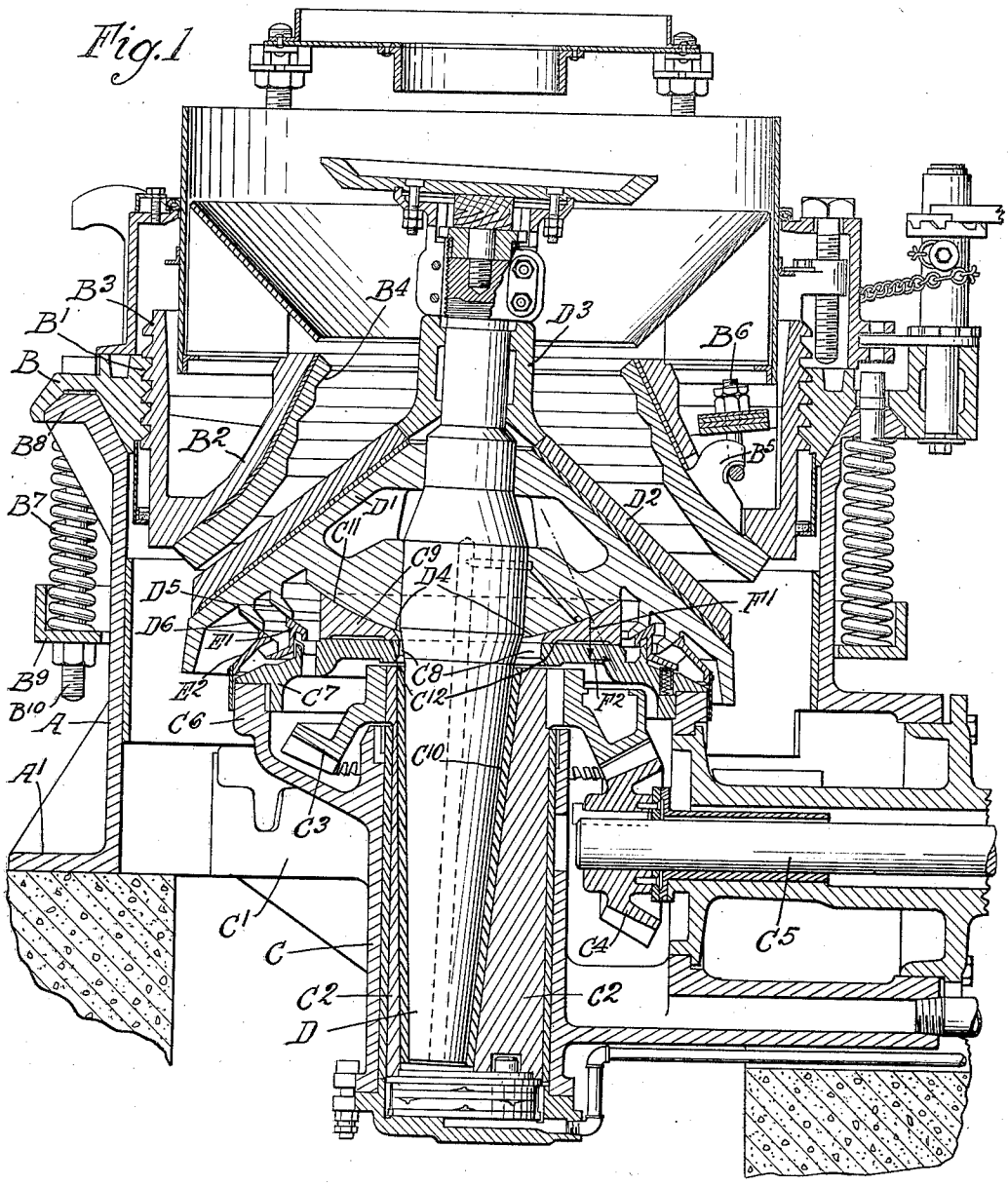
Dec. 3, 1940. O. C. GRUENDER 2,223,956

CRUSHER

Original Filed July 13, 1935 2 Sheets-Sheet 1

