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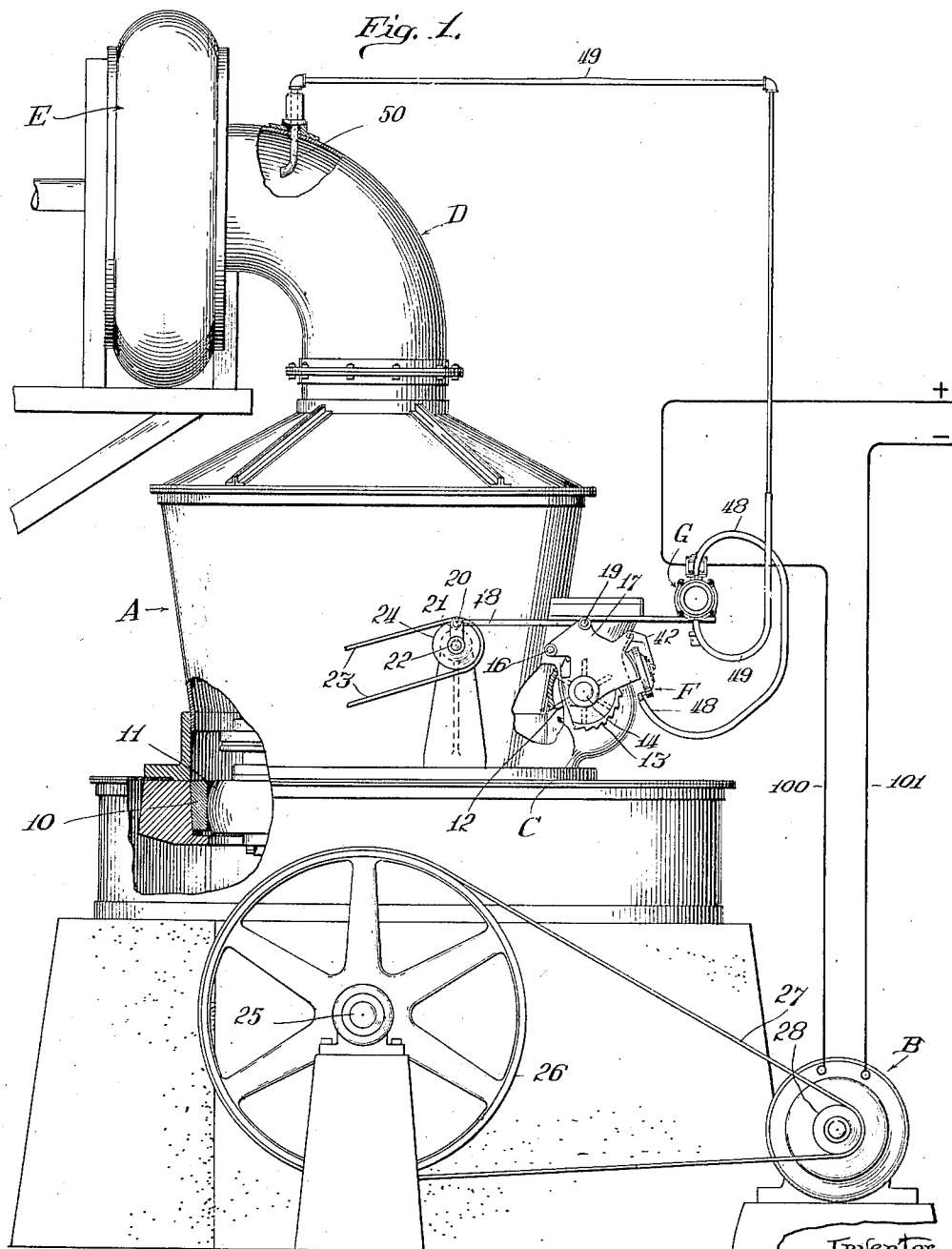
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F. I. RAYMOND

FEED CONTROLLING MECHANISM

Filed April 24, 1925

4 Sheets-Sheet 1



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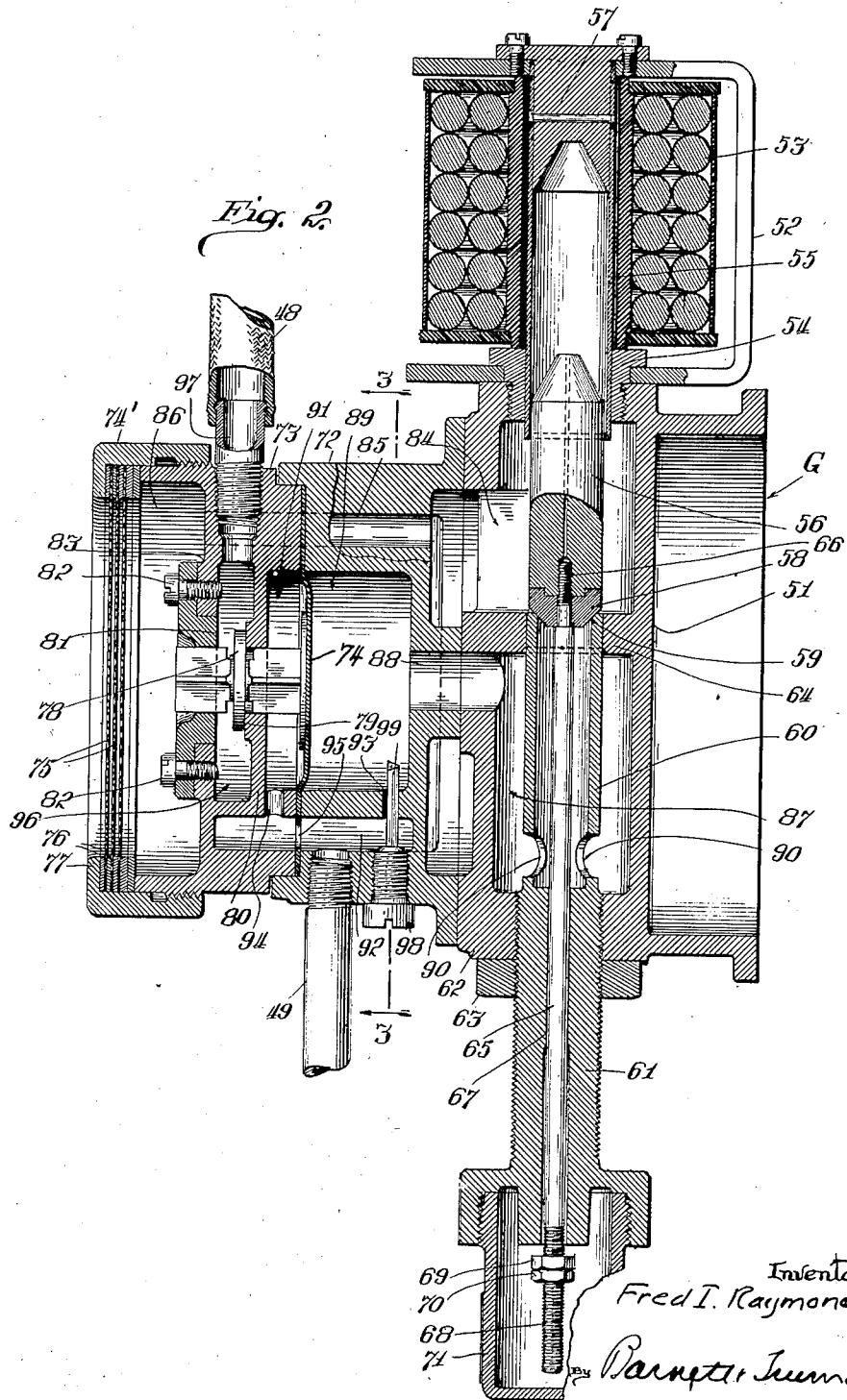
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F. I. RAYMOND

