May 19, 1964 C. A. ZIMMERMAN 3,133,707

SIZE ADJUSTMENT MECHANISM FOR GYRATORY CRUSHER

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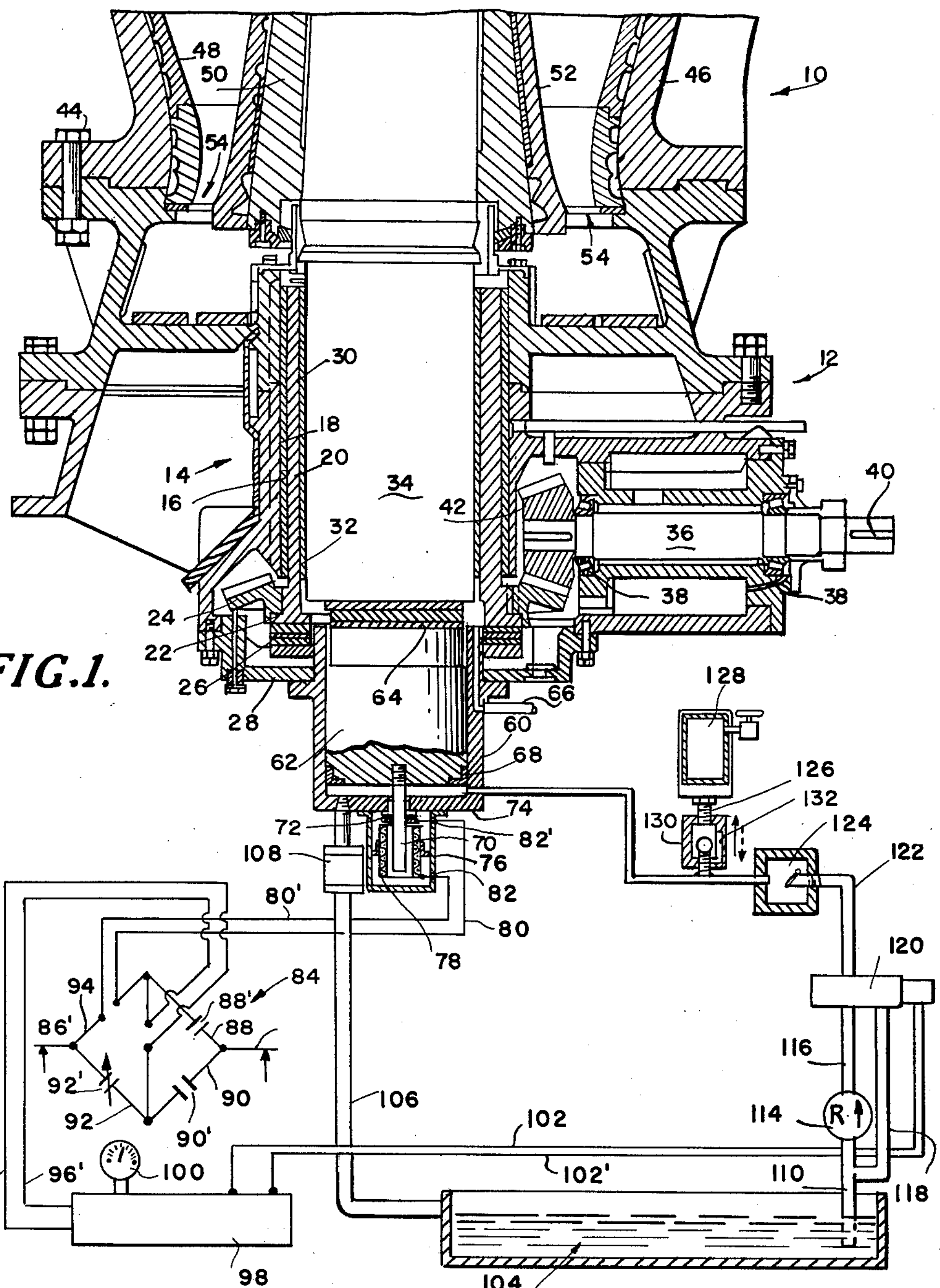

FIG. 1.