Fig. 1



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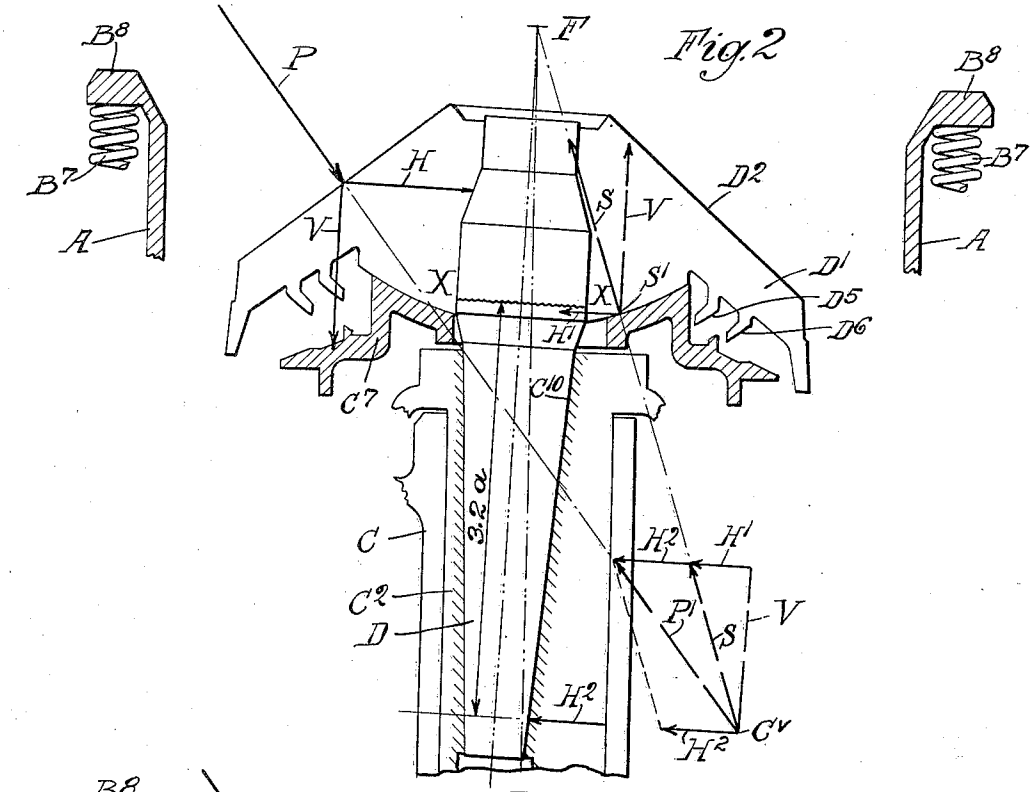