FEED CONTROLLING MECHANISM

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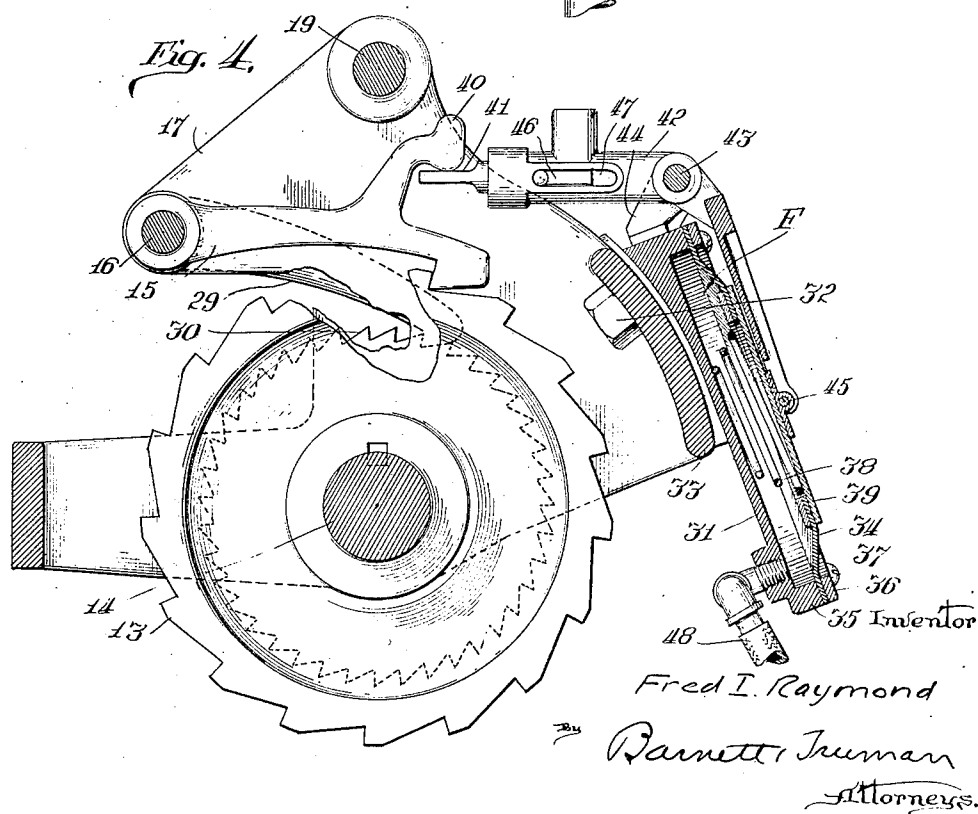
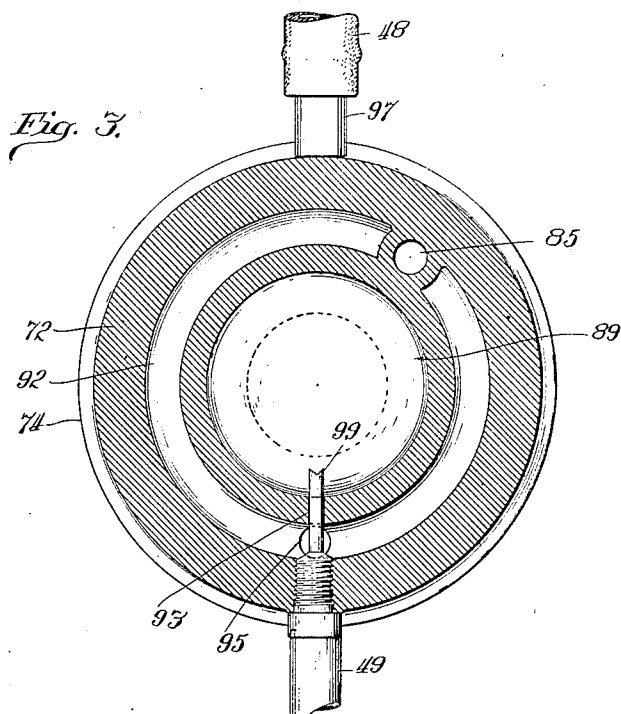
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FEED CONTROLLING MECHANISM

