Nov. 28, 1961 E. BOSSHARD 3,010,663

APPARATUS FOR CONTROLLING ROLLER MILLS

Filed Jan. 27, 1956 5 Sheets-Sheet 1

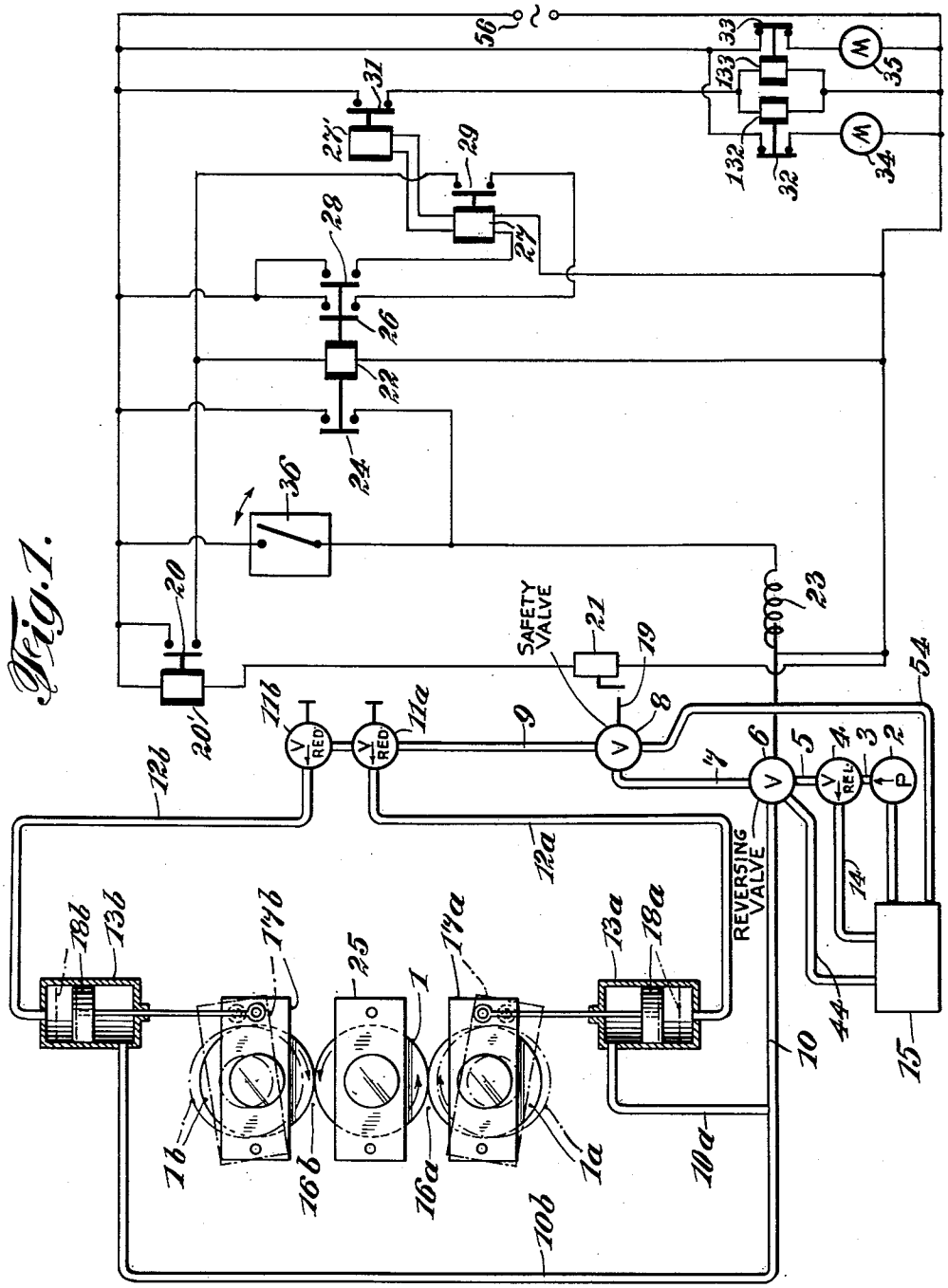

Fig. 1.

