

June 16, 1925.

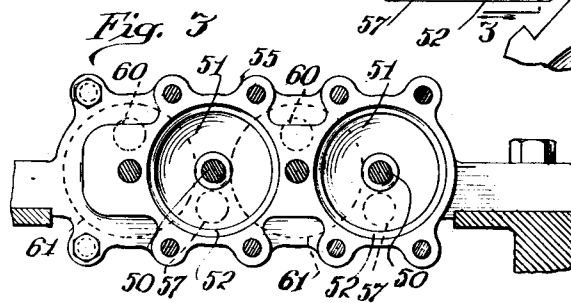
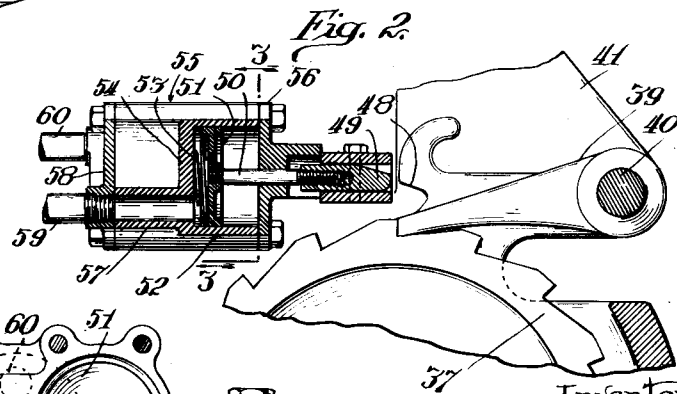
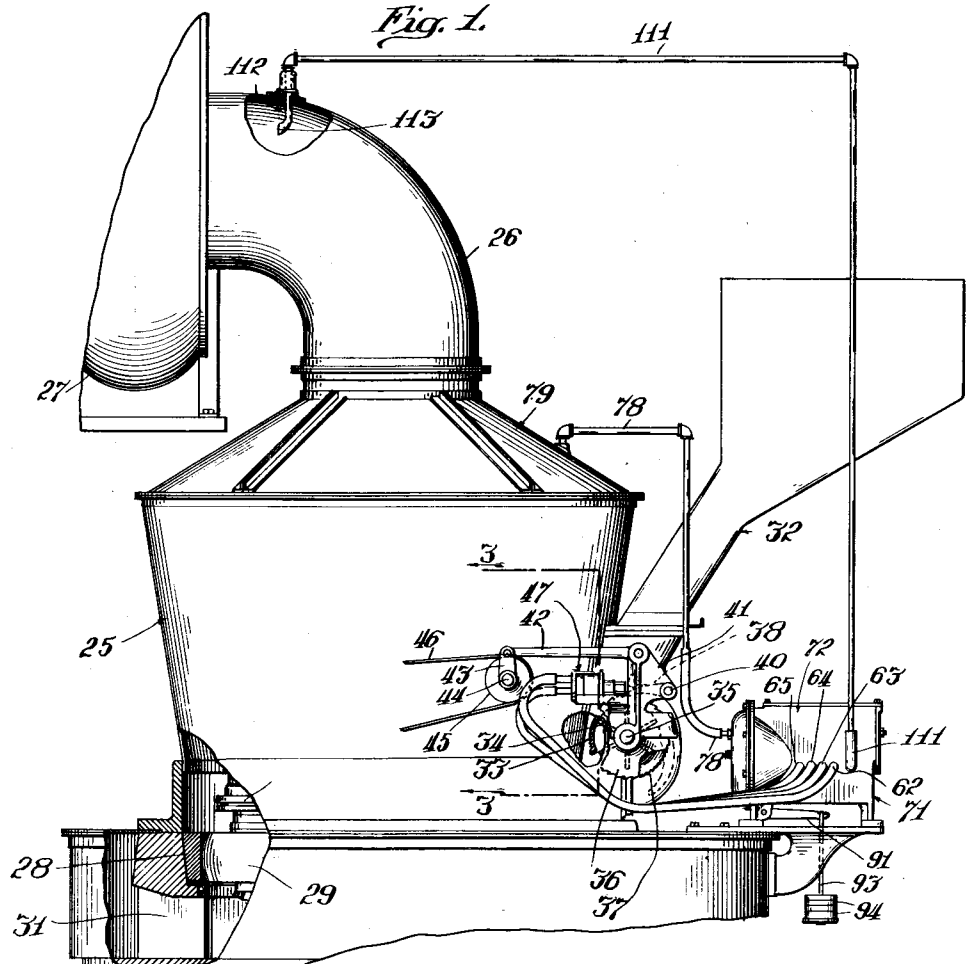
1,541,848

F. I. RAYMOND

FEED REGULATING MECHANISM

Filed June 26, 1923

4 Sheets-Sheet 1



Inventor
Fred I. Raymond
Barnett & O'Brien
Attorneys.

June 16, 1925.

1,541,848

F. I. RAYMOND

FEED REGULATING MECHANISM

Filed June 26, 1923

4 Sheets-Sheet 2

Fig. 4.