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4 Sheets-Sheet 3



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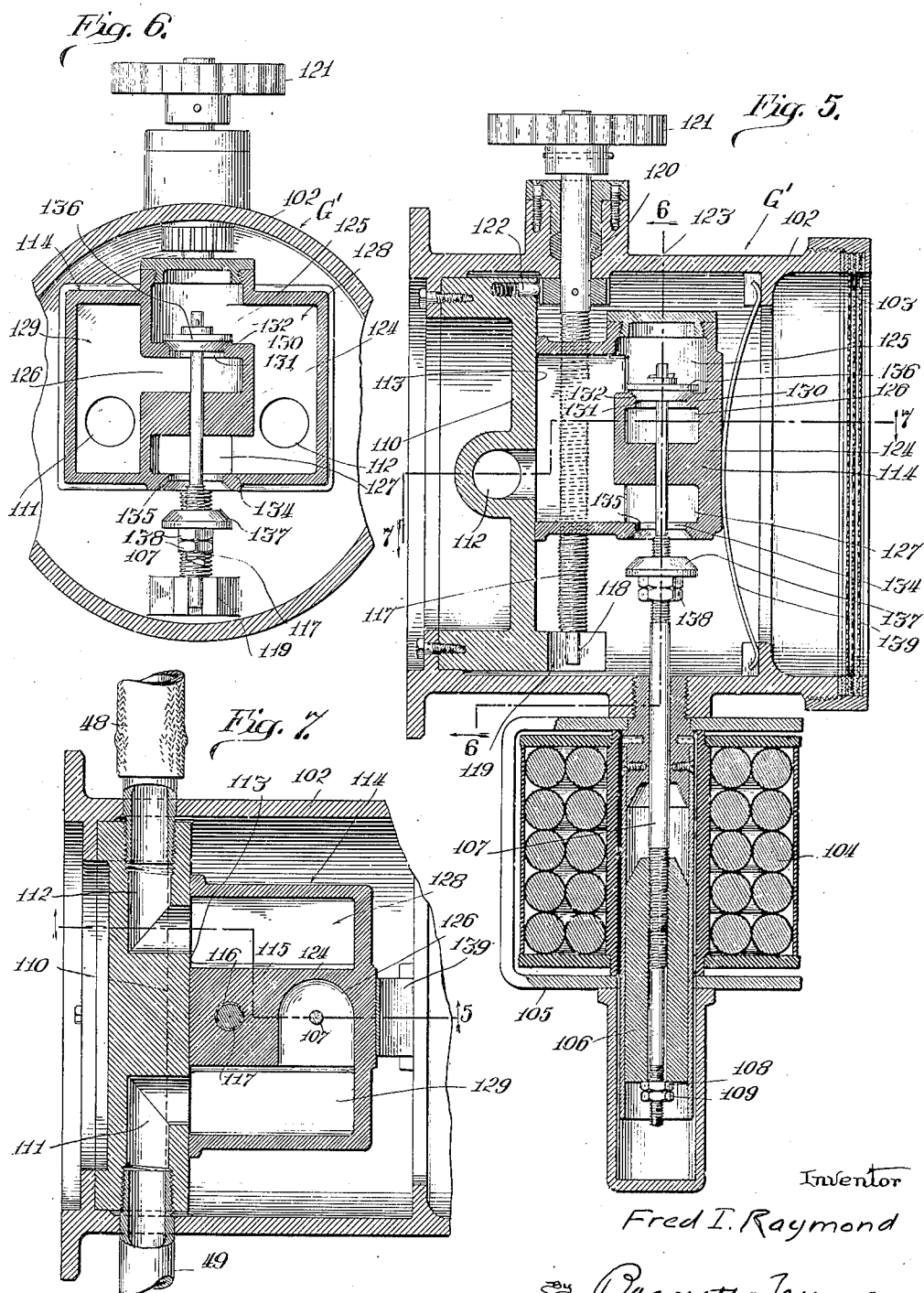
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FEED CONTROLLING MECHANISM

Filed April 24, 1925

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

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FEED-CONTROLLING MECHANISM.

Application filed April 24, 1925. Serial No. 25,562.

To all whom it may concern:

Be it known that I, FRED I. RAYMOND, a citizen of the United States, residing at River Forest, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Feed-Controlling Mechanism, of which the following is a specification.

My invention relates to mechanism for automatically regulating the feed of materials to pulverizing mills or like apparatus, so that the feed will be proportioned to the capacity of the mill, to the end that the mill may be operated at full capacity and without overloading.

The principal object of this invention is to provide a novel and improved feed regulator for a motor driven mill or other apparatus, which functions to control the feed in response to load conditions in the mill as reflected in changes in the performance of the motor due to the increase or decrease in the load thereon.

The mechanism contemplates more particularly, although the invention is not limited thereto, a mill in which the feeder is driven by a ratchet and pawl mechanism or other mechanism having a driving connection provided with members disengageable one from the other, and with this type of feeding mechanism in view, the regulator of my invention is designed so as to lift the pawl from engagement with its ratchet when the mill is overloaded, and to allow the pawl to engage with the ratchet when, through cessation or diminution of the feed, the load thereon has been reduced to the extent desired.

In this connection, one of the objects of the invention is to so construct the feed regulator that the pawl is moved into and out of engagement with the ratchet by a quick, practically an instantaneous action, which obviates any objectionable friction or interference as between the end of the pawl and the teeth of the ratchet.

A further object of the invention is to provide a lag in the mechanism so that it will respond only to load changes of a certain magnitude, and to make it possible to vary this lag or differential so as to adapt the mechanism for operation under varying conditions. It is not desirable to have the feed regulator act at every slight change in

the load one way or the other. The extent to which the mill may overload before it becomes desirable to shut off the feed may vary in accordance with the character of the material treated, the degree of pulverization required, and other operating conditions.

The invention has in view, more especially, a mill or other apparatus driven by an electric motor; and in this connection a further object is to provide an adjustment in the electrical device responsive to the changes in motor current intensity resulting from load fluctuations whereby the feed regulator may be made to act at different current intensities without affecting the differential as between the high and low intensities at which the mechanism is actuated in opposite senses. Preferably the arrangement is such that these two adjustments can be made independently of each other.

A further object is to provide a feed regulator comprising an electrical device responsive to changes in intensity of the motor current, and a pneumatically operated mechanism for controlling the feeding means, that is to say, moving the pawl into and out of engagement with the ratchet, which pneumatic mechanism is governed in its operation by the electrical device.

The invention consists of the new and improved constructions, arrangements and devices to be herein described and claimed for carrying out the above stated objects and such other incidental objects as will be referred to in the following specification.

