

May 19, 1964

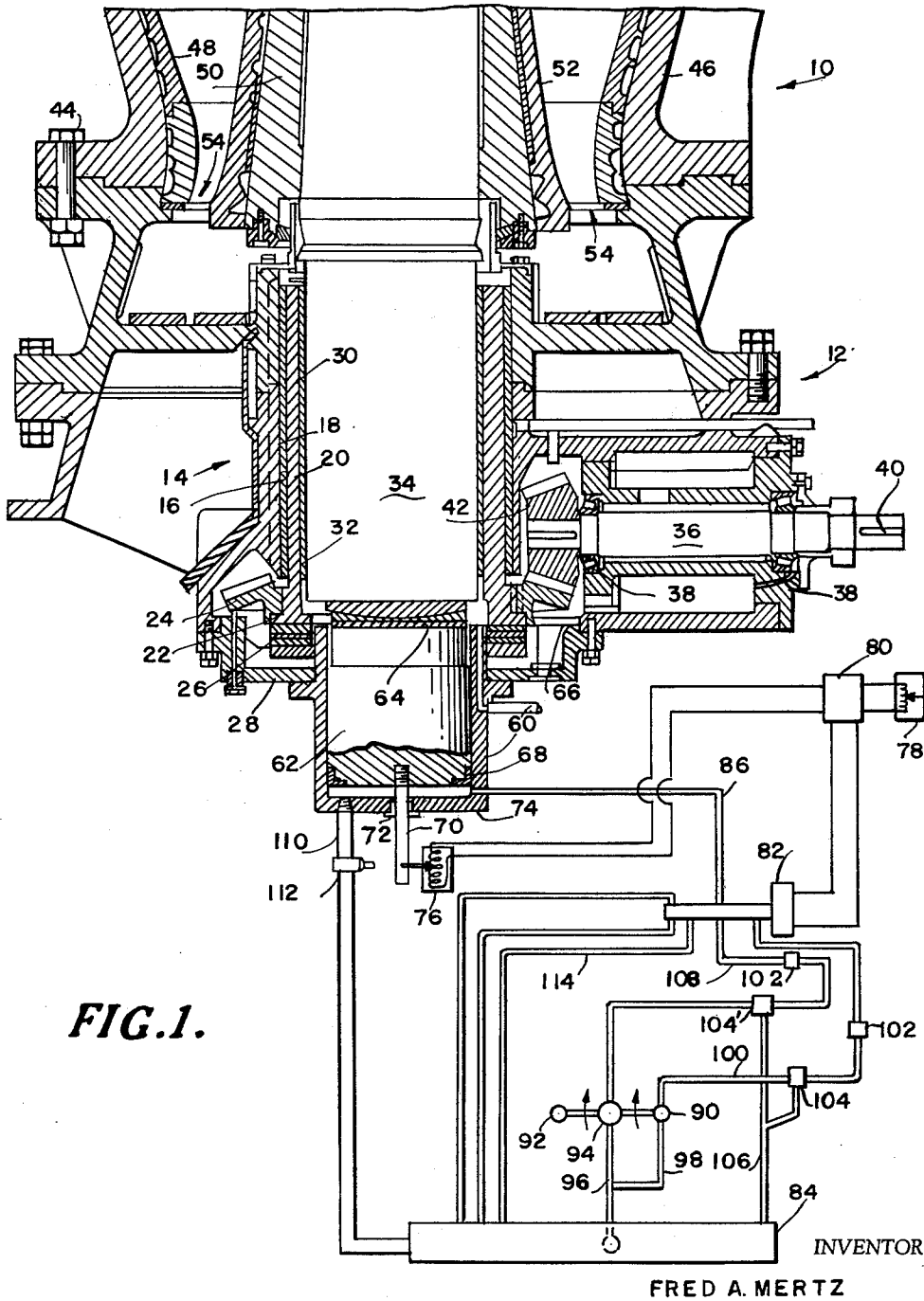
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3,133,706

GYRATORY CRUSHER HYDRAULIC ADJUSTMENT

Filed Nov. 2, 1960

2 Sheets-Sheet 1



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3,133,706 GYRATORY CRUSHER HYDRAULIC ADJUSTMENT

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Filed Nov. 2, 1960, Ser. No. 66,745

11 Claims. (Cl. 241—32)

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.

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 free 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 slideable 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 the case may require. 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 crusher of this invention hydraulic means is provided to automatically position the crusher shaft relative to the concave while the shaft is gyrating.

It is an object, therefore, of this invention to provide a gyratory crusher having means to automatically position the crusher head when the shaft is gyrating.

It is another object of this invention to provide means responsive to vertical movement of the crusher shaft to automatically restore the crusher shaft to a predetermined position.

It is a still further object of this invention to provide in a gyratory crusher indicating means carried by the crusher shaft support, which means actuates a hydraulic fluid pump, depending upon the vertical movement of the crusher shaft to automatically reposition the shaft.

These and further objects and advantages will become readily apparent to those skilled in the art upon reading the following detailed description taken in conjunction with the appended drawings in which:

FIGURE 1 is an axial section of a gyratory crusher equipped with the automatic shaft positioning means of this invention; and

FIGURE 2 is a perspective view with parts in section of the gyratory crusher of FIGURE 1.