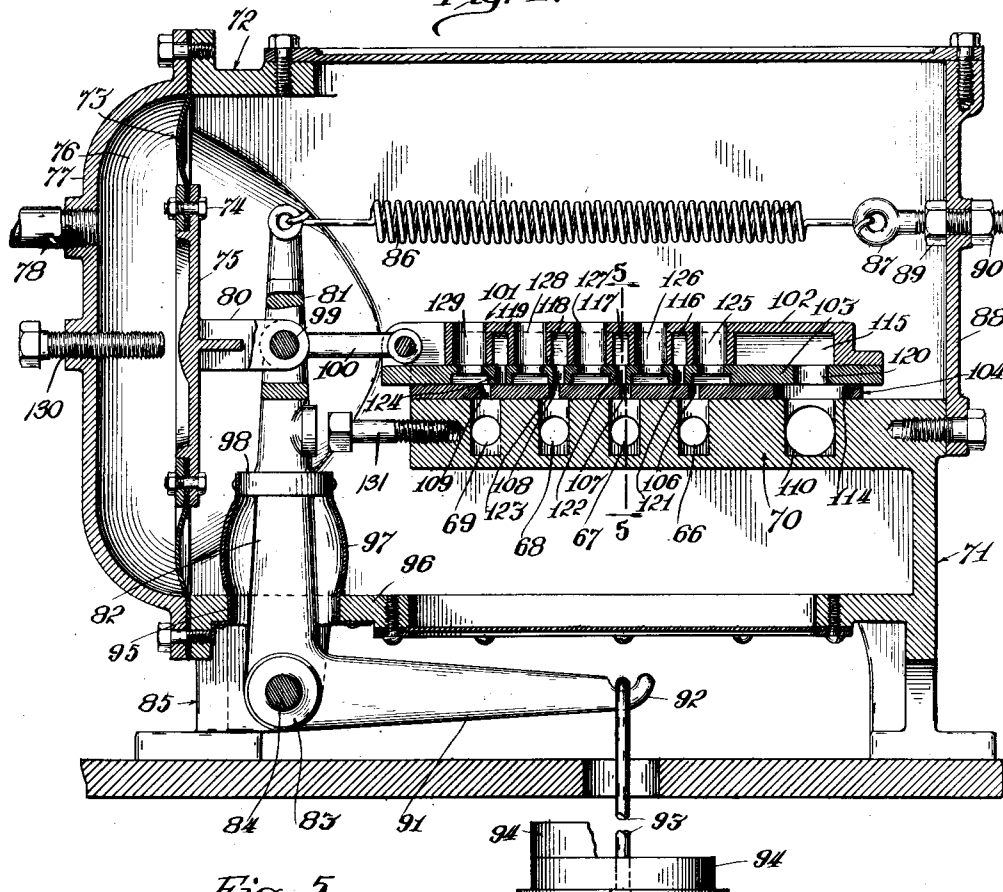


Fig. 5.

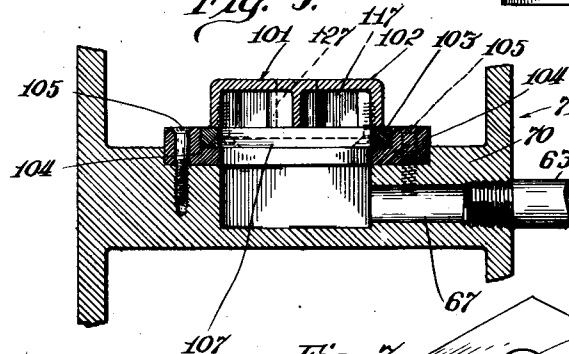


Fig. 6.

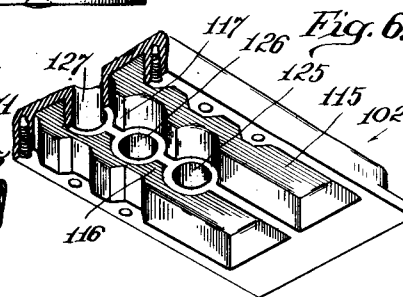
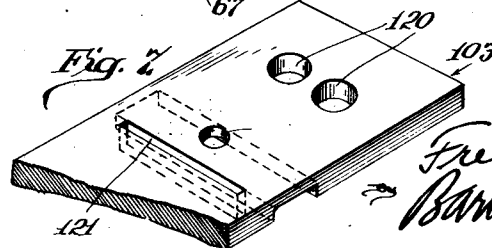


Fig. 7.



Inventor.
Fred I. Raymond
Barrett Newman
Attorneys

June 16, 1925.

1,541,848

F. I. RAYMOND

FEED REGULATING MECHANISM

Filed June 26, 1923

4 Sheets-Sheet 3

Fig. 8.

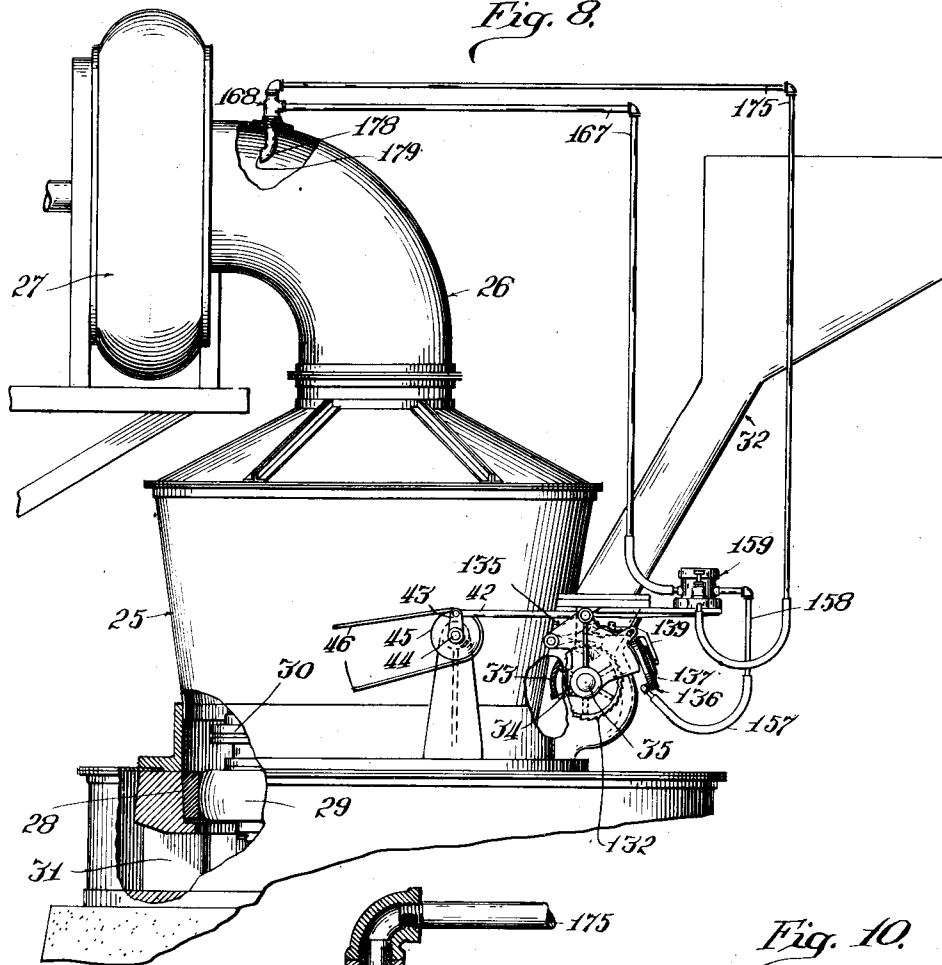


Fig. 9.