The invention is illustrated, in certain preferred embodiments, in the accompanying drawings wherein—

Fig. 1 is a side elevation, with certain parts shown in section, of a pulverizing mill of the "Raymond" type provided with a feed regulator constructed in accordance with this invention.

Fig. 2 is a vertical sectional view of the electrical device responsive to changes in intensity of the current through the motor that drives the mill.

Fig. 3 is a sectional view on line 3—3 of Fig. 2.

Fig. 4 is a sectional elevation of the pneumatic mechanism for controlling the engagement of the pawl of the feeding mechanism with its ratchet.

Fig. 5 is a longitudinal sectional view of a modified form of controller responsive to changes in motor current intensity, and

Figs. 6 and 7 are sectional views on line 6—6 and 7—7, respectively, of Fig. 5.

Referring first to Figs. 1 to 4 inclusive, A designates a pulverizing mill of the Raymond type, B the electric motor for driving the mill, C the mechanism for feeding material to be pulverized into the mill, D the pipe through which the pulverized material is discharged, and E the fan for exhausting the air from pipe D and the mill in order to effect the separation of the finely ground material and its discharge from the mill.

In the type of mill shown for the purpose of illustration the pulverization of the material takes place between a stationary annular member or bull ring 10 and a plurality of rollers 11 which revolve on their axis and which move circularly around the inner surface of the bull ring. The feeding mechanism consists of an overshot pocket feeder 12 which is given a step-by-step rotation by means of a ratchet 13 fixed to the shaft 14 of the feeder and a pawl 15 pivoted at 16 to a carrier 17 mounted for oscillation on shaft 14 and given its oscillatory movements by means of a pitman 18 pivoted at 19 to the carrier and at 20 to a crank 21 on a shaft 22 which is rotated continuously by a belt 23 and pulley 24. 25 designates the main driving shaft of the mill carrying a belt pulley 26 for a driving belt 27 which extends around a pulley 28 on the rotor of electric motor B.

The feed regulating mechanism is designed so as to lift pawl 15 from engagement with ratchet 13 when the overload on the mill has reached a certain magnitude, and to release the pawl so as to bring it into engagement again with the ratchet when the overload has been reduced to normal. If the feeder is rotated by a single pawl 15 the operation of the regulator brings about a complete cessation of the feed until the mill has cleared. However, my invention contemplates an arrangement whereby the quantity of feed per unit of time may be merely diminished, when the mill overloads, instead of being stopped entirely. When this arrangement is used a second pawl 29 is employed which operates upon a second ratchet 30 having smaller teeth than the ratchet 13. Pawl 29 functions to rotate the feeder at a slow speed after pawl 15 has been disengaged from its ratchet. During the operation of ratchet 15 pawl 29 continues to move but it is practically ineffective.

In the preferred embodiments of the invention shown, in the drawings, the pawl 15 is raised from the ratchet 13 by means of a pneumatic device F evacuated when the overload on the mill has reached the

point at which the feed regulator is set to operate. This pneumatic device consists of a casing 31 secured by tap screw 32 to a flange 33 on the carrier 17, and of a flexible diaphragm 34 secured to the rim portion 35 of the casing by means of a ring 36 and screws 37, a coiled spring 38 being preferably interposed between the bottom of casing 31 and a plate 39 secured to diaphragm 34, the latter being in the form of an annulus. The pawl 15 is formed with a lip 40 adapted to be engaged by a finger 41 carried by a bell crank 42 pivoted at 43 to a bracket 44 on casing 31 and pivoted at 45 to the diaphragm plate 39. As a matter of convenience the finger 41 which engages lip 40 of the pawl is formed on a slide 46 which extends into a recess 47 in the upper end of the bell crank so that by retraction of the slide the feed regulator may be made inoperative.

Any suitable means may be employed for exhausting the air from the pneumatic F. Preferably I utilize for this purpose the vacuum produced by the fan E. The application of suction to pneumatic F is governed by a controller G which is responsive to changes in intensity of the current passing through motor B. 48 is a tube connecting the pneumatic F with the controller G. 49 is a pipe connecting controller G with the mill or discharge pipe. Preferably pipe 49 terminates in a nozzle 50 which extends into the upper portion of pipe D and is bent so that its open end is turned in the direction of fan E.

The construction of the controller G is shown in Figs. 2 and 3. 51 designates a casing on the top of which is supported, by means of an arm 52, an electro-magnet, preferably a solenoid coil 53, arm 52 being secured to the casing by means of a bushing 54 through which projects a sleeve 55 extending through the coil 53 and adapted to receive the armature or core 56 of the solenoid. A stop block 57 may be arranged in the upper end of sleeve 55 although it is not intended that the core should reach this point in the normal operation of the apparatus. The core 56 has secured thereto a valve 58 adapted to cooperate with a valve seat 59 formed on the upper sleeve-like extension 60 of a tubular member 61 which has a threaded engagement with the bottom 62 of casing 51, the member 61 being held at any position of adjustment with respect to casing 51 by means of a lock nut 63. The upper end of the sleeve 60 passes through an opening in a web 64 extending across casing 51. 65 is a rod, the end 66 of which is threaded and extends through valve 58 into core 56 (incidentally holding these parts together) the rod 65 extending through a bore 67 in the valve seat member 61 and its lower end being threaded, as

indicated at 68, for stop and lock nuts 69, 70. The adjustment as between member 61 and casing 62 raises and lowers the valve seat 59. The adjustment of nuts 69, 70 makes it possible to vary the extent of movement of valve 58 from its seat under the magnetic attractive of the solenoid for its core. Preferably the end of rod 65 is enclosed by a cap piece 71. Secured to the side of casing 51 is a casing member 72 and to this member another casing member 73. A flexible diaphragm 74 is clamped at its edge between casing members 72, 73. Casing member 73 has screwed thereon a ring 74' which holds in place a plurality of air filters 75 arranged with the interposition of suitable spacers, between the outstanding flange 76 of casing member 73 and an intumed flange 77 of the clamping ring 74'. Secured to diaphragm 74 is a valve 78 adapted to bear in one position upon a valve seat 79 formed on a web 80 extending across casing member 73, and in another position, against a valve seat 81 secured by screws 82 to a web 83 on casing member 73.

