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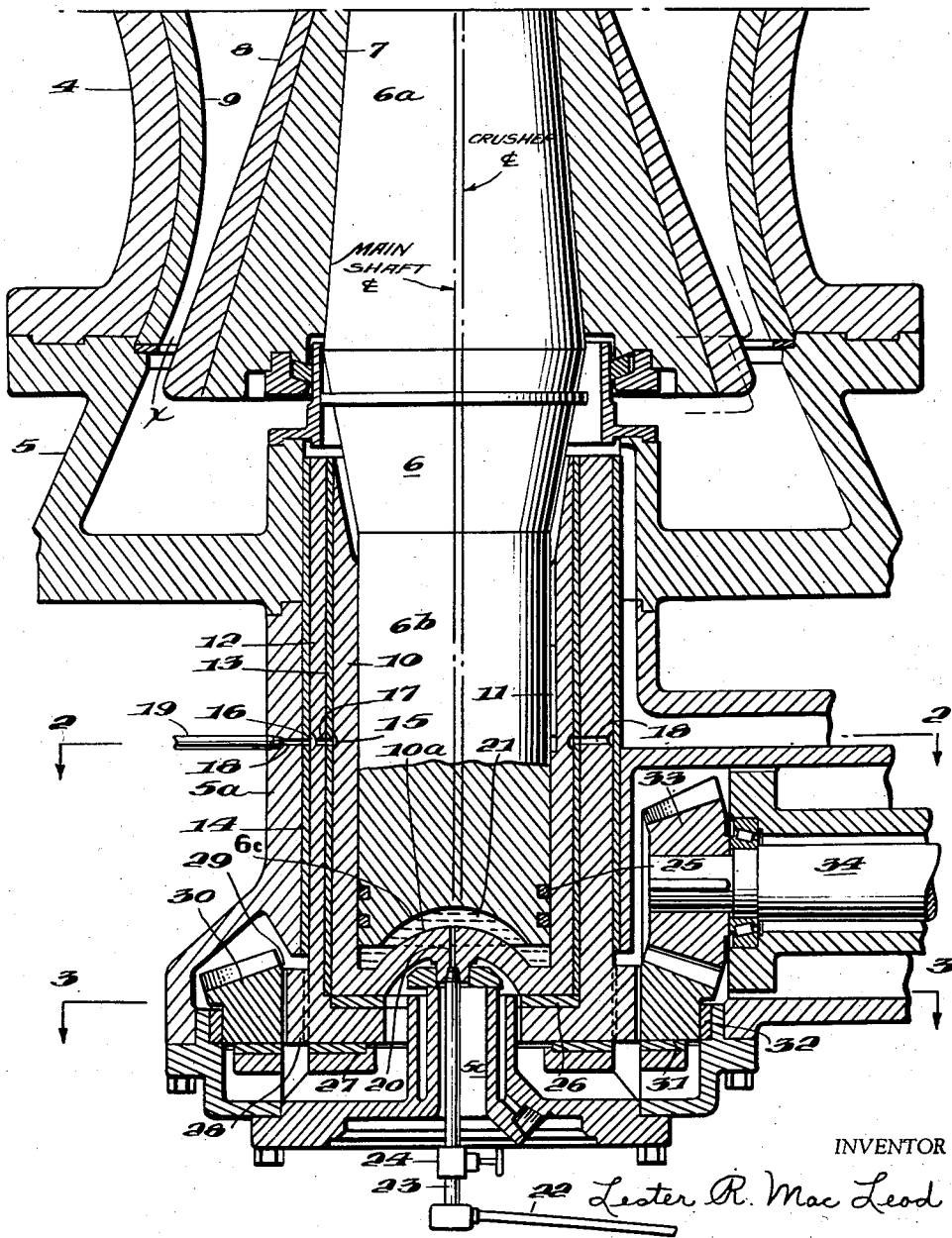
L. R. MacLEOD
GYRATORY CRUSHER WITH HYDRAULIC MEANS
FOR ADJUSTING CRUSHER HEAD

2,833,486

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2 Sheets-Sheet 1

Fig. 1.



