July 19, 1955 A. W. KJELGAARD 2,713,461

GYRATORY CRUSHER

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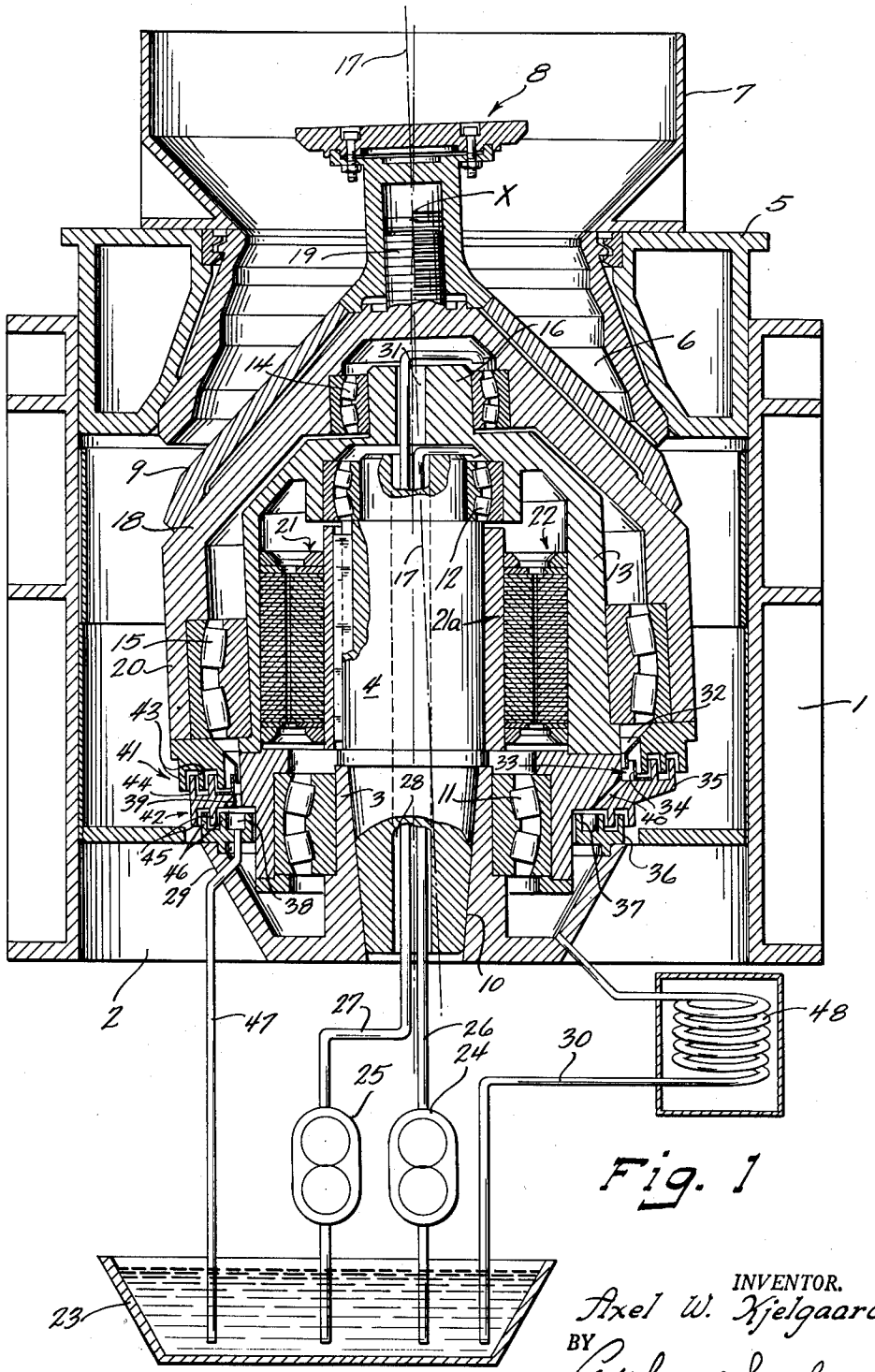