The casing structure 51, 72 and 73, is formed with the following chambers and ports: 84 is a chamber above valve seat 59 and 85 a port connecting this chamber with a chamber 86 open to the atmosphere through the air filters 75. 87 is a chamber below valve seat 51, 88 a port connecting this chamber with a chamber 89 on the inner side of diaphragm 74, and 90, 90 are ports through the valve seat member 60. 91 is a chamber on the outer side of diaphragm 74 and 92 is a space almost surrounding the chambers 89 and 91, chamber 89 communicating with space 92 through a port 93 of relatively small diameter, while chamber 91 communicates with space 92 through a larger port 94. Diaphragm 74 extends across the space 92 but is formed with openings 95. 96 is a chamber which communicates alternately with chambers 91 and 86 in accordance with the position of valve 78. Tube 48, which leads to the pneumatic F and which is flexible, is fitted to a nipple 97, the end of which extends through casing member 73 into chamber 96. Pipe 49 leading to the discharge pipe D of the mill is tapped into casing member 72 so as to communicate with the space 92. In order to clean the small port 93 casing member 72 is provided with a screw stud 98 having an eccentrically arranged blade 99.

The solenoid coil 53 is arranged in circuit with the leads 100, 101 of the driving motor B. It will be understood that the motor and its connections are indicated in a diagrammatic manner. Any electric motor may be used of a type wherein change of load on the mill will involve fluctuations of the current through the motor.

Operation (Figs. 1 to 4 inclusive).—The parts of the controller G are shown in the positions which they take when the mill is feeding. The pawl lifter pneumatic F is open to the atmosphere through tube 48, chamber 96 and chamber 86, so that the pawl 15 is in position to engage ratchet 13 at each alternate oscillation of the pawl carrier 17. If the mill becomes over loaded, that is, if the material fed into the mill by feeding device C exceeds the grinding capacity of the mill or the capacity of fan E to remove the pulverized product, this overloading will be reflected in the current passing through the motor leads and when the intensity of the motor current has reached the intensity at which the feed regulator is set to function, solenoid 56 will be attracted by coil 53 so as to move valve 58 from seat 59. The increase in current intensity which brings about energization of coil 53 to the extent necessary to raise the valve, will depend to a certain extent upon the position of the core with respect to the coil when valve 58 is seated and the adjustment of these parts is possible by screwing member 61 up and down in casing 51 which raises or lowers the valve seat 59 and with it the valve and core. When valve 58 is unseated air at atmospheric pressure from port 85 will pass valve 58 and reach chamber 89 on the inner side of diaphragm 74 and deflect the diaphragm 74 outwardly so as to move valve 78 from its seat 79 to its seat 81. While valve 58 was closed chamber 89 was subject to the vacuum through port 93, space 92 and pipe 49. After valve 58 has been opened the exhaustion of air from chamber 89 continues but as the cross sectional area of port 93 is small, the net result of opening valve 58 is to increase the pressure in chamber 89 to a point but little below atmospheric pressure. On the other hand, the suction from the mill continues to be exerted against the other side of diaphragm 74, chamber 91 being in communication with space 92 and pipe 49 through the relatively large opening 94. The movement of valve 78 from seat 79 to seat 81 closes the port between chamber 96 and chamber 86 (atmosphere) and opens communication between chamber 96 and chamber 91. The latter chamber is subject to the mill vacuum and hence pneumatic F is exhausted, bell crank 42 is rocked and pawl 15 disengaged from its ratchet 14, stopping the feed, provided ratchet 30 and pawl 29 are not used, and diminishing the feed if the second ratchet and pawl mechanism is employed. When valve 58 is closed its under side is subject to the vacuum in chamber 87 and the connected ports and chambers. Hence the magnetic field of the solenoid coil is intensified sufficiently to bring about a movement of the core and valve, and the valve is unseated, the pressures on opposite sides of the valve are immediately balanced

and the valve is at once opened to its fullest extent. Inasmuch as the ports from the atmosphere to chamber 89 (assuming valve 58 to be unseated) are all of relatively large area in comparison with the area of port 93 through which chamber 89 is connected to the vacuum, the opening of valve 58 produces a sudden rush of air into chamber 89, the pressure in which is almost instantaneously raised to a point close to atmospheric pressure, while the low pressure is still maintained on the other side of diaphragm 74. As a result, the movement of valve 78 is a quick movement and the collapse of pneumatic F is produced by a movement which is substantially instantaneous. This is important in order that there should be no undue friction or interference as between the pawl and the ratchet teeth when the pawl is being raised out of engagement with the ratchet.

The intensity of current passing through the solenoid coil necessary in order to produce a magnetic field sufficient to move the core from its position on the valve seat, is greater, obviously, than is necessary to maintain the core in the raised position. This is due to inertia, to the vacuum on the under side of the seat and to the fact that when raised the core is closer to a position of balance in the coil. Therefore the regulator will not operate to start the feed until the load on the mill has diminished to a point considerably below that at which the regulator was actuated to stop the feed. In other words, the regulator is designed to operate only upon a difference of current intensity of appreciable magnitude and this differential is subject to adjustment. By moving the stop nut 69 up or down on the threaded end 68 of rod 65, the amplitude of movement of the core may be varied, so that the core, on being attracted by the magnetic field will penetrate to a greater or less extent into the coil. The greater the movement of the core into the coil the greater will be the difference between the magnetic force necessary, on the one hand, to move the core from its seat, and, on the other hand, the force necessary to hold it in the raised position. This adjustment is independent of the vertical adjustment of valve seat 59. The latter adapts the controller to function, as to its operation in opposite directions, at different current intensities. The former adjusts the apparatus so that the operating differential is greater or less.

When the motor current has diminished in intensity sufficiently to allow the solenoid to drop its core the weight of the core brings about the sudden closing of the valve necessary to produce an instantaneous expansion of the pneumatic F. The pawl is, therefore, engaged with the ratchet, by a movement which is practically instantaneous.