Fig. 2

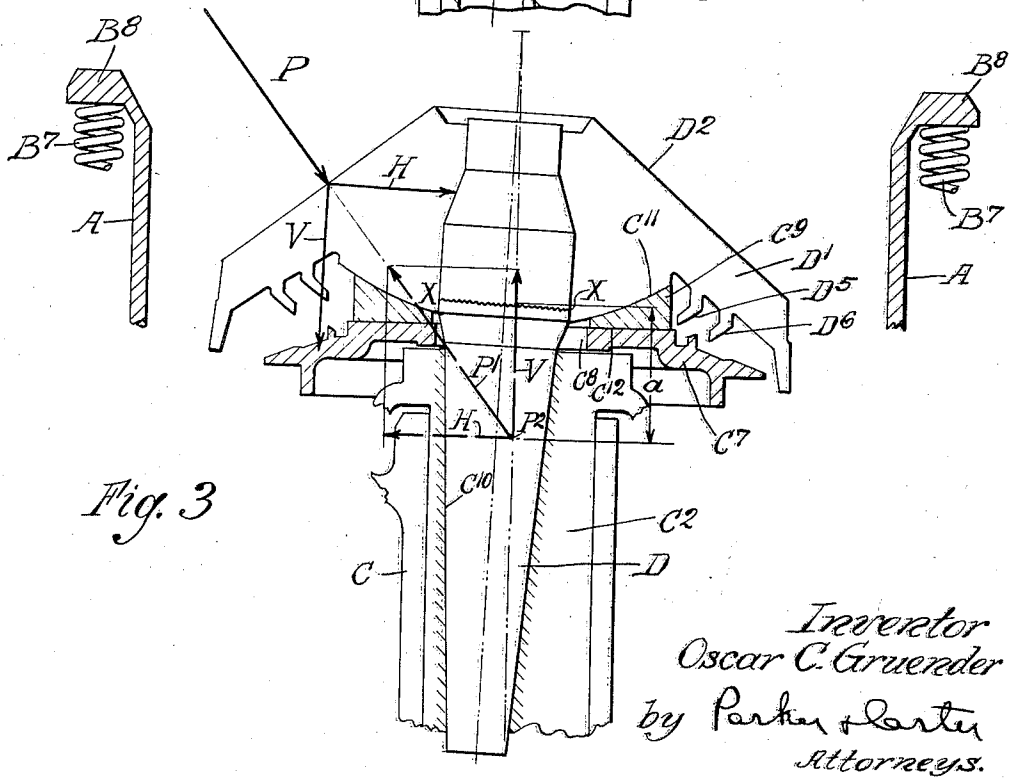


Fig. 3

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2,223,956

CRUSHER

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8 Claims. (Cl. 83—10)

My invention relates to an improvement in crushing devices. It is particularly applicable to gyratory crushers in which a crushing head is employed with a depending actuating shaft which penetrates an eccentric sleeve beneath the head, the rotation of which sleeve imparts a gyratory movement to shaft and head.

One purpose of my invention is the provision of an improved means for supporting the head. Another purpose is the provision of means for substantially reducing strains and stresses upon the shaft caused by the crushing pressure of the head against the material undergoing crushing. Another purpose is the prevention of climbing of the head, when mounted upon a spherical bearing.

Another object of this invention is to provide a method for reducing the stresses in the shaft by locating the horizontal component forces as close to the spherical bearing as possible, thereby reducing the bending moments to which the shaft is subjected. Another object of this invention is to provide a form of step bearing plate which carries out this method as efficiently as possible. Another object of the invention is to provide lubrication to both surfaces of the bearing plate. Another object of the invention is to permit of a means for the use of the proper metal on one face of the spherical bearing.

Other objects will appear from time to time in the course of the specification and claims.

I illustrate my invention more or less diagrammatically in the accompanying drawings, wherein:

Figure 1 is a vertical axial section through a gyratory crusher embodying my invention;

Figure 2 is a diagram illustrating the force distribution of a typical gyratory crusher; and

Figure 3 is a diagram showing the force distribution of a similar crusher to which my invention has been applied.

Like parts are indicated by like symbols throughout the specification and drawings.

I wish it to be understood that my invention may be applied to a wide variety of gyratory crushers and to a wide variety of shapes of head, it having been shown in Figure 1 in connection with one type of head and in the diagrammatic Figure 3 in connection with another.

Referring to the drawings, A generally indicates a cylindrical main bearing frame with its bottom flange or flanges A1 resting on a foundation.

Mounted on the upper edge of the main frame A is the tilting ring B with a screw threaded portion B1 in mesh with a correspondingly screw threaded portion B3 of the bowl B2. B4 is any suitable liner secured to the bowl as by lugs B5 and the bolts B6. B7 are springs compressed between the bottom of the flange B8 above the top of the main frame A and the abutment ring B9. B10 are tension members connecting the ring B with the abutment ring B9, whereby the springs B7 are effective to hold the ring B normally fixed in relation to the main frame A.

C indicates a central bearing member which may be connected as by the spider C1 to the frame A. Rotatable within the bearing C is the eccentric sleeve C2, having at its top a gear C3 in mesh with the pinion C4 on a drive shaft C5, whereby the eccentric sleeve C2 may be rotated. C6 indicates a gear box formed unitarily with the bearing sleeve C. C7 is a cover therefor apertured as at C8 in alignment with the eccentric sleeve C2. C9 is a spherical bearing plate shiftably mounted on the cover C7 to enable its centering itself in relation to any play between the crushing shaft D within the aperture C10.

Mounted on top of the crusher shaft D is a crushing head D1 upon which is any suitable crushing mantle D2 which may be held suitably in position thereon as by any suitable locking sleeve D3. The head is formed with a spherical lower bearing surface D4 conforming to and opposed to the bearing member C9 having the concave spherical bearing surface C11 facing upward and a flat lower bearing surface C12. The main weight of the head is borne by these opposed bearing surfaces.