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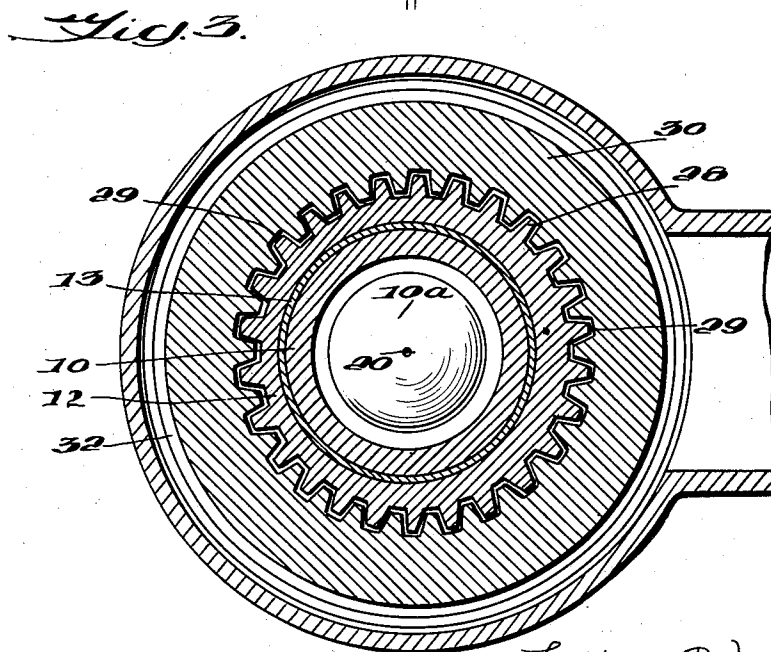
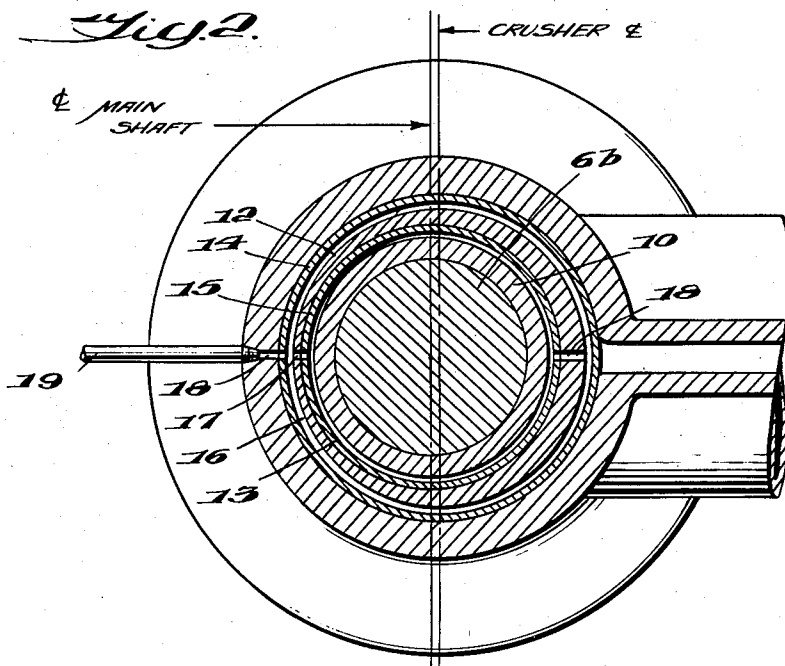
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GYRATORY CRUSHER WITH HYDRAULIC MEANS FOR ADJUSTING CRUSHER HEAD

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4 Claims. (Cl. 241—215)

This invention relates to gyratory crushers of the type having an upright shaft to which gyratory motion is imparted by a rotary eccentric in which the shaft is journaled eccentrically of the axis of rotation of the eccentric. The shaft is journaled for free rotation caused by the rolling of a head, secured to the shaft, on the material being ground between the head and an inverted hollow conical bowl. As the shaft and hence also the head are driven in their eccentric path, it causes a progressive opening and closing of the space between the head and bowl. The result is a continuous crushing of the material in the bowl on the side which is closing and release of the crushed particles on the opposite side to drop down and eventually out of the bowl as the head recedes from the bowl.

Dependent upon the size of ground product desired, it is necessary to arrange the head, and hence also the upright shaft to which it is secured, for vertical adjustment in the eccentric so as to effect a corresponding adjustment of the minimum clearance between the head and concave bowl to produce the particular size of product desired. Moreover, when crushing very hard ores such as an iron ore known as Taconite, wear on the replaceable liners customarily used on the head and bowl is quite rapid and an adjustment between the head and bowl every few days to maintain a constant size of ground product is not at all unusual.