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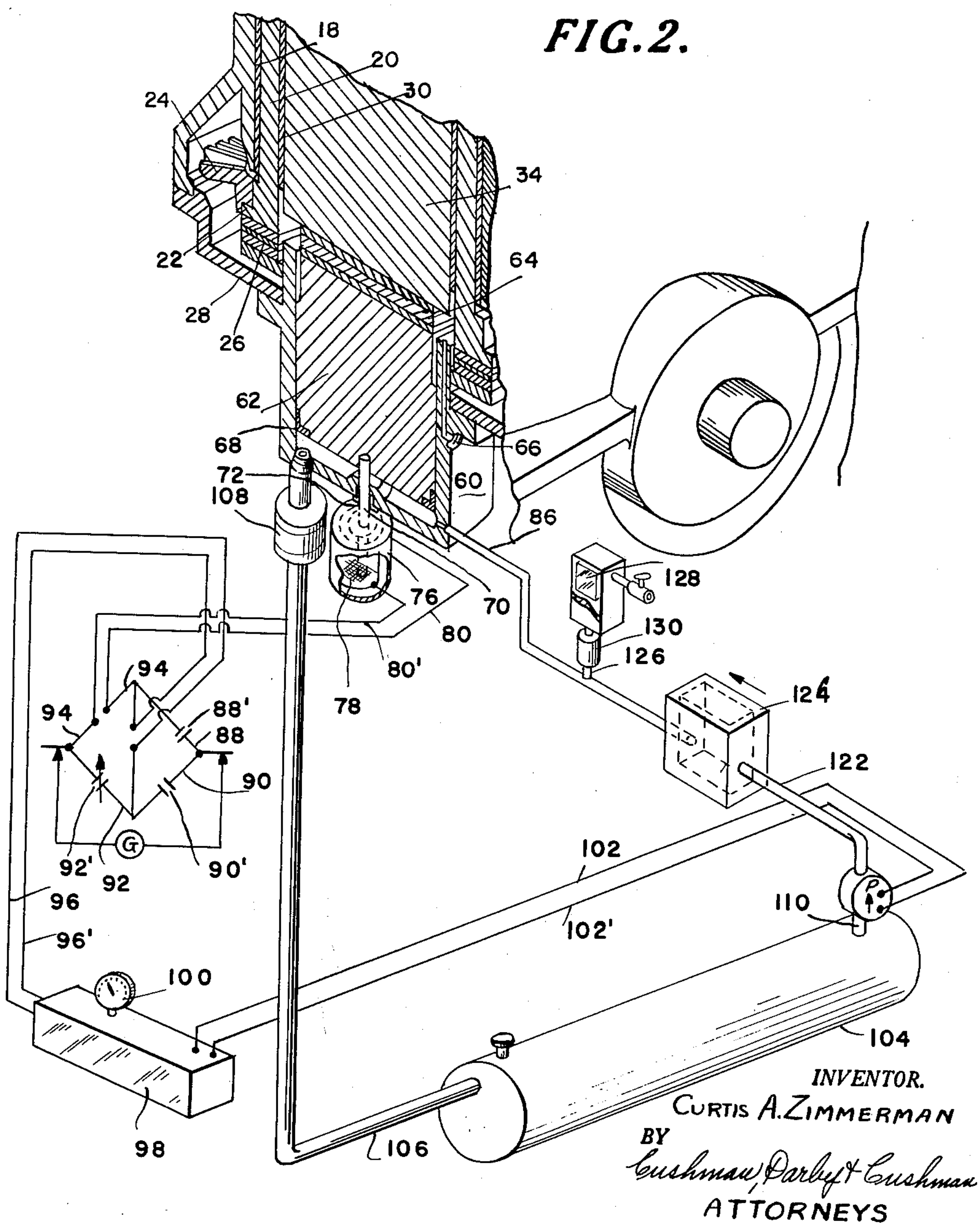
FIG. 2.