In order to protect the main bearing surface thus formed, the periphery thereof is surrounded by sealing members E1 and E2 which abut projections of the cone D1 on co-acting spherical surfaces D5 and D6. Besides protecting the main bearings from the entrance of dust and other foreign matter, these elements prevent the escape of lubricating oil. The space within the sealing members E1 and E2 may be subjected to a slight air pressure to more effectively exclude the entrance of dust.

The bearing surfaces C11 and C12 of the bearing plate C9 may be provided with proper oil grooves and channels to effectively lubricate both the top and bottom surfaces. The weight of the cone D1, together with its mantle D2, locking sleeve D3 and other appurtenances, including the shaft D tend to bear down on the bearing plate C9 and hold it centrally in relation to the spherical surface C11 of the cone D1. In case the cone D1 attempts to climb on the surface C11, it will

create a bearing pressure on the surface C11 directed radially to the surface, this pressure having a horizontal and a vertical component, the horizontal component tending to displace the bearing plate C9 in the direction of climb, the magnitude of these two forces being represented by the direction and magnitude of the lines F1 and F2, respectively.

In order to illustrate the structure and the purpose of the structure above described and the effect of the changes made over the prior art, I have employed Figure 2 as illustrating the prior art and Figure 3 as illustrating my invention. Figure 2 is a diagrammatic force sketch showing the forces acting upon a gyrating cone or head not equipped with one of my shiftable bearing plates C9. Figure 3 is a force diagram illustrating the result of the application of one of the shiftable bearing plates to a gyratory crusher.

Referring to Figure 2, which shows a crusher without my invention, a crushing force P is shown directed downward and to the right in magnitude equivalent to the force required to lift the spring loaded bowl B, B2 of Figure 1, and in a direction as would occur if a crushing blow were struck to the left of the cone. This force would tend to move the cone to the right and is resisted in such movement by the spherical bearing, the eccentric bearing and the shaft bearing. The spherical bearing takes up part of the force P, the reaction of which for that moment is concentrated on the right. The force P also sets up a tendency to move the crusher shaft D to the right, due to its horizontal component, which is resisted by a force H2 located at the lower end of shaft D and acting in a direction toward the left, the position of this force being determined from actual examples of shafts and therefore, its direction (horizontal), determines the point C^v at the intersection with the line of direction of the force P.

The reactive force at the spherical bearing acts radially, that is its direction is through the center of the spherical surface, as at F, tending to lift the cone without producing a movement and is represented in magnitude and direction by the line S. This force must also act through the center C^v and therefore determines the point at which the load on the spherical bearing surface is concentrated, as at S1, which may be resolved into two forces, one acting vertically upward from the point S1 and the other acting horizontally from the point S1, as H1. Both forces H1 and H2 tend to hold the horizontal components of the force P, that is H, in equilibrium, so that the sum of these two forces therefore act together in a direction toward the left. In order to determine the magnitude of the force H2, with the force P being known, it is only necessary to complete the parallelogram of forces by extending a line downward from the point establishing the magnitude of the force P parallel to line of force S, which intersects the line of force of H2 passing through the point C^v. The force H2 therefore sets up a bending moment in magnitude and direction as shown, its distance from zone of breakage being the vertical distance to the point C^v, this moment being sufficiently large to cause a fracture.

It will be noted that as the radius of the spherical bearing becomes greater, the intersection point C^v of the forces P and S moves upward along the line of force P until finally, when the radius becomes infinity, the line of force S becomes vertical and the plane of the spherical bearing becomes flat and at right angles to the axis of the eccentric. The point C^v in this case would be at the intersection of the center line of the eccentric and the line of force P. As the point C^v rises, the application point of the force H2 also rises until it acts at the intersection of the center line of the eccentric and the line of the force P.

Figure 3 illustrates my invention in operation. It will be noted that the same force P is assumed in magnitude and direction as previously. This may be resolved into a horizontal and vertical force acting at P2 and held in equilibrium by equal and opposite forces. A simple force diagram results, in which the horizontal force H acting to the left, sets up a moment about the line of breakage X—X acting in a clockwise direction and the vertical force V acting downward on an arm, tending to cause counter-clockwise rotation, the difference of these two moments, therefore, being the resultant which tends to break the shaft D. The resultant moment, it will be noted, will be less than half of that of the previous case and is well within the safe limits of the shaft stress.