Fig. 1

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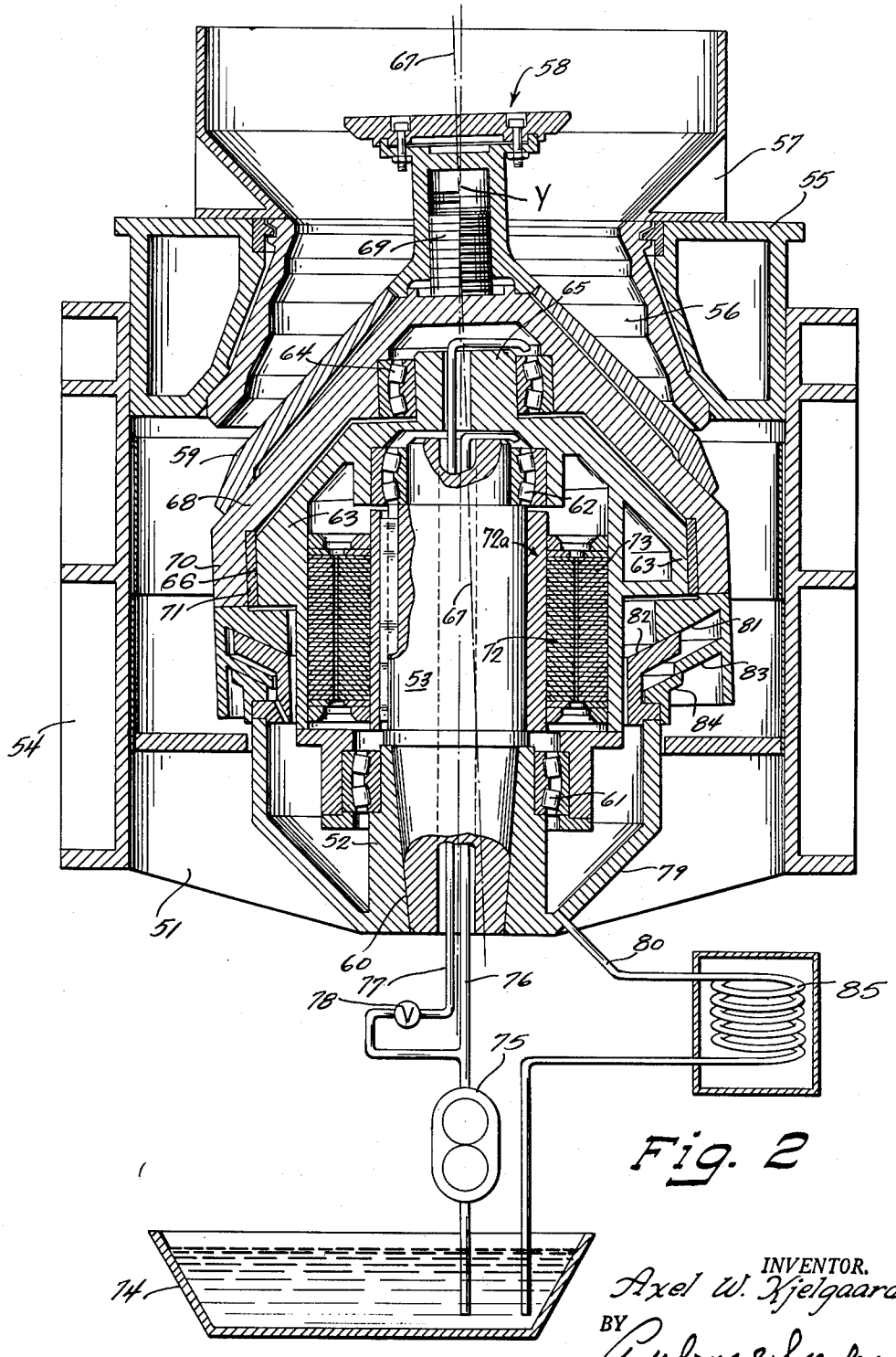

Fig. 2

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GYRATORY CRUSHER

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This invention relates to gyratory stone and ore crushers and particularly to the incorporation of the electric motor for driving the crusher within the movable inner crushing member, and the provision of suitable oiling and cooling of the associated bearings and motor, respectively.