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United States Patent Office

3,133,707

Patented May 19, 1964

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SIZE ADJUSTMENT MECHANISM FOR GYRATORY CRUSHER

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Filed Mar. 23, 1961, Ser. No. 97,790
9 Claims. (Cl. 241—37)

This invention relates to gyratory crushers of the type having an upright shaft to which a gyratory movement is imparted by a rotary eccentric in which the shaft is journaled, and has particular reference to a new and improved control means for gyratory crushers of this type.

In gyratory crushers of the upright shaft type, gyratory movement is imparted to the shaft by a rotary eccentric in which the shaft is journaled for rotary and axial movement, with the rotary movement being caused by the rolling of a crusher head secured at the upper end of the shaft, on the material deposited in the hopper and caught between the head and the concave. Ordinarily, the upright shaft is axially slidable in the eccentric and the crusher is provided with an adjustable support at the lower end of the shaft so that the shaft may be adjusted vertically for the purpose of positioning the crusher head relative to the concave for a fine or coarse product, as required. In the majority of known gyratory crushers the vertical shaft adjustment is usually accomplished manually when the crusher shaft is stopped and not gyrating. This obviously is a costly and time-consuming procedure.

In the co-pending application of Mertz, Serial No. 66,745, there is provided a new and improved gyratory crusher which contemplates electro-hydraulic control means therefor, and particularly disclosed in this co-pending application, is a potentiometer control means for regulating the longitudinal position of the shaft, and indicating its position.

This application has reference to an improvement of the electro-hydraulic control means in the co-pending Mertz application, Serial No. 66,745.

It is an object of this invention to provide a new and improved control means for a gyratory crusher of the character described.

Another object of this invention is to provide an electrically actuated fluid pressure control means for a gyratory crusher having a crusher shaft support, which includes shaft indicating and repositioning means, the electrical control means therefor including a Wheatstone bridge circuit.

Still another object of this invention is to provide an electro-hydraulic means for gyratory crusher of the character described which includes a shaft indicating and repositioning means operatively controlled by an electrical system including a capacitive Wheatstone bridge circuit, which provides an output signal for actuating the hydraulic shaft repositioning system in response to changing conditions.

A further object of this invention is to provide an electro-hydraulic control means for regulating the longitudinal position of a gyratory crusher shaft which is of simple and inexpensive construction, and utterly reliable and trouble-free in operation.

Further objects and advantages of this invention will become apparent in the specification, claims and accompanying drawings wherein:

FIGURE 1 is an elevation section view of the gyratory crusher together with a diagrammatic view of the control means according to this invention; and

FIGURE 2 is a perspective view of a modified embodiment of the structure shown in FIGURE 1.

Reference is now made to the drawings wherein like numerals refer to similar elements.

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In FIGURE 1, the crusher comprises a frame including an upper section 10 and a lower section 12. The lower section 12 has a centrally disposed hub 14 with a vertical bore 16 in which, by means of a cylindrical bearing liner 18, is rotatably journaled a rotary member or eccentric 20. The eccentric 20 is cylindrical and has an annular peripheral flange 22 at its lower end to which is affixed a ring gear 24. The eccentric 20 is supported for rotary movement by an annular step bearing 26 interposed between the flange 22 at its lower end to which is affixed a ring gear 24. The eccentric 20 is supported for rotary movement by an annular step bearing 26 interposed between the flange 22 and the lower end 28 of the hub 14. The eccentric 20 is provided with an eccentric vertical bore 30 having a cylindrical bearing liner 32 and in which is journaled the lower end of an upright crusher shaft 34.

