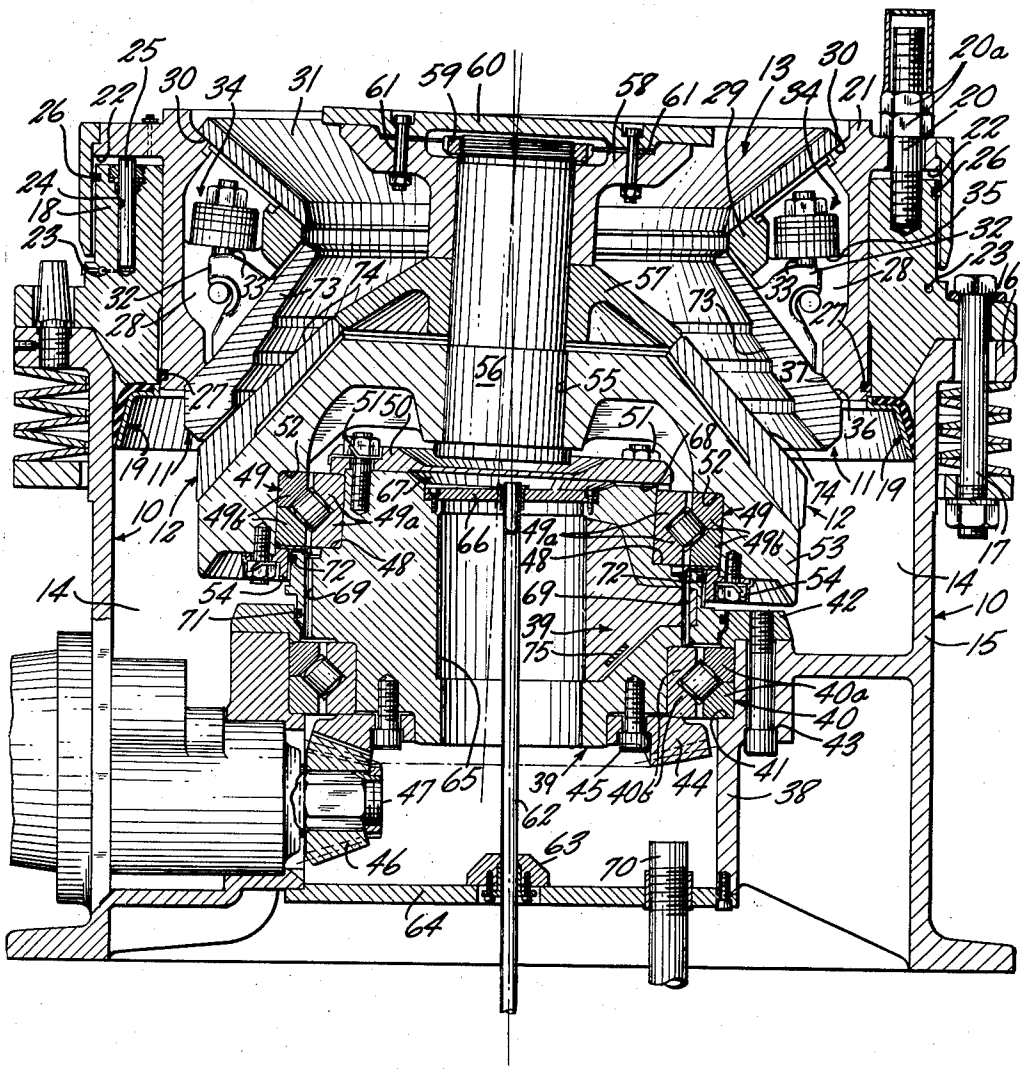
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CONE CRUSHING MECHANISM

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CONE CRUSHING MECHANISM

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This invention relates to crushing mechanism and more particularly to a crushing mechanism having an improved and highly simplified actuating and bearing structure for imparting complex crushing motions to the crushing members.

The complex motions of the movable crushing members of cone type crushers impose extremely heavy loads in many different directions on the bearing structure. Because each direction of thrust should be squarely met by a suitable bearing if efficiency, power, and long life are to be attained, there have been evolved for use in crushing mechanisms intricate multiple bearing assemblies which are costly to build and maintain. Moreover, because the products such as rock dust resulting from operation of crushing mechanisms are inherently inimical to bearings the additional design problem is posed of protecting the bearings as well as the entire lubricating system from the highly penetrating and abrasive products of the crushing operation. The complex crusher motions including gyrations and nutations make effective and economical sealing extremely difficult.

An object of the present invention is to provide a crushing mechanism having a highly simplified yet efficient, robust and fully protected actuating and bearing mechanism.

For a more complete understanding of the invention as well as other features and objects thereof, reference may be had to the following specification taken in conjunction with the accompanying drawing which is a view in vertical section taken along the central axis of a cone crushing mechanism representative of how the present invention can be applied.