According to the invention the stator of the motor is mounted on and fixed to the vertical stationary column supporting the movable inner crushing member, and the rotor of the motor is carried by a housing which supports the inner member for gyratory movement about the vertical axis of the stator. Separate oiling means extending within the column is provided for the lubrication of the bearings supporting the motor housing and the bearings supporting the crushing member on the motor housing.

An object of the invention is to incorporate electric motor means within the structure of a gyratory crusher to provide a more rugged structure at a cost less than that of the separate crusher and motor.

Another object is to provide an outer rotor to drive the inner crushing member directly.

Another object is to protect more fully the motor against damage.

Another object is to utilize the bearing lubrication and sealing means to protect the motor against damage and overheating.

Another object is to control the lubrication and cooling of the motor separately as required.

Another object is to support the motor housing between widely spaced bearings and the inner crushing member from the housing to utilize the bearing support provided by the housing.

These and other objects and advantages of the invention will be more fully disclosed in the following description of a preferred embodiment of the invention illustrated in the accompanying drawings.

In the drawings:

Figure 1 is a transverse vertical axial section through the crusher and showing the lubrication and cooling means therefor diagrammatically; and

Fig. 2 is a view similar to Fig. 1 showing a similar crusher incorporating an alternate type of bearing and seal for the inner crushing member and showing a modified lubrication and cooling system.

The annular wall 1 forms the outer part of the frame 2 of the crusher shown in Fig. 1. The central hub 3 of frame 2 supports the fixed, vertical column shaft 4 centrally within the wall 1 of the frame 2.

The outer crushing member includes the bowl or concave 5 supported by frame 2 for vertical adjustment by means, not shown, and the concave liner 6. The hopper 7 at the top of the crusher is disposed to receive the material to be crushed and direct the same into the open upper end of the bowl or concave 5. The cap structure 8 gyrates with the inner crushing member which includes the mantle or cone 9 and is adapted to

distribute the material evenly about the mantle 9 and within bowl or concave 5 for crushing.

The gyratory movement of mantle 9 is adapted to crush the material to successively smaller sizes with each revolution about the axis of column 4. The material crushed to the desired maximum size is allowed to fall from betweeen concave liner 6 and mantle 9 to a chute, not shown, within the crusher for discharge.

The lower tapered end of column 4 is seated and fixed within the tapered bore 10 of hub 3 which latter carries the large double-row roller bearing unit 11 coaxially therewith. The roller bearing unit 12 is mounted on the upper end of column 4 and with bearing unit 11 supports the cylindrical motor housing 13 for rotation on the vertical axis of the column.

Housing 13 has an annular external surface disposed eccentrically of fixed shaft 4 and may comprise a number of joined sections for assembly. Housing 13 provides a rigid structure for supporting exteriorly thereof the upper and lower bearing units 14 and 15, respectively. The trunnion 16 formed at the upper end of housing 13 carries the inner race of bearing unit 14 adjacent to and above the upper end of column 4. The lower bearing unit 15 encircles housing 13 and is carried thereby between the bearing units 11 and 12 supporting the housing.

