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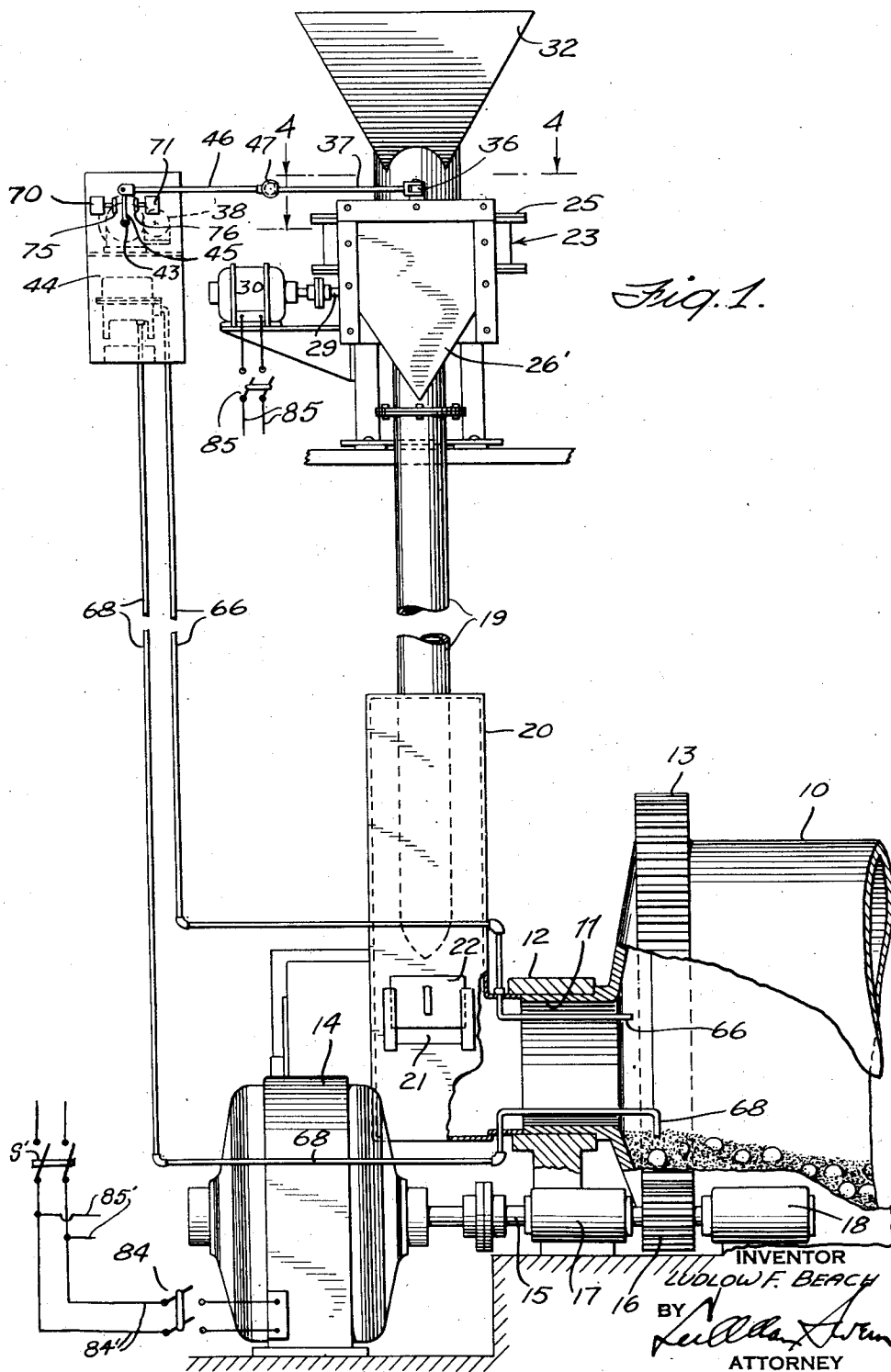
L. F. BEACH

2,398,774

APPARATUS FOR PULVERIZING MATERIALS

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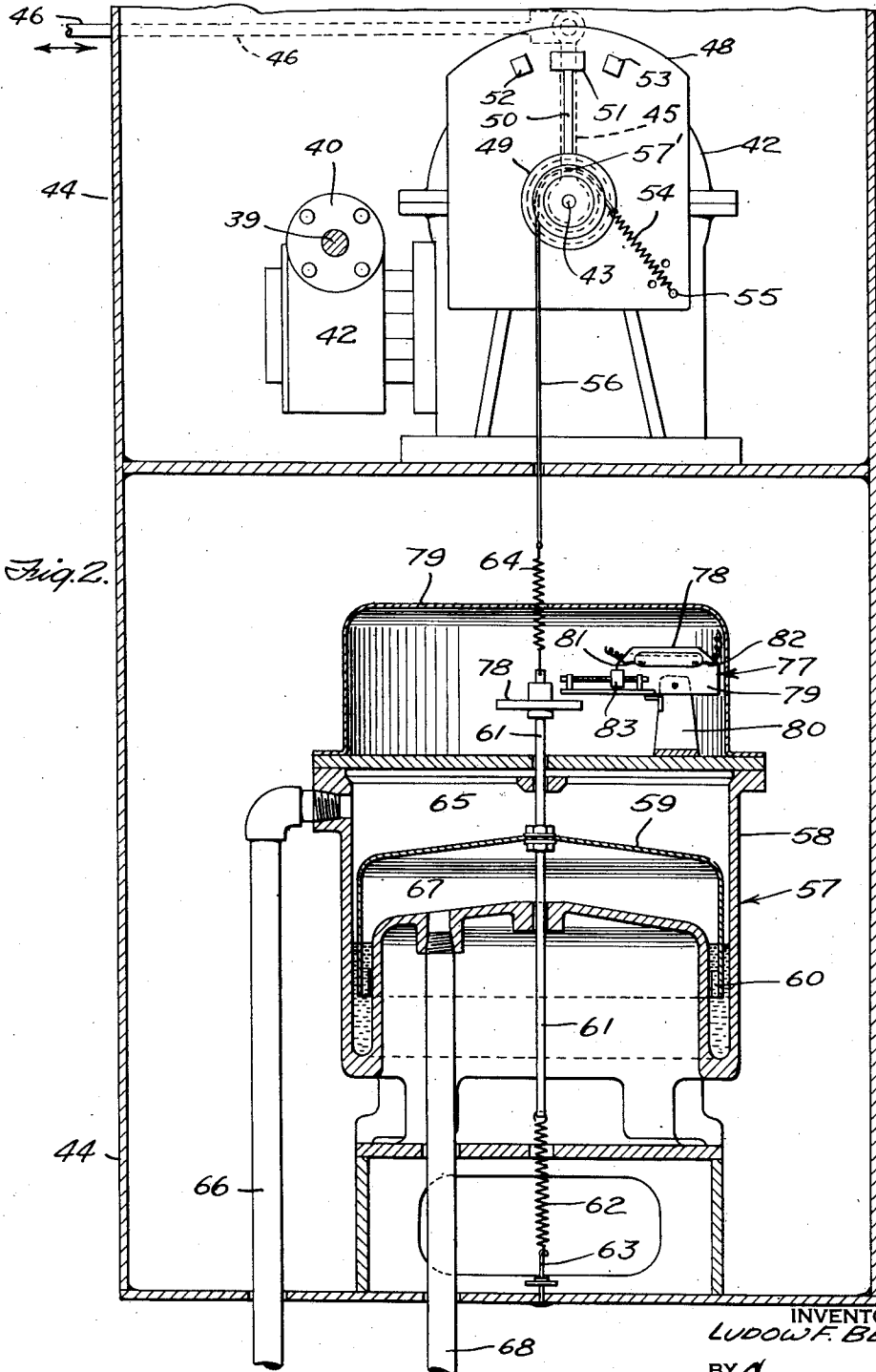
L. F. BEACH