Referring now to 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 cylindrically 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 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

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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 due to 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.

In this invention the problem has been eliminated by providing 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 indicator rod 70 in its lower end projecting through a seal 72 in the closed end 74 of the cylinder 60. The free end of the rod 70 is operatively connected with a detecting potentiometer 76 in such a manner that any vertical movement of the crusher shaft 34 and supporting piston 62 from a predetermined position will be detected by the potentiometer 76 through vertical movement of the rod 70.

The detecting potentiometer 76 is connected by a suitable electrical circuit, shown schematically in FIGURE 1, to a second or adjusting potentiometer 78 and a summing point 80 which transmits an electrical signal to an electro-hydraulic servo valve 82 when the two potentiometers are out of balance. In such an arrangement, when the output level of the detecting potentiometer 76 is equal to the output level of the adjusting potentiometer

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eter 78, the resultant output registered by the summing point would be zero, and no signal would be transmitted to the servo valve 82. If the output levels of the potentiometers are not equal, then the summing point 80 will register the difference and transmit a signal to the servo valve 82.

Generally speaking, the servo valve 82 controls a source 84 of hydraulic fluid under pressure so that when the valve 82 moves in one direction fluid under pressure passes through the conduit 86 to the underside of the piston 62 of the crusher, causing the piston to move upwardly within the cylinder 60. Upward movement of the piston 62 moves the crusher shaft 34 and crusher head 50 upwardly to reduce the space 54 between the head and the concave 48. Conversely, when the valve moves in another direction no fluid flows through the conduit 86 and the piston 62 will move downwardly to increase the space 54. Any vertical movement of the piston 62 is translated into an electrical signal through the action of the indicator rod 70 and the detecting potentiometer 76. Any movement of the rod 70 will change the output level of the detecting potentiometer 76, and if the output level so changed is less than the output level of the adjusting potentiometer 78, the summing point will transmit one signal to the servo valve 82. On the other hand, if the output level of the detecting potentiometer 76 is more than the output level of the adjusting potentiometer 78, another signal will be transmitted from the summing point 80 to the servo valve 82. Therefore, depending upon the type of signal received from the summing point 80, the servo valve 82 will either allow fluid under pressure to raise the piston 62 or will allow it to fall.

In accordance with the present invention, the operator may place the crusher shaft 34 in any desired position to control the space 54 between the crusher head 50 and concave 48. The operator is also able to see where the crusher shaft 34 is disposed at all times, and the crusher shaft is also automatically restored to the predetermined position selected by the operator. Initially, the operator may set the shaft 34 to the desired predetermined position by setting the adjusting potentiometer 78. If the shaft is already in that position, the output of the detecting potentiometer 76 will equal that of the adjusting potentiometer and no signal will be transmitted from the summing point 80 to the servo valve 82. If the crusher shaft 34 is below the desired position, the detecting potentiometer through the action of the rod 70 on the piston 62 will have a different output level. The difference in output levels will be converted to an electrical signal by the summing point 80 which will be transmitted to the servo valve 82 causing it to move in the direction which will allow hydraulic fluid under pressure to pass into the cylinder 60 through the conduit 86 to raise the piston 62 and shaft 34. When the piston 62 reaches the desired position, the potentiometer outputs will be equal and no signal will be transmitted by the summing point 80 allowing the servo valve to move to its normal position to cut off the flow of fluid to the cylinder. Conversely, if the shaft 34 is above the desired predetermined level, the opposite will occur allowing the piston 62 to fall until the potentiometer outputs are equal. If at any time during the crushing operation the piston 62 moves above or below the predetermined setting because of leakage in the cylinder 60, tramp iron in the hopper, or other causes, the crusher shaft 34 will be automatically restored to the desired level through the operation of the potentiometer arrangement above described. The operator at no time need stop the crusher to restore it to its predetermined position in view of the automatic arrangement provided by this invention.

Referring again to FIGURE 1, there is shown schematically the hydraulic circuit responsive to the signal emitted from the summing point 80 to the servo valve 82. Connected to the sump or source of hydraulic fluid 84 is a small capacity pump 90 whose capacity is preferably