Bearing units 14 and 15 are mounted on the gyratory axis 17 which intersects the vertical axis of column 4 at X near the upper end of mantle 9. The inner crushing member or head 18 supporting mantle 9 is provided with an upstanding threaded stud 19 to receive cap 8 which secures the mantle on head 18. The upper part of head 18 is shaped to support fully the underside of the mantle 9 which is removable therefrom and forms a replaceable crushing surface. The upper end of head 18 is supported by bearing unit 14 which is located immediately beneath stud 19. The skirt portion 20 of head 18 extends downwardly thereof around housing 13 and is supported relative thereto by bearing unit 15. Head 18 is free to rotate about the axis 17 and will gyrate about the point X relative to the axis of shaft 4 when the housing 13 is rotated about the axis of shaft 4 as will be described. This increases and decreases the space between cone 9 and bowl 6 for each revolution thus effecting the crushing of the material to successively smaller size.

The diameter of the inner crushing member comprising mantle 9 and head 18 and the axial disposition of the bearings necessary to the adequate support thereof providing a given capacity, allows the incorporation of the motor elements in the structure of the crusher to novel advantage. According to the invention, the motor stator 21 is mounted on a sleeve 21*a* which is keyed to column 4 between the upper and lower bearing units 11 and 12, respectively, and within housing 13 and the rotor 22 is carried by housing 13 radially and circumferentially of stator 21.

The electrical energizing of the stator by means, not shown, effects rotation of housing 13 on the vertical axis of column 4. When there is no material in the bowl or concave 5 mantle 9 and head 18 are generally free to rotate therein with rotation of housing 13 on bearings 11 and 12. In the operation of the crusher, the material to be crushed in the bowl or concave 5 generally limits such rotation so that a gyratory movement of mantle 9 on a center at the intersection of axis 17 and the vertical axis of column 4 is effected for the crushing of the material by rotation of housing 13 on the latter axis.

The cooling of motor housing 13 and the lubrication of bearings 11, 12, 14 and 15 is effected by the circulation of a supply of oil by means shown diagrammati-

cally and which includes the sump 23 from which the pumps 24 and 25 are supplied with oil for delivery through the respective conduits 26 and 27. Conduit 26 extends upwardly from pump 24 through the central axial bore 28 in column 4 to bearing 12 within housing 13. The excess oil delivered to bearing 12 passes the bearing and flows downwardly into housing 13. The interior of housing 13 is cylindrical respecting its rotational axis, and baffles, not shown, may be employed therein to direct the oil over the rotor and parts of the stator to cool the same. The oil is otherwise allowed to flow by gravity downwardly from the lower end of housing 13 through bearing unit 11.

The annular pan 29 formed with hub 3 is disposed immediately beneath bearing 11 and extends upwardly around the lower end of housing 13. The return line 30 extends from pan 29 to sump 23.

Conduit 27 from pump 25 extends through bore 28 in column 4 and the opening 31 in the upper end of housing 13 to the upper bearing unit 14. The excess oil delivered to bearing 14 drains downwardly therefrom and passes between housing 13 and the inside of head 18 to the lower bearing unit 15.

The ring 32 carried by skirt 20 beneath bearing unit 15 hangs downwardly into the U-shaped channel 33 formed by the flanged ring 34 and the projecting flange portion 35 of housing 13. The U-shaped channel 33 is disposed beneath bearing unit 15 and extends circularly about the axis 17 of the bearing. The annular ring member 36 is mounted on the upper edge of pan member 29 and includes the inner two spaced upstanding circular, concentric flanges 37 which form the annular channel 38. Channel 38 extends about a center on the axis of column 4 and the axis of rotation of housing 13.

A number of discharge passages 39 and 40 formed in flange 35 extend from channel 33 downwardly thereof for draining the channel of the oil received from bearing unit 15. The lower ends of the passages 39 and 40 are equally spaced from the axis of column 4 and immediately above channel 38.

The eccentricity of channel 33 relative to channel 38 requires that the oil will drain through passages 39 and 40 notwithstanding the rotational movement of flange 35 and the passages thereof. The passage 39 shown in Figure 1 from a part of channel 33 near the vertical axis of column 4 extends generally downwardly so that oil flows readily therefrom by gravity. Passage 40 located oppositely of passage 39 respecting axis 17 necessarily extends radially inwardly at an angle so that rotation of housing 13 at sufficiently high speeds, may disallow the flow of oil through the passage.