According to early developments in this art, adjustments of the shaft were made manually. Moreover, the crusher had to be stopped while the adjustment was being made which was undesirable. Later developments have made it possible to use hydraulic power means and equivalent mechanical arrangements for effecting the adjustment in height of the shaft and without having to cease operation of the crusher while the adjustment is being made. The present invention relates to an improved construction for the latter type of shaft adjusting mechanism and more particularly to one using hydraulic power, the general arrangement being such that the eccentric, or more particularly a cylinder in the eccentric, and in which the shaft is journaled for rotation, functions also as the cylinder of a hydraulic motor, while the shaft functions as the piston of such motor. The novel construction makes it possible for vertical thrust loads to be carried down from the crusher head through the shaft and cylinder and eccentric by means of standard type step bearings which can be merely flat plates or roller thrust bearings, if desired, as distinguished from spherical type thrust bearings necessary on other known constructions for hydraulically adjusted crusher shafts.

The somewhat standard arrangement for imparting rotation to the eccentric is comprised of a beveled ring gear surrounding and secured to the eccentric, this ring gear meshing with a beveled pinion gear secured upon the end of a drive shaft. In the type of gyratory crusher to be described, rather large clearances are required in the cylindrical bearings of the eccentric. These bearings have replaceable bronze liners, known as outer and inner

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eccentric bushings, and it has been found that about $\frac{1}{8}$ " clearance in diameter is required for each of these bushings. This clearance increases with wear of the liners. The result is that the beveled ring gear is forced to move $\frac{1}{8}$ " or more from its center. With accurately cut teeth, this means that the tooth pressure moves out to one end of the tooth and ideal running conditions of the gears no longer exist. According to another aspect of the invention this difficulty is obviated by use of a flexible drive coupling between the eccentric and the beveled ring gear which enables the beveled ring and pinion gears to remain in perfect mesh thus improving the running condition of the gears and prolonging their life. The flexible coupling is obtained by a meshed set of internal and external gear teeth. The external teeth are part of and surround the eccentric and the internal teeth are formed on the beveled ring gear, such arrangement permitting the eccentric to move horizontally within the limits of the clearance in the bushing without disturbing the center of the beveled ring gear.

The foregoing as well as other objects and advantages inherent in the invention will become more apparent from the following detailed description of one embodiment thereof and from the accompanying drawings wherein:

Fig. 1 is a view generally in central vertical section, but with some parts shown in elevation, of a gyratory crusher incorporating the invention, it being noted that the upper structure of the crusher in the vicinity of the top bearing for the crusher shaft is conventional and has thus been eliminated in order that the lower part of the crusher in which the present invention resides might be illustrated at a larger scale;

Fig. 2 is a transverse section on line 2—2 of Fig. 1; and

Fig. 3 is also a transverse section on line 3—3 of Fig. 1.

With reference now to the drawing, the gyratory crusher is seen to include an inverted hollow conical hopper or bowl 4 located in the upper portion of a hollow frame or casing 5, and a gyratory member comprising an upright shaft 6 having secured thereto at its upper tapered end 6a a conical crushing head 7 which gyrates in the bowl 4. The crusher head is provided with a replaceable liner 8, known as a mantle, and the bowl 4 is also provided with a replaceable liner 9, known as a concave. These liners constitute the surfaces between which the material such as, for example, iron ore is crushed and hence must be replaced periodically.

The lower portion 6b of shaft 6 is cylindrical and fits concentrically in a bore within a cylindrical member 10, a key connection 11 being used between these two elements to permit vertical displacement of the shaft in the cylinder bore but prevent relative rotation therebetween. Cylinder 10 is journaled eccentrically within an eccentric bore in a cylindrical eccentric 12, and a replaceable bronze cylindrical wear liner 13, known as the inner eccentric bushing, is preferably placed between the outer surface of cylinder 10 and the eccentric bore within eccentric 12. Eccentric 12 is, in turn, mounted for rotation about its axis in a cylindrical bearing portion 5a, in the lower part of casing 5, there being preferably a replaceable bronze cylindrical wear liner 14, known as the outer eccentric bushing, used between the outer surface of eccentric 12 and the inner surface of the bearing portion 5a. The axis of rotation of the eccentric 12 is designated on the drawing by the legend "Crusher $\mathcal{C}$," and the axis of free rotation of shaft 6 and cylinder 10 within the eccentric is designated by the legend "Main Shaft $\mathcal{C}$." The $\mathcal{C}$ of the main shaft is inclined slightly from the vertical and intersects the $\mathcal{C}$ of the crusher near the upper end of the shaft where the top bearing (not shown) for this shaft is located.