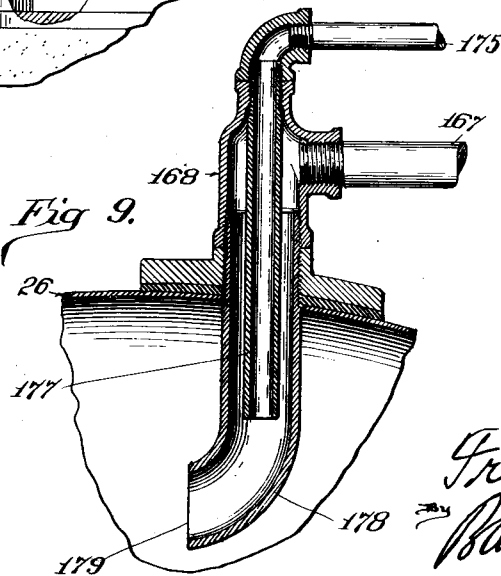
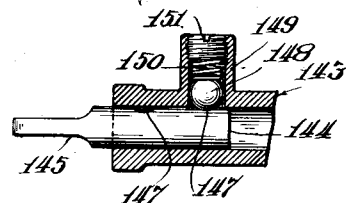


Fig. 10.



Inventor.

Fred. I. Raymond
Barnett L. Hume
Attorneys

June 16, 1925.

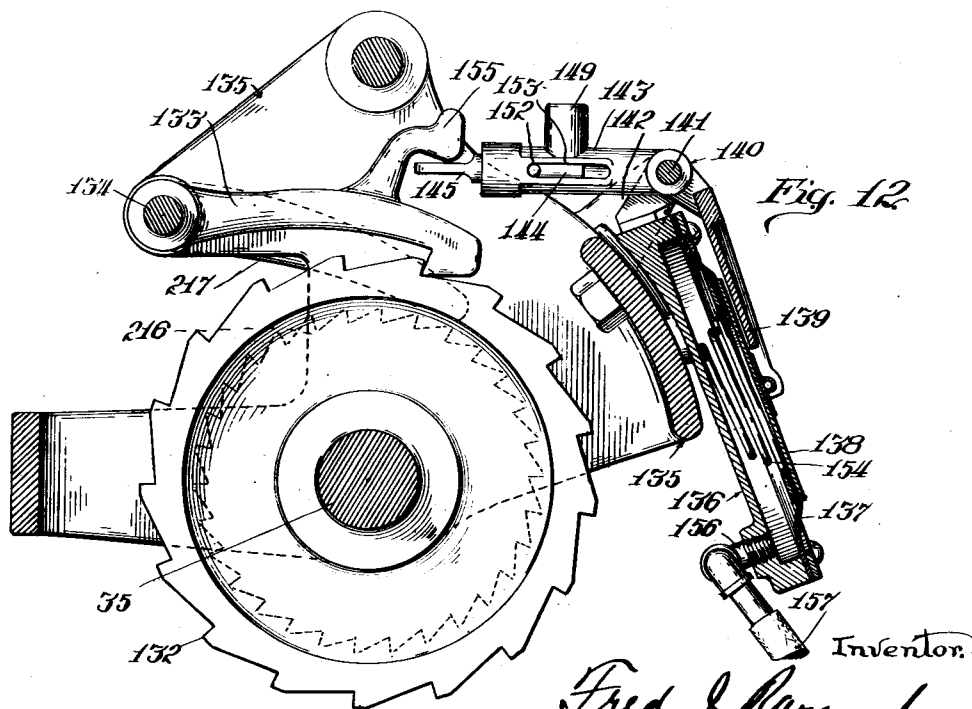
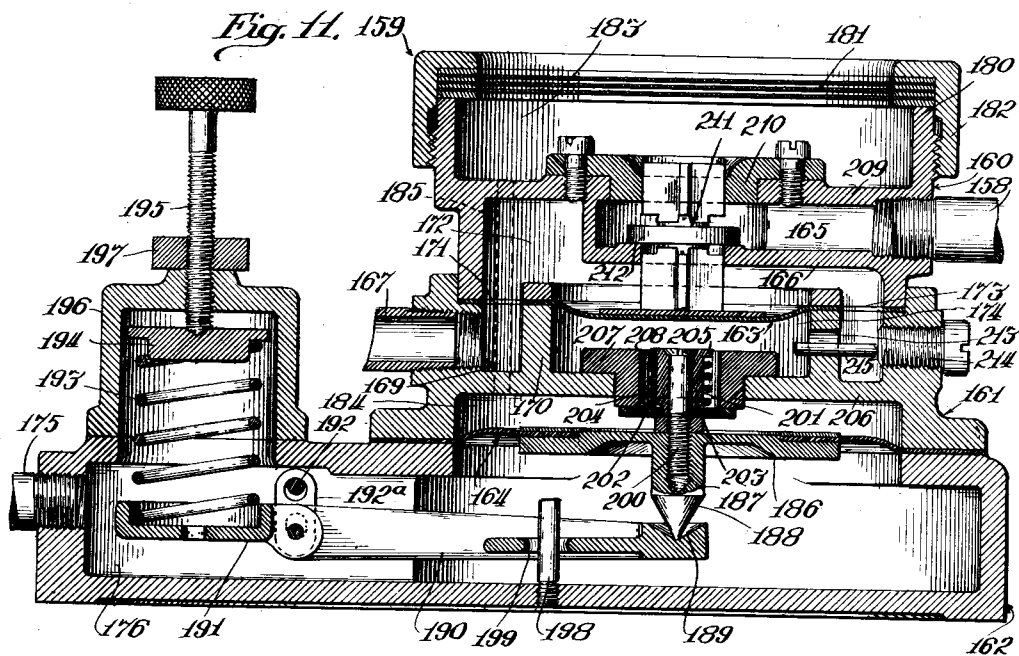
1,541,848

F. I. RAYMOND

FEED REGULATING MECHANISM

Filed June 26, 1923

4 Sheets-Sheet 4



Inventor.
Fred I. Raymond
Barrett D. Wiman
Attorneys.

UNITED STATES PATENT OFFICE.

FRED I. RAYMOND, OF EVANSTON, ILLINOIS, ASSIGNOR TO RAYMOND BROTHERS
IMPACT PULVERIZER COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF
ILLINOIS.

FEED-REGULATING MECHANISM.

Application filed June 26, 1923. Serial No. 847,774.

To all whom it may concern:

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

My invention relates to a feed regulating mechanism for pulverizing or grinding mills of the type involving the discharge of the material as it reaches the proper degree of pulverization by an air lift separation produced, for example, by a suction fan. Ordinarily in a mill of this type air is introduced into the mill below the region in which the material is pulverized and consequently, if the mill becomes overloaded because the material fed into it exceeds that withdrawn therefrom by the air lift, the vacuum in the upper part of the separator of the mill and in the pipe leading therefrom to the fan will become intensified.

