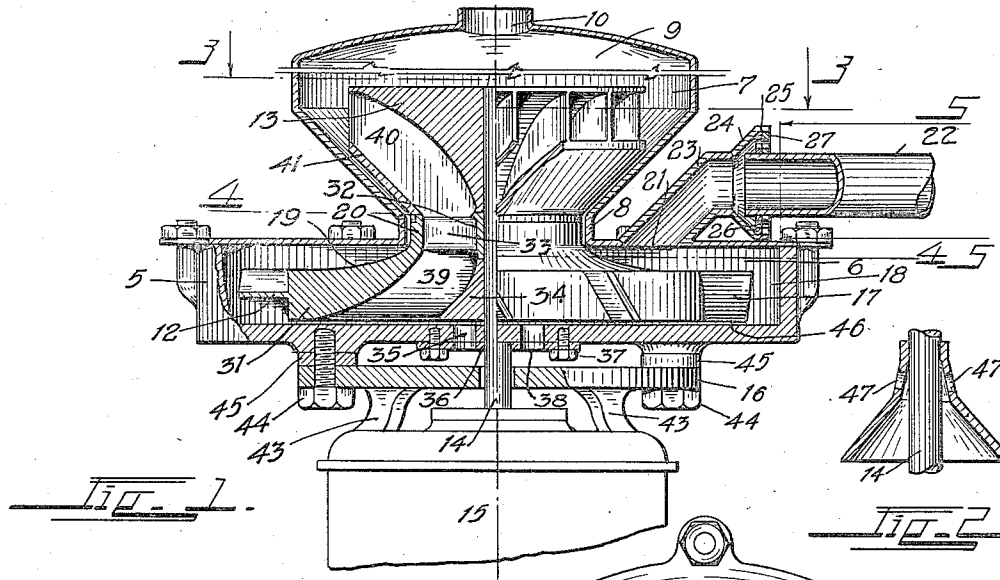


Fig. 1

Fig. 2

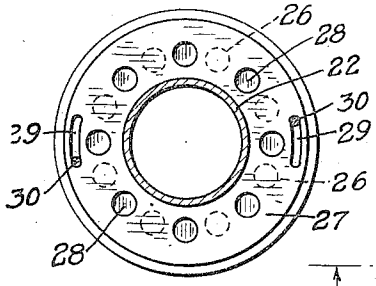


Fig. 5

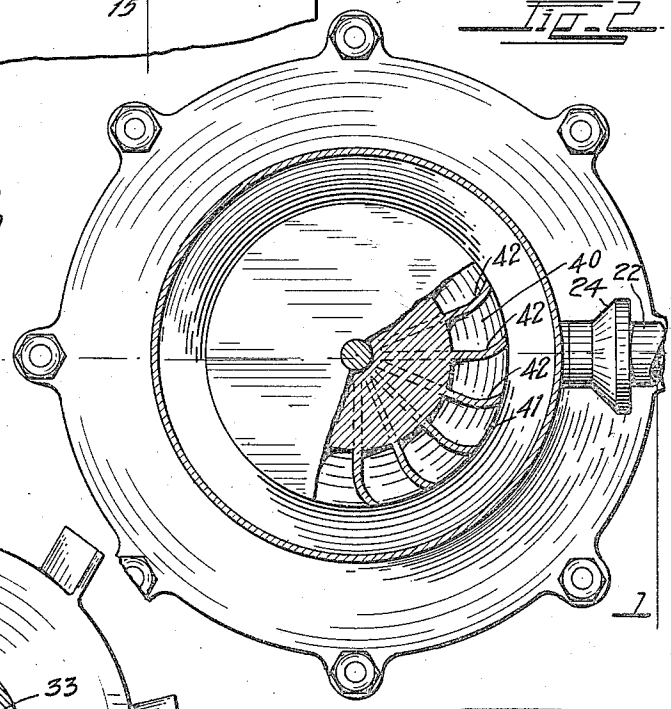


Fig. 3

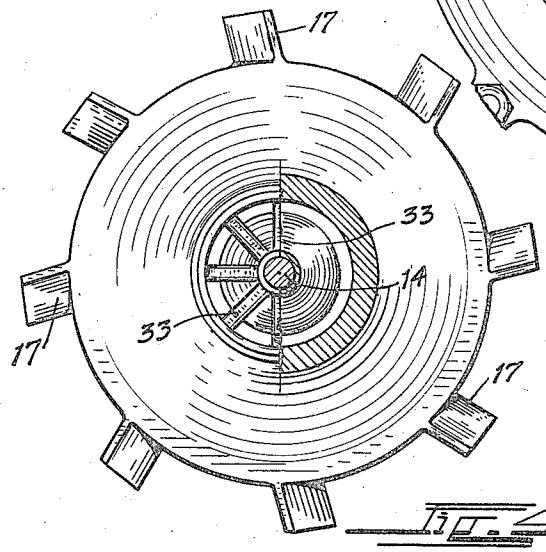


Fig. 4

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Patented Feb. 18, 1936 2,031,289

UNITED STATES PATENT OFFICE

2,031,289

GRINDING MILL

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Application January 19, 1932, Serial No. 587,485

14 Claims. (Cl. 83—11)

This invention relates to grinding mills, and more particularly to mills of the type used in connection with furnaces using pulverized coal as a fuel. It is to be understood, however, that a mill constructed in accordance with the present invention may be advantageously employed in grinding substances other than coal, as for example, pigments.

As in other mills at present in use, the material is reduced by attrition under the influence of centrifugal force, and the novelty of the present invention resides principally in the provision of a mill in which the material reduced to the desired fineness, is caused to move to a point of discharge, at a velocity gradually reduced by forces opposing the progressive movement of an air current which carries the product of the mill in suspension.

It is an object of the invention to produce this result by the provision of a practical and highly efficient mechanism of very simple construction.

Other objects reside in the provision of adjustable means for the control of air currents passing through the mill as a carrier for the pulverized fuel and as a medium to support combustion in the furnace with which the mill is associated, and still further objects are to be found in details of construction and in novel and advantageous arrangements and combinations of parts as will be fully disclosed in the course of the following description.

It is a distinctive feature of the invention that the speed reduction is obtained without impairing the suction by which air is drawn into the mill, and that the fuel is fed into the furnace in a suspended condition, at a velocity which restricts the movement of the fuel to a zone substantially commensurate with the area of combustion.