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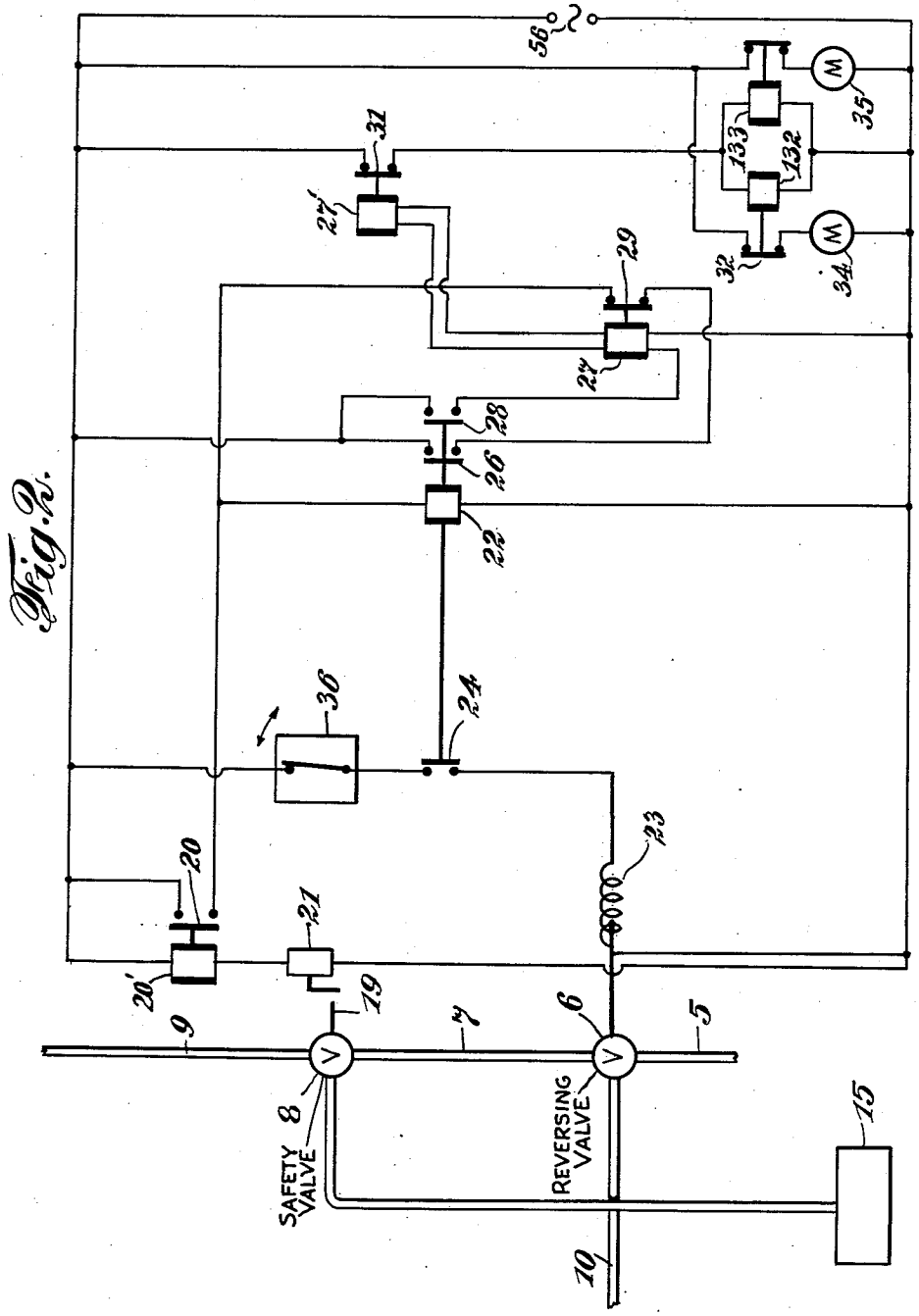

Fig. 2.