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1.5 gallons per minute. The pump 90 is operated by a motor 92, preferably one capable of from 7½ to 10 horsepower output, which also drives a larger capacity pump 94, preferably one with a capacity of 18 gallons per minute. If the servo valve 82 is caused to move in the direction to permit fluid to pass into the cylinder 60 to raise the shaft 34, fluid is withdrawn from the sump 84 through the conduits 95 and 98 through the small pump 90 and thence through the conduit 100 to the servo valve 82. The conduit 100 is provided with a filter 102 located downstream from the servo valve and also with a pressure relief valve 104 connected to the pressure relief conduit 106 which feeds into the sump 84. When the control oil fluid is introduced into the servo valve 82 through the conduit 102, the main valve will be caused to move to freely communicate the supply conduit 108 leading from the large pump 94 with the conduit 86 to permit fluid under pressure to be introduced to the underside of the piston 62 to cause it to rise. The conduit 108 is provided, as is the conduit 100, with a filter 102 in a pressure relief valve 104'. The cylinder 60 has a fluid return line 110 in communication with its closed end 74 and the return line 110 is provided with a pressure relief valve 112 to insure that the pressure within the closed end of the cylinder 60 is at the desired level. If for any cause the pressure within the lower portion of the cylinder 60 exceeds a predetermined amount in accordance with the valve 112, fluid will be permitted to pass through the valve and to the sump 84. If during the operation of the crusher or when the operator is placing the crusher shaft 34 in its predetermined position, the output signal from the summing point 80 to the servo valve 82 is such that the shaft should fall vertically, the main valve will move in the opposite direction as before described, to freely communicate the supply conduit 86 with a return conduit 114 communicating with the sump 84, thus permitting fluid to move out of the lower end of the cylinder 60 through the servo valve 82 and into the sump 84. When the shaft 34 has been moved either upwardly or downwardly by the operator or, due to the automatic operation of the potentiometer summing point arrangement, the servo valve 82 will be restored to this neutral position, thus maintaining the shaft at the pre-selected level.

It will thus be seen that there has been provided by this invention a structure in which the various objects hereinbefore set forth, together with many practical advantages, are successfully achieved. As various possible embodiments may be made of the mechanical features of the above invention, all without departing from the scope thereof, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A gyratory crusher including an upright shaft, a rotating member in which one end of said shaft is eccentrically journaled, a crusher head fixed on said shaft, a fixed concave surrounding said head and radially spaced therefrom, said shaft being slidable vertically to vary the space between said head and said concave, means for rotating said rotary member to gyrate said shaft, means for moving said shaft vertically, means to indicate vertical movement of said shaft during gyration from a predetermined position and means responsive to said indicating means to actuate said means for moving said shaft vertically to automatically restore said shaft to its predetermined position.

2. The structure defined in claim 1 wherein said means for moving said shaft vertically includes an expansible chamber at least partially supporting said shaft, and said automatic restoring means including means to introduce fluid under pressure to said chamber to move said shaft vertically.

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3. The structure defined in claim 2 in which said means for moving said shaft vertically includes a piston supporting said shaft and in which said indicating means includes a rigid element carried by said piston.

4. The structure defined in claim 1 including means coupled with said indicating means to create an electrical signal upon movement of said shaft from said predetermined position, wherein said automatic restoring means is responsive to said signal.

5. 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 fixed concave surrounding said head and spaced radially therefrom, said shaft being slideable vertically to vary the space between said head and said concave, means for rotating said rotary member to gyrate said shaft, a piston supporting said shaft, means for delivering hydraulic fluid to said piston under pressure, means to indicate vertical movement of said shaft from a predetermined position during its gyration, means including a detecting potentiometer circuit responsive to said indicating means to create an electric signal upon movement of said shaft, said signal actuating said hydraulic fluid delivery means to introduce fluid under pressure to said piston to move it and said shaft vertically to said predetermined position.

6. The structure defined in claim 5 including second indicating means remote from said shaft and responsive to said first indicating means to continuously indicate the vertical position of said shaft.

7. The structure defined in claim 5 including anti-friction bearing means disposed between said shaft and said piston means.

8. The structure defined in claim 5 in which said indicating means is carried by said piston means whereby vertical movement of said shaft moves said piston means and said indicating means.

9. The structure defined in claim 5 wherein said hydraulic fluid delivery means includes a pump in communication with said piston through a valve and wherein said means responsive to said indicating means includes a second potentiometer circuit providing a signal in accordance with the desired shaft position, said valve being responsive to the difference in the signals from said potentiometer circuits to regulate the flow of hydraulic fluid.

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10. A gyratory crusher including an upright shaft, a rotating member in which one end of said shaft is eccentrically journaled, a crusher head fixed on said shaft, a fixed concave surrounding said head and said concave, said shaft being slidable vertically to vary the space between said head and said concave, means for rotating said rotary member to gyrate said shaft, piston means supporting said shaft, an electrical circuit providing an output signal responsive to the difference in the shaft position and a predetermined position during gyration of said shaft, and hydraulic circuit means in communication with said piston, responsive to said signal for automatically restoring said shaft to its predetermined position, said hydraulic circuit means including overload relief means to lower said shaft in response to a predetermined excess pressure in said hydraulic circuit.

11. A gyratory crusher including an upright shaft, a rotating member in which one end of said shaft is eccentrically journaled, a crusher head fixed on said shaft, a fixed concave surrounding said head and radially spaced therefrom, said shaft being slidable vertically to vary the space between said head and said concave, means for rotating said rotary member to gyrate said shaft, means for moving said shaft vertically including an expandable chamber at least partially supporting said shaft and including means for conducting hydraulic fluid to and from said expandable chamber, a first electrical circuit for creating a first signal proportional to the vertical position of said shaft; a second electrical circuit for creating a second signal proportional to a desired vertical position of said shaft, and means responsive to the difference between said signals for actuating said hydraulic fluid conducting means to move said shaft to the vertical position established by said second electrical circuit.

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