It is apparent that the use of a bearing plate of this sort indicates a method of reducing the moments and therefore the stress in the shaft to such an extent as to be very useful in the art. It will be realized that whereas there is shown a practical and operative device, nevertheless, many changes might be made in size, shape and disposition of parts without departing from the spirit of the invention. The description and drawings should, therefore, be taken as in a broad sense, illustrative and diagrammatic, rather than as limiting the invention to the specific showing.

The use and operation of my invention is as follows:

This invention relates to a method for supporting a bearing of a gyratory cone crusher so as to reduce the stresses in the shaft supporting the cone of the crusher. This may become necessary in isolated cases where very hard materials are being crushed. It affords a means for reducing the weight and cost of crushers used where ordinary materials are being crushed. A device to carry out this method is illustrated in connection with a gyratory cone crusher in which the crushing head is mounted on a main spherical bearing. In such gyratory crushers, the stresses set up in the shaft supporting the cone at a point directly above the spherical bearing may occasionally be so great as to risk damage to the shaft. These stresses are commensurate with and proportional to the resistance to crushing. They may be considerably enhanced if unbreakable material passes through the crusher and in such case is commensurate with and proportional to the spring load on the yieldable member of the crusher. Such spring load is always adjusted to balance the crushing load of the particular ore passing through the crusher, which in some instances is harder than in others. It is natural that in instances where very hard ore is being crushed, the spring load is proportionately greater. To increase the diameter of the shaft to withstand such stress would require enlargement of all bearings and parts of the crusher, which would reflect in the cost of the apparatus and is therefore objectionable. The present invention solves the problem for even the hardest materials.

Referring to Figures 2 and 3, assume that a

crushing force P acting at right angles to the surface of the head is applied in the same relative position in either case. This crushing force will set up in the opposing crushing members a reactive force P1, opposing and equal to the force P. To produce this reactive force, two forces H2 and S in the case of Figure 2, or H and V in the case of Figure 3, will come into play, because a bearing can only take a force normal to its surface, and the crusher structure does not offer a bearing surface at right angles to the force P.

As the force P1 is the resultant of the two forces H2 and S in Figure 2 and H and V in Figure 3, the three must intersect at one common point, as C^v and P2 respectively.

Referring specifically to Figure 2, the crusher without my invention, a spherical socket bearing can only take up a force pointing towards its center of rotation F. Its direction will depend upon the location of the force H2, which may act anywhere along the crusher shaft. Whatever clearance exists between the shaft D and the eccentric C2 and between the eccentric C2 and the members C will be taken up under the influence of force P and the crusher head, being held central in the spherical bearing, will therefore rotate slightly about its fulcrum point F in the plane of the drawing, causing the clearance to be avoided at a point on the shaft D farthest from the fulcrum F as at H2 indicated in Figure 2, which is invariably the case. The force S does not enter into the present case, because it does not tend to produce bending in the crusher shaft.

In Figure 3, the force distribution differs from the force distribution of Figure 2, as the force S is replaced by a vertical force V, normal to the new bearing, because, due to the shiftable sliding plate C9, only such a force can be transmitted to the frame. The point of intersection of this force V with the direction of crushing force P determines the location of the force H, which is the one causing bending of the crusher shaft.

As a general example or comparison of the difference in bending moment to which the crusher shaft is subjected, the following calculation is given.

Assume crushing force equal to 100, the horizontal forces in Figure 2 and Figure 3 are 35 and 60 respectively. Similarly, a, which is the lever arm of force H, (referred to shaft section XX) equal to 1 in Figure 3, then the corresponding dimention (a) in Figure 2 (measured in the same scale) would be 3.2.

The bending moment therefore would be proportional to the product of force H times the lever arm; therefore, in case of Figure 2:

$$\text{Bending moment}=35\times 3.2\times a=112a$$

Similarly the bending moment of the force H when referring to Figure 3 would be

$$\text{Bending moment}=60\times a=60a$$

The shaft stress with a construction incorporating the bearing plate would therefore be:

$$\frac{60a}{112a}\times 100=53.5\%$$

of that set up in a crusher built according to Figure 2.