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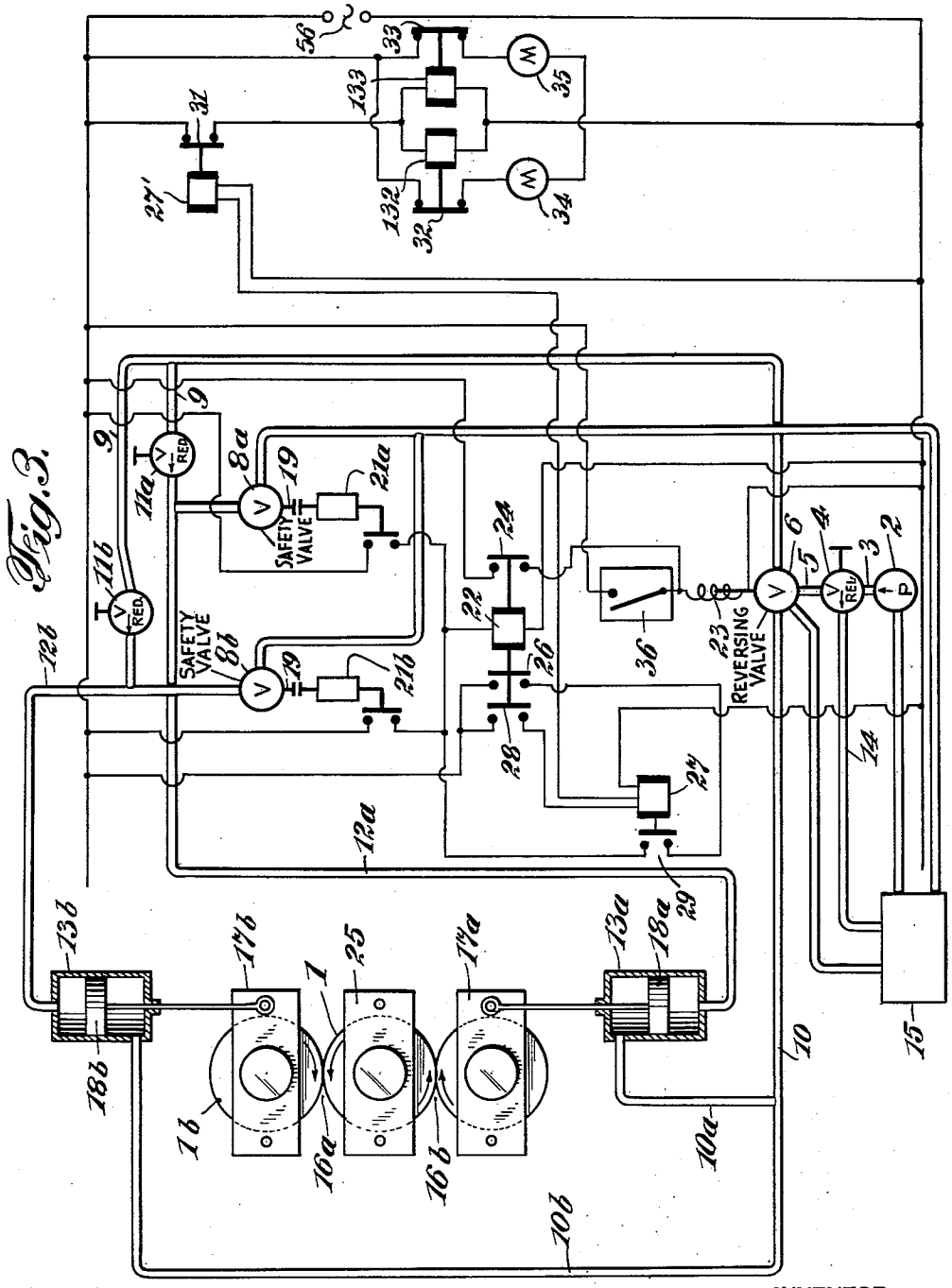

Fig. 3.

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Fig. 4.