It follows that the mill is well adapted for use in connection with furnaces having a limited combustion space, such as those employed for residential use.

In the accompanying drawing in the several views of which like parts have been similarly designated,

Figure 1 represents a sectional elevation of a mill embodying the distinctive features of the present invention,

Figure 2, a fragmentary sectional view showing a modification in the form of the apron or baffle which controls the movement of air currents to the mill,

Figure 3, a horizontal section taken on the line 3—3, Figure 1,

Figure 4, a section taken on the line 4—4, Figure 1, and

Figure 5, an enlarged section along the line 5—5, Figure 1.

Referring further to the drawing, the mill comprises a housing 5 divided into a cylindrical grinding chamber 6 and a fan chamber 7 of inverted conical form, connected by a restricted throat 8. The two chambers are axially in vertical alinement and the upper or fan chamber is continued into a dome 9 of suitable height provided with an outlet 10 through which the pulverized fuel is discharged.

The outlet may be in the axis of the mill as shown in the drawing or at any other point of the fan chamber, and it is connected with a conduit not shown in the drawing through which the product of the mill is conveyed to the furnace. The outlet and the conduit connected therewith are of standard diameter, regulated by the capacity of the burner in the furnace.

Mounted for rotation in the housing is a rotor composed of a grinding-element 12 in the grinding chamber, and a fan element 13 disposed in the fan chamber.

The two elements are preferably made separate from each other, and they are conjointly mounted upon a shaft 14 which projects through an opening in the bottom of the housing for its connection with a motor 15.

In the drawing, the mill has been shown as being supported upon the motor through the medium of a table 16, but it will be apparent without further illustration, that the mill and the motor may be placed in different positions with relation to each other, in which case a gearing or other motion transmitting means may be employed to drive the rotor of the mill by action of the motor.