For lubricating the relatively rotatable cylindrical surfaces, the outer surface of cylinder 10 is provided with

a peripheral groove 15 and the outer surface of eccentric 12 is provided with a similar peripheral groove 16 and at the same level as groove 15. One or more radial oil passageways 17 through the wall of eccentric 12 and liner 13 interconnect the oil grooves 15, 16, and a similar passageway 18 extends through the wall of the bearing portion 5a and liner 14 at the level of oil grooves 15, 16 for connection to a pipe 19 through which lubricating oil is delivered.

In accordance with the invention, an improved hydraulic arrangement is utilized to raise and lower shaft 6 and hence also the conical crusher head 7 and mantle 8 in relation to the concave 9 so as to adjust the minimum clearance x between the mantle and concave as the mantle gyrates about the axis of the crusher and is simultaneously rotated about its own axis by virtue of the rolling contact with the material being crushed. To this end, it will be seen that the lower end of the bore in cylinder 10 is closed by an end wall 10a which is domed inwardly and contains a passageway 20 therethrough by which to admit hydraulic fluid 21 under pressure into the cylinder bore between the bottom end wall 10a and the lower end of shaft 6 which is likewise domed inwardly at 6c to match the domed end wall 10a of cylinder 10. Hydraulic fluid 21 is supplied from a source of fluid pressure such as a pump, not shown, through a flexible conduit 22 and inlet pipe 23 containing a shut-off valve 24 by which fluid flow to and from the interior of cylinder 10 may be controlled. Consequently it will now be evident that elements 10 and 6b constitute respectively the cylinder and piston of a hydraulic motor. Shaft portion 6b is preferably provided with a plurality of sealing rings 25 to prevent leakage of the hydraulic fluid upward along the wall surface of the shaft thereby to prevent any change in a selected position of vertical adjustment of this shaft.

It will be noted that inlet pipe 23 for the hydraulic fluid is located within a cylindrical space 5c in the lower end of casing 5 of sufficient diameter to enable this pipe to execute its eccentric movement as cylinder 10 moves in its eccentric path.

To raise shaft 6 and hence also the head 7 and mantle 8, to thereby decrease the minimum clearance between the mantle 8 and concave 9, valve 24 is opened and more hydraulic fluid 21 is pumped into the cylinder 10. When the desired position for the shaft is reached, valve 24 is then closed thus locking the fluid in the cylinder. To lower the shaft and thus increase the minimum clearance between the mantle and concave, one follows the reverse procedure, opening the valve 24 and permitting the fluid to flow out of the cylinder 10 under the downward pressure of shaft 6 until the position desired for the shaft is reached whereupon valve 24 is reclosed. These adjustments can be made without stopping the crusher.

The arrangement described makes it possible to support the shaft and eccentric members by means of standard type flat step bearings as distinguished from spherical thrust bearings required for other constructions of hydraulic lifts for the crusher shaft, these bearings being necessary between the hydraulic piston and the bottom of the crusher shaft because the latter gyrates in an eccentric path. Thus in the present invention, the downward thrust load of the crusher head 7, shaft 6 and cylinder 10 is carried by a flat annular wear plate 26 and the downward thrust load of eccentric 12 is carried by a flat annular wear plate 27.

In accordance with a further aspect of the invention, the embodiment shown in the drawings makes it possible to maintain an optimum mesh condition between the bevel ring gear which rotates the eccentric and the bevel pinion gear which drives the ring gear. So far as is known, in all prior art crusher constructions, the ring gear is secured to or made integral with the eccentric. Consequently as wear occurs and increases

the original clearance in the eccentric bushings, the ring gear is forced to move correspondingly farther from its center. With accurately cut teeth, this means that the tooth pressure moves out toward one end of the tooth and ideal running conditions of the gears no longer exist. The improvement about to be described enables the ring and pinion gears to remain in perfect mesh and this desirable condition is accomplished by means of a flexible coupling between the eccentric and the ring gear.