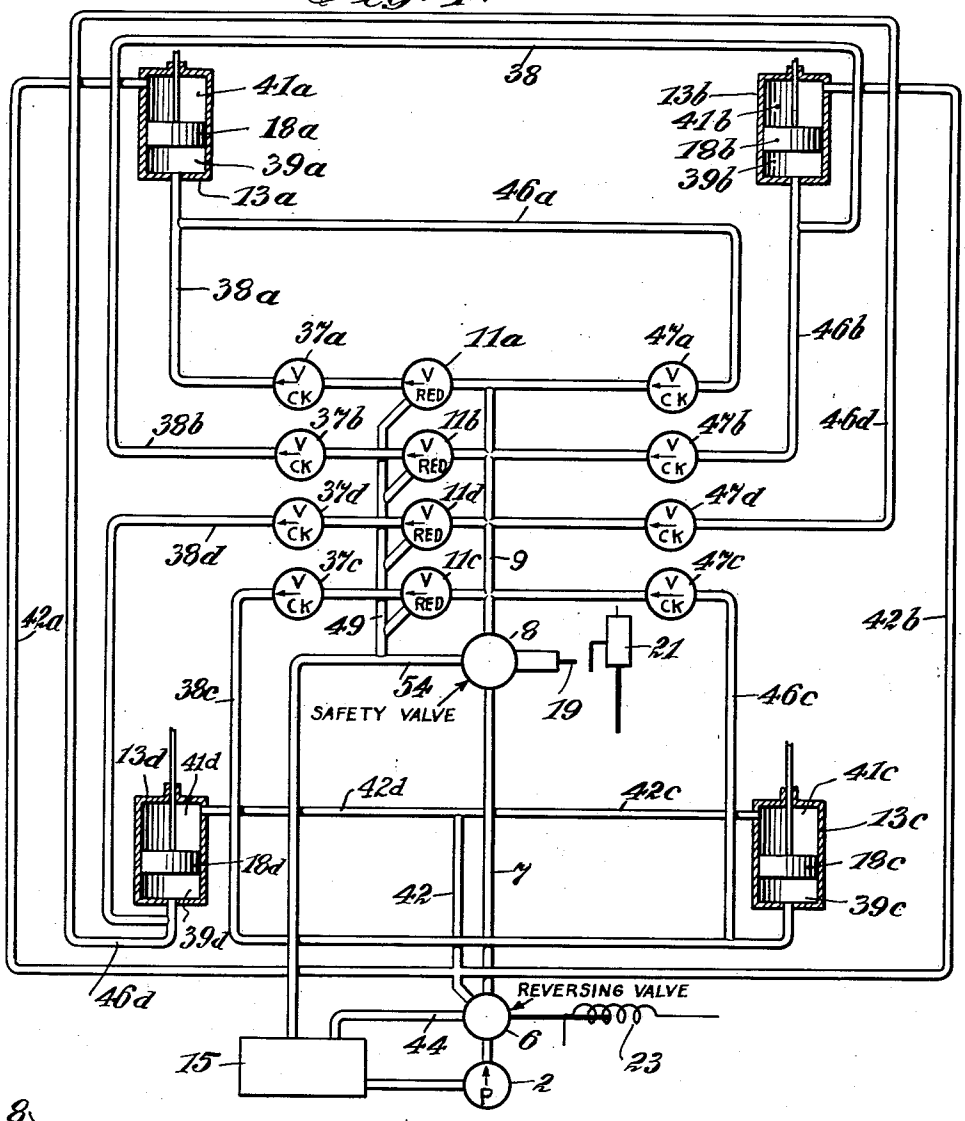

Fig. 5.

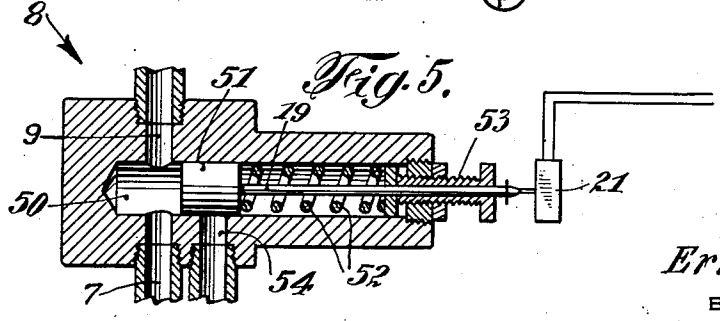

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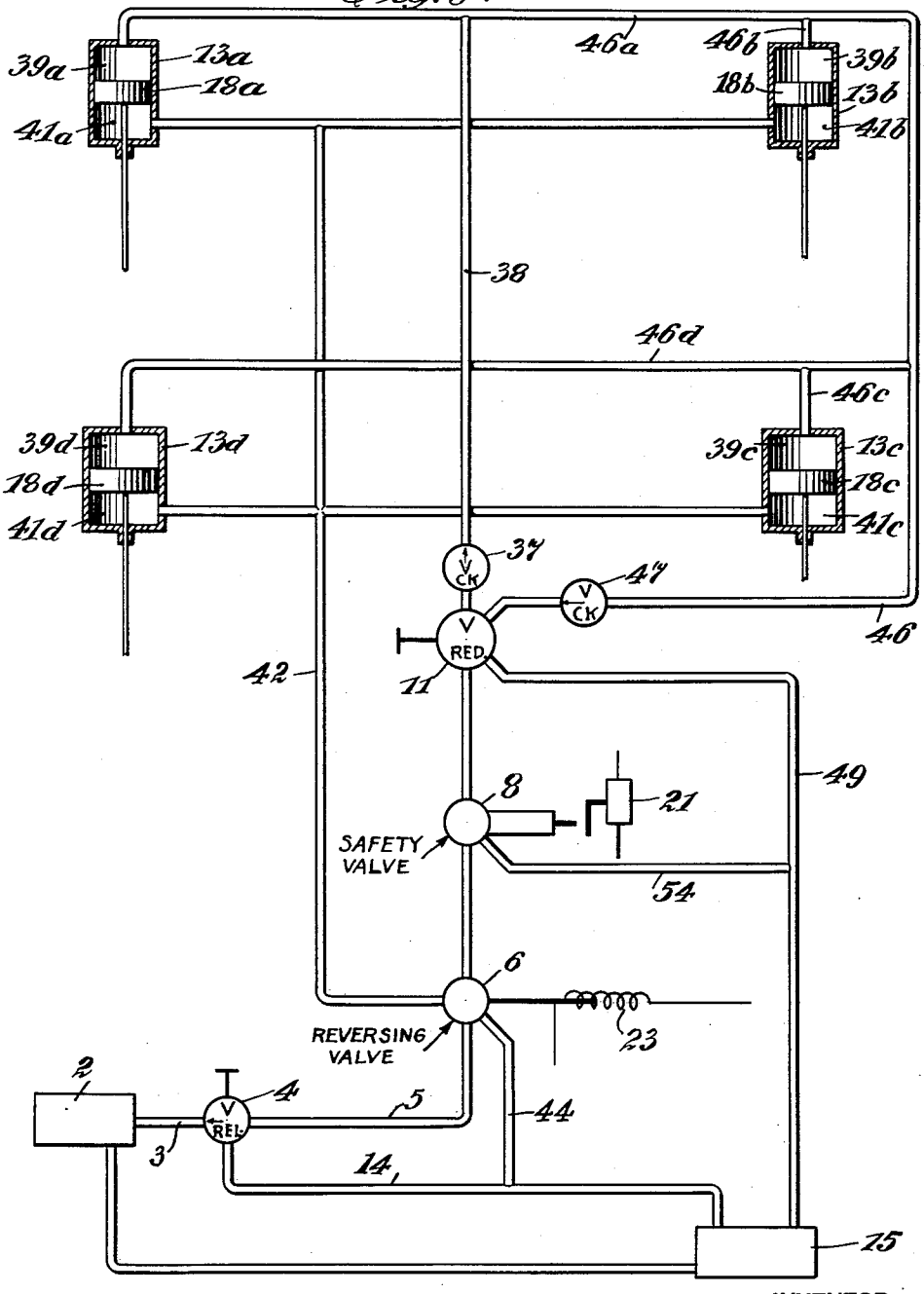
Fig. 6.