According to the invention, the ring 32 hanging in channel 33 prevents the oil therein from accelerating to the rotational velocity of flange 35 and housing 13 and the oil from moving to the outer part of channel 33 respecting the axis of column 4 by centrifugal force and spilling out over ring 34. Ring 32 serves to assure the proper draining of channel 33 in the normal operation of the crusher. Passages 39 and 40 may be elongated for greater size and is arcuate respecting the axis of column 4 and axis 17.

The labyrinth seals 41 and 42 are provided respectively between member 18 and flange 35, and between flange 35 and frame 2 and comprise two series of spaced concentric rings closing housing 13 and member 18. The rings 43 extend downwardly from member 18 and the rings 44 extend upwardly from flange 35 to form the seal 41 which closes the lower end of member 18 including channel 33. Rings 43 and 44 are concentric and have an axis coincident with axis 17 to accommodate relative movement between member 18 and housing 13.

Seal 42 includes the rings 45 which extend downwardly from flange 35 and the rings 46 of member 36 which extend upwardly between rings 45 to close the lower end of housing 13 including channel 38 and the bottom collecting pan 29. Rings 45 and 46 are concentric on the axis of column 4 to accommodate the rotation of housing 13 as described.

In the normal operation of the crusher, the relative rotation and gyratory movement of mantle 9 and head 18 is accommodated by seals 41 and 42. In starting the crusher, before admitting material to the bowl or concave 5, mantle 9 and head 18 are free to rotate with housing 13 on the vertical axis of column 4, and the oil delivered to the several bearings supporting the same through conduits 26 and 27 is allowed to spill outwardly and between the rings comprising seals 41 and 42. The rings comprising seals 41 and 42 are closely spaced without contact so that the oil from within and the dust from the atmosphere surrounding the crusher combine to form between the rings a residue which ultimately closes the spaces between the rings. The residue formed is carried by each ring to maintain an effective seal which prevents further dust from reaching the interior of head 18 and housing 13 and the oil which is recirculated therethrough.

As material is admitted to the bowl or concave 5, the rotation of mantle 9 and head 18 on column 4 is reduced to that allowed by the material and simulates a gyrating action corresponding to a wabble or nutation, and the action of ring 32 carried by skirt 20 in channel 33 becomes effective to restrain the further centrifugal action of the oil in channel 33 so that the oil will drain through passages 39 and 40 to channel 38. The return line 47 from channel 38 provides for the draining of channel 38 and the return of the oil to sump 23.

The two separate lubrication means provided allow for the direct temperature control of the motor comprising stator 21 and rotor 22 by cooling or heating of the oil circulating therethrough as provided for by the coils 48 in return line 30.

In the embodiment of the invention shown in Fig. 2, the frame 51 of the crusher includes the hub 52 which supports the vertical column or shaft 53 and the vertical annular frame wall 54. The fixed outer crushing member includes the bowl or concave 55 provided with the liner 56 and carries the hopper 57. The cap assembly 58 and the mantle 59 of the inner crushing member operates to distribute and crush the material within the bowl or concave 55 similarly as the crusher shown in Fig. 1.

Column 53 is fixed at its lower end in the tapered bore 60 of hub 52 which carries the lower bearing 61. The bearing 62 is carried by the upper end of column 53. The motor housing 63 is mounted for rotation on bearings 61 and 62 and the upper bearing unit 64 mounted on the trunnion 65 at the upper end of the housing. The annular external surface of housing 63 is disposed eccentrically of shaft 53. The outer cylindrical friction bearing surface 66 of housing 63 and bearing 64 are disposed on the gyratory axis 67 to support the inner crushing member or head 68 for relative rotation on axis 67. As in the first embodiment, head 68 is free to rotate about the axis 67 and will gyrate about the point Y relative to the axis of shaft 53 when the housing 63 is rotated about the axis of shaft 53 as will be described.