The illustrated cone crushing mechanism comprises a frame 10 which carries a pair of complementary crushing members 11 and 12, the latter of which is driven so as to gyrate and nutate within the former by actuating and bearing mechanism presently to be described. Material to be crushed such for example as pieces of stone are introduced into the top of the mechanism through an infeed hopper identified generally by the numeral 13 and the crushed product is withdrawn at the bottom of the mechanism through a suitable discharge channel (not shown) which communicates with the generally toroidal space 14 which surrounds the base of the driven crushing member 12.

The frame 10 includes a closed cylindrical wall portion 15 to confine the crushed product and which is formed at its upper edge with a flange 16. Yieldably clamped to the upper surface of the flange 16, as by spring loaded bolts 17, is an annulus 18 to the lower edge of which is attached a ring seal 19 which bears against the inner surface of the cylindrical wall portion 15 to form a tight seal but which is capable of vertical sliding motion. Adjustably attached to the annulus 18 by adjusting bolt means 20 is a top ring 21 formed with a downwardly opening channel 22 which slides over the annulus. The annulus 18 is formed with a high pressure oil manifold 23 supplied from a high pressure source (not shown) and

communicating with the lower end of each of three circumferentially arrayed vertical cylinders 24 (only one of which is shown) in which hydraulic plungers 25 are mounted. The introduction of oil pressure to the manifold 23 raises the hydraulic plungers 24 to bear upwardly against the top ring 21, the uppermost position of which is set by the bolt means 20. The channel space 22 between the upper end of the annulus 18 and the opposing surface of the top ring 21 is kept free of extraneous matter which might hinder the adjustment thereof by means of sealing rings 26 and 27.

The top ring 21 is formed on its inner surface with radially inwardly extending webs 28 terminating at their inner ends in a circular rib 29 which defines the throat of the hopper 13. Surmounting the rib 29 and also resting on a shoulder 30 formed on the inner edge of the top ring 21 is a flared, downwardly inclined hopper plate 31.

The outer and uppermost crushing member 11 has attached to its outer surface a series of cleats 32 underslung by tension members 33 the upper ends of which are secured by holding nut assemblies which rest on shoulders 35 formed on the webs 28 of the top ring 21. With the holding nuts 34 set up tight, the outer crushing member 11 is drawn upwardly so that a shoulder 36 on its outer surface tightly engages a corresponding shoulder 37 formed near the lower edge of the top ring 21.

The frame 10 is formed within the cylindrical wall portion 15 with a central support 38. Journaled in the support for rotation about a vertical axis which passes substantially through the center of the throat of the infeed hopper 13 is a rotor or annular mounting member 39. The rotor 39 is journaled in the support 38 by means of an X-type bearing 40 having a pair of its races 40*a* fixed to the frame 38 by the clamping action of a shoulder 41, formed on the inner surface of the support, and a clamping ring 42 secured to the support 38 by bolts 43. The action of the clamping ring preloads the bearing. The other pair of races 40*b* are clamped to the rotor 39 by means of a beveled ring gear 44 held in place by bolts 45. The ring gear 44 is engaged by a gear 46 fixed to a shaft 47 which is in turn journaled in the frame 10 and driven by a suitable driving motor (not shown).

The upper end of the rotor 39 is formed with a circular bearing supporting groove 48 which is eccentric with respect to the axis of rotation of the rotor and which is also canted so that its axis forms a slight angle with the vertical. Clamped in the groove 48 are the inner pair of races 49*a* of a second X-type bearing 49. The races 49*a* are clamped in place by means of a clamping cap 50 secured to the top of the rotor 39 by bolts 51 for example.

The outer pair of races 49*b* of the X-type bearing 49 are clamped and preloaded in a bearing groove 52 formed in the underside of a substantially conical body portion 53 for the inner crushing member 12 by a bolted clamping ring 54. The groove 52 is substantially coaxial with the conical body portion 53 or, more broadly, with the inner crushing member 12. The body portion 53 of the inner crushing member 12 is centrally apertured at 55 to receive a heavy tension shaft 56 which passes upwardly therethrough and over which are fitted an inner collar 57 having upwardly convergent outer walls, and a flared head portion 58, the whole being held together by means of a nut 59 screwed on to the threaded tip of the shaft 56. The head portion 58 and nut 59 are covered by a plate 60 secured as by bolts 61 to the flared portion of the head 58. It will be seen that the neck or narrow center portion of the inner crushing member 12 is disposed in the throat of the infeed hopper 13 and that the flared head is disposed within the flared hopper wall 31.

To lubricate the X-type bearings 40 and 49, a duct 62 from a suitable source of lubricant under pressure is passed upwardly through a sealing gland 63 in a frame

base wall 64 into the chamber which houses the gears 46 and 44, through an enlarged axial bore 65 in the rotor 39 and through a bushing in a small cap plate 66 bolted to the top surface of the rotor 39 to discharge into a cavity 67 defined by the cap plates 50 and 66. Lubricant flows outwardly from the cavity 67 through radial ducts 68 (only one of which appears in the drawing but several of which are provided throughout the circumference of the rotor) to spill on to the races of the X-type bearing 49. The lubricant from the bearing 49 gravitates through ducts 69 in the rotor 39 to spill on to the races of the X-type bearing 40, from which it drains into the chamber housing the gears 46 and 44, spilling out of this chamber through a stand pipe 70 having an inner height sufficient to insure that the gear 46 is partially immersed in the lubricant pool.