The grinding element 12 of the mill-rotor comprises a circular body provided with peripheral vanes 17, which project into the space between the element and the circumferential wall of the grinding chamber, and which in the operation of the mill function to throw material fed into the chamber 6, forcibly against the inner surface of the wall for its reduction by attrition in the grinding space 18. The upper surface 19 of the body flares to a neck 20 of reduced diameter by which the body is connected with that of the fan element hereinafter to be described, and the coal or other material to be ground is fed through an opening 21 in the top of the grinding chamber onto the said flaring surface whence it moves

into the grinding space 18 and into the path of the peripheral vanes.

The material is by means of a conduit 22 conducted from a conveniently located source of supply, through a suitable feeder mechanism to a neck 23 fixed on the top of the grinding chamber in connection with the opening 21.

The neck has a bell-shaped mouth 24 into which the conduit extends. A surrounding diaphragm 25 supports the conduit 22 in the bell-shaped mouth 24, and this diaphragm has a plurality of openings 26, as best shown in Figure 5 of the drawing, for the admission of air to the grinding chamber.

A rotary shutter 27 has openings 28 adapted to register with those of the diaphragm and the admission of air to the grinding chamber at this point of the mill may thus be regulated in accordance with differing requirements. The shutter placed flat against the diaphragm is slotted as at 29 for its movement on pins or bolts 30 projecting outwardly from the diaphragm.

The vanes of the grinding element slant downwardly and rearwardly with relation to the direction of rotation for the purpose of driving the material downwardly and rearwardly in the grinding chamber whereby to aid in reducing its velocity and in moving it to a point of exit below the rotor as will hereinafter be more fully explained.

The grinding element comprises a circumferential wall 31 and a hub 32 spaced apart and integrally connected by radiating spokes 33, which may be formed by extensions of the vanes of the fan hereinafter to be described. The hub is fixed on the rotor-shaft by any suitable means and it terminates into a flaring core 34 at the bottom of the element.

The rotor is spaced from the bottom of the housing, and the latter has beneath the core a plurality of openings 35 for the admission of air to the grinding chamber. A slotted shutter 36 rotatably supported beneath the bottom of the housing by screw-bolts 37 has openings 38 adapted to be brought into register with the openings 35 of the bottom, and the admission of air to the grinding chamber at this point, may thus be regulated at will.

The inner surface of the wall 31 of the grinding element curves upwardly and inwardly from the periphery of the same to provide with the correspondingly curved outer surface of the core 34, and upwardly and inwardly directed passage 39 connected with the spaces between the spokes 33 and/or the fan-vanes.

The fan element 31 is exteriorly shaped in conformity with the inverted cone-shaped wall of the fan chamber 7 and it is interiorly divided into a plurality of passages 40 which flare outwardly from the passage 39 of the grinding element, to egress-openings 41 at the periphery of the element.

The passages 40 are formed by the before-mentioned equidistantly spaced vanes 42 which radiate from the axis of the fan body and which at the peripheral egress openings 41 curve rearwardly with reference to the clockwise direction of rotation of the motor. The fan body connects with the neck 20 of the grinder-body by a rabbet-joint, as is shown in Figure 1.

The before-mentioned table 16 by means of which the mill is supported upon the motor, may be of circular form. It has a central opening for the passage of the mill-shaft and it has a plurality of legs 43, by means of which it rests upon the top of the motor or other support.

The mill housing is fastened upon the table by means of bolts 44, and washers 45 around the bolts, space the housing from the surface of the table. These washers provide a convenient means for varying the width of the space 46 between the mill rotor and the bottom of its housing, whereby to regulate the discharge of ground material from the grinding-chamber as will hereinafter be more fully described, it being apparent that by the use of washers of different thicknesses the mill housing may be raised or lowered with respect to the rotor fixed on the shaft of the motor.

In the operation of the mill, the coal fed into the grinding chamber above the grinding element, moves into the path of the vanes 17 which throw it into violent contact with the circumferential wall of the chamber. The coal reduced by attrition is in this manner comminuted until it is sufficiently fine and passes through the space 46 between the rotor and the bottom of the housing. The fan suction induces a continuous movement of a current of air entering the housing through its openings 26 and/or 35, in a circuitous path defined by the passage 39 of the grinding element, and the channels or passages 40 between the vanes 42 of the fan.