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APPARATUS FOR PULVERIZING MATERIALS

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INVENTOR
LUDOW F. BEACH
BY *L. F. Beach*
ATTORNEY

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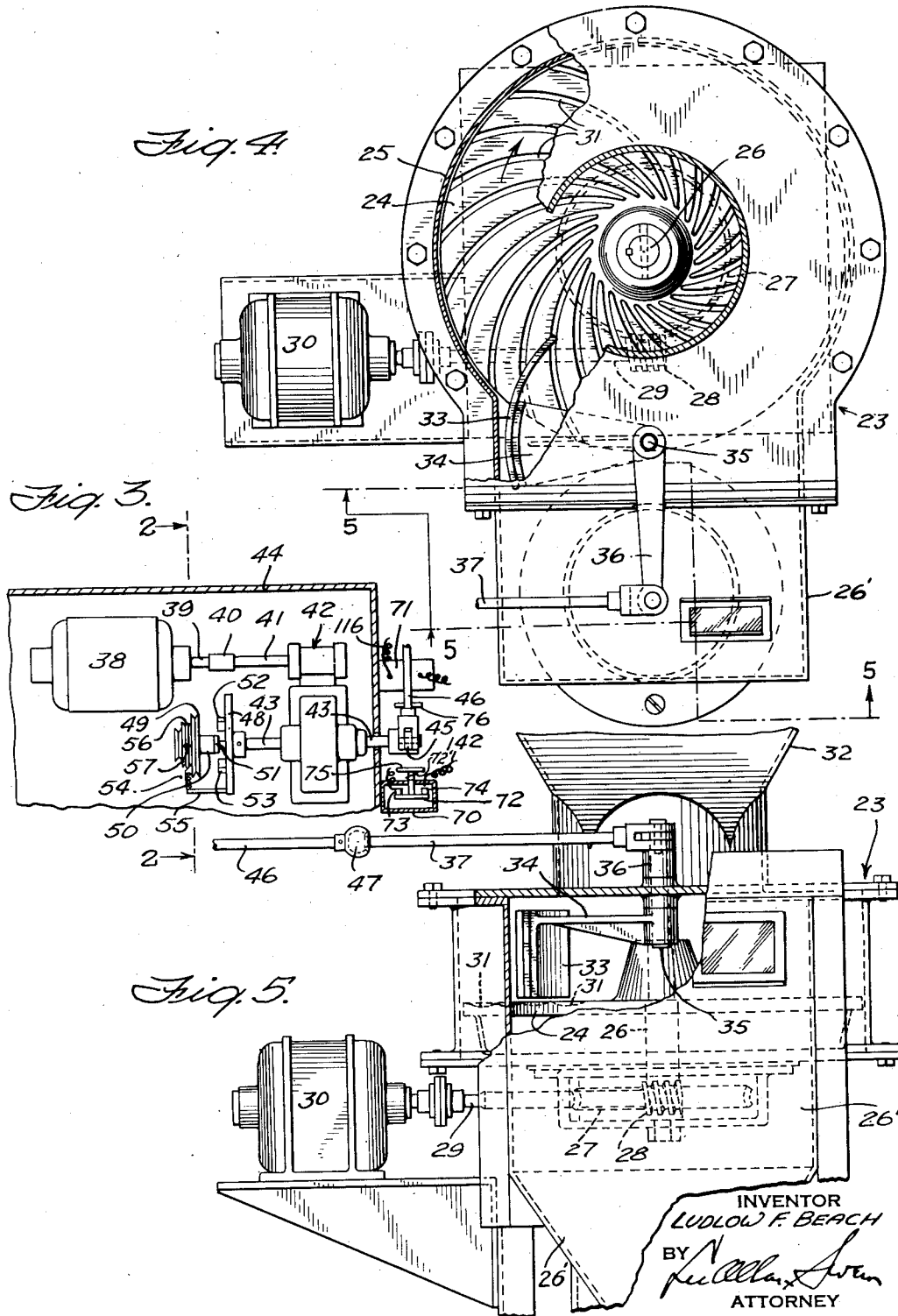
L. F. BEACH

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APPARATUS FOR PULVERIZING MATERIALS