In operation, when uncrushable material enters the crushing zone and is nipped between the bowl and gyrating cone, there is a tendency to displace the cone sidewise and downwardly, the motion downward being resisted by a tendency to bend the shaft and the horizontal moment tending to displace the center line of the cone shaft. The motion sidewise is unresisted excepting by the crusher shaft D within the aperture C10. There is therefore a tendency to bend the shaft, the moment of the horizontal force as in the previous case acting to oppose the moment of the vertical force, thereby reducing its effect. The resultant, therefore, is less than the vertical component multiplied by the distance from the center of the eccentric. Any tendency to climb on the spherical bearing is eliminated by the fact that the bearing plate may move sidewise. All clearance between the crusher shaft, eccentrics and bearing housing can be reduced to a minimum.

I claim:

1. In a gyratory crusher, a frame, a bowl, a head, a shaft unitarily moving with the head and downwardly extending therefrom, the upper end of said head and shaft being free for lateral movement in relation to said frame, a support for said head, fixed on said frame, and having a generally plane horizontal upper bearing surface, a supporting plate laterally slidable on said bearing surface, said plate having also an upper bearing surface on which said head is supported, an eccentrically apertured sleeve surrounding substantially the entire length of said shaft below said head, and means for rotating it and for thereby gyrating said shaft and head, the bearing connection between the shaft and eccentric sleeve constituting the sole means for limiting lateral movement of said head.

2. In a crusher, an outer frame, a crushing bowl mounted thereon, an inner frame, a fixed bearing associated therewith, the axis of which is generally vertical, an eccentrically apertured bearing sleeve rotatably mounted in said fixed bearing, a crusher shaft, the upper end of which is free from rotary bearing contact, a lower portion of which is mounted in the aperture of said sleeve, means for rotating said sleeve, a crusher head associated with the upper end of the shaft, the lower portion of the head being formed with a spherical, downwardly convex bearing surface, and a support for the head, including a fixed member positioned above said fixed bearing and supported upon the inner frame and having a generally horizontal upper bearing surface, and a supporting plate positioned between the bottom of the head and the top of said fixed member, said plate being formed with an upwardly concave spherical bearing surface conforming to the bottom of the head, and with a downward bearing surface conforming generally to and adapted to engage the upper bearing surface of the fixed member, said supporting plate being movable laterally in relation to said fixed member.

3. In a crusher, an outer frame, a crushing bowl mounted thereon, an inner frame, a fixed bearing associated therewith, the axis of which is generally vertical, an eccentrically apertured bearing sleeve rotatably mounted in said fixed bearing, a crusher shaft mounted in the aperture of said sleeve, means for rotating said sleeve, a crusher head associated with the upper end of the shaft, the lower portion of the head being formed with a spherical, downwardly convex bearing surface, and a support for the head, including a fixed member positioned above said fixed bearing and supported upon the inner frame and having a generally horizontal upper bearing surface, and a supporting plate positioned be-

tween the bottom of the head and the top of said fixed member, said plate being formed with an upwardly concave spherical bearing surface conforming to the bottom of the head, and with a downward bearing surface conforming generally to and adapted to engage the upper bearing surface of the fixed member, said supporting plate being movable laterally in relation to said fixed member, the spherical bearing surface between the supporting plate and the bottom of the head intersecting, if spherically projected, the opposed crushing faces of head and bowl.

4. In a crusher, an outer frame, a crushing bowl mounted thereon, an inner frame, a fixed bearing associated therewith, the axis of which is generally vertical, an eccentrically apertured bearing sleeve rotatably mounted in said fixed bearing, a crusher shaft mounted in the aperture of said sleeve, means for rotating said sleeve, a crusher head surrounding the upper end of the shaft, the lower portion of the head being formed with a spherical, downwardly convex bearing surface, and a support for the head, including a fixed member positioned above said fixed bearing and supported upon the inner frame and having a generally horizontal upper bearing surface, and a supporting plate positioned between the bottom of the head and the top of said fixed member, said plate being formed with an upwardly concave spherical bearing surface conforming to the bottom of the head, and with a downward bearing surface conforming generally to and adapted to engage the upper bearing surface of the fixed member, said supporting plate being movable laterally in relation to said fixed member, substantially the entire length of the crusher shaft extending below the head being in bearing engagement with the eccentrically apertured bearing sleeve.