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3,010,663
APPARATUS FOR CONTROLLING ROLLER MILLS

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13 Claims. (Cl. 241—36)

This invention relates to roller mills in general, and more particularly to a method and apparatus for electrohydraulically or electropneumatically controlling and relieving the pressures between the cooperating rollers when foreign bodies are passing therebetween.

The rollers in roller mills are usually protected against undue stresses by the provision of resilient elements in the bearing stressing devices that yield under undesirably high pressures occurring when foreign bodies pass between the rollers and permit their passage therebetween. A disadvantage of such known systems resides in that the rollers, urged by the resilient elements, return rather vehemently into their original position against each other or against any limiting stops provided for this purpose, after the foreign body or bodies have passed therebetween. Considerable damages may occur due to such violent return of the rollers, and the overstresses may even be so high, especially if hard or large foreign bodies pass between the rollers, that permanent impressions may remain therein.

The present invention provides a method for the electrohydraulic or electropneumatic control of roller mills, and considers automatic release of movably mounted rollers in case of undesirably high pressures, for example, if a foreign body passes between the rollers, and also a gradual return of the rollers into engaging position.

The invention also provides an apparatus for the practice of the above method which includes a valve for reversing the flow of fluid and an electromagnet whose coil actuates said reversing valve. The novel arrangement also includes a safety valve, a switch cooperating therewith, and controlling a relay in the circuit of the coil of the aforesaid electromagnet.

The safety devices of this character are satisfactory if overstresses of relatively short duration occur, such as may be caused by the passage of smaller metallic bodies. The results of extensive experimentation and observation in roller mills indicate that the foreign bodies passing between the rollers are generally small and cause overstresses of short duration only.

As two bearing stressing devices are necessary for each movably mounted roller, the number of safety devices generally corresponds to the number of such bearing stressing devices, but constructions are also known wherein a single roller safety device is used for each individual movable roller. The apparatus of this invention represents a substantial simplification in that it uses a single safety valve for all the bearing stressing devices of the roller mill. Preferably, at least one reducing valve is connected to and behind the safety valve. Furthermore, in some of the preferred embodiments of the novel apparatus, one or more check valves are mounted in appropriate positions.

Since a single reversing valve is sufficient for all the bearing stressing devices, the rollers may be engaged or released with a single motion.

The novel method and apparatus may be advantageously used in roller mills of any type, especially in connection with two rollers, such as are customary in milling industry, and also with three or more rollers, such as used for paint and chocolate manufacture. In all these industries, one or more rollers are mounted in fixed bearings and are combined with at least one roller held in movable bearings.

Other features and advantages of the novel method will become apparent in the course of the following detailed description of some at this time preferred embodiments of the apparatus for the practice thereof which are illustrated in the accompanying drawing, and the invention will be finally pointed out in the appended claims.

In the drawing, wherein similar characters of reference indicate similar elements,

FIG. 1 is a schematic representation of a roller mill with three rollers, embodying the novel safety device, certain components of the hydraulic mechanism having been omitted for the sake of clarity;

FIG. 2 shows a slight modification in the electrical wiring of the electrohydraulic control device;

FIG. 3 is a schematic view of a further modification, comprising a plurality of safety valves;

FIG. 4 shows schematically the hydraulic portion of the control system;

FIG. 5 is an enlarged sectional view of the safety valve; and

FIG. 6 illustrates schematically a still further modification of the control system.