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L. F. BEACH

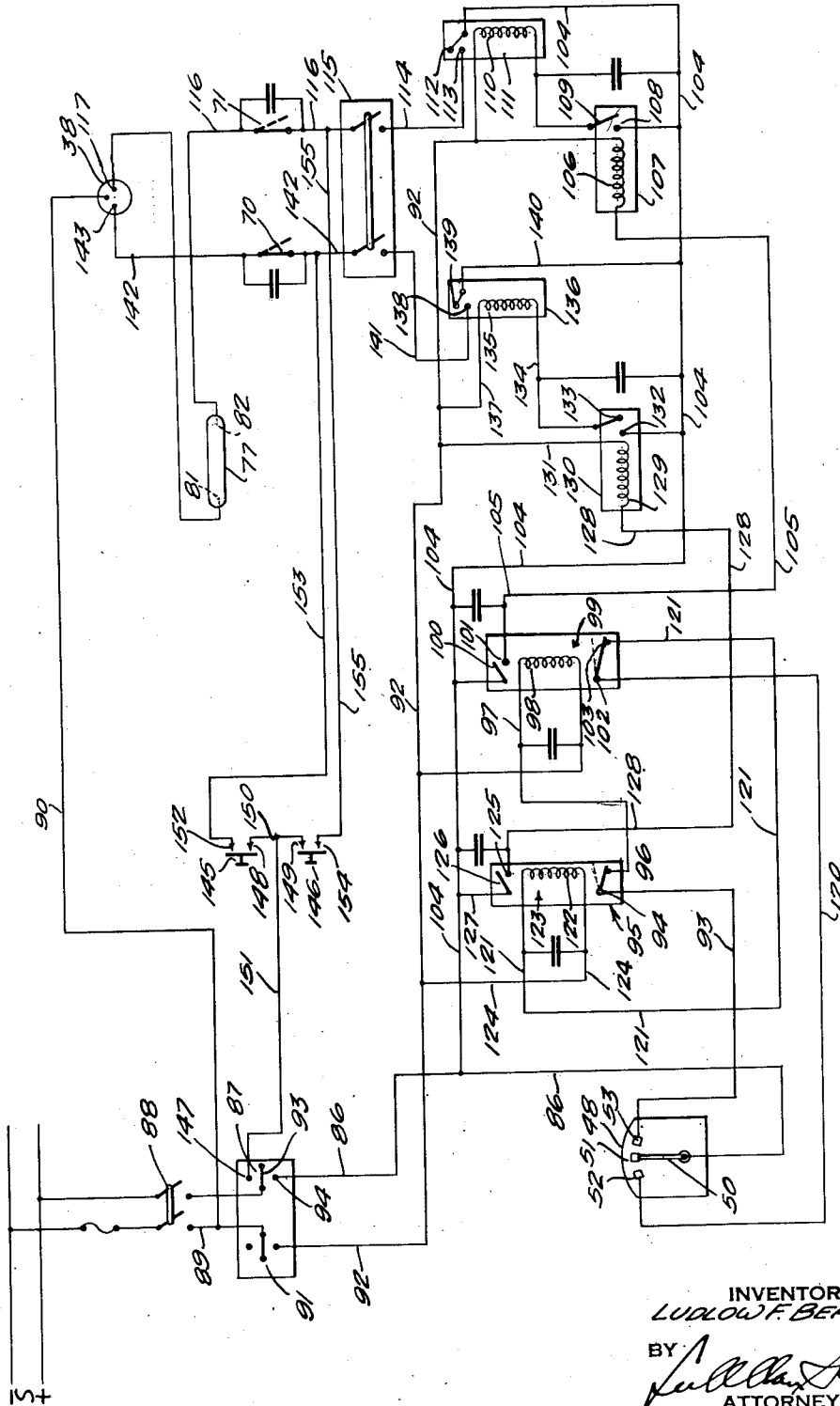
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APPARATUS FOR PULVERIZING MATERIALS

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Fig. 6.



INVENTOR
LUDLOW F. BEACH
BY *L. F. Beach*
ATTORNEY

UNITED STATES PATENT OFFICE

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APPARATUS FOR PULVERIZING MATERIALS

Ludlow F. Beach, Charleston, S. C., assignor to
Foster Wheeler Corporation, New York, N. Y.,
a corporation of New York

Application April 8, 1942, Serial No. 438,132

16 Claims. (Cl. 241—34)

This invention relates to pulverizers such as ball mill pulverizers, and more particularly relates to air-swept ball mills for pulverizing materials and to apparatus for controlling the feed of material to be pulverized to the mill.

It is necessary in pulverizers such as pulverizers of the ball mill type, in order to secure high efficiency and desired fineness of the product of the mill, to maintain the quantity or volume of the charge in the mill substantially constant irrespective of the output demand on the pulverizer. Should the amount of charge in the mill exceed a predetermined normal level, the charge may spill over into one or more of the mill trunnions and may restrict the air passage by which air enters the mill and the connection through which the pulverized product leaves the mill resulting in a decrease in the output of the pulverizer. Should the charge in the mill fall below a predetermined normal level there would be a deficiency of charge in the mill which will result in excessive wear of the grinding balls and liners of the mill.

In accordance with the present invention, material to be pulverized is continuously and uninterruptedly fed to the mill but the amount fed is automatically controlled to maintain a constant or substantially constant supply of material in the mill irrespective of the output demands on the pulverizer. By maintaining a substantially constant quantity of material in the mill, a substantially constant state of agitation is maintained, in consequence of which a substantially constant concentration of pulverized material in suspension in the air in the mill per unit quantity of the air is maintained and a constant output of a product of the desired fineness is secured.

The nature and advantages of the invention will be understood from the following description taken in conjunction with the accompanying drawings forming a part thereof, and in which:

Fig. 1 is a view in elevation, with parts thereof broken away, of a ball mill pulverizer together with the charge controlling apparatus embodying the invention;

Fig. 2 is an enlarged view of the charge controlling apparatus taken on the line 2—2 of Fig. 3, part of the apparatus being shown in transverse section and part being shown in elevation;

Fig. 3 is a plan view of a portion of the charge controlling apparatus shown in Fig. 1;

Fig. 4 is a plan view taken on the line 4—4 of Fig. 1;

Fig. 5 is a side view, partly in section and partly in elevation, taken on the line 5—5 of Fig. 4, and

Fig. 6 is a wiring diagram of the apparatus of the present invention.

Like characters of reference refer to like parts throughout the several views.

Referring to the drawings, reference numeral 10 designates the steel shell of the drum of a ball mill for pulverizing coal or other material. The drum or shell is provided with trunnions 11 on opposite ends thereof which are rotatably mounted in bearing supports 12. A ring gear 13 is suitably secured to the drum 10 and is driven by a motor 14 through a shaft 15 and a pinion 16. The shaft 15 is rotatably mounted in bearings 17 and 18. Material to be pulverized is fed to the drum 10 through a feed pipe 19 in communication with a chute 20. The chute 20 is connected to the trunnion 11 through which the material passes into the drum. Air for the mill is introduced through an opening 21 in the side of the chute 20, the size of which opening may be varied by adjusting the slide 22. Pulverized material is withdrawn from the drum through the trunnion at the opposite end of the drum, not shown, by the suction of an exhaust fan, the degree of suction depending upon the position of the damper 23.

A disc-type coal feeder 23, comprising a rotatable feed table 24 housed within a casing 25, has a chute 26 positioned adjacent the periphery of the table 24 at one side of the casing 25. The table 24 is keyed to a shaft 26 having a worm wheel 27 enmeshed with a worm 28 on a shaft 29 which is driven by a motor 30. The surface of the feed plate has a plurality of corrugations thereon formed by a plurality of spaced, raised ribs 31 which are curved from adjacent the center of the plate toward the periphery, the spaces between the ribs gradually increasing toward the periphery. The spaces between the ribs are adapted to receive fine particles of coal and through the action of centrifugal force, the particles are moved toward the periphery of the plate.

A hopper 32, which receives coal from a bunker in the usual manner, is adapted to discharge the coal onto the rotating feed table 24 at the central portion thereof, and the coal is moved to the outer periphery of the table by centrifugal force. Coal is adapted to be swept from the feed table 24 while it is rotating by an arcuate shaped shear arm 33 secured to a shear plate 34. The shear plate is secured to a vertically extending shaft 35 which is pivotally mounted in the casing 25 adjacent the chute 26 and extends through the top of the casing. Pivotal movement is imparted to the shaft 35 by an arm 36 secured at one end

to the shaft. An actuating rod 37 is pivotally secured to the opposite end of the arm 36. The shear plate is so positioned in relation to the feed table 24 that coal on the table will be rotated against the concave surface of the shear arm and will cause the coal coming in contact with the shear arm to be swept into the chute 26'. The amount of coal swept from the plate is governed by turning the shaft 35 to move the shear arm toward the central portion of the feed table to increase the area of the table swept by the shear arm and thereby increase the amount of coal swept into the chute 26', or by turning the shaft 35 to move the plate 33 away from the central portion of the feed table 24 to decrease the area of the table swept by the shear arm and thereby decrease the amount of coal swept into the chute 26'.