A laterally extending power or counter shaft 36 is journaled in the lower casing section 12 and is supported by suitable bearings 38. The outer end of the counter shaft 36 is adapted, as by the keyway 40, for connection to a suitable power train (not shown) to effect its rotation. The inner end of the counter shaft 36 has a pinion gear 42 secured thereon which meshes with the ring gear 24 secured to the eccentric or rotary member 20 so that when counter shaft 36 is rotated, the eccentric 20 also rotates, thus effecting a gyratory movement of the crusher shaft 34 journaled therein.

The upper crusher section 10 is secured to the lower section 12 by means of the bolts 44 and defines a conical material receiving hopper 46 which surrounds the upper end of the crusher shaft 34. The hopper 46 is suitably lined with a sectional liner or concave 48, while the upper end of the crusher shaft has a crusher head 50 affixed thereto. A replaceable mantle 52 preferably is affixed to the crusher head 50 and may rotate thereabout during the crushing operation due to its contact with the material placed in the hopper 46 for crushing. In this regard, the crushing of the material occurs by virtue of the material being caught between the concave 48 and crusher head 50 during the gyration of the shaft 34. The degree of fineness of the crushing is determined by the size of the space 54 between the lower end of the concave 46 and crusher head 50.

As the concave 46 is in the shape of an upright cone and the crusher head 50 is in the shape of an inverted cone, it is apparent that an upward movement of the crusher head relative to the concave will decrease the space 54 therebetween to produce a relatively fine final product. Conversely, a downward relative movement of the crusher head 50 will increase the size of the space 54 to allow for a relatively coarse product. In the gyratory crushers currently in use it is very difficult to control the position of the crusher head 50 to obtain a final crushed product of any uniformity because tramp iron and other matter occasionally is introduced in the hopper along with the material to be crushed. If the crusher shaft cannot move vertically, the foreign matter may jam or damage the crusher. On the other hand, if the crusher shaft may move vertically, it will normally move downwardly to allow the tramp iron to pass between the crusher head 50 and concave 48. When this occurs, it was formerly necessary to stop the rotation of the shaft 34 to reset it at its predetermined position. This obviously was a time-consuming and often costly operation.

There is here provided a cylinder extension 60 to the lower end 28 of the hub 14. A piston 62 is slideably disposed within the cylinder 60 and is adapted to support the crusher shaft 34. A suitable spherical bearing array 64 is interposed between the lower end of the shaft 34 and the piston 62 in that the former may gyrate freely relative to the piston. The bearing 64 is supplied with a lubricant by means of a lubricant passage **66** in the cylinder wall and in communication with a source of lubricant (not shown). The piston **62** is provided with a suitable sealing gasket **68** engaging the cylinder walls, and has a depending rod **70** in its lower end projecting through a seal **72** in the closed end **74** of the cylinder **60**.

The above-described structure is now known in the art having been described in the Mertz application Serial No. 66,745.

Secured to the closed end **74** of the cylinder **60** about the rod **70** is a protective closed casing **76**; and, mounted concentrically with the lower end of the rod **70** by any suitable means (not shown) in spaced apart relationship is a position indicating sleeve **78** which is insulated from the protective casing **76** and the rod **70**.

A first electrical lead **80** is operatively connected, as by a conducting ring, to the rod **70** between the seal **72** and the sleeve **78**; and a second electrical lead **80'** is operatively connected to the bottom of the sleeve **78**. These leads **80** and **80'** pass through insulated apertures **82, 82'** in the casing **76**. As is apparent, this arrangement provides a variable capacitor which will be discussed hereinafter.

According to this invention, a Wheatstone bridge circuit designated generally at **84** is operatively connected to a suitable source of electrical power (not shown) by leads **86, 86'**, and includes four legs **88, 90, 92** and **94**, the legs **88, 90** and **92** having capacitors **88', 90', 92'**, the last mentioned capacitor **92'** being of the variable type. The leg **94** of the circuit **84** is capacitive by virtue of the arrangement of the connection of the leads **80, 80'** to the rod **70** and the sleeve **76**, respectively, as previously discussed.