The principal object of the invention is to provide a mechanism for regulating the introduction of material into the mill in response to fluctuations in the vacuum therein so that in case the mill becomes overloaded or tends to become overloaded the feed will be interrupted or diminished in quantity; in the first instance, to allow the mill to clear, and, in the second place, to counteract the tendency to overload and thereby maintain proper balance between feed and discharge.

A further object of the invention is to provide a feed regulating mechanism which will utilize only pneumatic devices for accomplishing the desired purpose.

The invention contemplates particularly a rotary feeder operated by one or more ratchet and pawl mechanisms and with this arrangement in view an object of the invention is to provide an apparatus in which the pawl is engaged with and disengaged from the ratchet by an instantaneous or snap action, although the fluctuations of the vacuum in the mill will ordinarily be gradual.

A further object is to so construct the feed regulating mechanism that it will not be actuated at each slight variation in the intensity of the vacuum in the mill but will respond only to vacuum changes of some magnitude. The purpose of this is to pre-

vent too frequent engagement and disengagement of the parts driving the feeder which, if permitted, would result in unnecessary wear on the different elements of the regulating mechanism.

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

Fig. 1 is a fragmentary view, in side elevation, with certain parts shown in section, illustrating the application of my invention, in one embodiment, to a pulverizing mill of a common type.

Fig. 2 is a fragmentary view in side elevation, with parts in section, and on a larger scale than Fig. 1, of one of the feeder ratchets, its pawl and the pneumatic device for controlling the position of the pawl.

Fig. 3 is a fragmentary sectional view on line 3—3 of Fig. 1.

Fig. 4 is a longitudinal sectional view of a device, responsive to pressure fluctuations in the mill, for controlling the application of suction to the pawl controlling pneumatics.

Fig. 5 is a fragmentary cross sectional view on line 5—5 of Fig. 4.

Fig. 6 is a fragmentary view, in perspective, of the upper member of the multiple controlling valve shown in Figs. 4 and 5.

Fig. 7 is a similar view illustrating the lower member of this valve.

Fig. 8 is a view similar to Fig. 1 illustrating another embodiment of my invention.

Fig. 9 is a sectional view of the suction nozzle through which the exhaust of the pawl operated pneumatic and its controlling mechanism takes place.

Fig. 10 is a sectional view, in detail, of a device shown in assembled relation in Fig. 12 for disconnecting the feed regulating mechanism from the feeder.

Fig. 11 is a longitudinal sectional view of the controlling mechanism responsive to pressure fluctuations in the mill for governing the application of the vacuum to the pawl operating pneumatic, and

Fig. 12 is a side elevation, with parts in section, of the feeder ratchet, its pawl and the pneumatic for operating the pawl.

Referring first to Figs. 1 to 7 inclusive, 25 designates the casing of a pulverizing mill of the Raymond type, 26, the pipe through which the pulverized material is discharged

by operation of fan 27, 28 the bull ring of the mill against which bear a series of rollers 29 on pendant journals 30 and 31 air openings into the mill below the region in which pulverization takes place.

The mill is shown as provided with a feed chute 32 which terminates in a cylindrical casing 33 in which is arranged a rotary pocket feeder 34. To the shaft 35 of the feeder are fixed a plurality of ratchets. The illustrated installation employs four such ratchets, two being shown and designated 36 and 37. These ratchets are of the same diameter but differ in respect to the number of teeth formed thereon. The outer ratchet 36 has a minimum number of teeth. Ratchet 37 and the other two ratchets (not shown) have progressively larger numbers of teeth. The ratchets are rotated by four pawls, two of which are indicated and designated 38 (Fig. 1) and 39 (Fig. 2). These pawls are identical and are pivoted upon a shaft 40 forming part of a carrier 41 loosely mounted on the shaft 35 of the feeder. The carrier is oscillated by a pitman 42 shown as connected to a crank 43 on a drive shaft 44 provided with a pulley 45 for the belt 46. The throw of the pawls will be equal to (or slightly greater than) the arc subtended by a tooth on the ratchet wheel 36 having the smallest number of teeth, or a multiple thereof, so that with pawl 38 engaging ratchet 36 the feed into the mill will be at a maximum while with any other of the ratchet and pawl mechanisms in operation (and the ratchet mechanism or mechanisms having the smaller number of teeth out of operation) the feed into the mill will be proportionately diminished. This results from the lost motion between all of the pawls and their respective ratchets except the first ratchet and pawl 36, 38.

The feeder pawls are normally held out of engagement with their ratchets by means of spring pressed detents. These detents are withdrawn from the pawls by suction actuated pneumatics. The evacuation of the pneumatics takes place successively as the vacuum in the mill becomes intensified through overloading of the mill, the application of suction to the pneumatics being controlled by a multiple valve actuated in response to pressure fluctuations in the mill.

In Fig. 2 I have shown pawl 39 in operative relation with its ratchet 37 together with the pawl controlling pneumatic which is shown as under suction so that its detent is withdrawn from contact with the pawl. The other three pawls are provided with similar pneumatic devices, that for controlling the pawl 38 being shown in Fig. 1 and designated 47.

Figs. 4, 5, 6 and 7 show the multiple valve controlling mechanism for bringing about the application of suction to the pawl

controlling pneumatics in direct response to changes in the intensity of the vacuum in the mill.