Mechanism for actuating the shear arm 33 to control the amount of coal swept from the feed table 24 comprises a reversing motor 38 having a shaft 39 connected through a coupling 40 to the driven or high speed shaft 41 of a speed reducer 42. The drive or low speed shaft 43 of the speed reducer is adapted to rotate at a substantially lesser speed than the driven shaft 41. One end of the shaft 43 extends through the casing 44 in which the actuating mechanism is mounted, and has secured thereto an arm 45 on which is pivotally mounted an actuating rod 46 which is connected to the actuating rod 37 by means of a universal joint 47. The shaft 43 extends outwardly of the opposite side of the speed reducer and has a contact plate 48 of an electrical non-conductive material secured thereto and adapted to rotate therewith. A three-step pulley 49 is mounted on the shaft 43 outwardly of the contact plate 48 so as to be free to rotate on the shaft. A contact arm 50 having a contact 51 thereon, is secured to the pulley and is adapted to cooperate with contacts 52 and 53 positioned on the plate 48. A spring 54 is fastened at one end to the pulley 49 and at the opposite end is secured to the plate 48 by means of spring tension adjusting screw 55. The spring 54 is so positioned that when the spring is under tension, a clockwise force is exerted on the pulley 49. An actuating line 56 is secured to the pulley 49 at 57' and extends downwardly over the side of the pulley opposite the side on which the spring 54 is positioned. The line 56 is adapted to exert a force acting in a counterclockwise direction on the pulley 49 against the tension of the spring 54.

The line 56 is actuated by a controller 57 which comprises a casing 58 in which is located a bell float 59, the lower edge of which is submerged in a liquid, such as water or mercury. The edge of the bell float may be provided on the inside thereof with a bank 60 of cork or other material to aid in floating the bell. The bell has a substantially vertical rod 61 secured thereto and which moves with the bell. The rod 61 extends beyond the top and the bottom of the casing 58. The bottom of the rod 61 is attached to a spring 62, the tension of which is adapted to exert a downward force on the rod. The spring 62 is anchored to the casing 44 by means of a spring tension adjusting screw 63. The top of the rod 61 is connected to one end of a spring 64, the other end of which is connected to the actuating line 56. The chamber 65 in the casing 58 above the bell 59 is in communication with the interior of the drum 10 substantially above the desired normal level of the material in the drum through a reference tube 66, while the chamber 67 within the

bell 59 is in communication with the interior of the drum through a level control tube 68. The drum end of the tube 68 projects downwardly into the drum 10 to a point slightly below the normal level desired to be maintained in the drum.

It is desirable to limit the extent to which the shear arm 33 may be moved toward the central portion of the feed table 24 and also to limit the extent to which the shear arm may be moved away from the central portion of the feed plate. Limit switches 70 and 71 are employed for this purpose. The limit switch 70 as shown diagrammatically in Fig. 3, comprises a movable contact 72 which is normally held in engagement with fixed contacts 73 and 74 by spring 72' which are in circuit with the motor 38, as will hereinafter be fully described. The movable contact 73 has an actuating arm 75 thereon which is adapted to be actuated by the arm 45 on the shaft 43. When the shear arm 33 reaches the extent of its movement inward toward the center of the feed table, that is, when the shear arm 33 extends entirely across the feed table 24, the arm 45 which actuates the shear arm through the actuating rods 37 and 46, as will hereinafter be fully described, engages the movable contact arm 75 and breaks the circuit to the motor 38 and thereby prevents further movement of the shear arm toward the center of the feed table. The limit switch 71 which is similar in construction and in operation to the switch 70, is also adapted to be actuated by the arm 45. When the shear arm 33 reaches the extent of its movement away from the center of the feed table, for example, when the shear arm extends over only a minor portion of the table, the arm 45 engages the movable contact arm 76 on the switch 71 and breaks the circuit to the motor 38 preventing further movement of the shear arm away from the center of the feed table.

An auxiliary limit switch 77, Fig. 2, which is adapted to be tripped by a tripping plate 78 on the rod 61 of the controller 57, is mounted on the top of the controller and enclosed by a cover 79. This switch is adapted to act in the event of failure of the limit switch 70 and serves the same purpose. The switch 77 is a mercury switch comprising a glass tube 78 secured to a mounting block 79 pivoted to a support 80. As shown, the mounting block 78 is tilted by the tripping plate 78 as it moves upwardly with the bell float 59. The mass of mercury is thereby caused to move away from the switch point 81 thus breaking the contact between the points 81 and 82, thereby interrupting the circuit to the motor 38 and preventing further clockwise rotation of the shaft 43 and contact plate 48 which prevents further movement of the shear arm 33 away from the center of the feed table, since further actuation of rods 37 and 46 by movement of the arm 45 in a clockwise direction by the shaft 43 is prevented. A counter-weight 83 is positioned on the mounting block 79 and is adapted to return the switch 77 to its closed position when the position of the plate 78 permits. A similar auxiliary limit switch may be positioned on the top of the controller in such manner that it will be tripped by the tripping plate 78 when it moves downwardly to a predetermined point against the tension of the spring 54.

The movement of bell 59 is responsive to the differential in pressure between the chamber 67 within the bell and the chamber 65 in which the bell is positioned, and this differential will vary

with changes in level of the material being pulverized in the mill. Since the drum end of the reference tube 66 is permanently beyond contact with the charge, the pressure in chamber 65 will be the pressure in the mill. Covering and uncovering of the drum end of the level control tube 68 by coal, as hereinbefore mentioned, renders the tube more or less effective to conduct air, and the greater the extent to which the end is covered by an increasing charge of material in the drum, the less effective the tube 68 is rendered in conducting the air. The pressure in the tube 68 and therefore in the chamber 67, approaches atmospheric pressure as the drum end of the control tube 68 is covered by the charge in the drum. As the level of the charge in the drum 10 rises above the desired level, and the drum end of the level control tube 68 becomes covered, the pressure in the tube and in chamber 67 rises while the pressure in tube 66 and chamber 65 remains substantially the same, with the result that the bell 59 rises and moves the rod 61 upwardly. The tension in the spring 54 causes the pulley 49 to move in a clockwise direction on the shaft 43 as viewed in Fig. 2, without moving the shaft, thereby causing the arm 50 and contact 51 to move toward the contact 53. The extent to which the pulley 49 is turned in a clockwise direction by tension of the spring 54 is governed by the extent to which the drum end 69 of the control tube 68 is covered by the material in the mill. The more the end 69 is covered by the material, the nearer the pressure in the tube 68 and chamber 67 of the control 57 approaches atmospheric pressure, the more the bell 59 and the rod 61 and line 56 move upwardly, and the more the spring 54 imparts movement of the pulley 49 in a clockwise direction as seen in Fig. 2. When the level of the material in the drum rises to a point slightly higher than the desired level, the drum end of the tube 68 is obstructed to such an extent as to cause the pressure in the tube 68 to rise and thereby cause upward movement of the bell 59, rod 61 and line 56, sufficient to allow the contact 51 to be brought into engagement with the contact 53, by reason of the action of the spring 54 on the pulley 49.