The upper portion of the head 68 carries the crushing mantle 59 and is provided with the stud 69 which carries cap 58 securing mantle 59 on head 68. The lower projecting skirt 70 of head 68 is provided with an inner bearing liner 71 which fits the friction bearing surface 66 of housing 63. The motor stator 72 is mounted within housing 63 on the sleeve 72*a* keyed to column 53 between bearings 61 and 62, and the rotor 73 is carried by and within housing 63 around the stator 72 and when energized rotates housing 63.

The sump 74 provides the supply of oil to the pump 75 which is connected for delivery to conduits 76 and 77. Conduit 76 extends upwardly through column 53 to bearing 62 and conduit 77 extends upwardly through column

53 and the opening formed in the trunnion 65 of head 68 to bearing 64. The valve 78 provided in conduit 77 is provided to control the delivery of oil to the respective bearings in conjunction with the adjusted delivery of pump 75.

The annular pan 79 formed with hub 52 is disposed immediately beneath bearing 61 and extends upwardly around the lower end of housing 13 and the return line 80 is connected thereto to drain the oil from the bottom of pan 79.

In the operation of the crusher, relative movement of mantle 59 on head 68 and housing 63 is provided for by bearings 64 and 66 on the axis 67 to provide the gyratory crushing movement.

The complementary spherical bearing members 81 and 82 are secured respectively to the lower skirt 70 of head 68 and hub 52 to support head 68 and mantle 59 axially for gyratory movement on a center at the intersection of axis 67 and the vertical axis of column 53.

The complementary mating surfaces of bearing members 81 and 82 are lubricated by the oil from conduit 77 which passes through bearing 62 and flows between housing 63 and head 68 to friction bearing 71 and passes the latter bearing. The excess oil is allowed to drain from member 82 and flows directly downwardly into the collecting ring 79 for return to sump 74 through return line 80.

The complementary flanges 83 and 84 are carried respectively by bearing members 81 and 82 exteriorly thereof and engage each other to exclude foreign particles from the exposed portions of bearing 81. The coils 85 formed in return line 80 are provided for either cooling or heating of the oil as required.

In each embodiment of the invention the motor stator carried by the fixed or stationary column is firmly supported and is connected by leads not shown to a suitable source of electrical power. The rotor carried within the housing is fully protected against accidental damage and also against the weather so that the crusher may be mounted out of doors without added protection from the elements.

The size of the head of each crusher is adapted to accommodate the rotor housing and the stator so that a direct drive is provided from a motor inside the head.

The separate lubrication means provided allows for the controlled cooling of the motor comprising the rotor and stator located within the housing and the required lubrication of the inner and outer bearings supporting the head and mantle.

Various embodiments of the invention may be employed within the scope of the following claims.

I claim:

1. In a gyratory crusher including a frame, a vertical fixed shaft within said frame, an outer fixed crushing member carried by said frame, and an inner crushing member operating within said first named member to receive and crush material therebetween; a motor having a stator concentrically mounted on said shaft and a rotor extending around said stator, a motor housing for said stator and rotor and supporting the latter with the outer annular surface of the housing being disposed eccentrically of said shaft, bearing means supporting said housing on said shaft for rotation of the housing on a vertical axis by electrical energizing of the motor, and bearing means carried exteriorly of and by said motor housing and supporting said inner crushing member for rotation on said first named axis freely with said housing when the rotor is energized and for relative rotation on an axis offset from said first named axis.

2. A gyratory crusher comprising a frame, a vertical fixed column within said frame, an outer fixed crushing member carried by said frame, a gyratory crushing member operating within said first named member to receive and crush material therebetween, a motor having a stator concentrically mounted on said column and a rotor extending around said stator, a motor housing for said stator and rotor and supporting the latter with the outer annular surface of the housing being disposed eccentrically of said column, separate inner bearing means above and below said stator and supporting said housing on said column for rotation of the housing on a vertical axis by electrical energizing of the motor, and outer bearing means carried exteriorly of and by said motor housing and supporting said inner crushing member for rotation on said first named axis freely with said housing when the rotor is energized and for relative rotation on an axis offset from said first named axis.

3. A gyratory crusher comprising a frame, a vertical fixed column within said frame, an outer fixed crushing member carried by said frame, a gyratory crushing member operating within said first named member to receive and crush materials therebetween, a motor having a stator concentrically mounted on said column and a rotor extending around said stator, a motor housing for said stator and rotor and supporting the latter with the outer annular surface of the housing being disposed eccentrically of said column, separate inner bearing means above and below said stator and supporting said housing on said column for rotation of the housing on a vertical axis by electrical energizing of the motor, said inner crushing member including a skirt portion extending downwardly thereof and around said housing, and outer bearing means carried exteriorly of and by said motor housing and supporting said inner crushing member for rotation on said first named axis freely with said housing when the rotor is energized and for relative rotation on an axis offset from said first named axis, said outer bearing means including a radial-thrust bearing carried by said housing adjacent to the lowermost of said inner bearing means and supporting the skirt portion of said gyratory crushing member.

4. In a gyratory crusher including a frame, a vertical fixed column within said frame, a fixed outer crushing member carried by said frame, and an inner crushing member operating within said first named member to receive and crush materials therebetween; a motor stator concentrically mounted on said column, a rotor extending around said stator, a motor housing supporting said rotor therein with the outer annular surface of the housing being disposed eccentrically of said column, bearings carried by said column above and below said stator within said housing and supporting said housing on said shaft for rotation of the housing and rotor on a vertical axis by electrical energizing of the motor, bearings carried exteriorly of and by said motor housing and supporting said inner member for rotation on said first named axis freely with said housing when the rotor is energized and for relative rotation on an axis offset from said first named axis, and sealing means between the lower periphery of said inner crushing member and said frame extending circumferentially of said housing to enclose the housing.

5. In a gyratory crusher including a frame, a vertical fixed column within said frame, a fixed outer crushing member carried by said frame, and an inner crushing member operating within said first named member to receive and crush materials therebetween; a motor stator concentrically mounted on said column, a rotor extending around said stator, a motor housing supporting said rotor therein with the outer annular surface of the housing being disposed eccentrically of said column, bearings carried by said column above and below said stator within said housing to support said housing on said column for rotation of the housing and rotor on a vertical axis by electrical energizing of said stator and rotor, bearings carried exteriorly of and by said motor housing and supporting said inner member for rotation on said first named axis freely with said housing when

the rotor is energized and for relative rotation on an axis offset from said first named axis, sealing means between the lower periphery of said inner member and said frame and cooperating therewith to enclose said housing, a first lubricant supply conduit extending upwardly through said column for delivery of lubricant to said first named bearings, and a second lubricant supply conduit extending upwardly through said column and through an opening in the upper end of said housing for delivery of lubricant to said second named bearings.

6. In a gyratory crusher including a frame, a vertical fixed column within said frame, an outer crushing member carried by said frame, and an inner crushing member operating within said first named member to receive and crush material therebetween; a motor stator concentrically mounted on said column, a rotor extending around said stator, a motor housing supporting said rotor therein with the outer annular surface of the housing being disposed eccentrically of said column, bearings carried by said column above and below said stator within said housing to support said housing on said column for rotation of the housing and rotor on a vertical axis by electrical energizing of said stator and rotor, said motor housing supporting said inner crushing member for rotation on said first named axis freely with said housing when the rotor is energized and for relative rotation on an axis offset from said first named axis, sealing means between the lower periphery of said inner member and said frame and cooperating therewith to close the lower end of said housing, a lubricant supply conduit extending upwardly through said column for delivery of lubricant to said first named bearing above the stator, said housing being open interiorly to receive the lubricant passing said first named bearing above said stator and allow the lubricant passage by gravity to said bearing below the stator and to effect cooling of the stator and rotor within the housing.