With reference now to the lower part of Fig. 1, and Fig. 3, it will be seen that the lower end of eccentric 12 is provided with an externally toothed spur gear the teeth 28 of which fit between the teeth 29 of an internally toothed spur gear formed at the inner side of an annular bevel ring gear 30. Sufficient clearance is provided radially at the roots of the interfitted sets of teeth and circumferentially at the sides of the two sets of teeth to permit the teeth to mesh at slightly greater depth as the bushings 13, 14, wear. Gear 30, supported axially by an annular flat plate type thrust bearing 31 and maintained in radial alignment by a bushing sleeve 32, meshes with a bevel pinion gear 33 which is rotated by a horizontally disposed drive shaft 34. Consequently, as shaft 34 is driven, rotation of pinion gear 33 effects rotation of ring gear 30 which, in turn, effects rotation of eccentric 12 through the interfitted internal and external gear teeth 28, 29. Any wear in the bushings 13, 14 associated with the eccentric 12 is thus reflected only by a change in the clearances between the gear teeth 28, 29, and the mesh between the pinion and ring gears 33, 30 remains undisturbed. It should be noted that the external gear teeth 28 do not have to be formed integrally with the eccentric 12, as shown but rather can be made as a separate external spur gear which is then secured upon the eccentric. The same alternative arrangement is likewise possible with regard to the internal gear teeth 29 in relation to the ring gear 30.

In conclusion, it will be understood that the embodiments of the invention described and illustrated herein are to be regarded as typical rather than limitative of the invention as defined in the appended claims. Consequently minor changes in the construction and arrangement of parts may be made without departing from the spirit and scope of the invention.

I claim:

1. In a gyratory crusher, the combination comprising a first cylindrical member mounted for rotation about its axis, said member having a cylindrical bore therein extending longitudinally and eccentrically therein, a second cylindrical member journaled in the bore of said first cylindrical member and having a cylindrical bore extending longitudinally therein, the lower end of the bore in said second cylindrical member being closed, an upright cylindrical shaft having its lower end portion journaled in the bore of said second cylindrical member, said shaft being free to rotate about its axis and slidable longitudinally in the bore of said second cylindrical member, a head fixed upon the upper portion of said shaft, a bowl surrounding said head, the lower portion of the bore in said second cylindrical member below the lower end of said shaft constituting a hydraulic cylinder, and means for introducing hydraulic fluid under pressure into said cylinder to raise said shaft and hence also said head to effect an adjustment in the clearance between said head and bowl.

2. A gyratory crusher as defined in claim 1 and which further includes means enabling longitudinal movement of said shaft within the bore of said second cylindrical member but preventing relative rotation between said shaft and said second cylindrical member.

3. In a gyratory crusher, the combination comprising a crusher frame, an upright cylindrical eccentric member mounted for rotation about its axis in the lower portion of said frame, said member having a cylindrical bore extending longitudinally and eccentrically therein, a sec-

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ond cylindrical member journaled for free rotation in the bore of said eccentric member and having a cylindrical bore extending longitudinally therein, the lower end of said second cylindrical member and hence the bore therein also being closed, a wear liner between the bore in said eccentric member and the outer surface of said second cylindrical member, a plane step bearing between the lower end of said second cylindrical member and the adjoining inner surface of the end wall at the lower end of said eccentric, a plane step bearing between the outer surface of the end wall at the lower end of said eccentric and the lower portion of said frame, an upright cylindrical shaft having its lower end portion journaled in the bore of said second cylindrical member, said shaft being slidable longitudinally in the bore of said second cylindrical member but non-rotatable relative thereto, a head fixed upon the upper portion of said shaft, a bowl surrounding said head and supported by the upper portion of said frame, the lower portion of the bore in said second cylindrical member below the lower end of said shaft constituting a hydraulic cylinder, and means for introducing hydraulic fluid under pressure into said cylinder to raise said shaft and hence also said head to effect an adjustment of the clearance between said head and bowl.

4. In a gyratory crusher, the combination comprising a first cylindrical member mounted for rotation about its axis, said member having a cylindrical bore extending lon-

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gitudinally and eccentrically thereof, a second cylindrical member journaled in the bore of said first cylindrical member and having in its upper portion a cylindrical bore extending longitudinally therein, an upright cylindrical shaft having its lower end portion journaled in the bore of said second cylindrical member and longitudinally slidable therein, a head fixed upon the upper portion of said shaft, a bowl surrounding said head, the lower portion of the bore in said second cylindrical member below the lower end of said shaft constituting a hydraulic cylinder, and means for introducing hydraulic fluid under pressure into said cylinder to raise said shaft and hence also said head to effect an adjustment in the clearance between said head and bowl.

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