Referring to Fig. 2, the pawl 39 is shown as formed in its front end with a notch 48 adapted to be engaged by a detent 49 on the stem 50 of a piston 51 contained in a cylinder 52 supported on the oscillating pawl carrier 41. 53 is a coiled spring interposed between the piston 51 and the back wall 54 of cylinder 52. The cylinders for all four ratchet and pawl mechanisms form preferably a single structure designated as a whole by 55 (Fig. 3), the cylinders being closed at the front by a single head or closure plate 56. The structure 55 is formed with inlet ducts to the several cylinders, 57 designating the duct leading to cylinder 52. 58 is a back head provided with nipples leading to the aforesaid inlet ducts, 59 designating the nipple communicating with duct 57 and 60 the nipple corresponding to the cylinder 61 of the first or outer pneumatic 47 of the series. The four nipples are connected by flexible tubes 62, 63, 64 and 65 with ports 66, 67, 68 and 69, respectively, in a web 70 forming part of the controlling device, designated generally by the numeral 71 and shown in Fig. 4. This device consists of a casing 72 enclosing the web 70 across one end of which casing is arranged a flexible annular diaphragm 73 in the opening of which is secured by bolts 74 a plate 75. The vacuum chamber 76 formed between the flexible diaphragm and the end section 77 of the casing 72 is in communication with the interior of the mill casing through a pipe 78 which is tapped into the top member 79 of the mill. The diaphragm plate 75 is formed with a projection 80 which extends through the bifurcated portion 81 of an upstanding arm 82 of a bell crank lever 83 pivoted at 84 to the base portion 85 of casing 72. Attached to the upper end of arm 82 of the bell crank is a coiled spring 86, the other end of which is attached to an adjustable eyelet 87 threaded through the end wall 88 of casing 72 and held in proper position by lock nuts 89, 90. The horizontal arm 91 of bell crank 83 is formed with a hook 92 for a weight carrier 93 which may support any suitable number of weights 94. The arm 82 of the bell crank extends through an opening 95 in the bottom wall 96 of casing 72, protection being afforded against the entrance of dust through this opening by a flexible dust shield 97 secured to a boss 98 on the bell crank and to the lower wall 96 of the casing. The projection 80 on the diaphragm plate is secured to the bell crank lever by a pin 99 which provides attaching means for a connecting rod 100 connecting the lever with a multiple slide valve 101. This valve consists of an upper plate 102 and a

lower plate 103, rigidly secured together, and slides in a channeled guide plate 104 secured to the web 70 by screws 105 (Fig. 5). The guide plate 104 is formed with four ports 106, 107, 108 and 109 communicating with the ports 66, 67, 68 and 69, respectively, formed in the web 70. The web is also formed with a port 110 and from this port leads a pipe 111 provided at its other end with a nozzle 112 which extends into the discharge pipe 26 of the mill near fan 27, the nozzle having its mouth 113 opening toward the fan. Guide plate 104 has an opening 114 above port 110. The valve 101 is formed with communicating chambers 115, 116, 117, 118 and 119, the first of which communicates, for all positions of the valve, with duct 110 through opening 120 in the bottom plate 103 of the valve, the bottom plate of the valve being formed with ports 121, 122, 123 and 124 leading from chambers 116, 117, 118 and 119, respectively, and adapted to communicate in accordance with the position of the valve with ports 106, 107, 108, 109, respectively. The valve is also formed with through ports 125, 126, 127, 128 and 129 for the purpose of venting the ducts 66, 67, 68 and 69, and the pawl controlling pneumatics connected therewith, in certain positions of the valve.

The ports as above described are arranged so that as the vacuum in the mill increases, resulting in a movement of the valve 101 from right to left (Fig. 5) the ducts 66, 67, 68 and 69 will be evacuated consecutively in the order mentioned, the evacuation of each duct being continued until the evacuation of the next succeeding one of the series has been effected, while each duct is open to the atmosphere as soon as it has been cut off from the suction. The purpose of this is to prevent any interruption of the feed. One pawl is always active until the next succeeding pawl has been released and engaged with its ratchet. It is a matter of no importance that at certain intensity of vacuum two pawls will be released. In such case the pawl operating on the longer tooth will determine the amplitude of rotation of the feeder. In Fig. 4 the valve is shown in a position to bring about the actuation of the second and third pawl controlling pneumatics. The suction has been already cut off from the pneumatic which controls the pawl acting on the first ratchet wheel 36, and this pneumatic is vented through opening 125. The duct 69 for the fourth pneumatic is open to the atmosphere through opening 129 in the valve. The pawl which is actually active is pawl 39 operating on ratchet 37 (Fig. 2). With an increase of vacuum in the mill the suction will be cut off from the cylinder 52 of the second pneumatic, whereupon pawl 39 will be disengaged from its ratchet and the third pawl, already in engagement with its ratchet,

will continue the feed of material into the mill but in a smaller amount per unit of time. When the suction is cut off from any one of the pneumatics the spring 53 (Fig. 2) forces the piston 51 outwardly so as to bring detent 49 into the notch 48 in the pawl which latter will be raised by riding up the inclined edge of the tooth on which the pawl bears. There is a cam action between the detent and pawl which raises the pawl sufficiently to clear the teeth. Approximate adjustment of the controller 71 can be obtained by varying the number of weights 94 suspended from the horizontal arm 91 of the bell crank. A closer adjustment is made by means of the adjusting screw 87. 130 is a bumper screw arranged in the end casing section 77 to prevent the diaphragm from being flexed to too great an extent. 131 is a bumper screw on the web 70 to limit the movement of the bell crank lever, and the diaphragm, in the other direction.

Referring now to Figs. 8 to 12 inclusive, showing a modified and preferred form of invention: The pneumatic for controlling the engagement of the pawl with the ratchet and its disengagement therefrom is of the diaphragm type as shown in Fig. 12. The controller for governing the application of the suction to the pneumatic is shown in Fig. 11 and is constructed for the particular purpose of insuring quick action by the pneumatic, so that the pawl will be snapped into and out of engagement with its ratchet instantaneously and for the further purpose of giving the regulating mechanism a lag so that the pawl will not be moved into and out of engagement with every slight variation in intensity of vacuum in the mill. 132 designates a ratchet wheel on the shaft 35 of the rotary feeder 34. The ratchet is engaged by a pawl 133 pivoted at 134 to a pawl carrier 135 arranged to oscillate on the shaft of the feeder, the pawl carrier being given reciprocating movements by the driving mechanism 42, 43, 44, 45 and 46 described in connection with the apparatus shown in Fig. 1. The pawl operating pneumatic consists of a casing 136 supporting a flexible diaphragm 137 to which is secured a plate 138 having pivoted thereto one arm 139 of a bell crank 140 pivoted at 141 to ears 142 on the oscillating carrier 135. The arm 143 of bell crank 140 is tubular to receive the cylindrical portion 144 (Fig. 10) of a pawl lifter 145, the portion 144 of the pawl lifter being formed with two notches 146, 147 adapted to be engaged by a ball latch 148 arranged in a housing 149 on the tubular portion 143 of the bell crank, a spring 150 being interposed between the ball and the plug 151 which closes the end of the housing. The cylindrical portion of the pawl lifter is formed with a guide stud 152 extending through a slot 153 in the side of member 143.