Modification of controller (Figs. 5, 6 and 7).—The modification is concerned only with the construction of the controller here designated G'. 102 is a casing having an open side over which are arranged a plurality of air filters 103. The solenoid coil 104 is arranged in a casing 105 secured to the under side of casing 102. The core 106 of the solenoid has a threaded engagement with a rod 107, the rod extending through the core and being engaged therewith by set and lock nuts 108, 109. Set into the back of casing 102 is a member 110 provided with a port 111 with which is connected the pipe 49 which leads to the discharge pipe D of the mill, and with a port 112 to which extends the tube 48 connected with the pawl lifting pneumatic F. Against the inner face 113 of member 110 is a sliding valve casing 114 provided with a web 115 having a threaded bore 116 therein for a threaded adjusting shaft 117, this shaft having a bearing at 118 in a projection 119 at the bottom of member 110 and extending through a stuffing box 120 in the top of casing 102 and being provided with a button 121 by which the shaft may be rotated. 122 is a spring click set into a recess in member 110 and bearing against a button 123 on shaft 117. The forward part 124 of the web 115 is formed with recesses 125, 126, 127, recesses 125 and 127 opening into a chamber 128 on the pawl lifter side of web 115, port 113 leading from this chamber, while recess 126 opens into a chamber 129 on the other side of the web with which chamber communicates port 111 connected with the mill. The partition wall 130 between recesses 125 and 126 is formed with an opening 131 and the valve seat 132. The lower wall 133 of the movable valve casing is formed with an opening 134 and a valve seat 135. The rod 107 has fixed to the upper end thereof a valve 136 to cooperate with seat 132. Another valve 137 is arranged lower down on the rod to cooperate with seat 135. This valve has a threaded relation with the rod, for adjustment, and is held in fixed position by lock nut 138. 139 is a spring to force the valve casing 114 against member 110.

Operation (Figs. 4, 5 and 6).—With the parts in the position shown in these figures, the mill is feeding. There is a constant suction through pipe 49, chamber 129 and recess 126 against the under side of valve 136 tending to keep the valve seated. The pneumatic F is under atmospheric pressure through open port 134, recess 127, chamber 128, port 112 and tube 48. The flow of current through the solenoid coil 104 creates a magnetic field, but under the conditions assumed, this field is not sufficiently strong to overcome the weight of the core 106, the valve structure connected therewith, and the

suction against valve 136. When the field is increased by intensification of the motor current brought about through abnormal load on the mill, solenoid 104 will raise the core, and valve structure, to the extent permitted by the position of valve 137 on rod 107, such position being adjustable. Port 134 is closed, shutting off the pawl lifter pneumatic from the atmosphere and port 131 is opened so that the pneumatic will be exhausted, the air passing from the pneumatic through port 112, chamber 128, port 131, chamber 126 and port 111. The evacuation of the pneumatic takes place instantaneously because the movement of the valve 136 away from its seat is a very quick movement. This results from the fact that the movement of the valve is resisted by the vacuum on its under side. As soon as this resistance is overcome and the pressure equalized on both sides of the valve, the opening of the port to its fullest extent takes place instantaneously. The core remains in its upper position until there has been quite a considerable drop in the intensity of the magnetic field, that is to say, until the load on the mill has been considerably decreased over that at which the regulator was actuated to stop the feed. A lag is provided as in the case of the other form of controller. The upper side of valve 137 is now subject to the vacuum. The core 106 is nearer its balanced position in the coil than when the core and valves were in the other position. Hence the diminution in load on the mill must be of appreciable magnitude (variable by the adjustment of valve 137 on rod 107) before the regulator will be actuated to bring about resumption of the feed. Because of the vacuum over valve 137 the movement of the valves in this direction is an instantaneous movement bringing about a quick expansion of the pneumatic and a substantially instantaneous engagement of the pawl with the ratchet.

The adjustment of the core 106 on rod 107 is to adapt the regulator for motor currents of different amperage or to make it possible to vary the operation of the regulator so that it will be actuated at higher or lower intensities of the motor current.

I have described my invention in certain preferred embodiments, but propose to cover all modifications within the scope of the appended claims.

I claim:

1. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulator comprising an electric device responsive to changes in intensity of the motor current, and a pneumatically actuated mechanism governed by said electrical device for controlling the feeding means.

2. In combination with a mill, an electric

motor to drive the same, means for feeding material to the mill, a feed regulator comprising an electric device responsive to changes in intensity of the motor current, and a pneumatically actuated mechanism for starting and stopping the feeding means, which mechanism is controlled by said electrical device.

3. In combination with a mill, an electric motor to drive the same, and means for feeding material to the mill comprising a ratchet and pawl, a feed regulator comprising an electric device responsive to changes in intensity of the motor current, and a pneumatically operated mechanism governed by said electrical device for controlling the engagement of the pawl and ratchet.

4. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, power actuated means for throwing said feeding means into or out of operation, and an electrically operated device responsive to changes in intensity of the motor current of a certain magnitude for cutting on or off the power supply to said mechanism.

5. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulating mechanism responsive to changes in intensity of the motor current which is actuated only when the changes in such intensity reach a certain magnitude, and adjusting means whereby the magnitude of such changes necessary to bring about actuation of the regulating mechanism may be varied.

6. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulating mechanism responsive to changes in intensity of the motor current which is actuated only when the changes in such intensity reach a certain magnitude, and means for adjusting said mechanism so that it may be made to respond, for its movements in each direction, to different current intensities.

7. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, and a feed regulating mechanism actuated in opposed senses to control the feeding means when, through increase or decrease, a determinate difference in the intensity of the motor current is reached.

8. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulating mechanism actuated in opposed senses to control the feeding means when, through increase or decrease, a determinate difference in the intensity of the motor current is reached, and means whereby this differential may be varied.

9. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulating mechanism actuated in opposed senses to control the feeding means when, through increase or decrease, a determinate difference in the intensity of the motor current is reached, means whereby this differential may be varied, and means whereby the mechanism may be adjusted to operate at higher or lower current intensities without affecting said differential.
10. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulating mechanism actuated to start and stop the feed of the mill when, through increase or decrease, a determinate difference in intensity of the motor current is reached.
11. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulating mechanism actuated to start and stop the feed of the mill when, through increase or decrease, a determinate difference in intensity of the motor current is reached, and means whereby this differential may be varied.
12. In combination with a mill, an electric motor to drive the same, means for feeding material to the mill, a feed regulating mechanism actuated to start and stop the feed of the mill when, through increase or decrease, a determinate difference in intensity of the motor current is reached, means whereby this differential may be varied, and means whereby the mechanism may be adapted to operate at higher or lower current intensities without affecting said differential.
13. In combination with a mill, an electric motor to drive the mill, means for feeding material to the mill comprising a pair of disengageable members, power actuated mechanism for moving said members into or out of engagement and holding them in one or the other of these positions, and electric control means responsive to changes in the intensity of the motor current, for cutting on or off the power supply to said mechanism.
14. In combination with a mill, an electric motor to drive the mill, means for feeding material to the mill comprising a pair of disengageable members, power actuated mechanism for moving said members into or out of engagement, and electric controlling means responsive to changes of a given magnitude in the intensity of the motor current for throwing on or off the power supply to said mechanism.
15. In combination with a mill, an electric motor to drive the mill, means for feeding material to the mill comprising a pair of disengageable members, and a feed regulator comprising a device which when actuated brings about the disengagement and re-engagement of said members by an instantaneous movement of one of the same, and electrically controlled means for actuating said device in response to changes in the intensity of the motor current.
16. In combination with a mill, an electric motor to drive the mill, means for feeding material to the mill comprising a pair of disengageable members, a feed regulator comprising a device which when actuated brings about the disengagement and re-engagement of said members by an instantaneous movement of one of the same, and electrically controlled means for actuating said device in response to changes of a given magnitude in the intensity of the motor current.
17. In combination with a mill, an electric motor to drive the mill, means for feeding material to the mill comprising a pair of disengageable members, a feed regulator comprising a device which when actuated brings about the disengagement and re-engagement of said members by an instantaneous movement of one of the same, means for actuating said device in response to changes of a given magnitude in the intensity of the motor current, and means for adjusting the regulator whereby it may be actuated to bring about such engagement and disengagement in response to greater or smaller differences in motor current intensity.
18. In combination with a mill, an electric motor to drive the mill, means for feeding material to the mill comprising a pair of disengageable members, a feed regulator comprising a device which when actuated brings about the disengagement and re-engagement of said members by an instantaneous movement of one of the same, means for actuating said device in response to changes of a given magnitude in the intensity of the motor current, means for adjusting the regulator whereby it may be actuated to bring about such engagement and disengagement in response to greater or smaller differences in motor current intensity, and adjusting means independent of the aforesaid adjusting means whereby the regulator may be set to operate at higher or lower current intensities.
19. The combination with an apparatus and an electric motor for driving the same, of feeding mechanism automatically responsive to change in motor current intensity which is actuated to control the feed to the apparatus only when, by increase or decrease of the load on the apparatus differences of current intensities are produced of a given magnitude, and means for adjusting said mechanism to adapt it to respond to greater or lesser differences in motor current intensity.

20. The combination with an apparatus and an electric motor for driving the same, of feeding mechanism automatically responsive to change in motor current intensity which is actuated to control the feed to the apparatus only when, by increase or decrease of the load on the apparatus differences of current intensities are produced of a given magnitude, means for adjusting said mechanism to adapt it to respond to greater or lesser differences in motor current intensity, and means for adapting the mechanism to respond to higher or lower current intensities without affecting the aforesaid differential operation.

21. The combination with an apparatus and an electric motor for driving the same, of feeding mechanism, electrically controlled power actuated means automatically responsive to certain definite changes in motor current intensity for throwing said feeding mechanism into or out of operation, and means for adjusting said first mentioned means to adapt it to respond to higher or lower motor current intensities.

22. The combination with an apparatus, an electric motor for driving the same, and means for feeding material to the apparatus; of a feed regulator comprising an electric device responsive to changes in current flow through the motor, and a pneumatically operated mechanism actuated by said electric device.

23. The combination with a pulverizing mill having means for exhausting air therefrom, an electric motor for driving the mill, and means for feeding material to the mill; of a feed regulator comprising an electric device responsive to changes in current flow through the motor, and a pneumatic mechanism having an exhausting connection with the mill, which connection is controlled by said electric device.

24. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, an exhausting means, mechanism for alternately putting said pneumatic device into communication with the exhausting means and with air at atmospheric pressure, and an electric device subject to changes in current intensity for controlling said mechanism.

25. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, an exhausting means, mechanism for alternately putting said pneumatic device into communication with the exhausting means and with air at atmospheric pressure, and an electric device subject to change in current intensity for controlling said mechanism which is actuated only when said change in intensity reaches a given magnitude.

26. In combination with a feeder, a pneumatic device for controlling the operation

of the feeder, an exhausting means, mechanism for alternately putting said pneumatic device into communication with the exhausting means and with air at atmospheric pressure, an electric device subject to change in current intensity for controlling said mechanism which is actuated only when said change in intensity reaches a given magnitude, and means for adjusting said device to adapt it to respond to intensity changes of different magnitudes.

27. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, an exhausting means, mechanism for alternately putting said pneumatic device into communication with the exhausting means and with air at atmospheric pressure, an electric device subject to change in current intensity for controlling said mechanism which is actuated only when said change in intensity reaches a given magnitude, means for adjusting said device to adapt it to respond to intensity changes of different magnitudes, and means for adjusting said device to respond to higher or lower current intensities without affecting said differential action.

28. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, an exhausting means, mechanism for alternately putting said pneumatic device into communication with the exhausting means and with air at atmospheric pressure, an electric device subject to changes in current intensity for controlling said mechanism and means for adjusting said electrical device to respond to higher or lower current intensities.

29. In combination with a feeder, comprising separable driving elements, a pneumatic device for bringing about the engagement and disengagement of said elements, exhausting means, mechanism for alternately putting said pneumatic device in communication with the exhausting means and with air at atmospheric pressure, and an electrical device subject to changes in current intensity for controlling said mechanism.

30. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, an electromagnet subject to changes in current intensities, and mechanism controlled by the magnet for putting said pneumatic device alternately into communication with the exhausting means and with the air at atmospheric pressure.

31. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, an electromagnet subject to changes in current intensities, and mechanism controlled by the magnet for putting said pneumatic device alternately into communication with the exhausting means and with the air at atmospheric

pheric pressure, comprising a valve which when seated is subject on opposite sides to different pressures tending to keep the valve pressed to its seat.

32. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, an electromagnet, a solenoid coil subject to current of variable intensity, a solenoid core, and mechanism controlled thereby for putting said pneumatic device alternately into communication with the exhausting means and with air at atmospheric pressure.

33. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, and a valve associated with said core which controls communication between the pneumatic and the exhausting means.

34. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, and a valve associated with said core which controls communication between the pneumatic and the exhausting means and between the pneumatic and air at atmospheric pressure.

35. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, and a valve associated with said core which controls communication between the pneumatic and the exhausting means arranged so that when seated it is subject to low pressure on the side tending to keep it pressed to its seat.

36. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, a valve associated with said core which controls communication between the pneumatic and the exhausting means, and means for adjusting the length of travel of the core.

37. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, a valve associated with said core which controls communication between the pneumatic and the exhausting means, and means for adjusting the position which the core assumes when not attracted by the coil.

38. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, a valve associated with said core which controls communication between

the pneumatic and the exhausting means, means for adjusting the length of travel of the core, and means for adjusting the position which the core assumes when not attracted by the coil.

39. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, a valve associated with said core which controls communication between the pneumatic and the exhausting means and between the pneumatic and air at atmospheric pressure which is arranged so that when seated it is subject to low pressure on the side tending to keep it pressed to its seat, and means for adjusting the length of travel of the core.

40. In combination with a feeder, a pneumatic device for controlling the operation of the feeder, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, a valve associated with said core which controls communication between the pneumatic and the exhausting means and between the pneumatic and air at atmospheric pressure which is arranged so that when seated it is subject to low pressure on the side tending to keep it pressed to its seat, means for adjusting the length of travel of the core, and means for adjusting the position which the core assumes when not attracted by the coil.

41. Feed regulating mechanism comprising, in combination, a pneumatic device, exhausting means, a solenoid core subject to current of variable intensity, a solenoid core, a valve stem on said core, and a pair of valves on said stem adapted to alternately put the pneumatic in communication with the exhausting means and with the air at atmospheric pressure.

42. Feed regulating mechanism comprising, in combination, a pneumatic device, exhausting means, a solenoid core subject to current of variable intensity, a solenoid core, a valve stem on said core, a pair of valves on said stem adapted to alternately put the pneumatic in communication with the exhausting means and with air at atmospheric pressure, and a structure providing seats for said valve which is adjustable to vary the position which the core assumes when not attracted by the coil.

43. Feed regulating mechanism comprising, in combination, a pneumatic device, exhausting means, a solenoid core subject to current of variable intensity, a solenoid core, a valve stem on said core, and a pair of valves on said stem adapted to alternately put the pneumatic in communication with the exhausting means and with air at atmospheric pressure, one of said valves being adjustable so as to allow adjustment of the length of travel of the core.

44. Feed regulating mechanism comprising, in combination, a pneumatic device, exhausting means, a solenoid core subject to current of variable intensity, a solenoid core, a valve stem on said core, a pair of valves on said stem adapted to alternately put the pneumatic in communication with the exhausting means and with air at atmospheric pressure, and a structure providing seats for said valve which is adjustable to vary the position which the core assumes when not attracted by the coil, one of said valves being adjustable so as to allow adjustment of the length of travel of the core.

45. The combination with a pulverizing mill having means for exhausting the air therefrom, an electric motor for driving the mill, and means for feeding material to the mill comprising a ratchet and pawl; of a pawl lifting pneumatic, exhausting means, a solenoid coil in circuit with the motor, a solenoid core, a valve stem on said core, and a pair of valves on said stem adapted to put said pawl lifting pneumatic into communication alternately with the exhausting means and with air at atmospheric pressure.

46. The combination with a pulverizing mill having means for exhausting the air therefrom, an electric motor for driving the mill, and means for feeding material to the mill comprising a ratchet and pawl; of a pawl lifting pneumatic, exhausting means, a solenoid coil in circuit with the motor, a solenoid core, a valve stem on said core, and a pair of valves on said stem adapted to put said pawl lifting pneumatic into communication alternately with the exhausting means and with air at atmospheric pressure, said valve being arranged so that in each position of the core the closed valve is subject to a low pressure which tends to maintain said valve on its seat.

47. The combination with a pulverizing mill having means for exhausting the air therefrom, an electric motor for driving the mill, and means for feeding material to the mill comprising a ratchet and pawl; of a pawl lifting pneumatic, exhausting means, a solenoid coil in circuit with the motor, a solenoid core, a valve stem on said core, a pair of valves on said stem adapted to put said pawl lifting pneumatic into communication alternately with the exhausting means

and with air at atmospheric pressure, and a structure providing seats for said valves which is adjustable to move the core in and out of the coil.

48. The combination with a pulverizing mill having means for exhausting the air therefrom, an electric motor for driving the mill, and means for feeding material to the mill comprising a ratchet and pawl; of a pawl lifting pneumatic, exhausting means, a solenoid coil in circuit with the motor, a solenoid core, a valve stem on said core, a pair of valves on said stem adapted to put said pawl lifting pneumatic into communication alternately with the exhausting means and with air at atmospheric pressure, and a structure providing seats for said valves which is adjustable to move the core in and out of the coil, one of said valves being adjustable to make possible an adjustment of the length of travel of the core.

49. Feed regulating mechanism comprising, in combination, a pneumatic device, exhausting means, a solenoid core subject to current of variable intensity, a solenoid core, a valve stem on said core, and a pair of valves on said stem adapted to alternately put the pneumatic in communication with the exhausting means and with air at atmospheric pressure, said valves being arranged so that when each of them is seated it is subject to low pressure tending to maintain it in contact with its seat.

50. Feed regulating mechanism comprising, in combination, a pneumatic device, exhausting means, a solenoid coil subject to current of variable intensity, a solenoid core, a valve secured thereto, a diaphragm and diaphragm chamber, the latter having a port to the atmosphere controlled by said valve and a port of relatively small cross sectional area for maintaining the chamber in communication with the exhausting means, the other side of said diaphragm being in communication with the exhausting means through a larger orifice, and a valve on said diaphragm which in one position opens the pneumatic device to the atmosphere and in another position shuts off atmospheric pressure from the pneumatic device and opens the device to said exhausting means.

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