The grinding chamber has no outlet other than that provided by the above-mentioned path and the pulverized coal is thus compelled to pass downwardly around the lip at the periphery of the grinding element into the path of the upwardly directed air current which carries it to and through the egress openings of the fan.

The coal-bearing currents upon entering the dome of the mill housing, move to and through the outlet 10 of the same, and thence to the furnace with which the outlet is connected. The air current should be of sufficient volume to carry the coal-dust in suspension, and should the air supplied with the feed through the openings in the diaphragm 25 be insufficient for that purpose or to support combustion, auxiliary air may be caused to enter the mill with the feed through the openings in the bottom of the housing or vice versa.

In any event, the volume of air supplied to the housing may be regulated at both points of admission by adjustment of the respective shutters so that the operation of the mill may be accurately controlled in accordance with combustion requirements or other variable conditions and demands.

Regulation of the clearance space 46 between the rotor and the bottom of the housing, as hereinbefore explained, controls the fineness of the coal at which it may meet the air currents which carry it to the outlet of the mill.

The core 34 of the rotor, covering the air-intake openings in the bottom of the housing, serves as a protective apron to prevent the coal dust from passing through the openings, and directing it to the inlet of the passage 39. The core 34 may be made hollow and connected with the passage by means of openings 47, as shown in Figure 2, in which case a stream of air is caused to enter the passage at a higher point to augment that entering the rotor through the entrance in its bottom surface.

The curvature at the ends of the fan blades decreases the air pressure without impairing the suction of the fan and aids in insuring a con-

tinuous movement of the air currents without detrimental pulsation.

By compelling the discharge of the pulverized coal at a point below that at which it is fed into the mill and below the zone of its reduction by the action of the grinding mill, and by causing it to move from said point in an upward direction through restricted spaces to the point of delivery with the air currents, the velocity of the currents is progressively reduced, with the result that the air is introduced into the furnace in a lazy stream, with the coal particles held in a state of suspension, above the point of combustion.

The downward and rearward inclination of the blades 17 of the grinding element aids in reducing the velocity of the air currents, imparts a downward movement to the coal during its comminution and counteracts any fan action of the grinding element which might oppose the downward movement of the coal.

The form of the restricted path through which the coal is drawn upwardly to the point of discharge, materially aids in reducing the velocity of the coal-carrying air stream by repeated changes of direction and by frictional contact with its restricting surfaces.

What I claim and desire to secure by Letters Patent is:

1. Apparatus of the character described comprising a housing divided into a grinding chamber having a feed opening and an air inlet, and a fan chamber, having an outlet for material-bearing air currents, a rotor movable about an axis in the housing and comprising a grinding element in the grinding chamber, spaced from a surface of the same, and a fan-element in the fan chamber, said elements providing conjointly a channel interiorly of the same for the movement of said air-currents to the outlet, having its entrance in the grinding element, in connection with said space, a support for the housing and interchangeable inserts between the support and the housing, for varying the width of said space.

2. A grinding mill comprising a housing, and within the same a rotary body including a grinding-element having an inlet and a fan-element having an outlet, said body having an enclosed continuous passage therethrough connecting the inlet of the grinding-element with the outlet of the fan-element, for the passage of a product of the grinding-element from the inlet to the outlet under the influence of the fan-element.

3. A grinding mill comprising a housing, and within the same, a rotary body including a grinding-element having an inlet and a fan-element having an outlet, the body having formed therein an enclosed continuous direction-changing channel connecting the inlet of the grinding-element with the outlet of the fan-element, for the passage of a product of the grinding-element from the inlet to the outlet under the influence of the fan-element.

4. A grinding mill comprising a housing, and within the same, a rotary body including a grinding-element having an inlet and a fan-element having an outlet, the body having formed therein an enclosed continuous channel connecting the inlet of the grinding-element with the outlet of the fan-element, for the passage of a product of the grinding element from the inlet to the outlet under the influence of the fan-element, and the housing having an outlet for said product, out of alinement with the outlet of the fan-element.