The purpose of this arrangement is to provide for sliding the pawl lifter back into the bell crank so as to disconnect the regulating mechanism from the pawl. 154 is a spring arranged back of the diaphragm plate 138. The end of the pawl lifter engages an ear 155 on pawl 133. The space between casing 136 and diaphragm 137, 138 is evacuated through a nipple 156 connected by flexible tube 157 with a pipe 158 which leads to the controller designated as a whole by numeral 159.

The controller comprises a casing made up of casing sections 160, 161 and 162, a flexible diaphragm 163 being clamped between sections 160 and 161 and a flexible diaphragm 164 being similarly arranged between sections 160 and 162. Pipe 158 leading to the pawl operating pneumatic, above referred to, communicates with a chamber 165 formed by a web 166 within casing section 160. 167 is a pipe leading from a suction nozzle 168 in the discharge pipe 26 of the mill near the fan 27, and extending to a chamber 169 formed in the casing section 161 by a web 170. This chamber communicates by an opening 171 in diaphragm 163 with the chamber 172 above the diaphragm. The diaphragm is formed with another opening 173 whereby chamber 172 is in communication with a chamber 174 under said diaphragm. A pipe 175 connects the upper end of the suction nozzle 168 with a chamber 176 below diaphragm 164. A pipe section 177 arranged within the vacuum nozzle forms a continuation, in effect, of pipe 175. The lower end of the vacuum nozzle is curved as indicated at 178 and has its opening 179 facing the fan 27. The upper casing section 160 is formed with an upstanding boss 180 to the top of which are secured filter discs 181 by means of an annular nut 182. The space 183 below the filter is in communication with a chamber 184 directly above diaphragm 164 through a duct 185 in the wall of casing 160, 161. Diaphragm 164 has secured thereto a plate 186 formed with a depending stud 187 having a pointed end 188 bearing in the conical recess 189 in a lever 190 formed with a spring seat 191 the lever being loosely and pivotally supported on a stud 192, by means of a link 192*. The spring seat 191 supports a coiled spring 193, the upper end of which bears against a follower 194 seated against the end of an adjusting screw 195 extending through a bonnet 196 on the casing section 162, the adjusting screw being held in fixed position by a lock nut 197. 198 is a guide stud for lever 190, the stud extending through an opening 199 in the lever. Secured by a screw 200 to the upper face of the diaphragm plate 186 is a guide stem 201 for a valve 202 which has limited vertical movement in an annular recess 203

in the guide stud and is normally held at the bottom of the recess by a coiled spring 204, the upper end of which bears against a shoulder 205 on the stem 201. The lower web 206 of casing member 161 is provided with a valve seat 207 having an opening 208 therethrough for the valve stem 201. The upper web 209 of casing section 160 is provided with a valve seat 210 for a valve 211 which, in its lower position, is adapted to engage with a seat 212 formed on web 166. Valve 211 is supported on the upper diaphragm 163. For cleaning out possible accumulation of dirt in the port 213 connecting chamber 174 with chamber 172, a screw plug 214 is provided in the side wall of casing section 171 which has a stud 215 semi-circular in cross section to project into the port 213.

The operation of the regulating mechanism shown in Figs. 8 to 12 inclusive is as follows: The drawings show the feeder in operation, pawl 133 being in engagement with the ratchet wheel 132. The ratchet is turned and with it the feeder through the oscillatory movements of the pawl carrier 135 to which the pawl is pivoted. The intensity of the vacuum in the mill is at or below normal, or possibly slightly above normal, but not enough to actuate the regulating mechanism. The vacuum in chamber 176 is relatively low so that spring 193 holds the diaphragm 164 in its upper position seating valve 202 against the seat 207. The low pressures developed in chambers 172 and 174 by the suction in pipe 167 are equal, since these chambers are in communication through openings 173, 213 and as a result valve 211 is in its lower position against seat 212 shutting off the pawl lifting pneumatic 136, 137 from the low pressure in chamber 172 and opening the same to the atmosphere through the port in valve seat 210 and the air pervious filters 181.

Assuming now that the mill becomes overloaded through excess of material fed in over that discharged by the exhausting apparatus, the vacuum in the part of the mill above the region of pulverization will increase in intensity due to the increased resistance of the accumulated solids to the entrance of air through the air openings 31 below the pulverizing rollers 29. Increased suction in the mill will be followed by an increased suction in chamber 176 of the controller 159 which, acting upon diaphragm 164, will pull down valve stem 201. The first downward movement of the diaphragm will not unseat valve 202 since the stem can slide for a certain distance through the valve compressing spring 204. When, however, the upper shoulder of the recess 203 on the valve stem comes against the valve, further downward movement of the diaphragm will unseat the valve and as soon

as the air pressure is relieved on the under side of the valve 202 spring 204 will move the valve quickly against the shoulder at the lower side of the recess on the stem fully opening the port between chamber 184 and chamber 174. The chamber 184 is constantly open to the atmosphere through port 185. As soon as valve 202 is unseated air at atmospheric pressure will enter the chamber 174 under diaphragm 163 and as the port 213 through which chamber 174 communicates with chamber 172 is relatively small in comparison with opening 171 between chamber 172 and the suction pipe 167 the pressure under diaphragm 163 will be greater than the pressure above the diaphragm so that valve 211 will be raised against its upper seat 210, shutting off the pawl lifting pneumatic from the atmosphere, putting it in communication with vacuum chamber 172. As a result the diaphragm 137 of the pawl lifting pneumatic will be collapsed compressing spring 155 and the bell crank of lever 139 will be rocked so as to cause the pawl lifter 145 to bear against the ear of the pawl and lift the pawl out of engagement with ratchet 132. The pawl will be held out of engagement with the ratchet so long as the abnormal increase of vacuum in the mill continues. As soon, however, as the mill has cleared reestablishing the normal vacuum therein, spring 193 of the controller will rock lever 190 to bring valve 202 against its seat, whereupon the pressures on opposite sides of diaphragm 163 will be equalized, valve 211 moved to its lower seat and the vacuum shut off from the pawl lifting pneumatic and the latter vented to the atmosphere.

It will be observed that the construction of the controller 159 is such that the pawl lifting pneumatic is not actuated for every slight and transitory fluctuation in the intensity of vacuum in the mill. The pneumatic is actuated to move the pawl in opposite directions at certain maximum and minimum vacua in the mill susceptible of variation by adjustment of the controller. The controller has a lag so that the maximum and minimum vacua must be of appreciable duration in order to bring about actuation of the pawl lifting pneumatic. Furthermore, the operation of lifting the pawl from its ratchet is instantaneous. The suction is applied to the pneumatic which operates the pawl lifter suddenly by the quick upward movement of valve 211 resulting from the rush of air at atmospheric pressure through the port 208 which is opened fully under the action of spring 204 as soon as the air pressure on the under side of the valve has been relieved. The air under diaphragm 163 bleeds out through opening 213 but this opening is so small that as soon as

valve 202 is open to the full chamber 174 is kept filled with air at a pressure but slightly below atmospheric pressure.