The output of the capacitive circuit **84** is provided by leads **96, 96'**, which are connected to an amplifier **98** of a suitable type known in the art. There is provided a suitable indicating means **100** operatively connected to the amplifier for indicating the amplified output of the amplifier **98**. Such indicating means **100** are well known in the art and, for example, may include a conventional galvanometer operatively connected to the output circuit of the amplifier **98**. The output leads of the amplifier **98** are designated **102, 102'** and provide the signal for actuating the hydraulic portion of the control means, as will now be discussed.

There is provided a source **104** of fluid and a return conduit **106** which is in communication with the piston **62** and **74** through the end of the cylinder **60**. A relief valve **108** is provided in the conduit **106** to insure that the pressure within the closed end of the cylinder **60** is at the desired level. A conduit **110** is in communication at one end with the fluid source **104** and at its other end with a pump **114**. There is provided a pump outlet conduit **116** together with a pump bypass conduit **118**, both the pump outlet conduit **116** and bypass conduit **118** being in communication with a conventional electromagnetic servo valve **120**. A valve outlet conduit **122** provides a supply of fluid under pressure to the cylinder **60** to regulate the elevation of the piston **62** therein, as will become apparent. In communication with this conduit **122** is a branch conduit **126**, the conduit **126** having a diaphragm type accumulator **128** at one end thereof. A check valve **130** is disposed in the branch conduit **126** between the high pressure conduit **122** and the accumulator **128**, the valve **130** having a bleed return passage **132**.

In the embodiment of the control means shown in FIGURE 1, the output signal from the amplifier in leads **102, 102'** are operatively connected to the servo valve **120**, and, the pump **114** is continuously driven by a suitable power source (not shown).

In order to regulate the position of the pressure shaft **34**, the operator manually regulates the variable capacitor **92'** to a predetermined value which provides the desired quality of crushed material. In this regard, the variable capacitor **92'** may have predesignated indicia thereon to indicate various positions of the shaft **34**, as will be apparent. Further, the capacitance of the leg **94** of the Wheatstone bridge circuit **84** is regulated by the gap of the capacitive distance between the electric leads **80, 80'** which provide varying capacitance depending upon the relative position of the piston **62** (of the shaft **34**) relative to the bottom portion of the indicating sleeve **78**. The capacitance of the other side of the Wheatstone bridge circuit **84**, which includes the legs **88** and **90**, provides a predetermined base signal. Thus, when the Wheatstone bridge circuit **84** is balanced, i.e. no differential signal output, there will be, of course, no signal transmitted to the amplifier **92**, and consequently no output signal therefrom. This would be the situation while the piston **62** is positioned at its desired longitudinal position within the cylinder **60**. If the pressure within the lower end of the cylinder **62** should drop and thereby cause a lowering of the shaft **34**, the capacitance in the leg **94** of the circuit will decrease, thereby providing a differential signal to the amplifier **98**. This signal is, in turn, amplified and provides an output signal to the servo valve **120**.

Considering now the hydraulic system, in FIGURE 1 the pump **114** is being driven from a suitable source of power (not shown) and the output therefrom is recirculated back to the input side of the pump **114** by virtue of the position of the servo valve **120**, which directs the fluid back through the bypass conduit **118** to the inlet side of the pump **114**. Of course, at this time there is no fluid transmitted through the conduit **122** as the valve **120** has closed the passage therebetween. Now, when the differential signal is transmitted from the amplifier **98** to the servo valve **120**, the valve is actuated to provide communication between the pump outlet conduit **116** and the high pressure conduit **122**, whereby the hydraulic fluid passes into the lower side of the cylinder **60**, raising the pressure therein. The fluid will continue to move into this area until the capacitance in the leg **94** is increased a sufficient amount to balance the signal in the circuit **84**, at which time the signal differential will drop to zero and the valve **120** is restored to its original position. In this regard, the check valves **124** and **130** together with the accumulator **126** minimize any subsequent undesired fluctuations in the pressure within this high-pressure portion of the system. Thus, it is apparent that the relative position of the shaft **34** will be automatically maintained in its desired position and any excess or decrease in pressure will be compensated for. To change the position of the pressure shaft **34**, the operator then selects another capacitance i.e. shaft position on the leg **92** and the signal differential again will provide a change in the longitudinal position of the shaft **34** as is apparent.