5. In a crusher, an outer frame, a crushing bowl mounted thereon, an inner frame, a fixed bearing associated therewith, the axis of which is generally vertical, an eccentrically apertured bearing sleeve rotatably mounted in said fixed bearing, a crusher shaft, the upper end of which is free from rotary bearing contact, a lower portion of which is mounted in the aperture of said sleeve, means for rotating said sleeve, a crusher head associated with the upper end of the shaft, the lower portion of the head being formed with a spherical, downwardly convex bearing surface, and a support for the head, including a fixed member positioned above said fixed bearing and supported upon the inner frame and having a generally horizontal upper bearing surface, and a supporting plate positioned between the bottom of the head and the top of said fixed member, said plate being formed with an upwardly concave spherical bearing surface conforming to the bottom of the head, and with a downward bearing surface conforming generally to and adapted to engage the upper bearing surface of the fixed member, said supporting plate being movable laterally in relation to said fixed member, the entire bearing portion of the crusher shaft being located below the crusher head.

6. In a crusher, an outer frame, a crushing bowl mounted thereon, an inner frame, a fixed bearing associated therewith, the axis of which is generally vertical, an eccentrically apertured bearing sleeve rotatably mounted in said fixed bearing, a crusher shaft, the upper end of which is free from rotary bearing contact, a lower portion of which is mounted in the aperture of said sleeve, means for rotating said sleeve, a crusher head associated with the upper end of the shaft, the lower portion of the head being formed with a spherical, downwardly convex bearing surface, and a support for the head, including a fixed member positioned above said fixed bearing and supported upon the inner frame and having a generally horizontal upper bearing surface, and a supporting plate positioned between the bottom of the head and the top of said fixed member, said plate being formed with an upwardly concave spherical bearing surface conforming to the bottom of the head, and with a downward bearing surface conforming generally to and adapted to engage the upper bearing surface of the fixed member, said supporting plate being movable laterally in relation to said fixed member, the entire bearing portion of the crusher shaft being located below the spherical bearing surface of the supporting plate.

7. In a crusher, an outer frame, a crushing bowl mounted thereon, an inner frame, a fixed bearing associated therewith, the axis of which is generally vertical, an eccentrically apertured bearing sleeve rotatably mounted in said fixed bearing, a crusher shaft, the upper end of which is free from rotary bearing contact, a lower portion of which is mounted in the aperture of said sleeve, means for rotating said sleeve, a crusher head associated with the upper end of the shaft, the lower portion of the head being formed with a spherical, downwardly convex bearing surface, and a support for the head, including a fixed member positioned above said fixed bearing and supported upon the inner frame and having a generally horizontal upper bearing surface, and a supporting plate positioned between the bottom of the head and the top of said fixed member, said plate being formed with an upwardly concave spherical bearing surface conforming to the bottom of the head, and with a downward bearing surface conforming generally to and adapted to engage the upper bearing surface of the fixed member, said supporting plate being movable laterally in relation to said fixed member, the entire bearing portion of the crusher shaft being located below the spherical bearing surface of the supporting plate, the upper end of the eccentrically apertured sleeve extending closely adjacent said bearing surface, said bearing surface extending throughout a substantial proportion of the bottom surface of the head.

8. In a gyratory crusher, a concave, a head, a shaft unitarily moving with said head and downwardly extending therefrom, the upper end of head and shaft being free for lateral movement, a bearing support for said head adapted to permit lateral movement of said head, an eccentrically apertured sleeve surrounding substantially the entire length of said shaft below said head, and means for rotating it and for thereby gyrating said shaft and head, the bearing connection between shaft and eccentric sleeve constituting the sole means for limiting lateral movement of said head, said bearing support including a fixed generally horizontal bearing member, a bearing plate sliding thereon having a lower bearing surface resting upon and conforming to the upper surface of said fixed horizontal bearing member, and having a spherical concave upper bearing surface, a lower portion of the head having a spherical convex bearing surface conforming thereto, the aperture of said eccentrically apertured sleeve being slightly inclined from the vertical.

OSCAR C. GRUENDER.