The regulating means shown in Figs. 8 to 12 inclusive involves a cessation of the feed when the mill overloads. However, this mechanism is equally well adapted to produce a diminution in the amount of material fed into the mill as well as the stopping of the feed. It will be possible to provide the feeder shaft 35 with a ratchet 216 and provide a second pawl 217 on shaft 134 to rotate ratchet 216. These parts are indicated in dotted lines in Fig. 12. Ratchet 216 is designed to rotate the feeder through a smaller arc for each operative stroke of the pawl carrier and is not provided with a regulating device but operates constantly. The pawl and ratchet mechanism 216, 217 will be ineffective when pawl 133 is in engagement with its ratchet 132 but will serve to give a diminished feed when pawl 133 is made inactive.

To disconnect the regulating mechanism from pawl 133 the pawl lifter 144, 145 is slid into the tubular portion 143 of the operating bell crank until notch 147 (Fig. 10) is engaged by the ball check 148.

I claim:

1. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material therefrom, a feeder, a pneumatic for controlling the feeder, and a device responsive to pressure changes in the mill for actuating said pneumatic only when pressure changes of predetermined magnitude take place.

2. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material therefrom, a feeder having an operating member, a pneumatic for operatively connecting and disconnecting said member with the feeder, and a device responsive to pressure changes in the mill for actuating said pneumatic only when pressure changes of predetermined magnitude take place.

3. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material therefrom, a feeder comprising a ratchet and pawl, a pneumatic for bringing said pawl into and out of engagement with said ratchet, and a device responsive to pressure changes in the mill for actuating said pneumatic only when pressure changes of predetermined magnitude take place.

4. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material therefrom, a feeder, means operated through vacuum produced in the mill for controlling the operation of the feeder, and means responsive to fluctuations in the intensity of the vacuum in the mill for actuating said controlling means

only when pressure changes of predetermined magnitude take place.

5. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material therefrom, a feeder, means for controlling the operation of the feeder, a valve to control communication between the mill and the feeder controlling means, and means responsive to fluctuations in the intensity of the vacuum in the mill for imparting movements to said valve.

6. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material therefrom, a feeder comprising a ratchet and pawl, a device operated through vacuum produced in the mill for bringing about the engagement of the pawl with and disengagement from the ratchet, a valve to control communication between the mill and said pawl operating device, and means responsive to fluctuations in intensity of the vacuum in the mill for imparting movements to said valve.

7. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material therefrom, a feeder comprising a ratchet and pawl, mechanism supported so as to oscillate with said pawl, a pneumatic similarly supported for moving said pawl into and out of operative engagement with the ratchet, and means responsive to fluctuations in the intensity of the vacuum in the mill for actuating said pneumatic.

8. In combination with a pulverizing mill, a discharge pipe, and exhausting apparatus for removing the pulverized material through said discharge pipe, a feeder, and pneumatically operated mechanism for controlling the operation of the feeder comprising an air conduit leading from said mechanism to a point in the discharge pipe adjacent said exhausting apparatus, said air pipe having a nozzle extending within the discharge pipe which opens toward said exhausting apparatus.

9. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder comprising a ratchet and pawl, a pneumatic normally holding the pawl out of engagement with the ratchet which, when evacuated, releases the pawl, and mechanism responsive to fluctuations of pressure in the mill for controlling the evacuation of the pneumatic.

10. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder comprising a ratchet and pawl, a cylinder mounted to oscillate with the pawl, a piston in said cylinder having a detent which normally holds the pawl out of contact with the ratchet, and mechanism for controlling the evacuation of the cylinder

in response to fluctuations in pressure in the mill.

11. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a plurality of driving devices for the feeder which operate the same to bring about the introduction of the material into the mill in different quantities per unit of time, and mechanism for connecting said driving devices with and disconnecting the same from the feeder selectively in accordance with different pressures in the mill.

12. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a plurality of driving devices for the feeder which operate the same to bring about the introduction of the material into the mill in different quantities per unit of time, and mechanism for connecting said driving devices with and disconnecting the same from the feeder selectively in accordance with different pressures in the mill, said mechanism operating to connect one of said devices to the feeder, in each case, before the then operating driving device is disconnected from the feeder.

13. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a plurality of ratchets and pawls for rotating the feeder to vary the feed into the mill, and mechanism for bringing about engagements of said pawls with and disengagements of the same from their ratchets selectively, in accordance with fluctuations of pressure in the mill.

14. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a plurality of ratchets and pawls for rotating the feeder to vary the feed into the mill, and mechanism for bringing about engagements of said pawls with and disengagements of the same from their ratchets selectively, in accordance with fluctuations of pressure in the mill, said mechanism operating to effect the engagement of one of said pawls with said ratchet, in each case, before the then operating pawl has been disengaged from its ratchet.

15. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a plurality of ratchets and pawls for rotating the feeder to vary the feed into the mill, pneumatic detent devices released by suction for normally holding said pawls out of engagement with their ratchets, respectively, and multiple valve devices for controlling the application of suction to said pneumatic detent devices selectively in accordance with fluctuations of pressure in the mill.

16. In combination with a pulverizing

mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a plurality of ratchets and pawls for rotating the feeder to vary the feed into the mill, pneumatic detent devices released by suction for normally holding said pawls out of engagement with their ratchets, respectively, and a multiple valve device for bringing about the application of suction to said pneumatic devices successively as the intensity of the vacuum in the mill changes.

17. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a plurality of ratchets and pawls for rotating the feeder to vary the feed into the mill, pneumatic detent devices released by suction for normally holding said pawls out of engagement with their ratchets, respectively, and a multiple valve device for bringing about the application of suction to said pneumatic devices successively as the intensity of the vacuum in the mill changes, said multiple valve device operating to keep one pawl in engagement with its ratchet, in each case, until the succeeding pawl has been engaged with its ratchet.

18. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder comprising a plurality of ratchets and pawls operating to vary the feed into the mill, pneumatic detent devices released by suction for normally holding said pawls out of engagement with their ratchets, respectively, and controlling mechanism for applying suction to said pneumatics successively comprising a conduit leading from the mill to the controller, a plurality of conduits leading from the controller to said pneumatics respectively, a diaphragm subject to pressure fluctuations in the mill, a lever connected with said diaphragm, a multiple valve operated by said diaphragm for putting the conduits leading to said pneumatics into communication successively with the first named conduit and venting said pneumatics successively as the vacuum is shut off from the same, and an adjustable element which resists the movement of the diaphragm.

19. In combination with a pulverizing mill, exhausting means for discharging the pulverized material from the mill, a feeder, means for driving the feeder comprising an operating element, a pneumatic for moving said operating element into and out of operative position, and mechanism responsive to fluctuations of pressure in the mill for effecting the instantaneous actuation of said pneumatic device.

20. In combination with a pulverizing mill, exhausting means for discharging the pulverized material from the mill, a feeder, means for driving the feeder comprising an

operating element, a pneumatic for moving said operating element into and out of operative position, and mechanism which is unaffected by small changes in the intensity of the vacuum in the mill but is operated by changes of determinate magnitude to actuate said pneumatic device.

21. In combination with a pulverizing mill, exhausting means for discharging the pulverized material from the mill, a feeder, means for driving the feeder comprising an operating element, a pneumatic for moving said operating element into and out of operative position, and mechanism which is unaffected by changes in the intensity of the vacuum in the mill that are small and of short duration but is operated by changes of a determinate magnitude or duration to actuate said pneumatic.

22. In combination with a pulverizing mill, exhausting means for discharging pulverized material from the mill, a feeder, means for driving the feeder comprising a ratchet wheel, an oscillating pawl carrier, and a pawl thereon, and mechanism for moving said pawl into and out of engagement with the ratchet comprising a casing on the carrier, a flexible diaphragm extending across the casing, a lever operated by the diaphragm, and a pawl lifter operated by the lever.

23. In combination with a pulverizing mill, exhausting means for discharging pulverized material from the mill, a feeder, means for driving the feeder comprising a ratchet wheel, an oscillating pawl carrier, and a pawl thereon, and mechanism for moving said pawl into and out of engagement with the ratchet comprising a casing on the carrier, a flexible diaphragm extending across the casing, a lever operated by the diaphragm, and a pawl lifter operated by the lever which is adjustable to a position in which it will not engage the pawl.

24. In combination with a pulverizing mill, exhausting means for discharging pulverized material from the mill, a feeder, means for driving the feeder comprising a ratchet wheel, an oscillating pawl carrier and a pawl thereon, and mechanism for moving said pawl into and out of engagement with the ratchet comprising a casing on the carrier, a flexible diaphragm extending across the casing, a bell crank lever oscillated by the diaphragm, and a pawl lifter on said bell crank lever.

25. In combination with a pulverizing mill, exhausting means for discharging pulverized material from the mill, a feeder, means for driving the feeder comprising a ratchet wheel, an oscillating pawl carrier and a pawl thereon, mechanism for moving said pawl into and out of engagement with the ratchet comprising a casing on the carrier, a flexible diaphragm extending across

the casing, a bell crank lever oscillated by the diaphragm, and a pawl lifter telescopically arranged with respect to the bell crank for the purpose described.

26. In combination with a pulverizing mill, exhausting means for discharging the pulverized material from the mill, a feeder, means for driving the feeder comprising a ratchet wheel, an oscillating pawl carrier and a pawl thereon, and mechanism for moving the pawl into and out of engagement with the ratchet comprising a pneumatic device on the carrier and a pawl lifter operated by said pneumatic device.

27. In combination with a pulverizing mill, exhausting means for discharging the pulverized material from the mill, a feeder, means for driving the feeder comprising a ratchet wheel, an oscillating pawl carrier and a pawl thereon, mechanism for moving the pawl into and out of engagement with the ratchet comprising a pneumatic device on the carrier and a pawl lifter operated by said pneumatic device, and controlling mechanism subject to fluctuations in the intensity of the vacuum in the mill which when subjected to continued maximum and minimum vacua actuates the pawl operating pneumatic in opposite directions.

28. In combination with a pulverizing mill, exhausting means for discharging the pulverized material from the mill, a feeder, and means for regulating the operation of the feeder comprising a pneumatic device and mechanism subject to fluctuations in intensity of the vacuum in the mill for controlling the pneumatic comprising a valve in the conduit leading from the pneumatic, and means which at maximum and minimum vacua in the mill moves said valve in opposite directions.

29. In combination with a pulverizing mill, exhausting means for discharging the pulverized material from the mill, a feeder, and means for regulating the operation of the feeder comprising a pneumatic device and mechanism subject to fluctuations in intensity of the vacuum in the mill for controlling the pneumatic, comprising a valve which in one position subjects the pneumatic to suction and in another position opens the same to the atmosphere, and means for moving said valve in opposite directions.

30. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a

feeder, a pneumatic for governing the operation of the feeder, and controlling mechanism for alternately subjecting the pneumatic to suction from the mill and to atmospheric pressure comprising a valve which in one position places the pneumatic in communication with the mill and in another position in communication with the atmosphere, and means subject to vacuum fluctuations in the mill for controlling the movement of said valve.

31. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a pneumatic for governing the operation of the feeder, controlling mechanism for alternately subjecting the pneumatic to suction from the mill and to atmospheric pressure comprising a valve which in one position places the pneumatic in communication with the mill and in another position in communication with the atmosphere, and a diaphragm for operating said valve subject, on opposite sides, to suction from the mill but through openings of different cross sectional area, a valve for alternately opening to the atmosphere and shutting off from the atmosphere the space on the side of said diaphragm subject to suction through the smaller opening, and a diaphragm subject to pressure fluctuations in the mill for opening and closing said last named valve.

32. In combination with a pulverizing mill, exhausting apparatus for removing the pulverized material from the mill, a feeder, a pneumatic for governing the operation of the feeder, controlling mechanism for alternately subjecting the pneumatic to suction from the mill and to atmospheric pressure comprising a valve which in one position places the pneumatic in communication with the mill and in another position in communication with the atmosphere, a diaphragm for operating said valve subject, on opposite sides, to suction from the mill but through openings of different cross sectional area, a valve for alternately opening to the atmosphere and shutting off from the atmosphere the space on the side of said diaphragm subject to suction through the smaller opening, and a diaphragm subject to pressure fluctuations in the mill for opening said valve to the full instantaneously and for closing the same.

FRED I. RAYMOND.