Referring now to FIGURE 2, the system is modified somewhat, while retaining the significant features of the invention in FIGURE 1. In this regard, the output signal from the amplifier directly drives an electrical motor operatively connected to the pump **114'**. In this embodiment, there is no need for the servo valve **120** or the bypass conduit **118** arrangement, as the pump **114** is directly actuated by the output signal of the amplifier **98**. Otherwise, the system in FIGURE 2 operates in a manner substantially the same as disclosed in FIGURE 1.

It should be noted that the elevated position of the piston **62** can be decreased by providing an amplifier circuit which only actuates the servo valve **120** when the capacitance of the leg **94** is to be increased a desired amount determined by the capacitance of the variable capacitor **92'**. Thus, the accumulator **128** may be operatively connected to a source of fluid under pressure which may be decreased, thereby reducing the pressure in the high-pressure conduit **122**. Also, the relief valve **108** may be manually opened, thereby decreasing the pressure in the cylinder, as is apparent.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiments have been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

I claim:

1. In a gyratory crusher including an upright shaft, a rotary member in which one end of said shaft is eccentrically journaled, a crusher head fixed on said shaft, a shaft concave surrounding said head and spaced vertically therefrom, said shaft being longitudinally movable to vary the space between said head and said concave to adjust the size of the crushed material, means for rotating said rotary member to gyrate said shaft, cylinder and piston means supporting said shaft, the combination of control means for regulating the longitudinal position of said shaft comprising: a Wheatstone bridge circuit responsive to movement of said cylinder and piston means to provide an electrical output signal; and means for introducing pressurized fluid to said cylinder and piston means in response to the signal from said Wheatstone bridge circuit.

2. Structure according to claim 1 wherein said Wheatstone bridge circuit is capacitive, and one of the legs of said circuit includes a variable capacitor for setting the desired longitudinal position of said shaft.

3. Structure according to claim 2 further including means for amplifying the output signal of said circuit.

4. Structure according to claim 1 wherein said hydraulic means includes a fluid source, pump means in communication with said fluid source at the inlet thereof, and a high-pressure conduit in communication with said cylinder means and the outlet of said pump means.

5. Structure according to claim 4 including a servo

valve on the outlet side of said pump means, a bypass conduit communicating with the inlet side of said pump means and said valve, said valve being responsive to the output signal of said circuit to control the flow of fluid to said bypass conduit and said high-pressure conduit.

6. Structure according to claim 4 wherein said pump means is operatively actuated in response to the output of said circuit to move fluid from said source through said high-pressure conduit to said cylinder and piston means.

7. Structure according to claim 4 including a branch conduit in communication with said high-pressure conduit, said branch conduit including a bleed-return check valve and diaphragm accumulator means connected thereto for minimizing fluctuating pressures in said high-pressure conduit.

8. Structure according to claim 2 including rod means fixed to said piston means, a stationary member disposed adjacent said rod in spaced apart relationship, and electrical conducting means forming a portion of said circuit operatively connected to said rod and said member whereby a variable capacitor as provided, the capacitance varying relative to the position of said rod with respect to said member.

9. Structure according to claim 8 wherein said rod extends downwardly from the underside of said piston means, and said member is in the form of sleeve operatively fixed to the underside of said cylinder means about said rod.

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