In order to seal the bearings 40 and 49 from the effects of the crushed material which issues from the working surfaces of the crushing members 11 and 12, a first sealing ring 71 is fitted between the clamping ring 42 and the other cylindrical surface of the rotor 39 and a second sealing ring 72 is fitted between the inner cylindrical surface of the clamping ring 52 of the inner crushing member 12 and an opposing cylindrical surface formed on the rotor 39 with the same eccentricity and cant as the bearing supporting groove 48, also formed on the rotor. Sealing rings 71 and 72 are preferably secured to the clamping rings 42 and 52, respectively, and received in corresponding grooves formed in the rotor 39.

The actual working surfaces 73 and 74 of the outer and inner crushing members 11 and 12 respectively are of hardened abrasion resistant material with the inner surface 74 being substantially conical and having an apex angle which is slightly larger than the average apex angle of the surface 73. The surface 73 is circumferentially serrated as indicated in the drawing to present a series of conical surfaces of progressively lesser apex angles proceeding upwardly from the bottom, with the lowermost portion having an angle which is substantially the same as that of the inner crushing surface 74.

In order to promote smoothness of operation, the rotor 39 is preferably dynamically balanced about the center vertical axis by means of counterweights 75 which can take the form for example of lead poured into core spaces within the rotor 39.

In operation, upon rotation of the rotor 39 the inner crushing member 12 will be caused to gyrate and at the same time nod or nutate within the outer crushing member to produce a highly efficient grinding action between the complementary grinding surfaces 73 and 74. A corresponding motion of the upper end of the inner crushing member will occur within the hopper 13 to encourage infeed. The complex motion of the inner crushing member 12 is the result of the eccentric and canted mounting of the X-type bearing 49 on the rotor 39, it being significant that the axis of the X-type bearing 49 is at angles to the axis of rotation of the rotor 39, i.e., of the other X-type bearing 40. In the illustrated arrangement the point of intersection of the two axes of the bearings 40 and 49 occurs at a point above the crushing surfaces and in the vicinity of the infeed hopper 13.

The complex crushing motion of the inner crushing member 12 results in corresponding complexity in the forces which must be transmitted to the frame 10 by the two bearings 40 and 49. The gyrating action for example introduces radial forces in all directions and the nodding action as well as the resistance of the material being crushed introduces axial forces over a certain range of angles. All of these forces are accommodated efficiently by the X-bearing 49 and carried through the rotor body 39 to the X-bearing 40 through which they are transmitted with equal efficiency to the frame 10. Thus using but two basic bearing assemblies, a highly effective, rugged, and efficient motion generating system is created in accordance with the present invention. Adjustment of the unit can be effected by means of the nuts 20*a* on the adjustable bolts 20 to raise or lower the inner crushing member in cooperation with the hydraulically actuated support plungers 25.

While the invention has been described with specific reference to the accompanying drawing showing one preferred embodiment thereof, it should not be regarded as limited except as defined by the following claims.

We claim:

1. Crushing mechanism comprising relatively movable complementary crushing members, and means to actuate one of the crushing members including a rotary member, first bearing means to mount the rotary member for rotation about a vertical first axis, and second bearing means comprising an X-type bearing having races that are eccentric with respect to the first axis to mount the crushing member on the rotary member for rotary movement relative thereto about a second axis at an angle to the first axis, the second axis intersecting the first above the lower portions of the complementary crushing members.

2. Crushing mechanism according to claim 1 wherein the first bearing means is an X-type bearing.

3. Crushing mechanism according to claim 2 wherein a frame supports the inner and outer crushing and rotary members and includes wall means defining material input and output zones, and wherein the inner crushing member is formed with a depending annular flange surrounding the rotary member, the frame is formed with an annular wall portion surrounding the rotary member and having its axis common with the first axis, and the rotary member is formed with a pair of annular surfaces, the first of which faces the wall portion of the frame and has its axis common with the first axis and the second of which faces the depending annular flange of the inner crushing member and has its axis common with the second axis, and sealing rings between the respective opposed surfaces.

4. Crushing mechanism comprising frame means defining a vertical operating axis, an outer crushing member fixed to the frame with its axis common with the operating axis, an inner crushing member, and means to mount the inner crushing member for nutation within the outer member including an X-type bearing having its two parallel sets of races contained in parallel planes at an angle to the horizontal and surrounding the operating axis, the X-type bearing thereby having its axis at an angle to the operating axis, means to fix one set of the races to the inner crushing member, and means to rotate the other set of races about the operating axis.

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