As shown in the wiring diagram of Fig. 6, which illustrates one manner in which the control mechanism may be connected, the contact 51 is in electrical connection with one pole of an electrical source S through the line 86, single pole double throw switch 87, and double pole single throw switch 88. The other pole of the source S is in electrical connection with one terminal of the reversing motor 38 through the switch 88 through the lines 89 and 90. Therefore, when the switch 88 is closed, electrical current passes from one pole of the electrical source S, through the switch 88, line 89 and line 90, to the motor 38. The line 89 is also connected to one terminal of a switch 91 which when closed, connects the lines 89 and 92 so that current from one pole of the source may flow into the line 92. When the switch 87 is closed so that the movable contact 93 engages the fixed contact 94, current flows from the opposite pole of the source through the switch 88, switch 87, line 86 and into the contact 51. When the contact 51 engages the contact 53, current flows from the contact 51 into the contact 53, thence into the line 93' and the contact 94' of the relay 95. From the contact 94', current flows into the contact 96 of the relay 95 thence through the line 97 into one end of the coil 98 of the relay 99. The contacts 94' and 96 of the

relay 95 are normally closed. The other end of the coil 98 is connected to the line 92 which has current flowing therethrough from the other pole of the electrical source. The coil 98 is thereby energized, causing the contacts 100 and 101 of the relay 99 which are normally open, to be brought into engagement, thereby causing the contacts 102 and 103 of said relay which are normally closed, to become disengaged. Engagement of the contacts 100 and 101 permits current to flow from the line 104 which is connected to the electrical conduit 86, through these contacts and into the line 105, whence the current passes into one end of the coil 106 of the relay 107 which receives current from line 92. The coil 106 is thereby energized, causing the contacts 108 and 109 of the relay 107, which are normally open, to be brought into engagement. Current passes from the contact 109 into one end of the coil 110 of the relay 111, the other end of the coil receiving current from the line 92. The coil 110 is thus energized, causing the contacts 112 and 113 which are normally open, to be brought into engagement. Engagement of the contacts 112 and 113 permits current to flow from the line 104 into the line 114 and thence into the switch 115 which is closed when the automatic feed control is functioning. From the switch 115 the current passes into the line 116, through the limit switches 71 and 77 and into the terminal 117 of the motor 38. Therefore, when the contacts 51 and 53 are in engagement, current from one pole of the electrical source flows from the switch 88 through the contacts 93 and 94 of the switch 87, through the lines 86 and 104, contacts 112 and 113 of the relay 111, thence into the motor through the switch 115, line 116, limit switches 71 and 77, and motor terminal 117. Current from the opposite pole of the source passes from the switch 88 into the line 89 and 90 directly to a motor 38.

Connecting the motor 38 into the circuit as described, causes the motor to turn the shaft 39 and high speed shaft 41 of the speed reducer 42 in such a direction that the low speed shaft 43 of the speed reducer is turned in a clockwise direction as viewed in Fig. 2. Turning of the shaft 43 in this direction, causes the arm 45 to move in a clockwise direction which in turn causes rods 46 and 47 to move to the right as shown in Fig. 4, which causes the arm 36 on the pivot shaft 35 to turn in a counterclockwise direction thereby moving the shear plate 34 and the shear arm 33 in a counterclockwise direction, or away from the center of the feed table 24, thereby causing a lesser portion of the feed table to be covered by the arm and causing less coal to be fed into chute 26' and thence into the drum 10.

Turning of the shaft 43 in a clockwise direction as viewed in Fig. 2, by the motor 38, also causes the contact plate 48 to turn in a clockwise direction. The tension of the spring 54 will cause the contact 51 to follow the contact 53, thereby holding said contacts in engagement as the contact 53 rotates with the plate 48, since the spring tends to exert a clockwise rotative force on the pulley 49 to which the arm 50 is attached. The contact 51 therefore follows the contact 53 and is held in engagement therewith until the pulley is rotated to a point where the tension exerted by the spring 54 is equal to the force exerted on the rod 61 and line 56 by the bell 59. The motor 38 will move the plate 48 and contact 53 slightly beyond this point, thereby breaking the engagement between these contacts. Disengagement of

the contacts 51 and 53 prevents further passage of current through the line 93, contact points 94 and 96 of the relay 95 and line 97 into the coil 98 of the relay 99, thereby causing the coil to become deenergized and permitting the contacts 100 and 101 to return to their normally open position which prevents passage of current into the line 105 and into the coil 106 of the relay 107. Coil 106 is deenergized and the contacts 108 and 109 are permitted to return to their normally open position. With the disengagement of the contacts 108 and 109, current no longer flows into the relay 111 from the relay 107, which deenergizes the coil 110 of said relay and permits the contact 112 to move out of engagement with the contact 113. Breaking of the engagement between the contacts 112 and 113 prevents current from flowing into the motor through the terminal 117 by way of the line 114, switch 115, line 116 and limit switch 71. Accordingly, the motor 38 is stopped and further counterclockwise movement (Fig. 4) of the shear arm 33 is prevented. The extent to which the shear arm 33 may move in this counterclockwise direction, is limited by the limit switch 71 which is adapted to be engaged by the arm 33 so that the flow of current through the line 116 to the motor terminal 117 is broken, and the motor is stopped. The contacts of the limit switch are adapted to be disengaged when the shear arm 33 extends over only a minor portion of the surface of the feed table 24 adjacent the outer periphery thereof. The auxiliary limit switch 77 is actuated by the tripping plate 78 in the event the limit switch 71 fails to operate.

Should the level of the charge in the mill decrease, thereby reducing the extent to which the drum end of the level control tube 68 is covered, the suction in the tube 68 will be increased and will cause the bell 59 to move downwardly, thereby moving the rod 61 and line 56 downwardly and imparting a counterclockwise movement (Fig. 2) to the pulley 49 against the tension of the spring 54. Counterclockwise movement of the pulley moves the arm 50 and contact 51 in a counterclockwise direction, the contact 51 moving toward the contact 52 on the plate 48. The extent to which the pulley 49 is moved in a counterclockwise direction is governed by the extent to which the bell 59 is moved downwardly by the suction in the chamber 67 and tube 68. As the level of the charge in the drum 10 falls toward the drum end of the tube 68, the suction in the tube increases until the bell 59 has been moved downwardly to an extent sufficient to move the contact 51 into engagement with the contact 52.