5. A grinding mill comprising a housing, and within the same, a rotary body including a grinding-element having an inlet and a fan-element having an outlet, the body having formed therein an enclosed continuous channel connecting the inlet of the grinding-element with the outlet of the fan-element, for the passage of a product of the grinding-element from the inlet to the outlet under the influence of the fan-element, the grinding-element being spaced from a surface of the housing to provide a restricted entrance to the inlet.

6. A grinding mill comprising a housing, and within the same, a rotary body including a grinding-element having an inlet and a fan-element having an outlet, the body having formed therein an enclosed continuous channel connecting the inlet of the grinding-element with the outlet of the fan-element, for the passage of a product of the grinding-element from the inlet to the outlet under the influence of the fan-element, and the housing having an opening for feeding material to the grinding-element, and a regulatable intake for air to the inlet.

7. A grinding mill comprising a housing, and within the same, a rotary body including a grinding-element having an inlet and a fan-element having an outlet, the body having formed therein an enclosed continuous channel connecting the inlet of the grinding-element with the outlet of the fan-element, for the passage of a product of the grinding-element from the inlet to the outlet under the influence of the fan-element, and the housing having an opening for feeding material to the grinding-element, and at different points, intakes for air to the inlet.

8. Apparatus of the character described comprising a housing divided into a grinding chamber having a feed opening and an air inlet, and a fan chamber having an outlet for material-bearing air currents, a rotor movable about an axis in the housing and comprising a grinding element in the grinding chamber, spaced from a surface of the same, and a fan-element in the fan chamber, said elements having conjointly formed therein an enclosed channel for the movement of said air currents to the outlet, said channel having its entrance in the grinding element, in connection with said space, and means for varying the width of said space by movement of the housing relative to the rotor.

9. A grinding mill comprising a housing divided into a grinding chamber having a feed-inlet and a fan chamber having a product-outlet, and a rotor in the housing including a grinding element in the grinding chamber and a fan element in the fan chamber, the rotor having interiorly an enclosed continuous channel for passage of the ground product from one chamber to the other.

10. A grinding mill comprising a housing defining a grinding chamber having a feed-inlet and a fan chamber having a product-outlet, a rotor in the housing including a grinding element in the grinding chamber and a fan element in the fan chamber, the feed-inlet being above the grinding element in the grinding chamber, the rotor having interiorly an enclosed continuous channel for passage of the ground product from one chamber to the other.

11. A grinding mill comprising a housing divided into a grinding chamber and a fan chamber having a product-outlet, a rotor in the housing providing a grinding element in the grinding chamber and a fan element in the fan chamber, and means for delivering feed material into the

grinding chamber in a moving stream of air, the rotor having interiorly an enclosed continuous channel for passage of the ground product from one chamber to the other.

12. A grinding mill comprising a housing divided into a grinding chamber having a feed-inlet and a fan chamber having a product-outlet, a vertical shaft in the housing, and a rotor on the shaft including a grinding element in the grinding chamber and a fan element in the fan chamber, the rotor having interiorly an enclosed continuous channel for passage of the ground product from one chamber to the other.

13. A grinding mill comprising a housing divided into a grinding chamber having a feed-inlet and a fan chamber above the grinding chamber, having a product-outlet, a vertical shaft in the housing, and a rotor on the shaft including a grinding element in the grinding chamber and a fan element in the fan chamber, the rotor having interiorly an enclosed continuous channel for passage of the ground product upwardly from the grinding chamber to the outlet in the fan chamber.

14. A grinding mill comprising a housing divided into a grinding chamber having a feed-inlet and a fan chamber above the grinding chamber having a product-outlet, a rotor in the housing including a grinding element in the grinding chamber and a fan element in the fan chamber, the rotor having interiorly an enclosed continuous channel for passage of the ground product upwardly from one chamber to the other, said rotor being spaced from a wall of the housing to provide a passageway for the ground product from the grinding chamber into said channel, the feed-inlet being disposed above the grinding element.

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