Referring now in detail to the illustrated embodiments, and first to that shown in FIG. 1, a source of pressure such as a pump 2, generates the pressure necessary for urging the movable rollers 1*a*, 1*b* against a stationary roller 1. The hydraulic fluid flows from pump or fluid pressure generator 2 through a conduit 3, a pressure relief valve 4, a conduit 5, a reversing valve 6, conduit 7, safety valve 8, conduit 9, the pressure reducing valves 11*a*, 11*b* for the individual cylinders, and through conduits 12*a*, 12*b* into the pressing cylinders 13*a*, 13*b*, acting as the bearing stressing devices. The hydraulic fluid in excess returns to the tank 15 over the pressure relief valve 4 via a conduit 14. Valve 4 is of customary design; its purpose is to limit the pressure which may be built up in pump 2 by opening line 14 to line 3 whenever the pressure built up in the pump exceeds a given value. Valves 11*a*, 11*b* regulate the pressure exerted on the rollers. If a foreign body enters one of the gaps 16*a*, 16*b* when the rollers 1, 1*a*, 1*b* are in engagement, the overstress is transmitted over the movable bearing supports 17*a*, 17*b* and pistons 18*a*, 18*b* to the hydraulic fluid in cylinders 13*a*, 13*b*. The excessive pressure is transmitted by the hydraulic fluid from said cylinders over the lines 12*a*, 12*b* and the line 9 to the safety valve 8. The manner in which such excessive pressure bypasses the valves 11*a*, 11*b* will be explained in connection with FIG. 4. In response to such excessive pressure, safety valve 8 moves the rod 19 which actuates a switch 21, energizing relay 20' to close switch 20 and, thereby, energize relay 22. Relay 22 closes contacts 24, 26 and 28. Contact 24 permits the current to flow in the coil 23 which electromagnetically reverses the valve 6 to permit flow of hydraulic fluid to the opposing sides of pistons 18*a*, 18*b* in respective cylinders 13*a*, 13*b*, via conduits 10, 10*a* and 10*b* and to permit return flow of fluid from line 9 over valve 8, line 7, valve 6 and line 44 back into the tank 15. The rollers 1*a*, 1*b*, supported in movable bearing supports 17*a*, 17*b*, are then moved away from the stationary roller 1 which is mounted in the fixed bearing supports 25, until the pistons 18*a*, 18*b* reach the end of their strokes in cylinders 13*a*, 13*b*. As soon as the safety valve 8 reaches its releasing position, i.e., when the pressure of the fluid drops sufficiently, the switch 21, controlled by rod 19 of safety valve 8, returns to its original "off" position, but the relay 22 remains energized as the contact 26 is in "on" position and the circuit including said relay 22 remains closed. At the same time the contact 24 main-

tains closed a circuit including the coil 23 which controls the reversing valve 6. A time-lag relay 27 is actuated simultaneously with the relay 22 by means of the contact 28. On elapse of a predetermined time period, the time-lag relay 27 opens the holding circuit of relay 22 by means of the contact 29, deenergizing the relay 22, which interrupts the supply of current from source 56 to coil 23, whereupon the reversing valve 6 returns into its initial position. The fluid flows again from valve 6 over line 7, valve 8, line 9, pressure reducing valves 11*a*, 11*b* and through lines 12*a*, 12*b* into the cylinders 13*a*, 13*b* to actuate the pistons 18*a*, 18*b* in a direction to cause engagement of fixed roller 1 by movable rollers 1*a*, 1*b*. A contact 31 actuated by the actuating coil of an adjustable time-lag relay 27′ mounted in series with the time-lag relay 27, may be opened after a set time period, whereby the safety switches 32, 33 of the mill driving motor 34 and the motor 35 for pump 2, respectively, are opened to idle the entire apparatus. The switches 32, 33 are actuated by relays 132, 133, respectively, in the circuit of the contact 31. The second time-lag relay 27′ may be set so as to open the switch 31 say five seconds after the opening of switch 29 for the following reason:

When the movable rollers are released because of the passage of a foreign body through one of the gaps 16*a*, 16*b*, the switch 29 remains closed for a certain time set in the time-lag relay 27, for example thirty seconds, and is thereupon reopened to permit engagement of the rollers. If the foreign body is still between the rollers 1–1*a* or 1–1*b*, the regulating process begins anew. In such exceptional cases of extremely large foreign bodies, or when a foreign body is jammed between the rollers, the second relay 27′ which is mounted with the time-lag relay 27, opens the contact 31 say five seconds after the contact 29 has been opened, and the operation of the entire system is stopped. When the pressure in line 9 reaches a level high enough to operate rod 19, the latter is displaced in a direction to right not only to operate switch 21 but also to expose the intake end of a line 54 which latter leads back to tank 15 and thus permits return flow of fluid from line 9, over valve 8, and into the tank. This is illustrated in greater detail in FIG. 5. The line 44 between reversing valve 6 and tank 15 serves the dual purpose of connecting line 10 with the tank when lines 5 and 7 communicate over valve 6, and to connect line 7 with the tank when line 5 communicates with line 10 over valve 6.

In addition to the above-described automatic roller control system, a hand-actuated switch 36 is provided to permit the release or engagement of the rollers by a single hand movement if a foreign body passes between the rollers 1, 1*a*, 1*b* through one of the gaps 16*a*, 16*b*.

In FIG. 2, the electric control system differs from the above-described embodiment in that the contact 24 is in the line between hand-switch 36 and coil 23. Coil 23 is under current when the rollers 1, 1*a*, 1*b* are engaged. If the safety valve 8 is actuated by an overpressure, the contact 20 closes the circuit of relay 22 and contact 24 opens the circuit of coil 23. After actuation of relay 22 and contact 28, the time-lag relay 27 is actuated closing contact 29. On elapse of a predetermined time period, the time-lag relay 27 opens the holding circuit of relay 22 by opening contact 29. With contact 29 open, relay 22 is deenergized and contact 24 closes. With contact 24 closed, the circuit of coil 23 is closed, whereupon the coil 23 brings the reversing valve 6 into a position to permit the pistons 18*a*, 18*b* to move the rollers 1*a*, 1*b* into engagement with the roller 1.