When the contact 51 engages the contact 52, the switches 87, 88 and 91 being closed, electrical current flows from one pole of the source S through the line 86 into the contact 51, thence into the contact 52, whence it passes through the line 120, the normally closed contacts 102 and 103 into the line 121, and thence into the coil 122 and energizing the coil 122, since the opposite end of the coil is in communication with the opposite pole of the source S through the lines 124 and 92, switch 91, line 89 and switch 88. Energization of the coil 122 causes the normally open contacts 125 and 126 to engage and to permit current to flow through contacts 125 and 126 from the lines 86, 104 and 127, into the line 128. Current in the line 128 flows into one end of the coil 129 of the relay 130, the opposite end of which is connected to the line 92 by the line 131. The coil 129 thereby is energized and the normally open contacts 132 and 133 are closed. Current from the line 104

passes through the contacts 132 and 133 into the line 134, thence to one end of the coil 135 of the relay 136 thereby energizing the coil, since the opposite end thereof is connected to the line 92 by means of the lead 137. Energizing the coil 135 causes the normally open contacts 138 and 139 to close and permits current to flow from the line 104 through the line 140, through the closed contacts 138 and 139 into the line 141, thence through the switch 115 which is closed, into the line 142, through the limit switch 70 to the terminal 143 of the motor 38 which is caused to turn in a direction opposite to the direction to which it turns when current flows into the motor through the terminal 117. Turning of the motor in the opposite direction, causes the low speed shaft 43 of the speed reducer to be turned in a counterclockwise direction (Fig. 2) which turns the arm 45 in a counterclockwise direction moving the rods 46 and 37 to the left and causing the arm 36, shaft 35, shear plate 34, and shear arm 33, to move in a clockwise direction. The shear arm 33 thereby is caused to move toward the central portion of the feed table 24 and to cover a greater extent of the surface of the feed table and to cause a greater amount of material to be passed into the chute 26 and into the drum 10.

Counterclockwise rotation (Fig. 2) of the shaft 43 by the motor 38 also causes the contact plate 48 to turn in a counterclockwise direction. The downward pull exerted on the rod 61 and line 56 will cause the contact 51 to follow the contact 52 and to hold these contacts in engagement as the contact 52 rotates with the plate 48. The counterclockwise rotation of the contact 51 and the pulley 49 is against the tension of the spring 54, thereby increasing this tension. The contacts 51 and 52 remain in engagement until the pulley 49 reaches a point in its counterclockwise rotation where the tension of the spring 54 equals the downward force exerted by the bell 59. When this state of equilibrium is reached, counterclockwise movement of the pulley 49 and contact 51 ceases. The motor 38 will move the plate 48 and contact 52 slightly beyond this point, thereby breaking the engagement between the contacts 51 and 52. Disengagement of the contacts 51 and 52 prevents further passage of current through the line 120, contact points 102 and 103 of the relay 99, and line 121 into the coil 122 of relay 123, which causes the coil to become deenergized thereby permitting the contacts 125 and 126 to return to their normally open position. This interrupts the flow through the line 128 to the coil 129 of the relay 130 and causes the coil to become deenergized, and permits the contacts 132 and 133 to return to their normally open position which interrupts the flow of current to the coil 135 of the relay 136 and deenergizes the coil, thereby breaking the contact between the contacts 138 and 139. Disengagement of the contacts 138 and 139 prevents further passage of current through the line 141, switch 115, line 142 and limit switch 70 into the motor 38 through the terminal 143. The motor 38 is thereby stopped and further clockwise movement (Fig. 4) of the shear arm 33 is prevented. The extent to which the shear arm 33 may rotate in a clockwise direction is limited by the limit switch 70 which is engaged by the arm 45 so that the flow of current through the line 142 to the motor terminal 143 is broken and the motor 38 is stopped. The contacts of the limit switch are adapted to be disengaged when the shear arm 33 extends entirely across the surface of the feed table 24 from the outer to the inner

periphery thereof. An auxiliary limit switch, such as the switch 77, may be used in the line 142 which would be engaged by the tripping plate 78 in its downward movement to tilt the switch and break the connection between the contact points therein in a manner similar to breaking of the connections between the contacts in the switch 77.

It is desirable at certain times, particularly during the starting of the pulverizer, to operate the shear arm 33 independently of the automatic control hereinbefore described. For this purpose, as shown in Fig. 6, hand operated push buttons 145 and 146 are provided. When it is desired to control the operation of the motor 38 and thereby to actuate the shear arm 33 by means of the push buttons 145 and 146, the switch 88 is closed, the switches 91 and 115 are opened, and the movable arm 93 of the switch 87 is turned so that the contact thereon engages the fixed contact 147 which is connected to one fixed contact 148 of the switch 146 and one fixed contact 149 of the switch 145 through the lines 150 and 151. The other fixed contact 152 of the push button switch 145, is connected to the line 142 by means of the electrical conduit 153, while the second fixed contact 154 of the push button switch 146 is connected to the line 116 by means of the lead 155.

The switch 145 is closed when it is desired to move the shear arm 33 in a clockwise direction (Fig. 4) toward the inner periphery of the feed table 24. Current will then flow from one pole of the source S through the switch 88 into the contacts 93 and 147 of the switch 87, thence through the lines 151 and 150 into the contact 148 of the switch 145. The current then flows through the movable contact of this switch into the fixed contact 152, whence it flows into the lines 153 and 142 through the limit switch 70, thence into the motor 38 through the terminal 143, and causes the motor to turn in a direction to rotate the shaft 43 of the speed reducer in a counterclockwise direction (Fig. 2). When it is desired to turn the shaft 43 in a clockwise direction and thereby turn the shear arm in a counterclockwise direction and toward the outer periphery of the feed table 24, the switch 146 is closed and the switch 145 is opened. Current will then flow from the line 150 into the fixed contacts 149 and 154 of the switch 146 thence through lines 155, 116 and limit switches 71 and 77 into terminal 117 of the motor 38, causing the motor to operate.

With the apparatus of this invention the quantity of the charge in the drum of the mill is automatically maintained at a predetermined level irrespective of the output demand on the pulverizer. While the amount fed to the drum of the mill may vary in accordance with the output demand on the mill, the material to be pulverized is continuously fed to the mill. The means for feeding material to the drum is adapted to be stopped when the mill is stopped. This may be accomplished by any desirable means cooperating with the feed motor 30 which will interrupt the flow of current to said motor when the mill motor 14 is stopped, for example by connecting the lead wires 84' and 85' of the switches 84 and 85 respectively to a switch connected to an electrical source so that when the switch S' connected to the source is opened the flow of current to the motors 14 and 30 is interrupted.

Since variations may be made in the form of the invention herein disclosed, it will be understood that the invention is not to be limited except by the scope of the appended claims.