7. In a gyratory crusher including a frame, a vertical fixed column within said frame, a fixed outer crushing member carried by said frame, and an inner crushing member operating within said bowl to receive and crush materials therebetween; a motor stator mounted on said column, a rotor extending around said stator, a motor housing supporting said rotor therein with the outer annular surface of the housing being disposed eccentrically of said column, bearings carried by said column above and below said stator within said housing to support said housing on said column for rotation of the housing and rotor on a vertical axis by electrical energizing of said stator and rotor, said motor housing supporting said inner member for rotation on said first named axis freely with said housing when the rotor is energized and for relative rotation on an axis offset from said first named axis, a lubricant supply conduit extending upwardly through said column for delivery of lubricant to said first named bearing above said stator, said housing being open interiorly and opening downwardly to receive the lubricant passing said first named bearing above said stator and allow the lubricant passage by gravity to said bearing below the stator for discharge, a collecting ring beneath said lower bearing to receive the oil passing said bearing, and cooling and pumping means connected to said lubricant supply conduit to recirculate the lubricant past said bearings and maintain said rotor and stator within normal operating temperatures.

8. In a gyratory crusher including a frame, a fixed vertical column within said frame, an outer crushing member carried by said frame, and an inner crushing member operating within said first named member to receive and crush materials therebetween; a housing mounted on said column and within said inner member for rotation on a vertical axis with the outer annular surface of the housing being disposed eccentrically of said column, means mounted internally of the housing to drive the housing, spaced bearings carried by said housing exteriorly thereof and rotatably supporting said inner member for relative rotation freely with the housing when the latter is rotated on an axis offset from said vertical axis, a lubricant supply conduit from said frame extending upwardly through said column and housing to the uppermost of said bearings for delivery of lubricant thereto, the lowermost of said bearings being disposed to receive by gravity the lubricant passing from the upper bearings and between the housing and said inner member, a channel collecting ring carried by said housing beneath said lowermost bearing and having a number of discharge passages opening downwardly thereof, said ring extending about the offset axis of said bearings and the lower ends of said discharge passages being equally spaced from the vertical axis of said column, a second collecting ring carried by said frame immediately beneath the lower ends of said discharge passages, and rigid means fixed to said inner member and extending downwardly into said first named collecting ring whereby the normal gyratory movement thereof in the operation of the crusher with limited rotation prevents the radial centrifugal discharge of the oil from said first named ring by rotation thereof with said housing.

9. In a gyratory crusher, a frame, an upright fixed shaft mounted within said frame, a crushing bowl carried by the frame coaxially of the shaft, a driven member cooperating with the bowl to provide a crushing chamber therebetween, dynamo electric means mounted coaxially on the shaft, a driving member surrounding said means with the outer surface thereof disposed eccentrically of the shaft, a second dynamo electric means mounted within the driving member and connected thereto to drive the same when energized by said first named means, and bearing means carried exteriorly of said driving means, said bearing means having an axis intersecting the axis of said shaft and supporting said driven member for free rotation to gyrate said driven member about the driving member when the driving member is rotated.

10. In a gyratory crusher, an annular frame, an upright fixed shaft mounted centrally within the frame, a crushing bowl carried by the frame coaxially of the shaft, a cone cooperating with the bowl to provide a crushing chamber, an electric motor having a stator mounted centrally upon the fixed shaft and also having a rotor surrounding the stator and provided with a housing having an annular external surface disposed eccentrically of said shaft, bearing means rotatably supporting the housing upon the shaft, and other bearing means between said cone and said external housing surface and disposed to support the cone for gyration relative to the bowl whenever the motor is operated.

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