Furthermore, after elapse of a set time, the contact 31 is opened by time-lag relay 27′ to open the control circuit for the switches 32, 33 and stop the respective motors 34, 35.

A different embodiment of the apparatus of this invention is shown in FIG. 3, wherein safety valves 8*a*, 8*b* are provided for respective cylinders 13*a*, 13*b*, and connected between said cylinders and the pressure reducing valves 11*a*, 11*b*. If a foreign body passes between the rollers 1, 1*a*, 1*b* through either of gaps 16*a*, 16*b*, at least one of the safety valves 8*a*, 8*b* responds and actuates at least one of switches 21*a*, 21*b* and over relay 22 the switch 24, the latter energizing the coil 23 of the reversing valve 6. This disengages the rollers in the previously described manner. The time-lag relay 27 is actuated at the same time. After a set time (for example, between zero and 60 seconds), the contact 29 opens to interrupt the flow of current in relay 22 and coil 23 of the reversing valve 6. The rollers 1*a*, 1*b* again engage the stationary roller 1. Assuming that the disturbance caused by the presence of a foreign body is still present, the second time-lag relay 27′ mounted with relay 27, after a certain time (say 5 seconds after the opening of switch 29) opens the contact 31 and interrupts the control circuit of switches 32, 33 to arrest the driving motor 34 and pump motor 35. Before these motors are stopped, the rollers were automatically released, as described above.

In FIG. 4, four cylinders 13*a–d* of the same number of hydraulic bearing stressing devices are represented. The cylinders are supplied with hydraulic fluid by the pump 2 through the reversing valve 6, conduit 7, a single safety valve 8, the pressure reducing valves 11*a–d*, the check valves 37*a–d*, and the lines 38*a–d*. Check valves 37*a–37d* prevent small vibrations of the rollers from disturbing the reducing valves 11*a–11d*, respectively. As valves 37*a–37d* prevent the return flow of fluid from cylinder spaces or chambers 39*a–39d*, respectively, it is necessary to provide check valves 47*a–47d* which are normally closed because the pressure in lines 46*a–46d*, respectively, cannot overcome the pressure on the opposing sides of members 47*a–47d*, the pressure in lines leading from valves 47*a–47d* to valves 11*a–11d*, respectively, corresponding to the pressures prevailing at the inlet sides of members 11*a–11d*. If an unduly high pressure should develop in one of cylinder spaces or chambers 39*a–39d*, the corresponding one of check valves 47*a–47d* will open and transmit the pressure to valve 8. The pistons 18*a–d* are moved in the desired direction when the hydraulic fluid enters the respective spaces 39*a–d* in cylinders 13*a–d*. During such movement, the fluid flows from spaces 41*a–d* on the opposite sides of pistons 18*a–d* in cylinders 13*a–d* through conduits 42, 42*a*, 42*b*, 42*c* and 42*d*, reversing valve 6, the line 44 and back to the tank 15. The lines 46*a–d* with check valves 47*a–d* are used for the return of fluid to the tank 15 if there is an excessive pressure in the spaces 39*a–d*, or if the pump 2 is stopped and the pressure drops considerably in line 7. It is possible to reverse the direction of fluid flow by means of the reversing valve 6 which may be actuated manually or hydraulically. The overflows of reducing valves 11*a–d* are united in line 49. When the direction of pressures acting upon pistons 18*a–18d* is reversed to disengage the rollers, the pressure in line 9 between valve 8 and valves 11*a–11d* is reduced to zero because line 7, over valve 6, then communicates with return line 44 leading to tank 15. The hydraulic fluid expelled from cylinders 13*a–13d* can pass only over valves 47*a–47d*, respectively.

The safety device 8, shown enlarged in FIG. 5, includes an auxiliary cylinder 50 in communication with line 7. A piston 51 in the cylinder 50 is urged toward left by a coil spring 52. The tension of spring 52 may be controlled by a screw 53. In case of unduly high pressure of the hydraulic fluid, piston 51 moves toward right against the force of spring 52 to expose the end of the conduit 54 leading to the tank 15. In the embodiment of FIG. 5, piston 51 is mechanically connected with the rod 19 which presses against the end switch 21. On release and reengagement of the rollers, no change in the setting of roller mills has been made because no change in reducing value was necessary.

The embodiment shown in FIG. 6 includes four hy-

draulic bearing stressing devices in the form of cylinders 13*a–d* with a single reducing valve **11**. This embodiment permits the selection of different diameters for the pistons 18*a–d* of the individual cylinders 13*a–d* to control the pressing forces of the individual bearings. As shown, the diameters of cylinders 13*c*, 13*d* and of their pistons 18*c*, 18*d* are larger than those of cylinders 13*a*, 13*b* and pistons 18*a*, 18*b*.