What is claimed is:

1. Pulverizing apparatus comprising an air-swept revoluble drum adapted to contain a body of material, a feeding plate adapted to receive material on a surface thereof and from which surface material is supplied to the drum, a motor for constantly rotating said feeding plate while said pulverizing apparatus is in operation, a feeding member pivoted adjacent the feeding plate to turn on an axis substantially parallel to the axis of rotation of said plate, said feeding member cooperating with the surface of the plate, actuating means for turning the feeding member in a clockwise or a counter-clockwise direction on the pivot in relation to the plate for controlling the amount of material removed from the plate including a reversible electric motor, and control means for said motor comprising a switch for changing the direction of operation of said motor, said switch having a contact plate actuated by the reversible motor, spaced contacts on the plate, a movable contact adapted to be moved into engagement with one of the first-mentioned contacts to operate the motor in one direction and into engagement with the other of said first-mentioned contacts to operate the motor in the opposite direction and a control member for moving and holding said movable contact in engagement with said first-mentioned contacts, said member comprising means operated by the difference in pressure between members conducting separate, relatively small quantities of air from points within the drum, one of said points being disposed below the maximum desired level of material therein and another of said points being disposed above said maximum desired level, said engagement between the movable contact and the first-mentioned contacts being broken when the level rises above or falls below said predetermined level.

2. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for changing the quantity of material fed to the drum, and means movable in response to variations in the quantity of material in the drum, control means for said electrically actuated means comprising a first electrical contact movable upon movement of said electrically actuated means, and a second electrical contact arranged for engagement and disengagement with the first contact and movable with said movable means, said contacts being in circuit with said electrically actuated means, the arrangement being such that the operation of said electrically actuated means is controlled to change the quantity of material fed to the drum.

3. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for varying the quantity of material fed to the drum, and means movable in response to variations in the quantity of material in the drum, control means for said electrically actuated means comprising a plurality of electrical contacts movable upon movement of said electrically actuated means, and another electrical contact arranged for engagement and disengagement with said plurality of contacts and movable with said movable means, said contacts being in circuit with said electrically actuated means, the arrangement being such that the electrically actuated means is

operated to increase the amount of material fed to the drum when said other contact is in engagement with one of the plurality of contacts, and is operated to decrease the amount of material fed to the drum when said other contact is in engagement thereby to vary the amount of material fed to the drum to maintain a constant quantity of material therein.

4. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for varying the quantity of material fed to the drum, and means movable in response to variations in the quantity of material in the drum, control means for said electrically actuated means comprising spaced electrical contacts movable upon movement of the electrically operated means, and another electrical contact disposed between the spaced contacts and arranged for engagement and disengagement therewith, said other contact being movable with said movable means, said contacts being in circuit with said electrically actuated means, the arrangement being such that the electrically actuated means is operated to increase the amount of material fed to the drum when said other contact is in engagement with one of the spaced contacts, and is operated to decrease the amount of material fed to the drum when said other contact is in engagement with the other spaced contact thereby to vary the amount of material fed to the drum to maintain a constant quantity of material therein.

5. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for varying the quantity of material fed to the drum, and means movable in response to variations in the quantity of material in the drum, control means for said electrically actuated means comprising contact mounting means movable upon movement of said electrically actuated means, spaced contacts disposed on the mounting means, another electrical contact disposed between the spaced contacts and mounted for movement independently of the contact mounting means, said other contact normally being disengaged from the spaced contacts and arranged for engagement therewith and movable with said movable means, and resilient means normally under tension connected to said other contact and to the contact mounting means so that movement of the other contact with said movable means toward one of the spaced contacts will be against the tension of said resilient means and movement of said other contact toward another spaced contact will be with the tension of said resilient means, said contacts being in circuit with the electrically operated means, the arrangement being such that when the movable means responds to a decrease of the quantity of material in the mill the other electrical contact is moved into engagement with one of the spaced contacts to cause the electrically operated means to be operated to increase the amount of material fed to the drum, and when the movable means responds to an increase in the quantity of material in the drum the other electrical contact is moved into engagement with another of the spaced contacts to cause the electrically operated means to be operated to decrease the amount of material fed to the mill.

6. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for varying the quantity of material fed to the drum, and means movable in response to variations in the quantity of material in the drum, control means for said electrically actuated means comprising contact mounting means movable upon movement of the electrically actuated means, spaced contacts on the mounting means, another electrical contact between the spaced contacts arranged for engagement therewith and mounted for movement independently of the contact mounting means, means operatively connecting the other contact with the movable means, and a spring normally under tension connected to said other contact and to the contact mounting means so that movement of the other contact into engagement with one of the spaced contacts by the movable means will be against the tension of the spring and movement of the other contact into engagement with another of the spaced contacts will be with the tension of the spring, said contacts being in circuit with the electrically operated means so that engagement of the other contact with one of the spaced contacts will cause actuation of the electrically actuated means to increase the quantity of material fed to the drum and engagement of the other contact with another of the spaced contacts will cause actuation of the electrically actuated means to decrease the quantity of material fed to the drum, the arrangement being such that the spaced contacts are moved out of engagement with the other contact by movement of the contact mounting means by the electrically actuated means, when the amount of tension of the spring determined by the position of the movable means is insufficient to hold the other contact and the spaced contacts in engagement.

7. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for changing the quantity of material fed to the drum, and means movable in response to variations in the quantity of material in the drum, control means for said electrically actuated means comprising a first electrical contact movable upon movement of said electrically actuated means, and a second electrical contact arranged for engagement and disengagement with the first contact, said contacts being in circuit with the electrically actuated means, the second contact having movement with the movable means, the interval of engagement between the first and second contacts being determined by the extent of movement of the movable means, the arrangement being such that the operation of said electrically operated member is controlled to change the quantity of material fed to the drum.

8. In pulverizing apparatus having an air-swept drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for changing the quantity of material fed to the drum, and means movable in response to the pressure in a member conducting a relatively small quantity of air from a point within the drum disposed below the maximum desired level of material therein, control means for said elec-

trically actuated means comprising a first electrical contact movable upon movement of said electrically actuated means, and a second electrical contact arranged for engagement and disengagement with the first contact, said contacts being in circuit with the electrically operated member, the second contact having movement with the movable means, the interval of engagement between the first and second contacts being determined by the extent of movement of the movable means, the arrangement being such that the operation of said electrically operated member is controlled to change the quantity of material fed to the drum.

9. In pulverizing apparatus having an air-swept drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including electrically actuated means for changing the quantity of material fed to the drum, and means movable by the difference in pressure between members conducting separate, relatively small quantities of air from points in the drum, one of said points being disposed below the maximum desired level of material therein and another of said points disposed above said maximum desired level, control means for said electrically actuated means comprising a first electrical contact movable upon movement of said electrically actuated means, and a second electrical contact arranged for engagement and disengagement with the first contact, said contacts being in circuit with the electrically operated member, the second contact having movement with the movable means, the interval of engagement between the first and second contacts being determined by the extent of movement of the movable means, the arrangement being such that the operation of said electrically operated member is controlled to change the quantity of material fed to the drum.

10. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including a feeding plate adapted to receive material on a surface thereof, an electrically operated adjustable member cooperating with said plate for changing the amount of material fed therefrom to the drum, and means movable in response to variations in the quantity of material in the drum, control means for said electrically operated adjustable member comprising a first electrical contact movable upon operation of the adjustable member, and a second electrical contact arranged for engagement and disengagement with the first contact and movable with said movable means, said contacts being in circuit with said electrically operated member, the arrangement being such that the operation of said electrically operated member is controlled to change the quantity of material fed to the drum.

11. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including a feeding plate adapted to receive material on a surface thereof, an adjustable member cooperating with said plate for controlling the amount of material fed therefrom to the drum, a reversible electrical motor for operating the adjustable member to increase and decrease the amount of material fed to the drum, and means movable in response to variations in

the quantity of material in the drum, control means for controlling the operation of the electrical motor comprising a plurality of electric contacts movable by operation of said motor, and another electrical contact arranged for engagement and disengagement with said plurality of contacts and movable with said movable means, said contacts being connected in circuit with the electrical motor so that upon engagement of one of the plurality of contacts by said other contact the reversible motor will operate the electrically operated member to increase the amount of material fed to the drum and upon engagement of another of the plurality of contacts the reversible motor will operate the electrically operated member to decrease the amount of material fed to the drum, the arrangement being such that the operation of said electrically operated member is controlled to vary the quantity of material fed to the drum to maintain a substantially constant quantity of material therein.

12. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including a feeding plate adapted to receive material on a surface thereof, an adjustable member cooperating with said plate for controlling the amount of material fed therefrom to the drum, electrical driving means for operating the adjustable member to increase and decrease the amount of material fed to the drum, and means movable in response to variations in the quantity of material in the drum, control means for controlling the operation of the electrical driving means comprising a plurality of electric contacts movable by operation of said driving means, and another electrical contact arranged for engagement and disengagement with said plurality of contacts, said contacts being connected in circuit with the electrical driving means, said other electrical contact having movement with the movable means, the interval of engagement between said other contact and one of said plurality of contacts being determined by the extent of movement of the movable means, the arrangement being such that the operation of said electrically operated member is controlled to vary the quantity of material fed to the drum to maintain a substantially constant quantity of material therein.

13. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including a feeding plate adapted to receive material on a surface thereof, an adjustable member cooperating with said plate for controlling the amount of material fed therefrom to the drum, a reversible electric motor for operating the adjustable member, and means movable in response to variations in the quantity of material in the drum in respect to a predetermined quantity therein, control means for controlling the operation of the electrical motor comprising contact mounting means movable in opposite directions by operation of said motor, spaced contacts disposed on the mounting means, another electrical contact disposed between the spaced contacts and mounted for movement independently of the contact mounting means, the contacts being in electrical circuit with the motor, means operatively connecting said other electric contact with the movable means, whereby movement of the movable means in response to vari-

ations of the quantity of material in the drum in respect to a predetermined quantity will cause the other contact to engage one of the spaced contacts when the quantity of material falls below a predetermined amount to operate the motor and the adjustable member to feed a greater amount of material to the drum and cause said other contact to engage the other spaced contact when the quantity of material increases beyond a predetermined amount to thereby operate the motor and the adjustable member to feed a lesser amount of material to the drum, the interval of operation of said motor in either direction by the engagement of said other contact with the spaced contacts being determined by the amount of movement imparted to the other contact by the movable means.

14. In pulverizing apparatus having a drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including a feeding plate adapted to receive material on a surface thereof, an adjustable member cooperating with said plate for controlling the amount of material fed therefrom to the drum, a reversible electric motor for operating the adjustable member, and means movable in response to variations in the level of material in the drum in respect to a predetermined level therein, control means for controlling the operation of the electrical motor comprising contact mounting means mounted on a shaft to turn therewith, the shaft being rotated by said motor, spaced contacts disposed on the mounting means, another electrical contact disposed between the spaced contacts and mounted for movement independently of the contact mounting means, the contacts being in electrical circuit with the motor, means operatively connecting said other electric contact with the movable means whereby movement of the movable means in response to variations of the level of the material in the drum will cause the other contact to engage one of the spaced contacts when the level of the material falls below a predetermined level to operate the motor and the adjustable member to feed a greater amount of material to the drum and cause said other contact to engage the other spaced contact when the level of the material increases beyond a predetermined level to thereby operate the motor and the adjustable member to feed a lesser amount of material to the drum, the interval of operation of said motor in either direction by the engagement of said other contact with the spaced contacts being determined by the amount of movement imparted to the other contact by the movable means.

15. In pulverizing apparatus having an air-swept drum adapted to contain material to be pulverized, means for pulverizing the material therein, means for feeding to the drum material to be pulverized including a feeding plate adapted to receive material on a surface thereof, an electrically operated adjustable member cooperating with said plate for controlling the amount

of material fed therefrom to the drum, electrical driving means for operating the adjustable member to increase and decrease the amount of material fed to the drum and means movable in response to the pressure in a member conducting a relatively small quantity of air from a point within the drum disposed below the maximum desired level of material therein, control means for controlling the operation of the electrical driving means comprising a plurality of electric contacts movable by operation of said driving means, and another electrical contact arranged for engagement and disengagement with said plurality of contacts, said contacts being in circuit with the electrical driving means, said other electrical contact having movement with the movable means, the interval of engagement between said other contact and one of said plurality of contacts being determined by the extent of movement of the movable means, the arrangement being such that the operation of said electrically operated member is controlled to vary the quantity of material fed to the drum to maintain a substantially constant level of material therein.

16. In pulverizing apparatus having an air-swept revoluble drum adapted to contain a body of material, a feeding plate adapted to receive material on a surface thereof and from which surface material is supplied to the drum, a motor for constantly rotating said feeding plate while said pulverizing apparatus is in operation, a feeding member pivoted adjacent the feeding plate to turn on an axis substantially parallel to the axis of rotation of said plate, said feeding member cooperating with the surface of the plate, control means for turning the feeding member in a clockwise or a counter-clockwise direction on the pivot in relation to the plate for controlling the amount of material removed from the plate including a reversible electric motor, and control means for said last-mentioned motor comprising a switch for changing the direction of operation of said motor, said switch having a contact plate actuated by the reversible motor, spaced contacts on the plate, a movable contact adapted to be moved into engagement with one of the first-mentioned contacts to operate the motor in one direction and into engagement with the other of said first-mentioned contacts to operate the motor in the opposite direction, and a control member for moving and holding said movable contact in engagement with said first-mentioned contacts, said member comprising means operated by the difference in pressure between members conducting separate, relatively small quantities of air from points within the drum, one of said points being disposed below the maximum desired level of material therein and another of said points being disposed above said maximum desired level, said engagement between the movable contact and the first-mentioned contacts being broken when the level rises above or falls below said predetermined level.

LUDLOW F. BEACH.