The above-described safety device has proven to be absolutely satisfactory when dealing with short-lived overstresses of the rollers, for example, when the foreign bodies are nails, stones, or the like. However, if larger objects, such as plates or cleaning spatulas, are entrained by the rollers, a rather unlikely occurrence, it becomes necessary to switch the reversing valve in the above-described manner for brief disengagement of the rollers. Valves **4** and **11** may be provided with suitable hand grip members for manual operation.

Instead of using a hydraulic fluid for actuation of pistons 18*a–d* in respective cylinders 13*a–d*, a gaseous medium may be employed to provide an electropneumatic control system. Pump **2** is then replaced by a suitable blower.

While some preferred embodiments of the apparatus for the practice of my novel method have been shown and described, it will be understood that various changes and modifications may occur to persons skilled in the art within the spirit and scope of this invention which is defined in the appended claims.

I claim:

1. An apparatus for the control of roller mills having fixed and movable rollers adapted to be moved into engagement with, or away from, said fixed rollers, including a source of fluid, stressing means operatively connected with said movable rollers for applying fluid pressure thereto, conduit means for connecting said source of fluid with said stressing means, a source of fluid pressure in said conduit, fluid reversing means for controlling the flow of fluid under pressure to said stressing means whereby to move said movable rollers into engagement with, or away from, said fixed rollers, a safety device in said conduit responsive to a predetermined maximum pressure of said fluid in said stressing means, an electric circuit including switch means operatively connected with said safety device, a relay and electromagnet in said circuit, said electromagnet being controlled by said relay and operatively connected with said fluid reversing means.

2. The apparatus of claim 1, wherein said safety device is a safety valve and a connection is provided between said safety valve and said source of fluid for returning the fluid from said stressing means upon a predetermined maximum pressure therein.

3. The apparatus according to claim 1, wherein said fluid reversing means is a reversing valve operatively connected with said stressing means.

4. The apparatus of claim 1, wherein a stressing means is provided for each of said movable rollers, and a pressure reducing valve is connected between said safety device and said stressing means.

5. The apparatus according to claim 4, wherein an overflow line is provided between each of said stressing means and the respective ones of said pressure reducing valves, and a check valve is connected in each of said overflow lines.

6. The apparatus of claim 5, wherein a stressing means is provided for each of said movable rollers, and a pressure reducing valve is connected between said safety device and each of said stressing means.

7. The apparatus of claim 6, wherein each of said stressing means includes a cylinder and a piston operatively connected with a respective one of said movable rollers, said pistons having different diameters.

8. An apparatus according to claim 1, wherein a first time-lag relay is in the circuit of, and controlled by, said relay, said time-lag relay operating in such manner that said movable rollers are disengaged from said fixed rollers for a predetermined period of time in response to said predetermined maximum pressure of fluid in said stressing means.

9. An apparatus according to claim 8, wherein a second time-lag relay is in the circuit of said relay, and operatively connected with said source of fluid pressure, said second time-lag relay operating in such manner that the flow of fluid to said stressing means is interrupted when the predetermined maximum pressure of fluid persists.

10. An apparatus for the control of roller mills having fixed and movable rollers, and a drive motor for said rollers, including at least one cylinder for each of said movable rollers, a piston in each of said cylinders operatively connected to a respective one of said movable rollers for moving said movable rollers into engagement with, or away from, said fixed rollers, a source of fluid, a fluid reversing valve, a conduit for connecting said source of fluid with said reversing valve, a fluid pressure generator in said conduit, first fluid lines between said reversing valve and each of said cylinders for moving said pistons and said movable rollers in a direction to engage said fixed rollers, second fluid lines between said reversing valve and said cylinders for moving said pistons and said movable rollers in a direction away from engagement with said fixed rollers, at least one safety valve and at least one pressure reducing valve in said first fluid lines, an electric control system including a switch responsive to a predetermined maximum fluid pressure in said safety valve, a relay controlled by said switch and an electromagnet controlled by said relay, said reversing valve being responsive to changes in said electromagnet.

11. The apparatus of claim 10, wherein check valves are provided in said first fluid lines between said pressure relief valve and said cylinders.

12. The structure of claim 10, wherein a time-lag relay is provided in said electric control system and operatively connected with said motor and said fluid pressure generator.

13. The apparatus of claim 10, further comprising a third fluid line between said safety valve and each of said cylinders and a check valve in each of said third fluid lines for permitting return flow of fluid introduced through said first lines when the pressure in the respective cylinders exceeds a given value.

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CERTIFICATE OF CORRECTION

Patent No. 3,010,663 November 28, 1961

Ernst Bosshard

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 65, for the claim reference numeral "5" read -- 1 --.

Signed and sealed this 17th day of April 1962.

(SEAL)
Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents